International Committee on Global Geological and Environmental Change "GEOCHANGE" *(Munich, Germany)*
Ondokuz Mayıs University *(Samsun, Turkey)*
Halberg Chronobiology Center *(Minneapolis, USA)*
International Academy of Science H&E *(Innsbruck, Austria)*
Russian Academy of Sciences *(Moscow, Russia)*
Pakistan Academy of Sciences *(Islamabad, Pakistan)*
World Organization for Scientific Cooperation *(Munich, Germany)*
SETAC Chemistry and Industry *(Istanbul, Turkey)*
Global Network for the Forecasting of Earthquakes *(GNFE, UK, London)*

PROCEEDINGS

Natural Cataclysms and Global Problems of the Modern Civilization

WORLD FORUM – INTERNATIONAL CONGRESS

September 19-21, 2011 – Istanbul, Turkey

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PLENARY SPEECHES

GLOBAL GEOLOGICAL AND ENVIRONMENTAL CHANGE: THREATENING THE STABLE DEVELOPMENT OF CIVILIZATION

Prof. Dr. Elchin Khalilov
Chairman of World Forum – International Congress GEOCATACLYSM-2011,
Chairman of International Committee GEOCHANGE (Munich, Germany)

The time has come when accumulated earth science data make it possible to take a deeper look into the nature's global changes, and reconsider their extent and their role in the sustainable development of civilization. Many world scientists realize that not only do these changes affect the climate, but they have an impact on virtually the entire volume of the Earth, from its core to the atmosphere and magnetosphere.

Global Changes of the Environment, "GEOCHANGE", mean natural, planet-wide changes in nature, influenced by endogenous, exogenous and cosmic factors occurring within the solar system and having negative implications for the sustainable development of humankind.

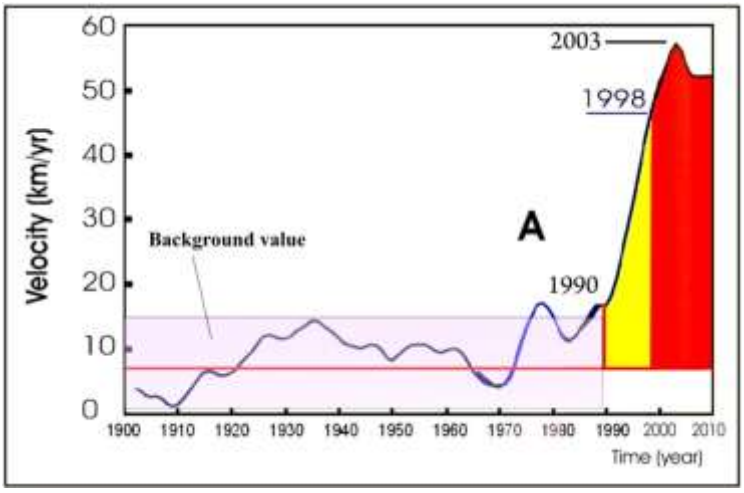
This summarizing scientific work by IC GCGE "GEOCHANGE" is our attempt to demonstrate the extent of these processes and how they influence the development of humankind. Those processes may destabilize the progress of civilization unless some preemptive and effective joint action is taken by the international community to ensure the maximum possible reduction in the number of casualties and economic damage caused by natural disasters.

The conclusions drawn on the basis of the research are as follows:

1. Magnetic poles' drift acceleration

The explosive, more than fivefold growth of the North Magnetic Pole's drift rate from 1990 to the present has been accompanied by a significant increase in Earth's endogenous activity. In 1998, the North Magnetic Pole's drift rate approached its maximum value.

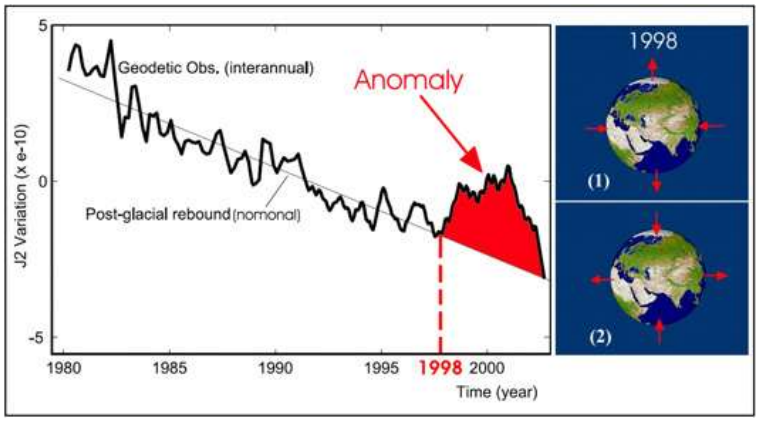
From roughly 1998 on, there has been observed a sharp increase in the number of large earthquakes and earthquake fatalities, of volcanic eruptions and tsunamis (catastrophic, medium-sized and weak).



Graph of velocity of North Geomagnetic Pole movement (N. Olsen and M. Mandea, 2007)

2. Anomalous J_2 coefficient change

1998 saw the beginning of abnormal changes in some of Earth's geophysical parameters, a leap in J_2 coefficient values in particular. This coefficient is determined using measurements made by the laser ranging system from US satellites.



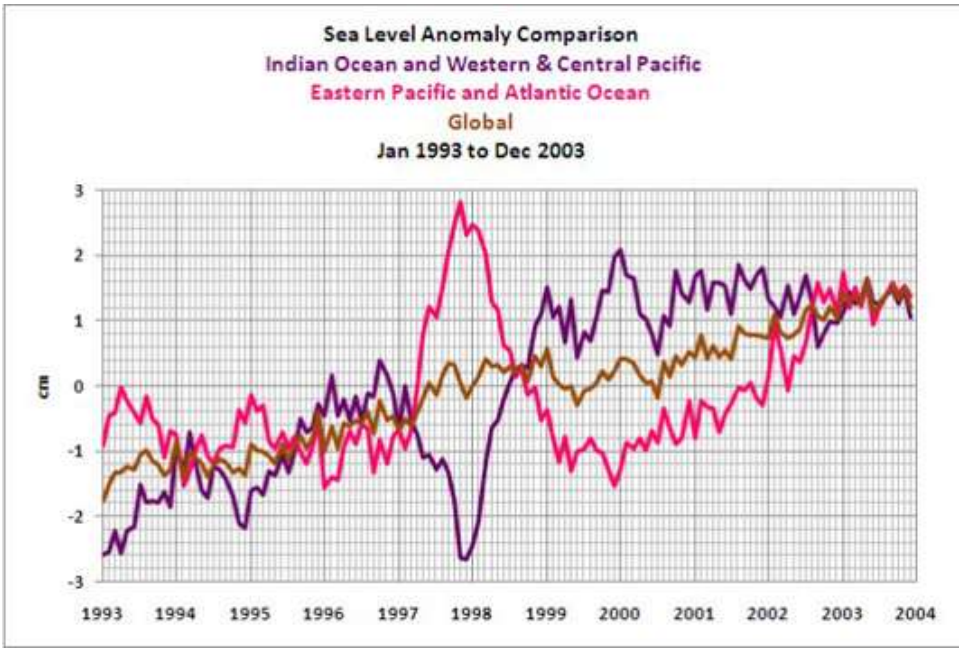
Variations of J_2 coefficient values according to C. Cox and B. F. Chao, 2002

The J_2 coefficient demonstrates the dynamics of the ratio between Earth's equatorial and polar radii. According to NASA, the J_2 coefficient had been decreasing for many years supposedly due to the release of meltwater from the mantle since the ice age. This was indicative of an increase in Earth's radius at the poles and its reduction at the equator. Meanwhile, new data show that since 1998 the J_2 coefficient began to grow. This process reflects the global redistribution of Earth's masses, as well as Earth's expansion at the equator and its flattening at the poles. Thus, some global-scale event is thought to have occurred in 1998; this could mean both global redistribution of Earth' masses and minor changes of its shape.

3. Global sea level change

During the period between 1997 and 1999, sea level fluctuations of the Indian Ocean, Western and Central Pacific were in antiphase to fluctuations of the Eastern Pacific and Atlantic

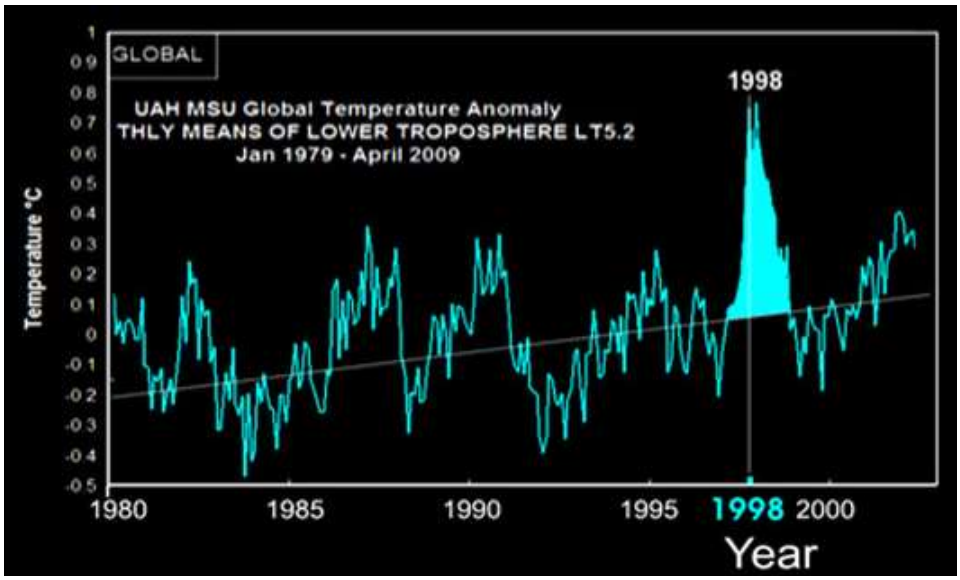
Ocean. While the level of the Eastern Pacific and Atlantic Ocean began to rise sharply from 1997 with a peak in 1998 (about 3 cm), the level of the Indian Ocean, Western and Central Pacific was falling with a 1998 minimum (about 3 cm). The timing of these processes coincided with the J_2 coefficient anomaly. Meanwhile, an article by B. F. Chao and others (B.F. Chao et al., 2003) indicates that even considering the model of possible impact of the redistribution of water masses in the world ocean, the actually observed effect of the J_2 coefficient is 3 times greater than those influences.



Comparison of graphs for sea level fluctuations of Indian Ocean and Western & Central Pacific with those of Eastern Pacific and Atlantic Ocean, as well as overall graph for global sea level fluctuations

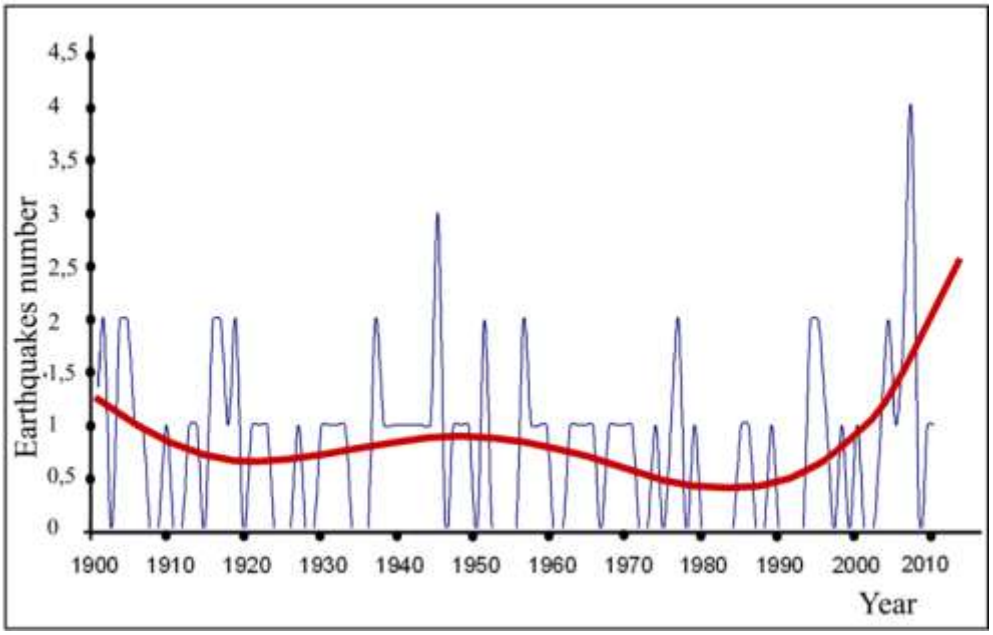
4. Global tropospheric temperature change

An anomalous, explosive growth of the global tropospheric temperature was observed in 1998.



5. Large earthquakes

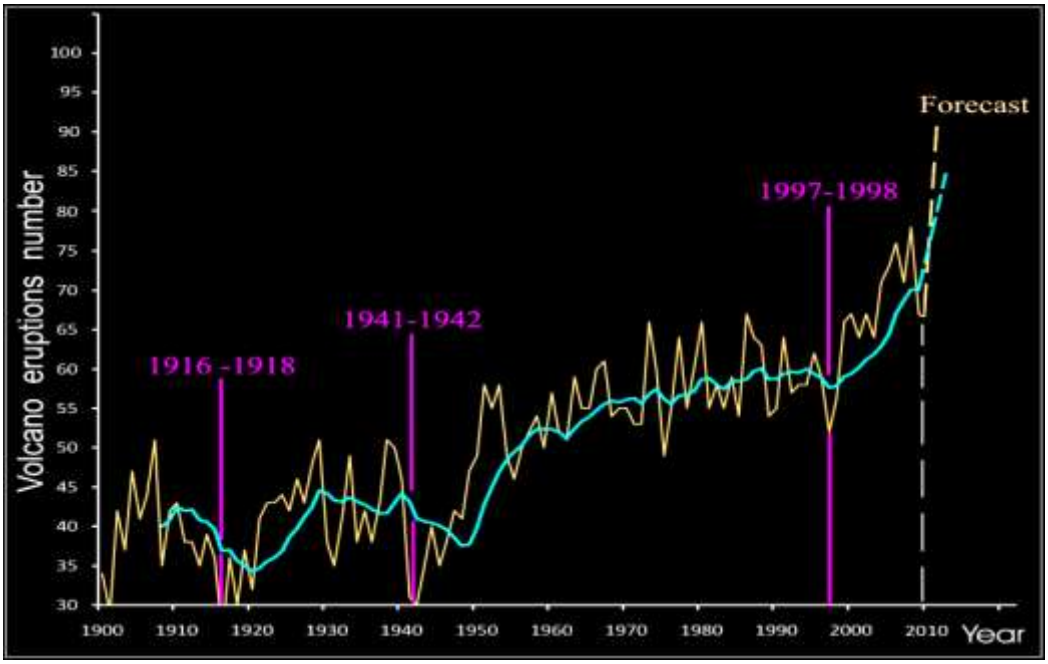
A comparative analysis of anomalous J_2 variations and the dynamics of numbers of large M> 8 earthquakes between 1980 and May 2010 has revealed that starting from 1997-1999, there has been a surge in the number of large earthquakes and fatalities caused by them according to the exponential law.



Graph for M>8 earthquakes

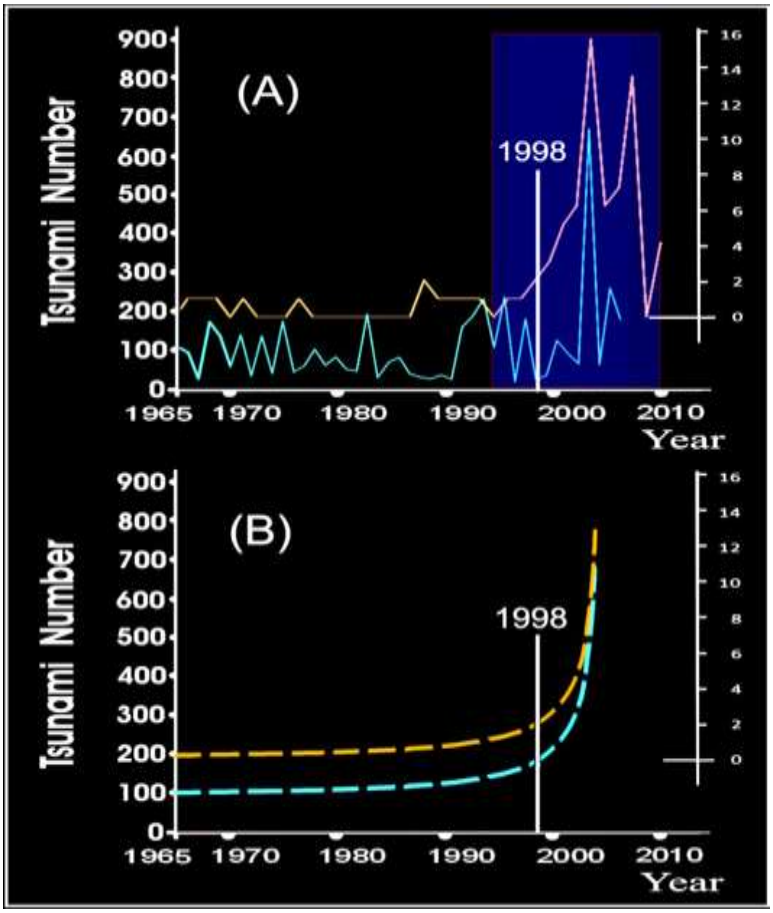
6. Volcanic eruptions

A comparative analysis of volcanic eruptions and J_2 variations has also showed that 1997-1998 were years of deep minimum of volcanic activity, followed by a sharp increase in volcanic activity observed to date.



7. Tsunamis

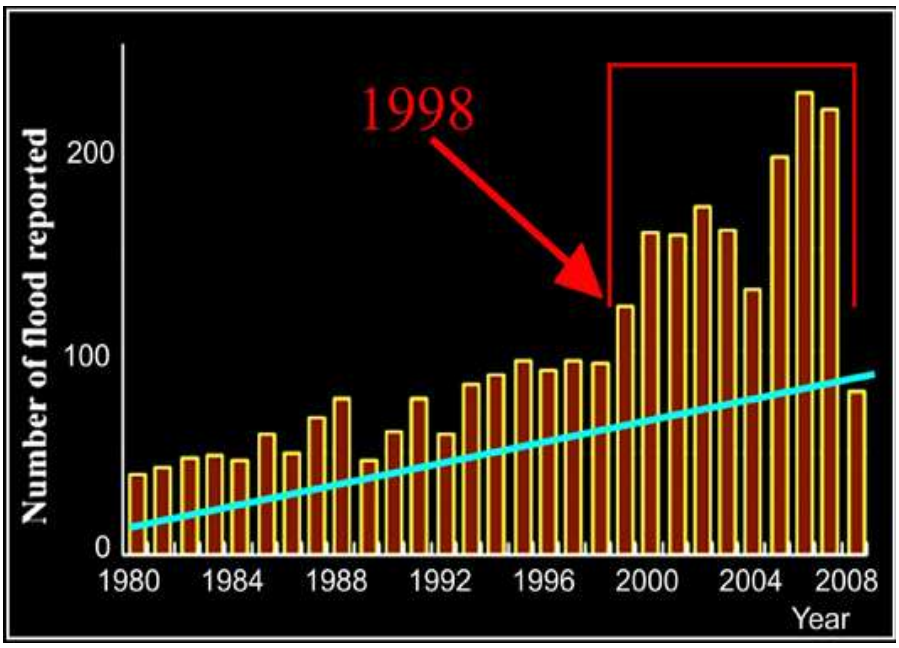
Since 1998, there has been observed a dramatic change in the tendency for statistical distribution of the annual numbers of catastrophic, medium-sized and weak tsunamis. The "leap" in the annual tsunami number statistics, witnessed since 1998 is described by exponential trends.



Graphs showing evolution of tsunami numbers between 1965 and 2010.
Y-axis: on the left - the number of medium-sized and weak tsunamis, on the right – the number of catastrophic tsunamis.(A) graphs show evolution of annual tsunami numbers; Catastrophic tsunamis graph is marked in yellow; weak and medium-sized tsunamis graph is marked in blue; (B) graphs show exponential trends of evolution of annual tsunami numbers. Catastrophic tsunamis trend is marked in yellow; medium-sized and weak tsunamis trend is marked in blue.

8. Floods

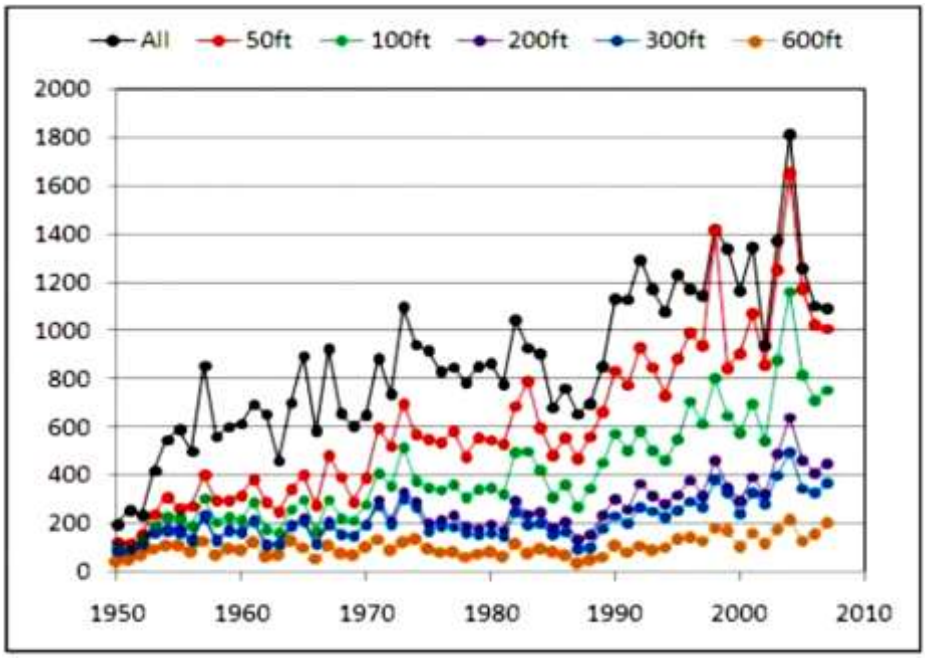
Analysis of the evolution of numbers of severe U.S. floods over the past 100 years makes it possible to conclude that there has been a substantial increase in this indicator since 1998. Studying the dynamics of the numbers of worldwide flood notifications from 2002 to late May, 2010 (according to the Global Flood Detection System, an experimental system aimed at providing flood disaster alerts) has shown a steady increase in the number of floods since 2005. Meanwhile, comparing the number of seasonal floods from 2005 to May 2010 (from February to late May) for the same period in previous years indicates some constant increase in the number of seasonal floods from year to year. In particular, the number of worldwide flood notifications received for the period between February 2010 and late May 2010 is more than 2,5 times higher than the figures for the same periods from 2002 to 2006 inclusive.



U.S. flood statistics from 1980 to 2008

9. Tornadoes

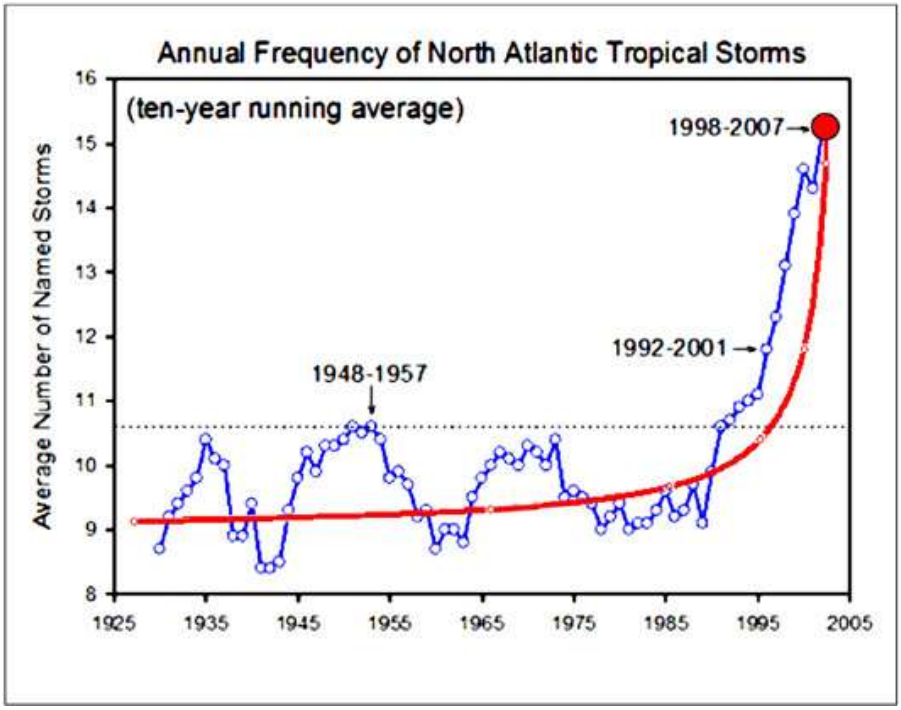
Germany has been given as an example of a sharp increase in the number of tornadoes since 1998. There were 2,5 times more tornadoes in Germany for 5 years (between 2000 and 2005) than over the preceding ten years. A similar situation can be observed in the U.S.



Graphs for U.S. all-class tornado activity between 1950 and 2007

10. Hurricanes and storms

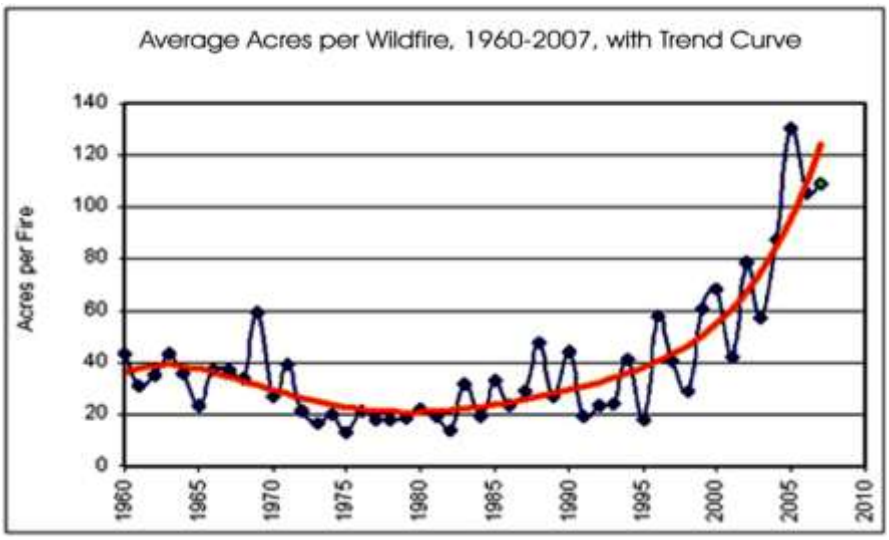
A surge was observed between 1998 and 2007 in the number of North Atlantic tropical storms, and this tendency continues today. An increase in the total number of Atlantic Basin hurricanes from 1944 to the present is observed as well.



Graph for numbers of North Atlantic tropical storms between 1925 and 2007
North Atlantic storms graph is marked in blue; Exponential trend is marked in red

11. Forest fires

The dynamics of the annual numbers of U.S. forest fires from 1960 to 2007 reveals their tendency to grow, with the "surge" beginning in 1998 as well. A similar pattern in the dynamics of forest fire statistics is observed in other regions of Earth.



Annual rates of average fire-affected area in U.S. between 1960 and 2007
(According to U.S. National Interagency Fire Center*)*

For instance, Kazakhstan in 1997 witnessed a "surge" in the form of a sharp increase in the number of forest fires and fire-affected areas. As for the territory of Eastern and Western Europe and the CIS, there is a tendency for the annual numbers of forest fires to soar as well, with the

general nature of their dynamics described by an exponential trend. Around 1998, there was observed a "surge" in the number of forest fires.

12. The role of natural factors in global climate change:

- The role of Earth's volcanic activity in global climate change is significantly higher than suggested in IPCC reports.

- Increased degassing of the mantle during the periods of intensification of Earth's endogenous activity can be one of the main factors causing global temperature changes. This process occurs as a result of the following: growing number of volcanic eruptions; increased seismic activity and higher rate of gases entering the atmosphere through deep faults in the crust; deep gases penetrating into the world ocean and subsequently the atmosphere as a result of intensification of the spreading processes. All this ought to result in higher amount of greenhouse gases released from the mantle into the atmosphere.

- An important role in climate change is attributed to global changes in the parameters of the geomagnetic field and magnetosphere; this refers in particular to the more than 500% increase in the North Magnetic Pole's drift rate and reduction of the geomagnetic field intensity. Today, the impact of magnetospheric processes on Earth's climate is considered a proven scientific fact.

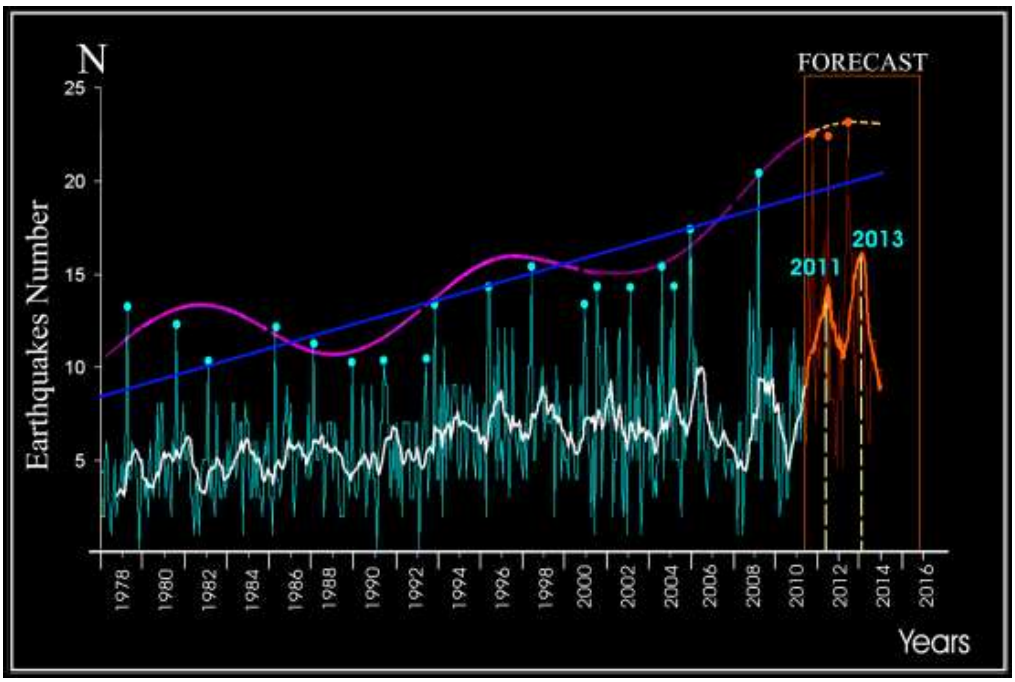
- Global climate change is also affected by solar activity, solar constant variations (flux of solar radiation) in particular, which is also a proven scientific fact.

As a result of the studies conducted, a conclusion has been drawn about the beginning of the so-called global "energy spike" in our planet's energy manifesting itself across all its strata: the lithosphere, hydrosphere, atmosphere and magnetosphere. The starting point for the global "energy spike" is roughly 1998. The global "energy spike" is explicitly reflected in the soaring statistical indicators for the vast majority of natural disasters most dangerous to humanity: earthquakes, volcanic eruptions, tsunamis, tornadoes, hurricanes, storms, floods and forest fires.

POSSIBLE FORECASTS OF SOME NATURAL CATACLYSMS AND COSMIC PROCESSES

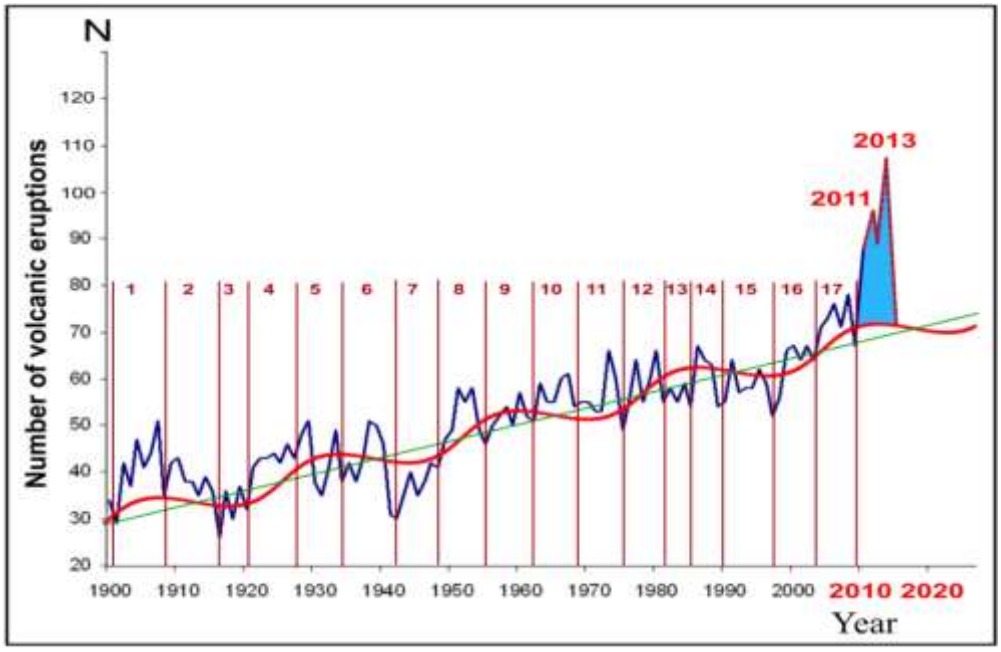
The first IC GEOCHANGE GCGE report can hardly be called complete without this appendix. The analysis conducted on the dynamics of statistics of many natural hazards, geophysical and cosmic parameters has showed their tendency to increase substantially since about 1998. However, it is obvious that the main point of this study is not about a formal statement of facts but rather in a possible prediction of future events.

Not only must we demonstrate the evolution of the dynamics of the number and scale of natural disasters, but we must also suggest possible patterns of future development of events, that is, provide a long-term forecast for Earth's most dangerous hazards. This section does not address other types of disasters, which is planned for the next IC GCGE reports. Attitude to the problem of forecasting natural disasters may be disputable; therefore this section is not included in the basic contents of the first IC GCGE report, being instead given as a special Appendix 1.



Graph for monthly numbers of M> 6,5 earthquakes between 1976 and 2010 forecasted until 2015 by highlighting sinusoidal trend (by E.N.Khalilov, 2010, according to USGS data)

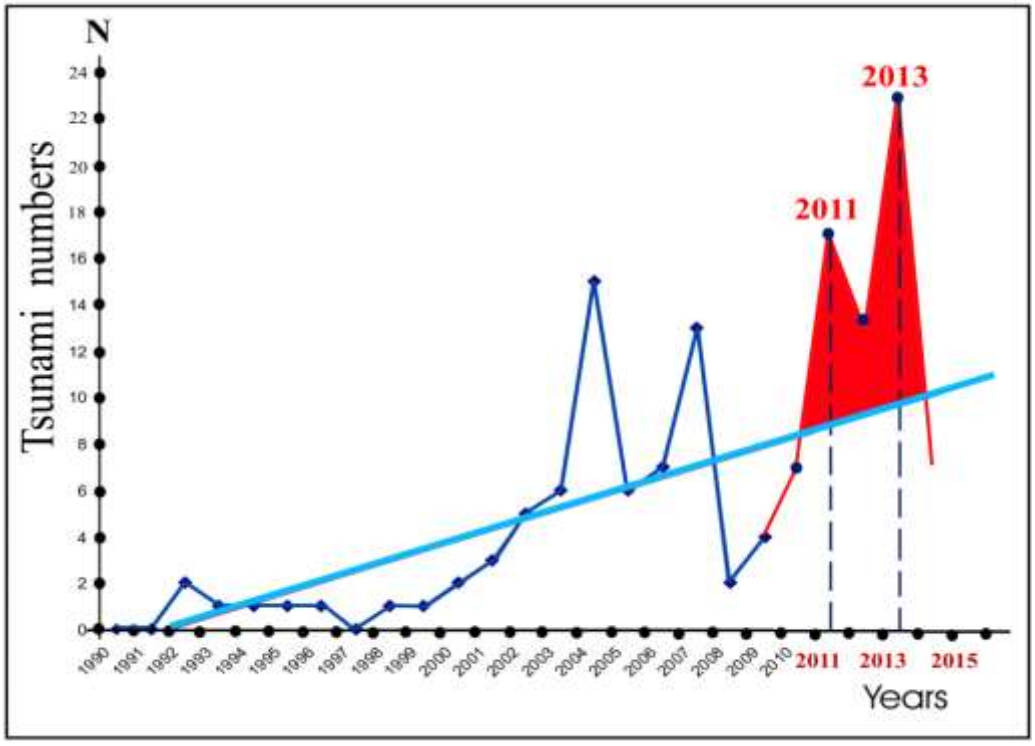
Graph for monthly earthquake figures is marked in light blue; sinusoidal trend enveloping highest peaks of monthly earthquake figures is marked in purple; number of earthquakes graph smoothed with 11-month averages is marked in white; straight-line trend is marked in dark blue; projected segment of seismic activity graph is marked in orange.



Graph for annual numbers of world's volcanic eruptions between 1900 and 2009 forecasted until 2020 (by E.N.Khalilov, 2010, according to Global Volcanism Program)

Graph for annual volcanic eruption numbers is marked in blue; sinusoidal trend is marked in red; straight-line trend is marked in green; 1-17 are cycles of volcanic activity.

We are not trying to predict specific events since it is too complicated and controversial an issue. Our objective is long-term forecasting of changes in the next decade's dynamics of global seismic and volcanic activity and tsunami manifestations. Tsunamis typically result from seismic and volcanic activity except for rare cases when they may be caused by other geological processes.



Graph for tsunami numbers between 1900 and 2010 (by E.N.Khalilov, 2010, according to ITIC – International Tsunami Information Centre data)

Tsunami numbers graph is marked in darker blue; straight-line trend is marked in lighter blue; forecasted graph for 2010-2015 tsunami numbers is marked in red.

In producing long-term forecasts, we have been relying on the well-known principle which long-term forecasts in all areas of science are based on. The principle is as follows: "To look into the future, one must study the past well".

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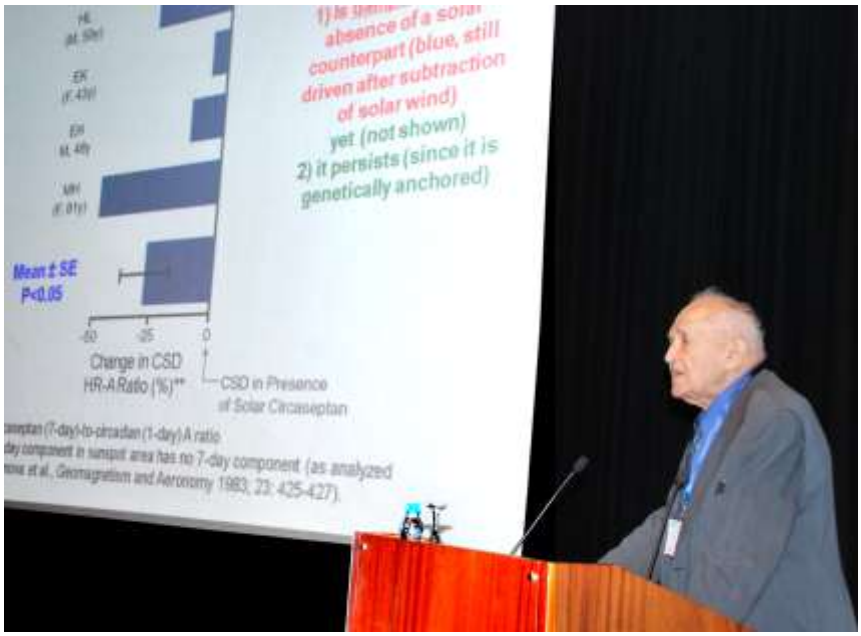
1. *Khalilov E.N.* Global changes of the environment: threatening the progress of civilization [First report of the International Committee GEOCHANGE, 30.06.2010]. International Scientific Journal: GEOCHANGE: Problems of global changes of the geological environment, Volume 1, 2010, SWB, London-Munich, pp.54-220, ISBN 978-9952-451-11-5, ISSN 2218-5798

AVOID PERSONAL, SOCIAL AND NATURAL CATACLYSMS BY TRANSDISCIPLINARY MONITORING AND INTERNATIONAL MULTILINGUAL WEBSITE

Prof. Dr. Franz Halberg,

Germaine Cornélissen, Larry A. Beaty, Yoshihiko Watanabe, Kuniaki Otsuka, George Katinas, Othild Schwartzkopff, Karl Hecht, Jinyi Wu, Ram Bahadur Singh & Abdullah al-Abdulgader

Presented with Vera Brandes and Dieter Broers for the project on The BIOsphere and the COSmos, BIOCOS



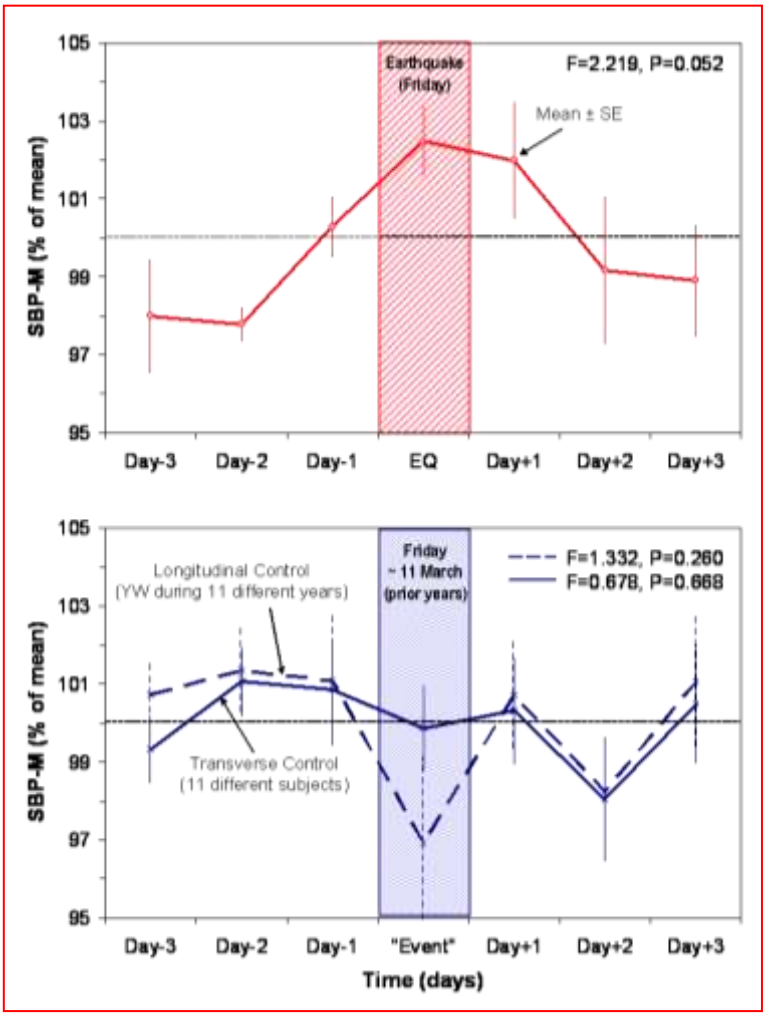
Prof. Dr. Franz Halberg – Honorary Chairman of the World Forum "GEOCATACLYSM-2011", Honorary Director of the Halberg Chronobiology Center (Minneapolis, US)

Dear Mr. Chairman, dear forum participants,

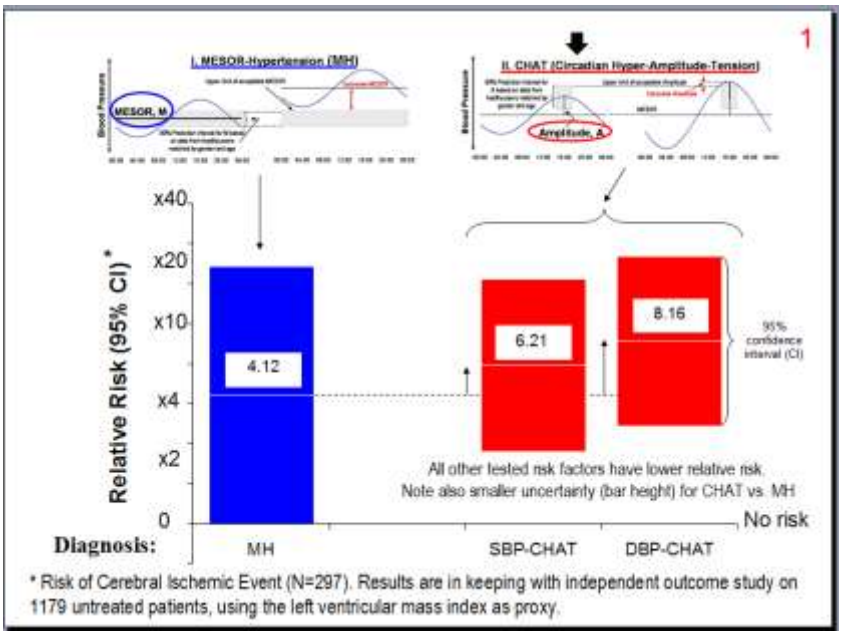
Dr. Yoshihiko Watanabe, who will present his data at this meeting, monitors the blood pressure of some of his patients for 7 days or longer. Thus, he happened to have data bracketing the time of the magnitude 9 Sendai earthquake on May 11, 2011. He found an increase in blood pressure average for 2 days preceding the quake and on the day of the quake. An introductory slide marks the difference between his patients in red and controls from a different corresponding calendar time in blue.

We thank Elchin KHALILOV for this opportunity to indicate how data showing antecedents of an earthquake are needed to avoid an incapacitating brain attack that can leave a person immobilized, unable to care for him/herself, and thus also learn about other natural and human-made cataclysms.

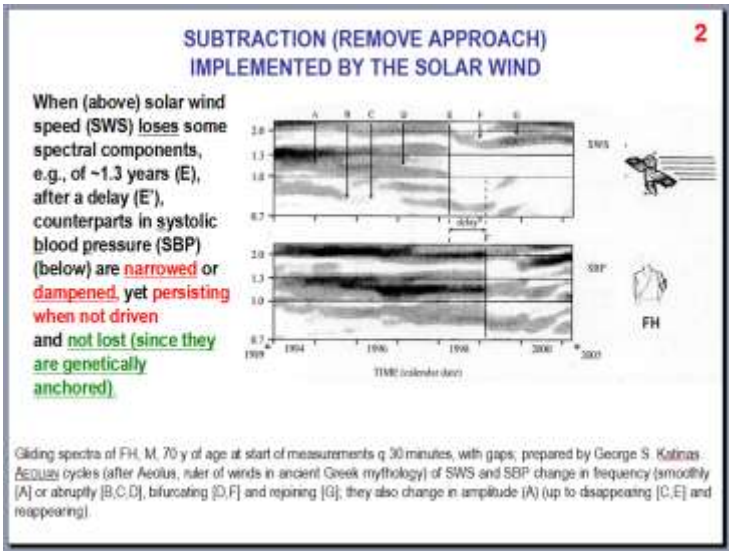
Avoiding a high blood pressure is a step in the right direction, since it is a high risk of severe disease. Chronobiologically interpreted ambulatory blood pressure (BP) and heart rate (HR) monitoring (C-ABPM) renders the diagnosis of MESOR-hypertension more reliable and detects otherwise undiagnosed risks of severe diseases such as a daily overswing, CHAT, that can occur with or without an elevation of the BP-mean, as seen in Figure 1.



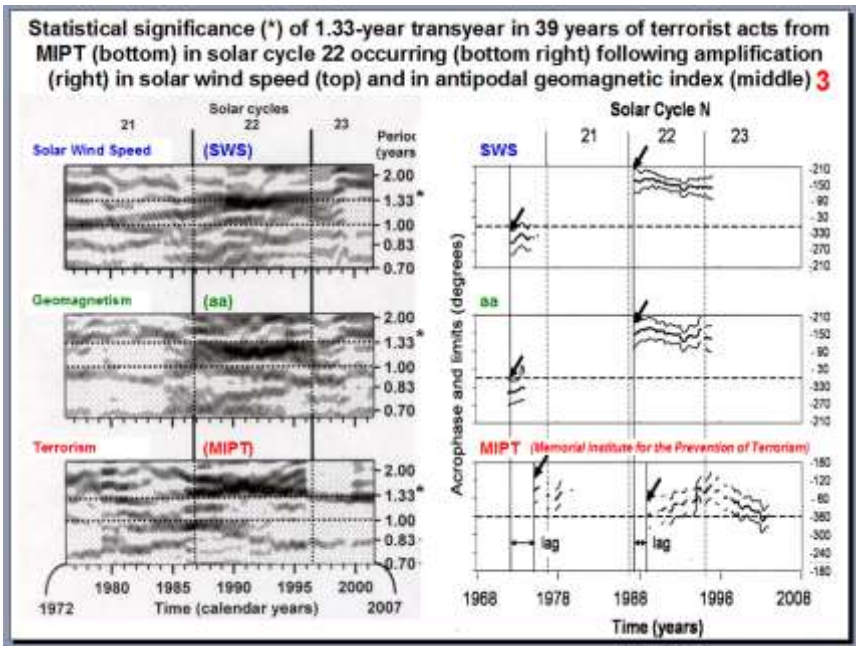
Human systolic blood pressure bracketing Mag. 9.0 Sendai earthquake (11 May 2011)



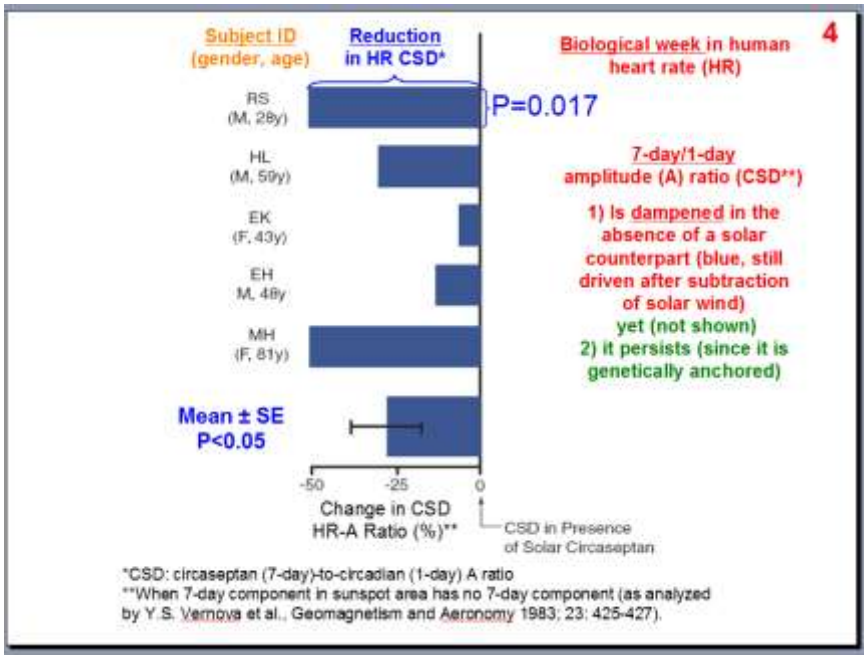
To detect these two separate (and other) vascular variability anomalies, VVAs, or disorders, VVDs, one measures BP & HR automatically half-hourly around the clock for at least 7 days or preferably automatically and continuously for a lifetime, for self-help in health care and to detect circadian and longer cycles, as shown in Figure 2. The bottom half of Figure 2 shows analyses of systolic BP (SBP) from 1989 in the language of cycles' frequencies between 2 and 0.7 years (y) on the ordinate. On the abscissa is time. In the top half, again between 2 and 0.7 year, SWS, the solar wind's speed (recorded by satellites), has a real black (prominent) component at about 16 months (1.3 years), a transyear. But at E, this transyear band is no longer detected. With a lag at E', the corresponding frequency band in SBP **has narrowed, is less black than before**, **has dampened, but continues.** The frequencies of solar wind speed, that still drive us, are built-into us and persist in the absence of a counterpart in SWS.



The left side of Figure 3 shows a correspondence of frequencies in time in solar wind speed (top), geomagnetism (middle) and terrorism (bottom). A prominent amplitude, in black, coincides in timing and frequency in the 3 variables. On the right (as seen from peaks in the best-fitting cosine's acrophases, bracketted by their 95% confidence intervals), when the 1.3-year frequency becomes significant in SWS and aa, again with a lag, terrorism also becomes intensified at that frequency and persists when the environment loses that frequency.



In Figure 4, the weekly component of heart rate is reduced but not eliminated when the sunspot area has no about 7-day component, another example mapped by a remove and replace approach, where the removal and/or replacement is done by the sun in Figure 4 for the biological week, in Figures 2 and 3 for the transyear.



A man responds to environmental cycles by the criterion of the number of shared frequencies. The reference standard is the association of solar activity and geomagnetism in blue on Figure 5. In red, the mood of a man, tested around the clock for > 43 years, shares numerically more frequencies with either the solar wind speed or with geomagnetism (red columns, right) than do the solar wind and geomagnetism with each other (blue). Systolic blood pressure monitoring is a proxy (in green) for the relation of mental functions to the environmental frequencies.

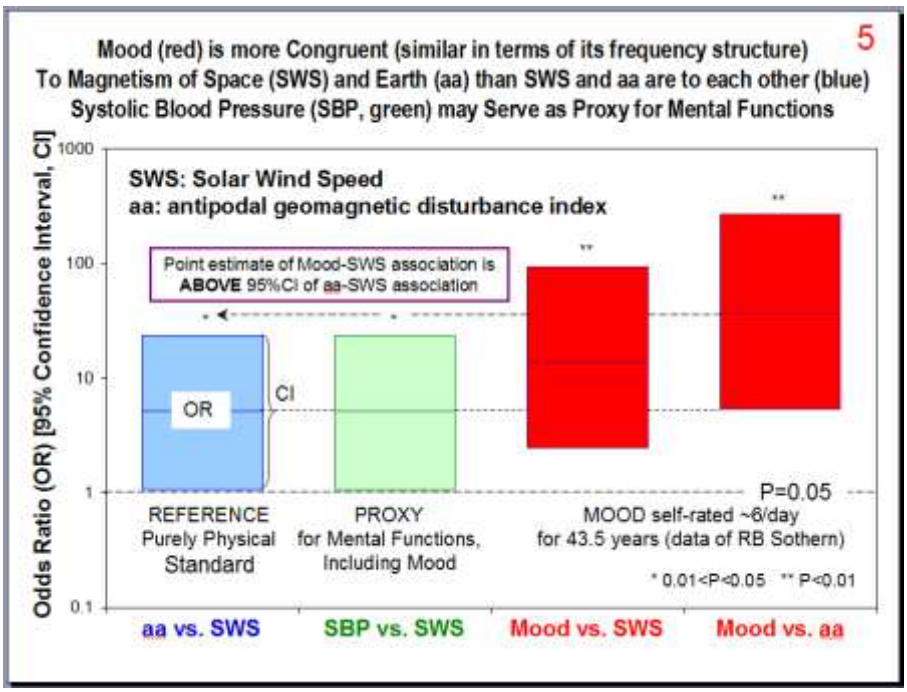
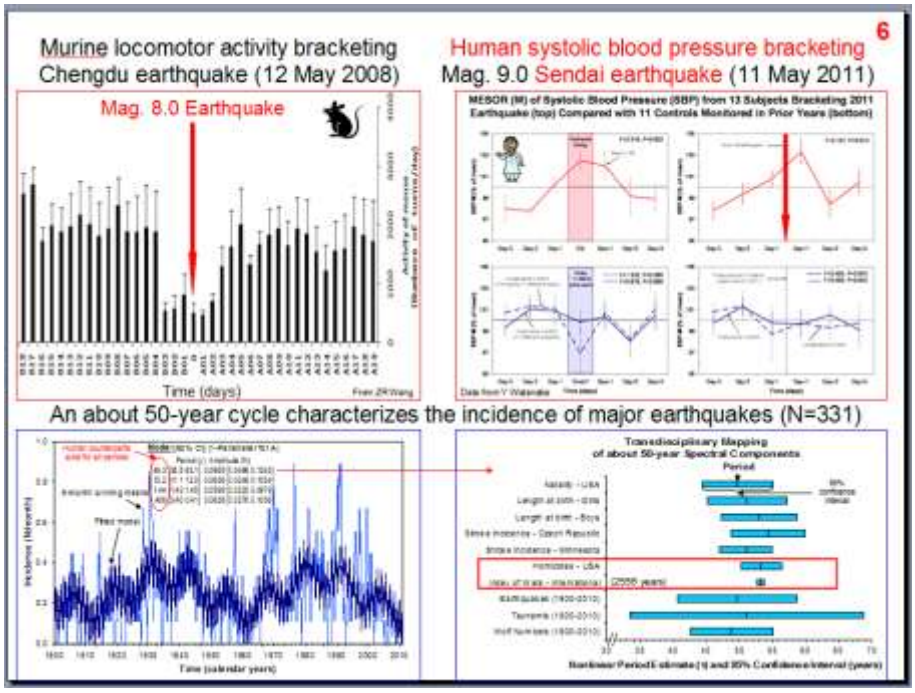
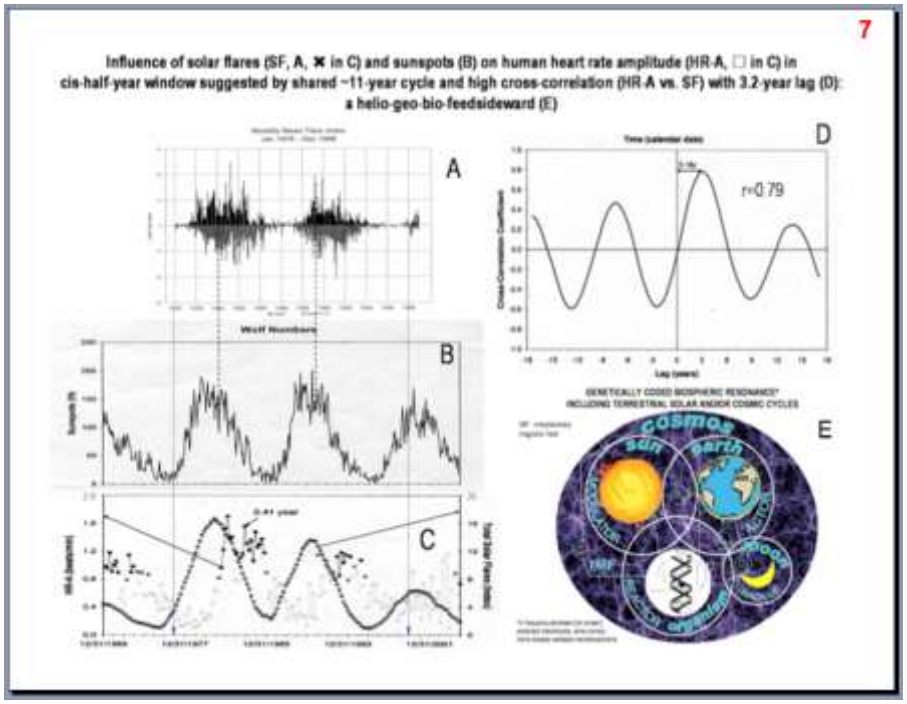


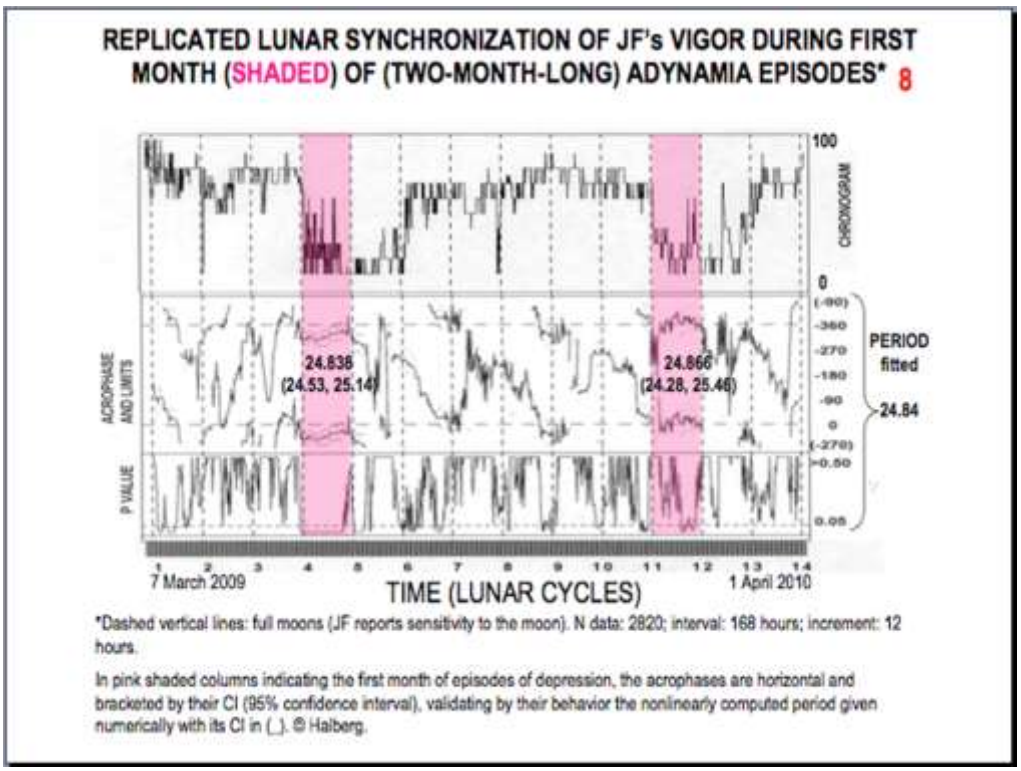
Figure 6 takes us to single earthquakes on top and to many below. In the mouse, in the upper left on top, the 2008 earthquake in China (magnitude 8) had antecedents in rodent activity. On the top right, Dr. Watanabe's data recall an increase in BP before the Sendai earthquake on 3 days preceding it, not found below in blue, in controls of different kinds. The section on the lower left shows mirror-images in frequencies of what the sun does to us, seen in the incidence of the last 331 major earthquakes, sharing part of a transdisciplinary spectrum. The section on the lower right reveals the earthquakes' ~50-year cycle in human affairs, ranging from natality to crime and war.

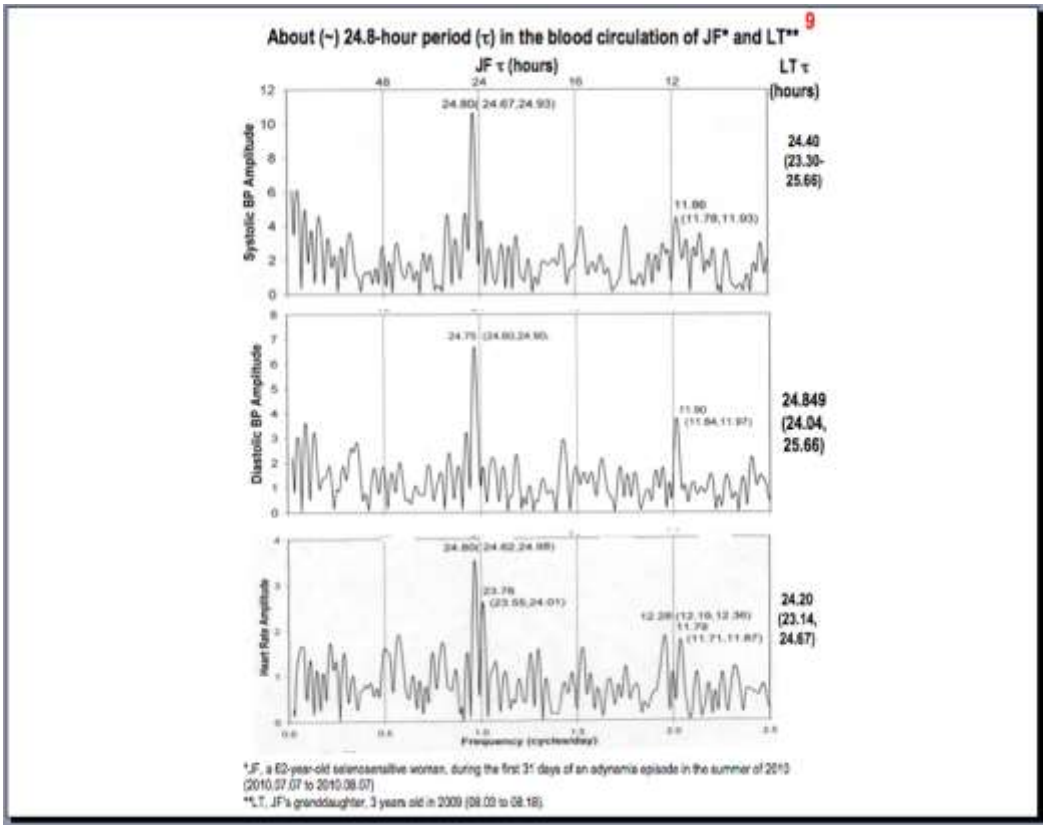


On the left of Figure 7, we find a modulation by solar flares (A) & by sunspots of an ~0.41-year-cis-half-year (C) which gains (black circles) or loses (open circles) statistical significance in human heart rate with an ~3.2-year lag (top right), while the bottom right introduces the moon, as documented in Figures 8-11.



The lunar effect is seen in the period or frequency domain in Figures 8-10 and in the sensitive phase domain in Figure 11. It started with the double tidal period of 24.8 hours in the first two consecutive months of the self-rated vigor of JF, who reported half-yearly downtimes for the prior 20 years, as shown in Figure 8. Figure 9 shows the 24.8-h period dominating the spectra of JF's circulation, and Figure 10 shows multiple periods in JF's endocrine system, the result of a tug-of-war among multiple periods shown to coexist in data intervals as short as 20 days.





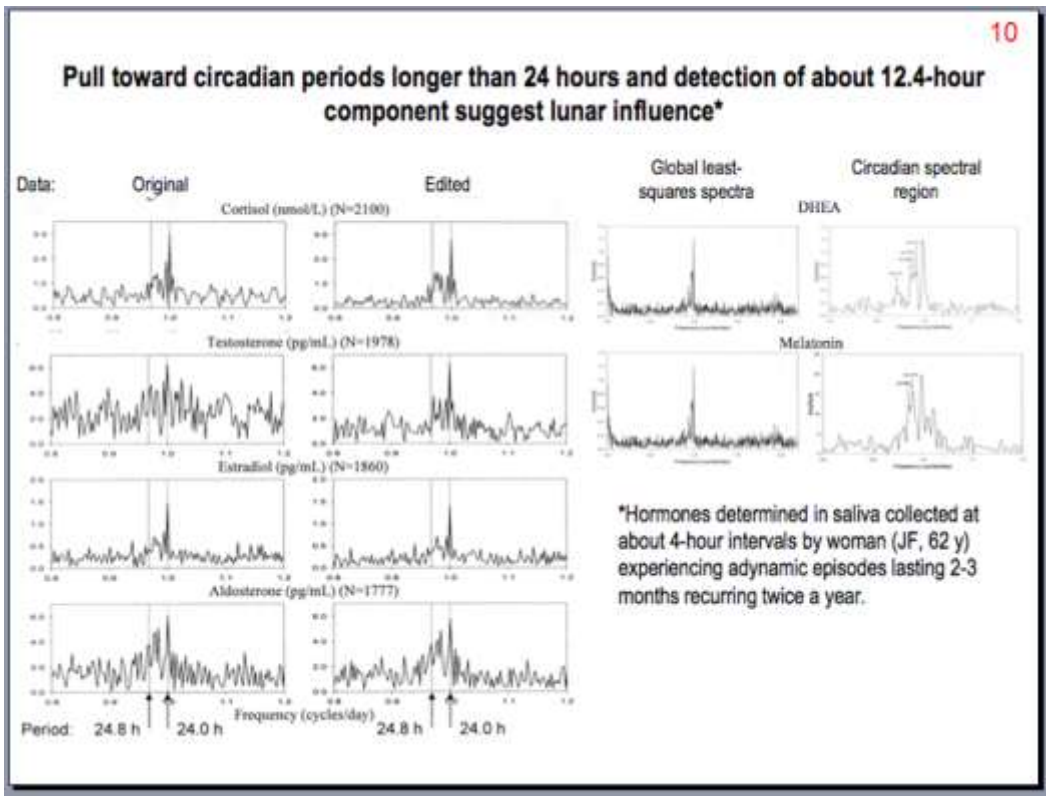
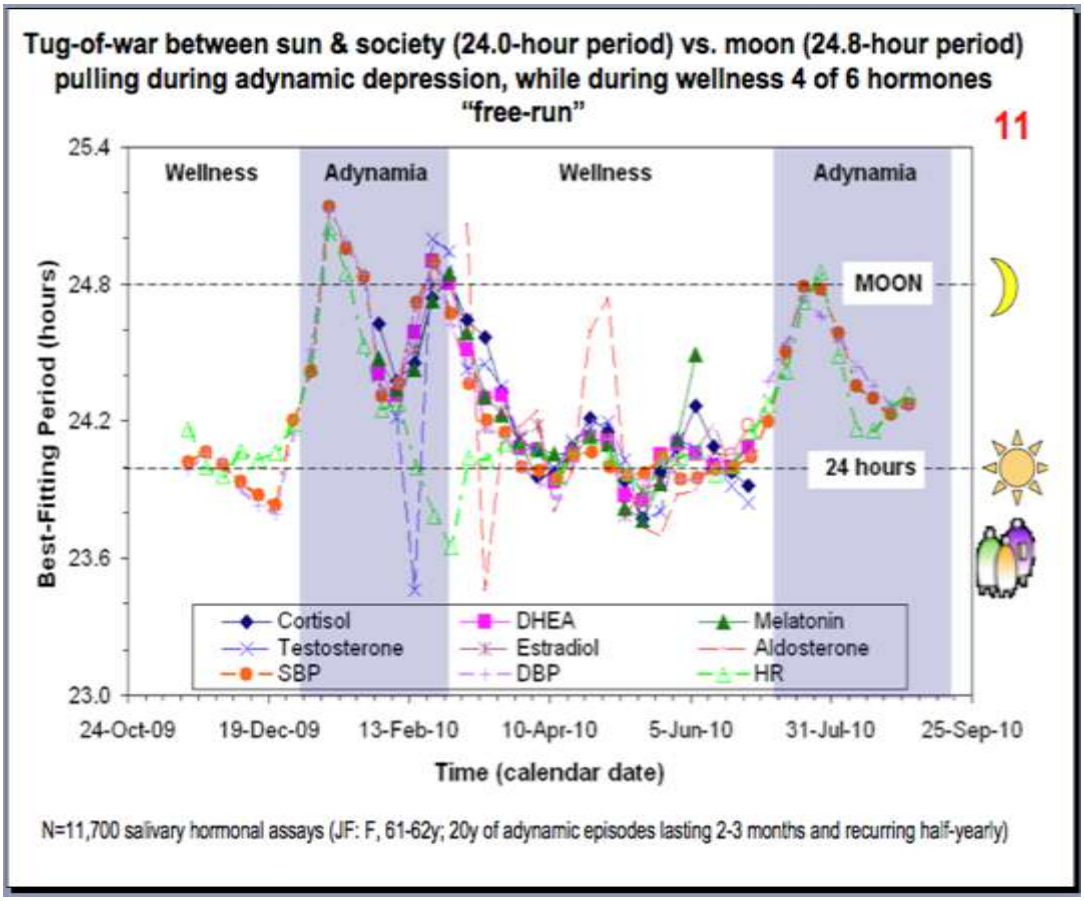
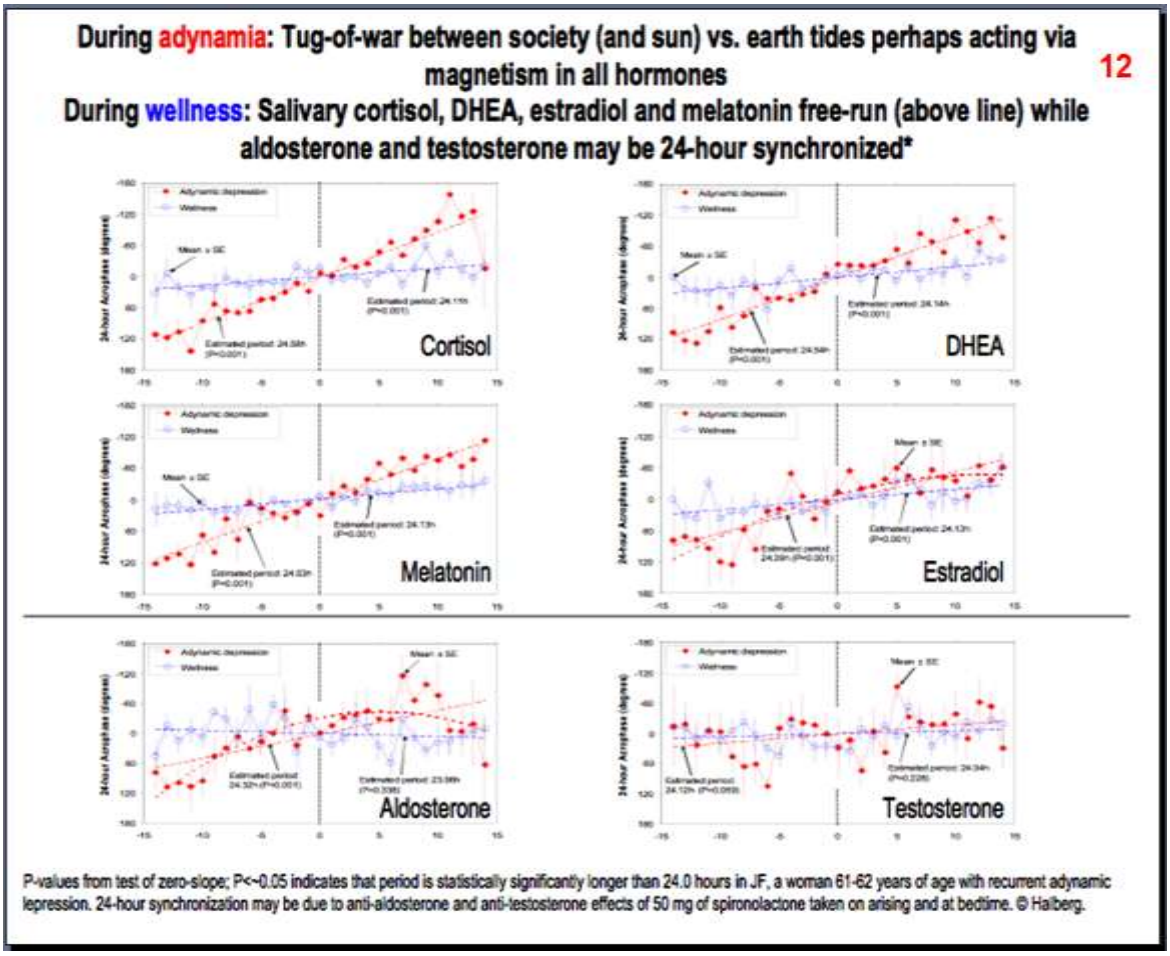


Figure 11 also shows different dominant frequencies in different hormones, circadian behavior, above and below the horizontal line, a free-run from society, and apparent 24-h synchronization (by medication) below this line.



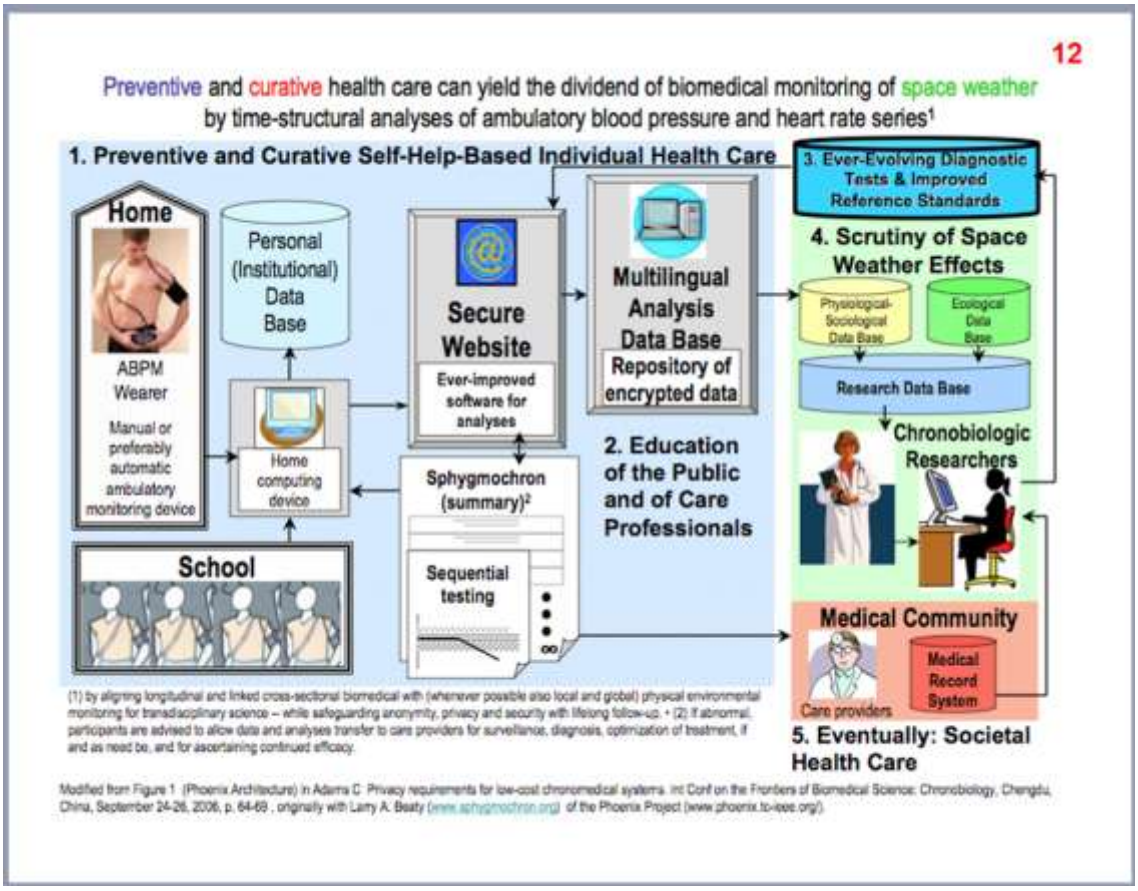


THE "LANGUAGE" of frequencies, amplitudes and phases lets us recommend that: **First,** there is a need for affordable unobtrusive monitoring tools and for data storage and continued automatic analyses on an international multilingual website (Figure 12). **Second,** everybody should thus have his/her blood pressure analyzed to gauge strain, to detect ascular variability anomalies, beyond the circadian frequency, where they already serve to prevent severe, otherwise undiagnosed, sometimes drug-induced diseases.

In the language of frequencies, we also suggest that :

Third, such monitoring allows study of effects of the sun by a remove-and-replace approach, as shown for the biological day, week, cis-half-year and transyear.

Fourth, social diseases like war, terrorism and crime, and natural cataclysms like earthquakes, can be analyzed in the same language of frequencies for any further associations with environmental cycles. As long claimed, but now resolvable in the frequency domain, human mental functions, i.a., our mood and thus our actions are influenced by space weather, as is systolic blood pressure, which can therefore serve as a gauge, as a proxy for mental functions.



Conclusion

Cost-effectively, by endeavors toward stroke and other severe disease prevention via C-ABPM monitoring, we may also get potential warnings and/or a better understanding of natural cataclysms, indispensable for rational countermeasures.

How practical is the foregoing:

The task of a website in analyzing data from all comers is now being performed by 2 senior individuals on a small scale; a manned international website could render the scale a worldwide service.

The goal of an unobtrusive device for wrist C-ABPM has been met by an instrument that is too expensive but there is documentation that an unobtrusive, affordable device is a possibility below US$ 100.

Just as pressure is monitored in a car's tires, HUMANS MUST NOT FLY BLIND

i.a.

1. University of Minnesota, Minneapolis, MN, USA

2. Tokyo Women's Medical University, Medical Center East, Tokyo, Japan

3. Paracelsus University, Salzburg, Austria

4. Halberg Hospital and Research Institute, Moradabad, India

NATURAL AND HUMAN-INDUCED CATASTROPHES: MODERN CHALLENGES FOR SUSTAINABLE DEVELOPMENT

Prof. Dr. Nikolay Laverov,
Vice President of the Russian Academy of Sciences, President of the National Center for Development of Innovative Technologies (Moscow, Russia)

Honorary Co-Chairman of the World Forum "GEOCATACLYSM-2011"

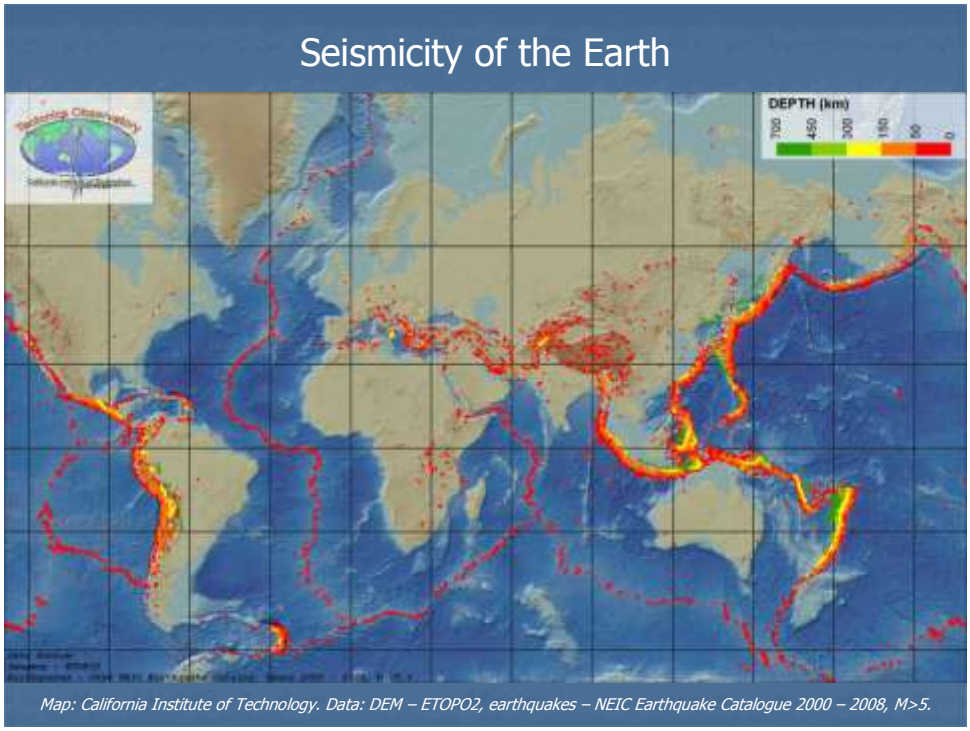
Dear Mr. Chairman, dear forum participants,

I would like to thank the organizers of this meeting for the opportunity to speak here about the new challenges posed by natural and human-made disasters. I would also like to convey warm greetings and congratulations from Yury Osipov, President of the Russian Academy of Sciences, who takes a keen interest in the problem discussed here and wishes success to the meeting participants.

For many years I have been dealing with the problems of natural and human-made disasters, becoming more and more convinced that our understanding of these natural factors in human lives is constantly increasing. And so, as the analysis shows, are the intensity and number of natural and natural-anthropogenic disasters. Today they are a source of deep social upheaval, mass suffering and death. The accompanying material losses have grown huge as well. This category of threats in today's society is becoming a leading one. The strategy of parrying them is based on the principle of the constantly increasing need for coordination of international efforts to develop a forecast for impending hazards, risk assessment and management organization. The dynamics of catastrophic events in natural processes more and more often falls within the category of natural anthropogenic disasters. In fact, today we almost always have a situation when natural disasters become at the same time human-made disasters, and large human-made disasters lead to grave natural, environmental consequences. The development of such hazards as earthquakes, volcanic eruptions, tsunamis, hurricanes, floods causes destruction of the technosphere and profound social upheaval. They have become the key destabilizing factor, posing a threat to the sustainable development of individual regions and countries. Some of them have acquired a global character. About 90% of accidents that have occurred in recent years have been caused by abnormal weather conditions. Natural and human-made disasters lead to the accelerated negative change of the

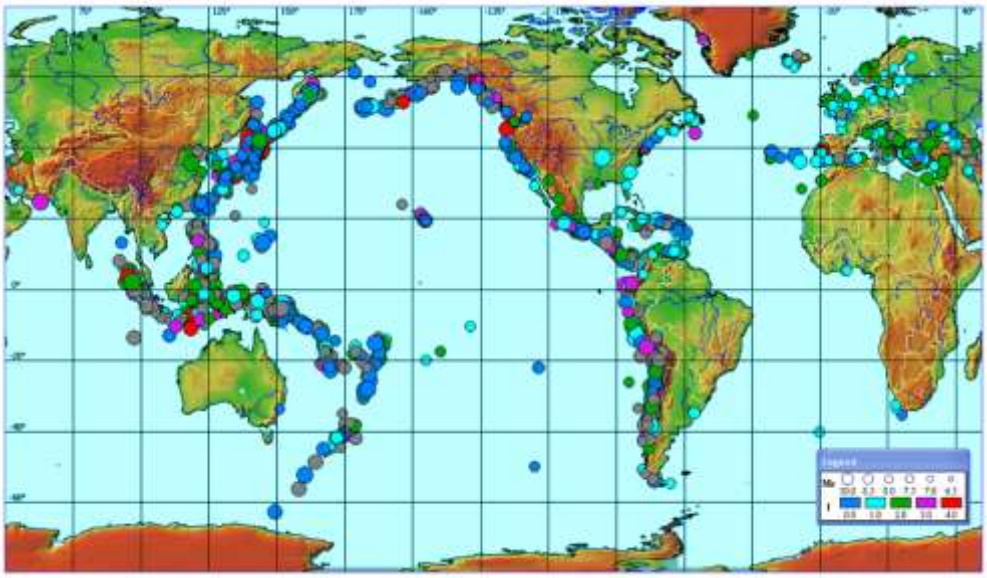
environment, the quality of which is deteriorating as well by the combination of disasters with human-made accidents and tensions in the social sphere.

It should be noted that the rapid population growth, the creation of megacities most often takes place in areas prone to natural hazards. Those, as you know, mostly are coastal, island territories, slopes of volcanoes and high mountains, swampy floodplains where volcanic activity and earthquakes are intense and frequent.



Map: California Institute of Technology. Data: DEM – ETOPO2, earthquakes – NEIC Earthquake Catalogue 2000 – 2008, M>5.

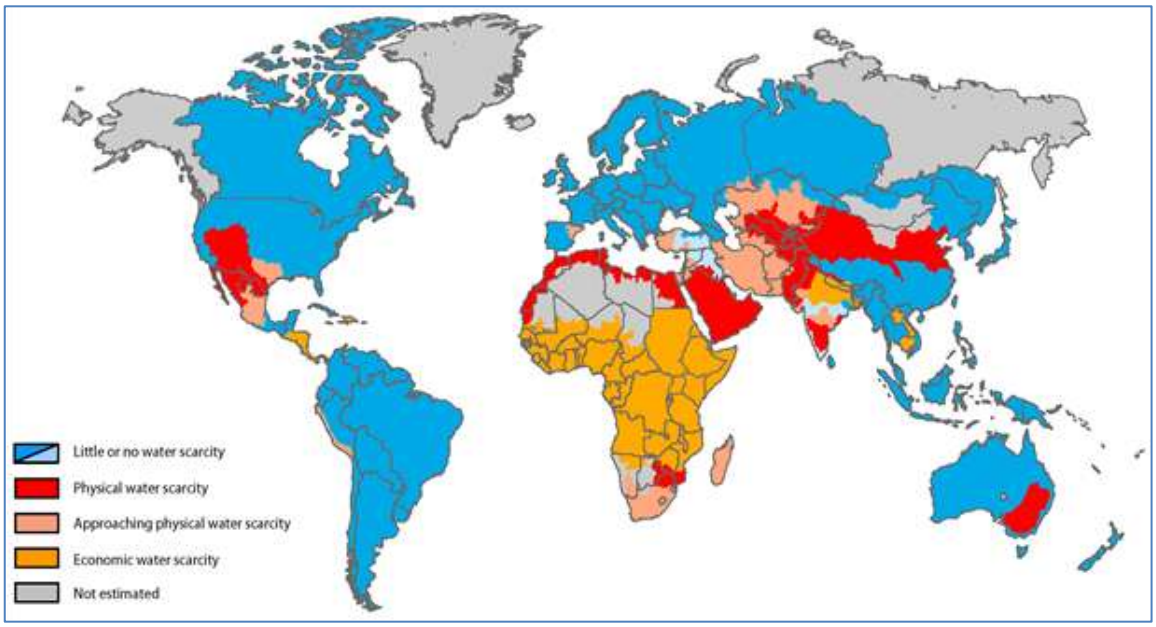
In these areas I have mentioned, tsunamis, landslides, mudflows are active as well.



Epicenters of tsunamigenic earthquakes from 2000 B.C. to 2008 A.D.

Typically, in such densely populated and underdeveloped areas no preliminary deep geological-engineering and other exploration is carried out, which is needed to assess the risk of

negative natural processes. The engineering preparation for construction of new industrial and social facilities is poor. Even in highly developed countries, major cities and coastal megacities are increasingly finding themselves in the center of devastating natural disasters, hurricanes in the first place, aggravated by the destruction of technosphere. Economic losses are getting huge. Human sufferings become repetitive and often widespread. The catastrophic processes increase the pollution of the hydrosphere of the earth, oceans, coastal areas, continental rivers and lakes. Over the past 30 years, pollution rates have exceeded industrial production growth rates. They are accounted for by the increased discharge: municipal and communal services, chemical plants, tanker accidents, oil and gas pipelines, drilling rigs used in offshore exploration in seas and oceans. The widespread introduction of fresh water into public utilities combined with recent occurrences of drought has led to two disastrous events: a sharp depletion of Earth's water resources and soil degradation.

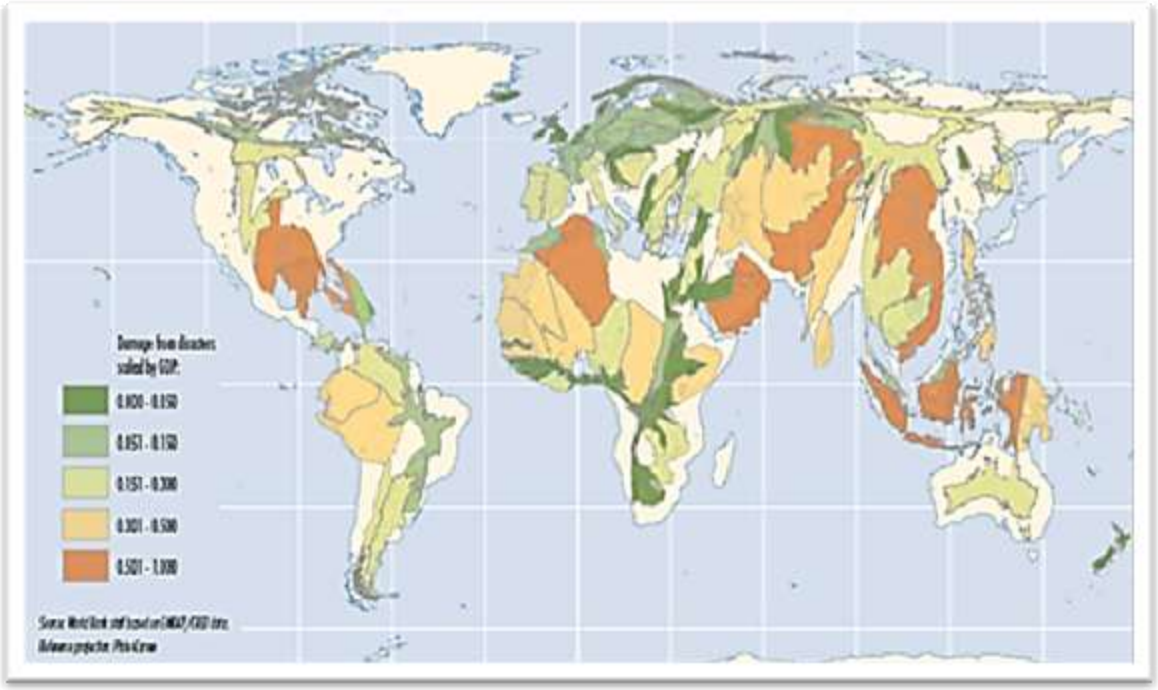


In major regions of the world, 60-70% of river flow is taken to human physiological needs. There is virtually no land reclamation or soil fertilization. The problem of providing Russia with water resources is included in the list of national priority tasks which have to be solved, according to the national security strategy. The problem of soil degradation, land reclamation and use of fertilizers has become critical and needs more detailed consideration of the international community since it is closely associated with food deficit and implementation of the international food program.

Abnormal weather conditions and their negative consequences have become more frequent. There have been major floods in Pakistan, China and Eastern Europe. The intense heat in the central part of Europe in July and August last year was accompanied by forest fires, and they clearly showed that we still have no scientifically sound and effective system for forecasting changes in weather conditions. To forecast the weather, the idea of a linkage between climate anomalies, regional fluctuations and circulation indices in the atmosphere closely associated with the life of the World Ocean is increasingly popular around the world. Among them, a particularly important role is played by pressure variability, temperature structures of the ocean surface, intensity of cyclone trajectories and movement of oceanic waves. The El Niso and La Nisa phenomena have begun to play a significant role in blocking continental atmospheric anticyclones that cause exhausting heat.

Among the periods of warmer seasons in Europe and East Asia in 1972, 1981, 2002 and 2010, the 2010 anomaly was the most severe for the entire period of observation and caused the death of many people in different countries, including Russia.

There is no doubt that the impact of natural disasters on economic development of countries is growing. Macroeconomic effects of natural disasters are contradictory and are largely conditioned by their intensity. The image below shows the comparative impact of cumulative damage from natural disasters over the last 30 years according to World Bank and United Nations experts. 5 types of regions can be distinguished on the map depending on their portion of expenditure from the GDP increase, required to remove the consequences of natural-anthropogenic disasters. It demonstrates a wide range of variations from 0.5% marked in green to 100% marked in red.



Damage from disasters scaled by Gross Domestic Product

The direct damage is estimated at 13-15% of annual GDP growth in the world. The share of the total damage in the annual GDP growth may reach 60% or more percent.

It is important to emphasize that in economically highly developed countries, economy usually does not experience long-term overloads. Devastating disasters tend to affect the growth rates of macroeconomic indicators in quarterly or semiannual periods. The average annual direct damage is estimated in the first tenths of the gross domestic product and has almost no effect on the consolidated annual budget. Unlike them, economies of developing countries experience a much more significant burden of the said damage and social loss. Developing countries, especially in Asia, bear the brunt of social loss: over 80% of the world's total number of persons killed and affected by natural disasters. The damage to their economies amounts to several percent, sometimes even tens of percent of the gross domestic product, which leads to larger deficits of national budgets. This is confirmed and supplemented by the fact that the differentiation of vulnerability to natural hazards and disasters manifests itself within countries between different social groups, by the level of welfare, significantly different demographic and cultural characteristics.

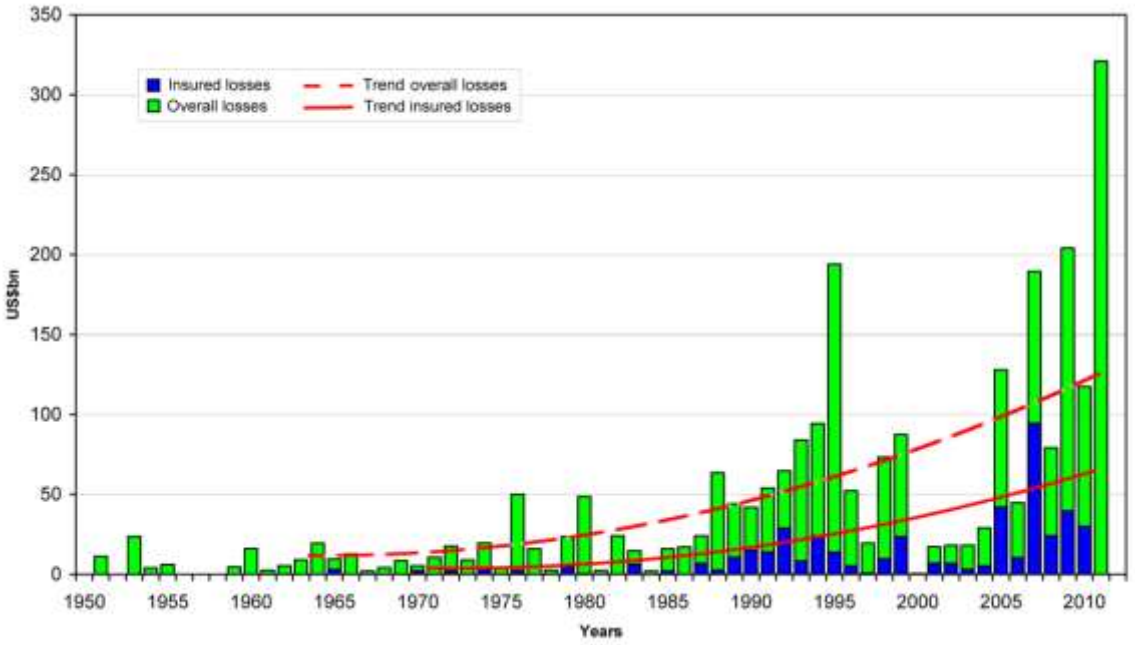
Of the total number of people killed in natural disasters and catastrophes around the world for the period between 1975 and 2010, about 65% were low-income people, 30% - people with income below average, 4% - higher than average and only 1% - people with high income. This higher vulnerability of the low-income population is apparently due not only to their limited resources for protection of their own lives. For low-income people, the very significance of natural hazard risks is, in our opinion, much less important compared to the social risks associated with the daily struggle for survival.

Considering the ways to reduce natural risks, approaches and priorities for action, we bring to the foreground the scientific understanding of natural disaster phenomena and the development

of protection methods against their negative effects. It is knowledge that is the basis for development of measures and application of safety standards, practical measures to reduce damage. Strengthening of the state support for science, especially for earth sciences and engineering disciplines which we today consider in a focused manner among these geocataclysms is necessary not only to modernize the economy but also to ensure sustainable development of society.

It is equally important to dramatically improve the education level of the population and training of professional staff. State support for science and education is not only an imperative to ensure safety from natural hazards but also a cost-effective policy. In addition to supporting the development of science and education to protect the population and territories from natural hazards, the state should play a key role in the development of its institutional and organizational mechanism as well. In a relatively short period of time, Russia has formed the legal basis for and unified system of the organization of action for the prevention and elimination of emergency situations, which has proved its effectiveness. In fact, it is recognized throughout the world. The process of improving the system is far from completion and achievement of the desired level of efficiency. The joint participation of the state and the public in this process is essential.

The most obvious is the need to provide financial and economic assistance to those affected by natural disasters, creation of a system of fair distribution of functions between federal and regional government agencies and foundations engaged in protection of the population and restoration of damaged industrial and social structures. It is necessary to increase the expenditures for preventive measures, including not only research I have mentioned but also monitoring of natural processes, their forecasting as well as re-equipment of the response forces.



Disasters with fatalities > 550 or with economic losses > 650 millions US$ are considered. Based on source data published by the Munich Re Group (http://www.munichre.com/).

Insurance against natural hazards has become an important direction in the activity of the state as an economic entity and regulator. It is especially topical in Russia given the embryonic stage of this activity's development. As convincingly demonstrated by the extreme weather situation of summer 2010, the state had to take upon itself most financial and material assistance to the affected regions and payment of compensations to affected residents. The lack of incentive in households to bear costs for ensuring their own safety is undoubtedly a negative factor in securing public safety. We see in the state a last-resort insurer which guarantees aid to the affected if the estimated damage is higher than that supposed to be covered by insurance premiums for household enterprises. This is happening more and more regularly. Private insurance companies cannot cope

with losses caused by disasters which are becoming increasingly frequent. Over the last thirty years, this figure was slightly above 33%, mostly being within the range of 15-20%.

Given the uneven development of insurance in different countries as well as the limited capacity of insurance companies, the proportion of actual recoverable losses turns out to be low and financial participation of the state is required. It is advisable to develop financial market tools regarding insurance, reinsurance and removal of consequences of natural disasters.

The Chernobyl Disaster, April 26, 1986
Radioactive cloud (red color) over the Northern Hemisphere, 10 days after the disaster event

It is important that our meeting takes place in Turkey where programs on insurance as well as those introduced by the World Bank allow governments to raise additional funds to reduce catastrophic risks. In Russia, the practice of using such tools is virtually absent; therefore we see development of insurance and financing of natural hazard risks as priority tasks of our and other countries.

In conclusion, I want to note the growing trend of human-made disasters. In this category, we include cataclysms caused by abnormalities of complex technical systems. They are most often associated with local or regional threats. They are based on social reasons, and the human factor is of great importance. Global human-made disasters are rare and even what happened now in Fukushima (Japan) is still not classified as global catastrophes. Here is an example of the energy sector where we see different kinds of threats associated with technological hazards. There are widely known emergency situations involving loss of life during extraction of coal in coal mines, technological accidents in mining and transportation of hydrocarbons. A real threat to the security of energy supply in many countries including our country is posed by the wear of power equipment and its poor quality. In particular, this was one of the main causes of this century's biggest accident in the nuclear power facilities in Fukushima, Japan, caused by a strong tsunami. One of the global human-made disasters in the world was the explosion of the Chernobyl NPS reactor in 1986. Radiation hazard of Chernobyl covers in fact the entire world and is undoubtedly global. It is often compared with the effects of the military use of nuclear weapons in 1945 and tests of powerful nuclear weapons in the atmosphere thereafter. The problem of proliferation of sensitive nuclear technologies and materials would become a less security threat in the category of key global issues.

Reduction of threats in this direction required taking measures, unique in their scale, by the UN, leaders of the USSR, Russia, the US and other countries.

The high level of collaboration of the UN-established International Atomic Energy Agency is unprecedented in its scope of solved problems and performance quality. In my opinion, this example of international cooperation to protect the public from global radiation threats deserves wide distribution, including for solving other environmental and disaster problems, in particular, those associated with natural and natural-anthropogenic disasters.

Thank you for your attention.

PROBLEMS OF UNIVERSAL TERMINOLOGY IN THE MODERN SCIENCE: WE NEED NEW PARADIGMATIC INSTRUMENTS

Prof. Dr. Walter Kofler,

President of the International Council of Scientific Development/International Academy of Science Health and Ecology (Innsbruck, Austria),

Honorary Co-Chairman of the World Forum "GEOCATACLYSM-2011"

Dear distinguished guests,

First I have the honor to welcome you in the name of the International Academy of Science Health & Ecology. I know you are coming from many countries all over the world and you have different long distances to come to us. But this is not the only difference. There is a bigger difference maybe between the disciplines which are here in this room and we agree – there is a need to integrate all of these different disciplines of natural and non-natural science, economy and politics to solve the problems. We are here to discuss in which way we can do this.

So I will use these greeting words to focus on maybe underestimated dilemmas which are in opposite to the wish we have all to solve the problems. There are some paradigmatic problems. We have to change our knowledge and our instruments and I will speak about different dilemmas. One dilemma is that indicators guide. Another dilemma is the dilemma of comprehensive communication between different sciences and the need of more and more specialization and then there is a gap between the creation of knowledge and the transfer into daily life and education.

Maybe you agree with my following position: we should not expect to be able to solve the problems for the future just with the weapons of the past. We need new instruments; we need paradigmatic new instruments. The need for paradigmatic progress in application is needed, not only the paradigmatic need in science. Maybe you remember the famous natural philosopher Thomas Kuhn in his book "The Structure of Scientific Revolutions". He distinguished between normal science on the basis of the given paradigm, and paradigmatic science – on the basis we have to change.

Such paradigmatic science is needed but we need to transfer to the young generation and to the technique too. We need to extend the position of Thomas Kuhn, apply it to education and transfer into daily life. We need more understanding for paradigmatic aspects in all other applied aspects of sciences, in medicine, in ecology, in understanding of sustainability and last but not least – in economy and politics. Maybe you can say this is clear, this is done. There is a basic concept about the key elements of a comprehensive, holistic understanding of our world and the integration of nearly all scientific disciplines, natural and non-natural ones, for this tool. The comprehensive view is the paradigmatic shift Thomas Kuhn is asking for. This is tool. It is true that society is spending a lot of money, especially for universities and similar institutions and expects that they will solve our problems within the available time thanks to this comprehensive interdisciplinary position.

But is this expectation realistic? Thomas Kuhn, the world-famous philosopher teaches us that normal science is done, and normal universities, they focus on normal science and therefore, on the increase of the applicability of given theories and the application, and not on paradigmatic research.

But without paradigmatic research, there are no paradigmatic new technologies and other applications. Therefore, I would say such an expectation is not realistic. If we are not able to solve open dilemmas and bring such dilemma. Indicators guide unconsciously but effectively. We are using indicators: about GNB we now have a very interesting report of a Nobel Laureate in France; they have done this research work and it could explain we are guiding in the wrong direction.

There is also in science the instrument to measure universities, on the level of points they make by publication. What is the consequence? Publications are higher ranked if you publish in highly specialized papers. But exactly we need specialized, not only specialists; we have to link this.

Therefore such a guide is guiding into the old direction, not to comprehensive science; to higher specialization and the young scientist has to fulfill the requirements of the universities to bring as many points as possible and he has no time to look over the border, he must be a specialist. In which way can we solve it? Oh yes, we had a very long discussion in the Forum of Alpbach: European Forum of technology and science. They said "Yes, first you should be an expert", then you should learn the new language to communicate. How many languages should you learn? Is this only to extend your vocabulary? Or is it not totally different? Einstein tells us: each scientific term is just a free invention of the human mind to make it easier to handle with our real world and our virtual world. But it's our invention on the basis of ontology, of your philosophy of the world, of your paradigm; if you have different paradigms, maybe natural science and non-natural science, there are idealistic and materialistic philosophies. There is no link, therefore you have to focus on this what we can communicate with another and this is a very small part in which the terminology fits together adequately. Do you believe really these are the real problems for the future? I don't believe this. Therefore we have to think over in which way we can change this position. But at the same time we need specialists. Without specialists we cannot use the power of our science. But parallel to this, we need also paradigmatic science. We should not expect that this can be done by traditional universities. But this can be done by organizations like the International Academy of Science. We are well-established scientists, we are paid, we have not to confirm our position, and we can spend time and do this.

There is a need, another gap we have to solve. This is the gap to transfer this quicker into daily life and for this, we have to change the education system in an adequate way. And we have to teach our students to think with the head of the other. This is the power of the future. And natural scientists must be able to understand a philosopher, a social scientist, a psychologist, and a politician. We would be very happy if the politicians would understand more science.

I hope this is the way. And this is the way we can do within other structures. If I see my friend Halberg, he has such an institution, which is done outside of the traditional way but highly linked with the scientific regulations. If you look at the International Academy of Science and other academies, we are doing this with our friends in Indonesia, in Pakistan, in Russia. If nothing is coming out, we have the positive answer. What we are doing is we are thinking. To think is a pleasure by its own, as Galileo Galilei teaches us.

Many thanks.

NATURAL CATACLYSMS: QUALITY HUMAN RESOURCES ARE WHAT FINALLY MATTER

Prof. Dr. Atta-ur-Rahman,
President of the Pakistan Academy of Sciences,
Coordinator General COMSTECH (Islamabad, Pakistan),
Co-Chairman of the World Forum "GEOCATACLYSM-2011"

Good morning, everyone!
It is a pleasure to be back in Turkey, where I have many friends.

I come from Pakistan, a country which has repeatedly faced many disasters, and it is a country where we had massive earthquakes a few years ago. Right now, we are going through floods in the area of Sindh, which have displaced tens of thousands of people, and last year we also had massive floods in the same province of Sindh. So it is a country with many and many problems presently.

I would like to focus in my brief presentation on the role of quality human resources in natural disasters because these cataclysmic hazards can be due to a variety of reasons but they can cause destruction, disruption of infrastructure, economical and agricultural losses, death and injury, diseases, sociocultural conflicts and various law and order situations.

Millions of human deaths have been caused according to Swiss Re and economic damage from disasters amounted to 222 billion $ just in last year and there have been recorded damage estimates of about 43 billion $ due to the Pakistan floods last year, 80 billion $ due to the Katrina hurricane and staggering 240 billion $ of losses in Japan due to the earthquake.

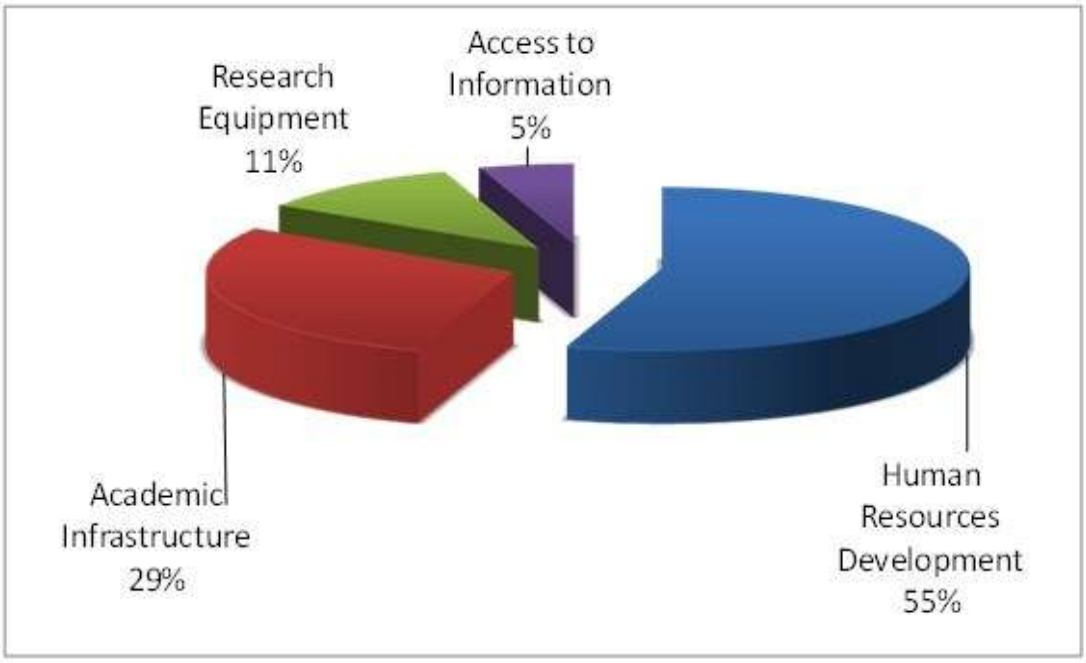
So, what we need to focus on is preparedness, realizing that the key is quality human resources, and knowledge and technology have become the key resource for tackling natural disasters.

In Pakistan, I was the minister for science and technology and also the minister for higher education, and I persuaded the government of Pakistan to increase the budget for science and technology by 6,400% and the budget for higher education by 2,400%, and this meant that we could launch huge programs in development of human resources in a variety of areas. This was a historic increase that took place.

Pakistan has a population of about 160-170 million people. We have 85 million below the age of 19; 54% of the population is below 19. That is a very large young population and if we can educate them in different fields, if we can provide them with the necessary skills in science, in technology, in education, then the question is how we attract the brightest into education and research, how we can excite the young minds about the wonders of science. Then we have to create the enabling environment through research funding, through salaries, through access to literature so that the brightest will opt for careers in science and education, if we are going to have a population prepared to tackle natural disasters in an educated and sensible manner.

So, one of the things which we undertook was a dramatic change in salary structures. The Pakistan perhaps became the first country in the world where a salary of a professor in a university was increased so that it became five times the salary of a federal minister in the government. This was done because we wanted to attract young men and women when they were deciding on careers to take up education and research as their first preference.

We started a massive program for training of quality human resources; we started with over a billion $ program to send students abroad to top universities; 11,000 scholarships were given. We started the world's largest full bright program to send students to top US universities. Each returning scholar was given a 100,000 $ research grant so that they could, as soon as they return, start working and operating.

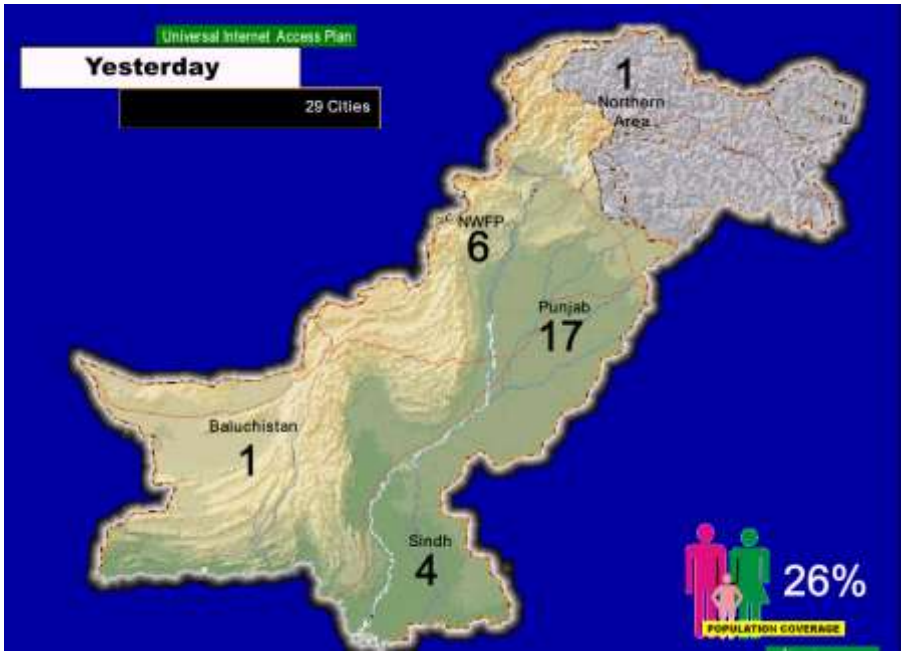


Distribution of Approved Project Cost

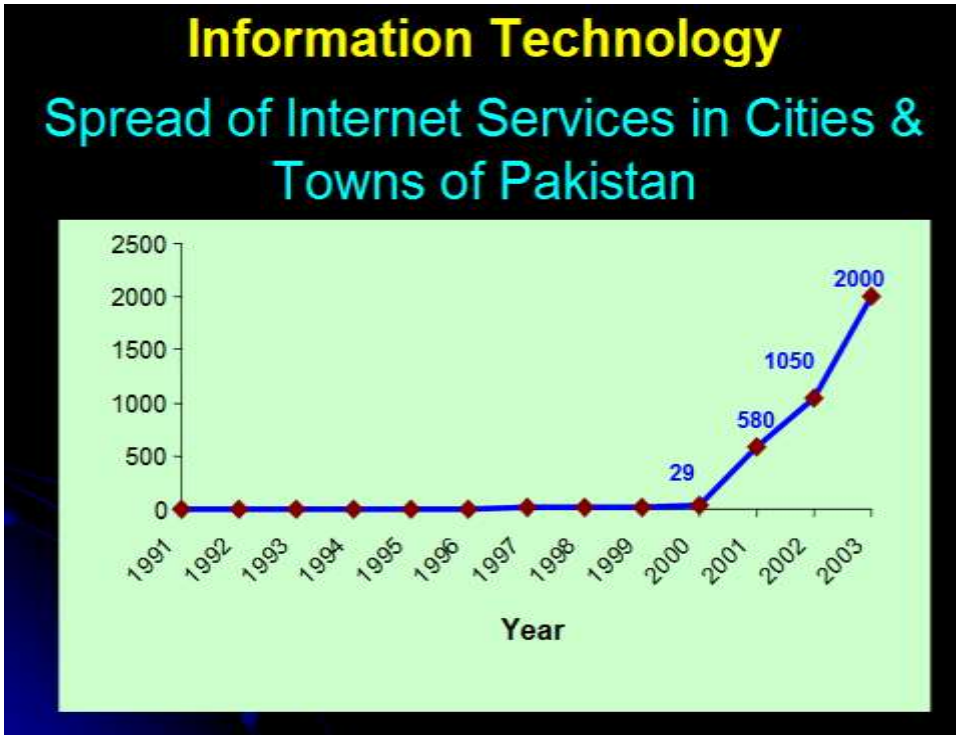
So this massive investment that we have made in the last 8 or 10 years, human resources, investments in scholarships in preparing the young because we need to realize that we live in a world where knowledge is the key driver for socioeconomic development. Natural resources have lost their meaning or have diminishing importance; the key is quality human resources and the

ability to unleash creative potential of the young through the challenging educational environment and through local opportunities to contribute.

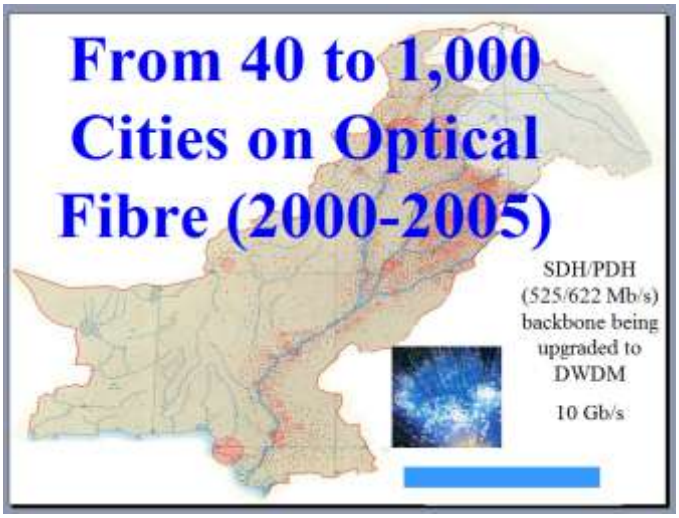
So, when I was Minister for IT and telecom, we had only 29 cities in Pakistan which had Internet.



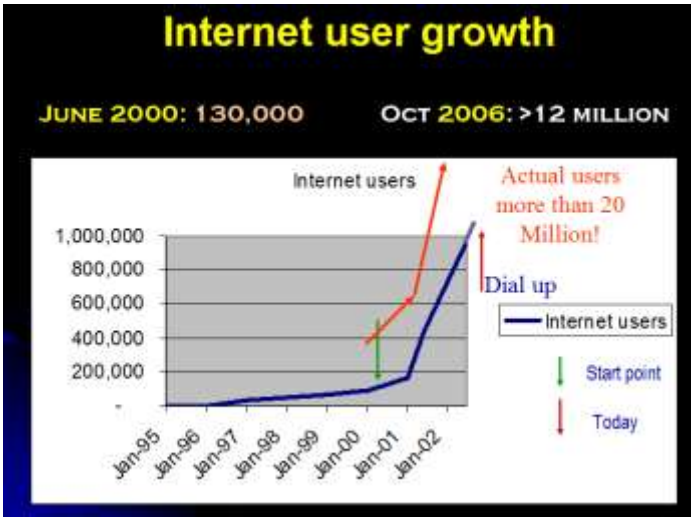
Communication is a vital component to tackle natural disasters, the ability to communicate rapidly.



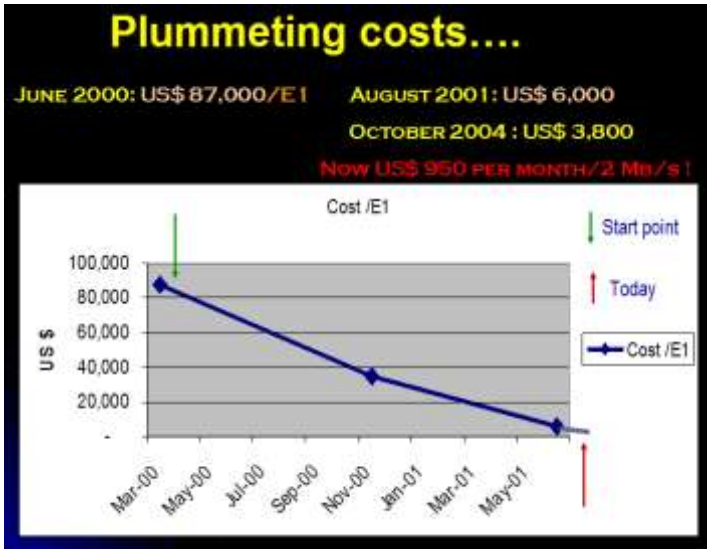
So we rapidly spread the Internet within 3 years; it was spread to 2,000 towns, cities and villages – a phenomenal growth. The fiber was spread from 40 cities to 1,000 cities within a few years.



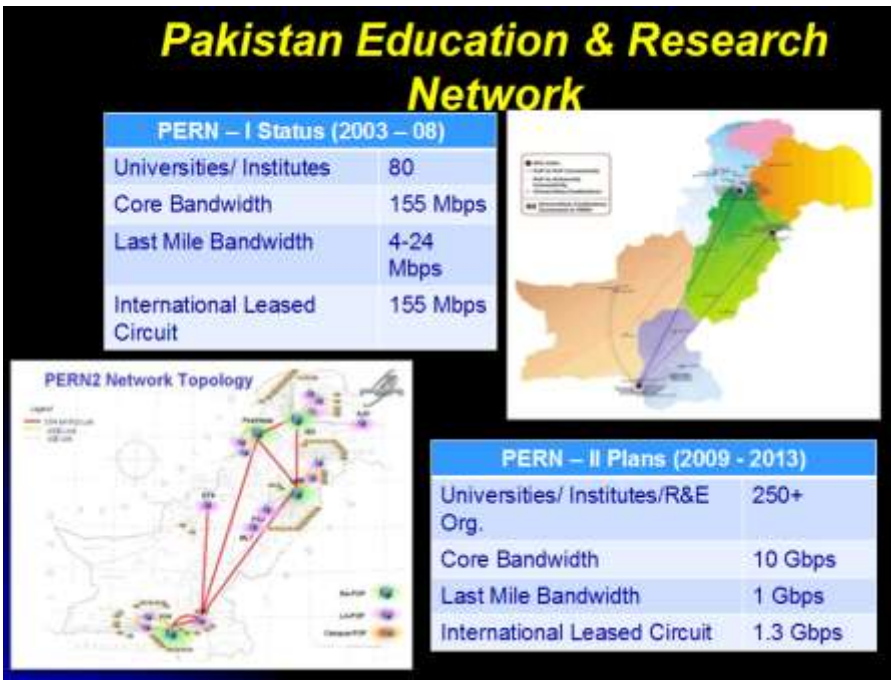
The Internet usage exploded,



and the cost of bandwidth was brought down.



These are the knowledge highways far more important than the road highways that we travel with, because on these knowledge highways information travels, knowledge travels.

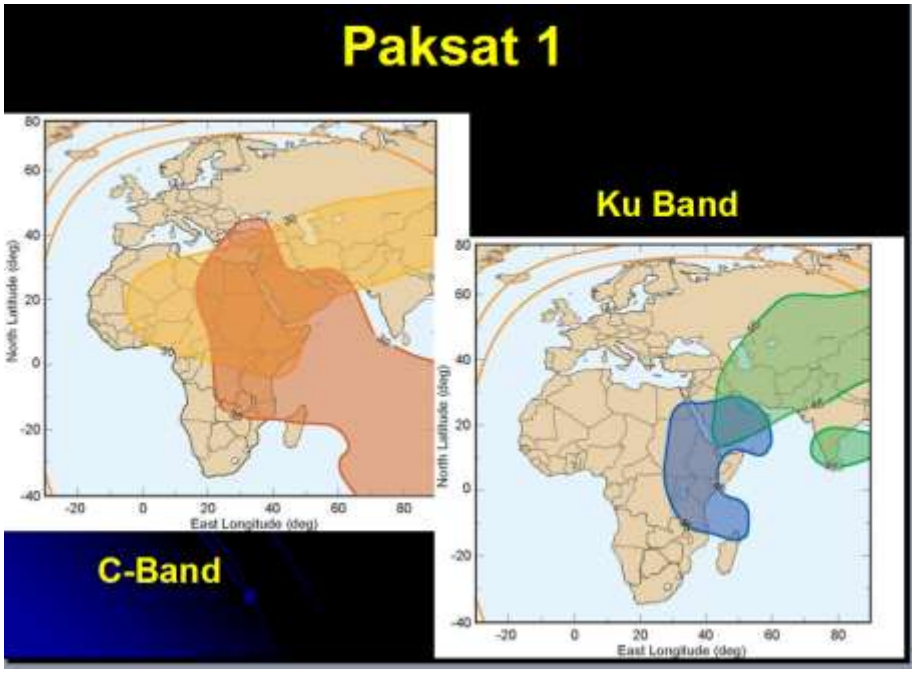


We set up an educational research network and used this also for telemedicine so that when the earthquake occurred in Pakistan, we were able to use telemedicine as a media tool to address some of the medical emergencies. This connects high-speed internet; every university has 1-Gbps connectivity and they are connected to 10-Gbps loops around major cities in Pakistan.

On this field we launched a digital library so that every student in every university in Pakistan has free access to 20,000 international journals with back volumes and to 60,000 textbooks from 220 international publishers, a huge repository of knowledge including all the relevant knowledge in geology and on disasters.

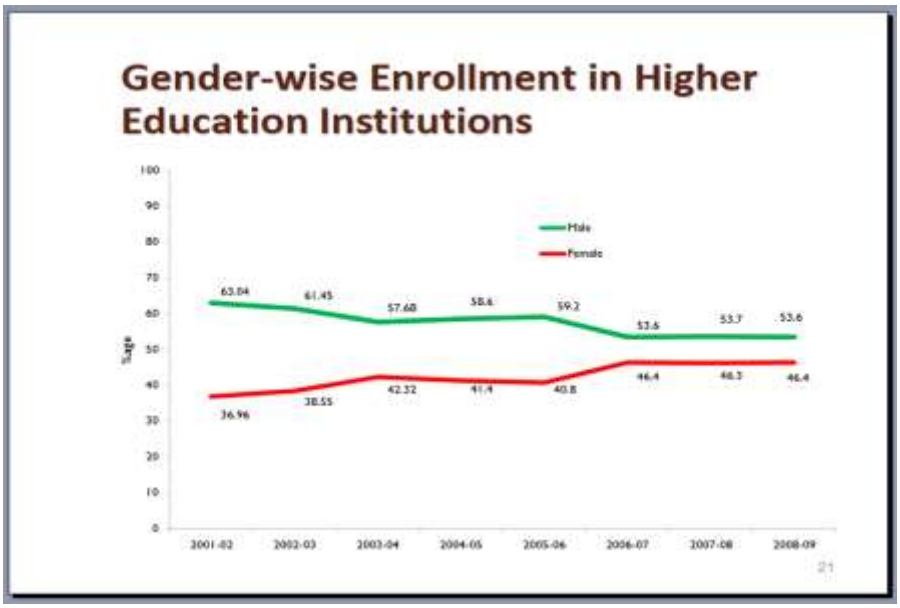
We started a distance learning program through series of lectures given daily from Harvard, MIT or Tokyo. And I listen live and interactively to my students in Pakistan. So it is a different world; it is a world very different from the world even 10 years ago, with the MIT open access website started within Pakistan.

We placed a satellite in space which is used for education and distance learning.



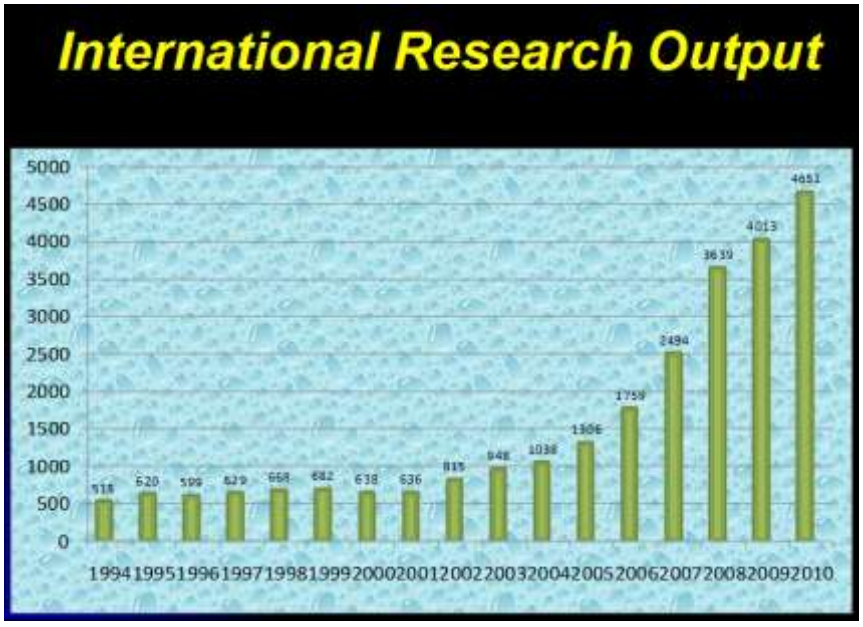
This huge increase resulted in tripling of the number of students within seven years from 276,000 to over 800,000 graduate students. The number of universities tripled; we set up centers of excellence in different fields including a center for earthquake engineering which was established in Islamabad at that time.

The gender balance has become much more even and equal.

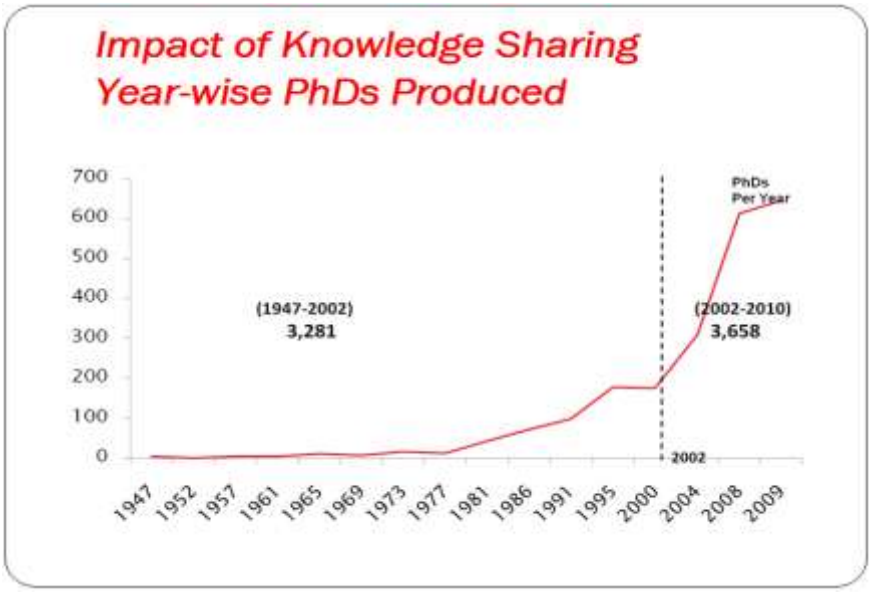


A 600% percent increase in ISI research publications and a 1000% increase in citations after removing self-citations.

This is what happened to the research output – there were only 500 or 600 papers in international journals, they have shot up to about 5,000, rapid increase in the international research publications and this growth continues in a phenomenal manner because of our realization that the key is quality human resources and it is research; universities are not about beautiful buildings, universities are about beautiful minds, about creativity.



This is the PhD output from our universities including in geology and in areas which are concerned with global weather patterns.



A number of universities were ranked in the top 300 of the world as a result of this, and some of them will hopefully be ranked among the top 200 this year.

A number of reports have been published; Nature, which is the world's leading science journal, has written four editorials on Pakistan, about how these changes have been made to make education a key for socioeconomic development, and the comprehensive reports by the World Bank, USAID and British Council.

This was my birthday gift last year; this was Nature's editorial comments when they complimented the work that we were doing.

The Royal Society, London of which I happened to be a fellow has published a book called "A new golden age" which says that this is a model. So what I am trying to emphasize is that preparedness for natural disasters requires education, and requires quality education, requires research and requires bringing together the various disciplines so that a multidisciplinary approach can be adopted to tackle natural disasters. If a country is not educated, if people are not educated, if they are not prepared in advance, you have to take a holistic, comprehensive look rather than a narrow look within each field to tackle this problem.

So this includes installation of effective warning systems, designing feasible emergency responses for rescue and evacuation; also post-disaster development, media problem – this can last for decades. The earthquake that occurred several years ago in Pakistan – we are still trying to recover from that, and we have not recovered from the floods last year, we are then confronted with another major flood in Pakistan. So: post-disaster development, reconstruction, strengthening and renovation.

I am coming to the end here; I will really conclude that again I will emphasize that it requires a comprehensive multidisciplinary approach with the provision of institutional, legal and financial foundations and international collaboration. There is a lot of knowledge that exists; we have to tap into this knowledge and use it to our advantage in the best way possible. The codes exist but many of the developing countries do not implement the codes, the knowledge is there. So implementation of building and floodway codes and avoiding building structures on areas which are susceptible on geologic foundations or in fault areas is important.

A well-organized outreach and communication program – this is again an extremely important part so that we can face calamities in a better manner.

My last statement is to endorse the suggestion made in 2010, in the state of California, multi-hazard mitigation plan that joint effort and collaborative partnership between scientists, international organizations, government departments and various stakeholders from local to federal governments and ordinary citizens are essential to minimize casualties and damage that natural cataclysms cause to humanity. Final word: the way forward is education, education and education.

Thank you.

GREETINGS TO PARTICIPANTS OF THE WORLD FORUM

Prof. Dr. Vitaly Starostenko
Academician, Director of the Institute of Geophysics of the National Academy of Sciences of Ukraine (Kiev, Ukraine)

On behalf of the Institute of Geophysics of the National Academy of Sciences of Ukraine, I welcome you here in Istanbul, in this very beautiful and very interesting place of the world.

We will have here a very good possibility to discuss the last scientific and practical results in forecasting of earthquakes.

I believe that professor Khalilov's new ideas, the new seismic station associated with his name give us the hopefulness that we will have progress in solving this very important and very formidable task.

My big thanks to professor Khalilov for the seismic station which our Institute has now. It will give us the possibility for more intensive work together with the international geophysical community. I wish all you success and all the best in our common work here.

Thanks to Professor Khalilov and his colleagues for organization of this congress.

Thank you for your attention and all the best to all of you once more.

Thank you.

SPECIAL SECTION 1
Earthquake Forecasting – 2011

PLANETARY ALIGNMENTS: POSSIBLE CAUSE OF EARTHQUAKES

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Introduction

Large earthquakes may be extremely devastating in terms of loss of human lives and property. A single large earthquake may release energy equivalent to hundreds or thousands of nuclear blasts and may level entire cities in a matter of a few seconds, costing billions of dollars in damage, not to mention the toll in human suffering. Several attempts have been made for foretelling earthquakes by different means in the past. Scientific disciplines like geomagnetic [1], energy accumulation rates [2], gravity anomalies [3], ground water levels [4], radon concentrations [5], thermal infrared [6], crustal stress [7], abnormal behavior of animals [8], ground-based electric fields [9], tidal forces [10], geo-electricity [11], seismic gaps [12], aftershocks [13], ground deformations [14], Ion concentrations in ionosphere [15], planetary positions [16], include the multidisciplinary areas in which research work is being carried out for the development of methodology regarding short period predictions of large earthquakes. The triggering of earthquakes may be tectonic in origin [17, 18] or it may also be non-tectonic such as changes in gravitational force due to the moon and various planets, comets, asteroids, meteoroids etc. This has been used in prediction of plate boundary as well as intraplate earthquakes [16].

The purpose of this report is to understand the planetary configurations in the solar system and to determine if certain planetary configurations could result in triggering large earthquakes.

The solar system

Gravitational attraction of the Sun controls the movement of planets. The solar system was formed billions of years ago, when gases and dust began to come together to form the Sun, the planets and other bodies of the system. The planets and asteroids all move around the Sun in the same direction as the Earth, in orbits close to the plane of the Earth's orbit and the Sun's equator. The planetary orbits lie within 40 astronomical units (6 thousand million kilometers) of the Sun; though the Sun's sphere of gravitational influence is much greater [19]. The Sun and the planets are shown in Fig.1 [20].

Planetary configurations

Ancient astronomers devised names to identify particular positions of the planets relative to the Earth and the Sun on the celestial sphere. This early system forms the basis for current definitions of planetary configurations.

Inferior Planets

The inferior planets, Mercury and the Venus, in which their revolving orbits are closer to the Sun rather than the Earth and are seen to undergo phases ranging from crescent to full and also exhibit retrograde motion (Fig.2) [21].

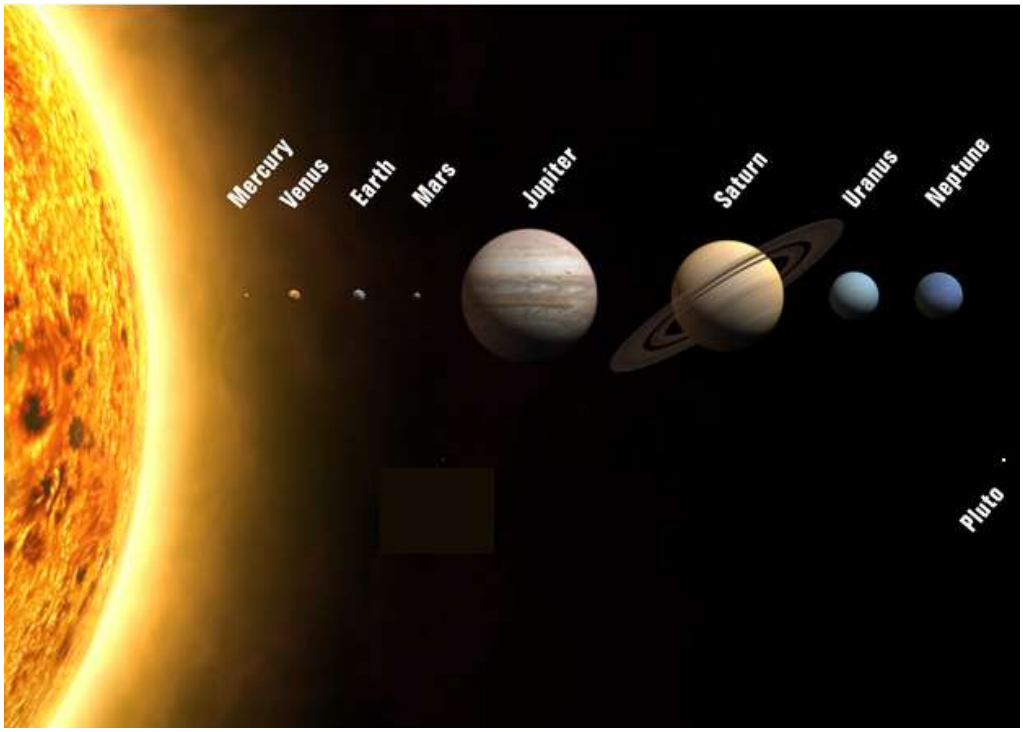

Fig.1. The Solar System

Superior planet

The planets moving around the Sun outside of the Earth's orbit are called superior planets. These planets are Mars, Jupiter, Saturn, Uranus, Neptune, Pluto and most of the minor planets in which their revolving orbits are outside of the Earth's orbit. Superior planets orbit the Sun more slowly than the Earth, and experience oppositions and superior conjunctions (Fig.3) [21].

Elongation

The elongation is the angular separation between the Sun and a planet or other Solar System as observed from the Earth. (Fig.4) [21] Elongations are measured in degrees eastward or westward of the Sun. The greatest eastward or westward elongation is the maximum angle between the Sun and a Solar System (Fig.5) [21].

Specific names are given to three main values of the elongation

Elongation	**Name**	**Description**
0^o	Conjunction	The Solar System lies on the same side of the Earth as the Sun
90^o	Quadrature	The Sun, Earth and Solar System lie at the corners of a right-angled triangle
180^o	Opposition	The Solar System lies on the opposite side of the Earth as the Sun

Opposition

A Solar System, such as a planet, comet or asteroid, is at opposition when it is on the opposite side of the Earth from the Sun. The elongation of a Solar System at opposition is 180^o.

The inferior planets, or other objects with orbits closer to the Sun than the Earth, can never be at opposition [21].

Inferior Conjunction

An inferior conjunction occurs when a planet lies along a straight line between the Earth and the Sun. At this point, the elongation is zero degrees, and the body will have the same right ascension on the celestial sphere as the Sun. Only the inferior planets, and asteroids or comets which have part or all of their orbits between the Sun and the Earth, can undergo an inferior conjunction (Fig.6) [21].

Superior Conjunction

A superior conjunction occurs when a planet, asteroid or comet, lies along a straight line joining the Earth and the Sun, but is on the opposite side of the Sun from the Earth. The elongation of a Solar System at superior conjunction is zero degree. A Solar System object at superior conjunction will have the same right ascension on the celestial sphere as the Sun (Fig.7) [21].

Present Classification of Planets

At the present time in astronomy the planets are classified into two categories, the Terrestrial and the Jovian planets. The terrestrial planets include the Mercury, the Venus, the Earth, and the Mars. These planets are closer to the Sun and have small masses and radii, rocky and solid surfaces, high densities, slow rotation, weak magnetic fields, few moons and no rings. The Jovian planets include the Jupiter, the Saturn, the Uranus, and the Neptune. These planets are also called gas giants. They are far from the Sun, have large masses and radii, gaseous surface, low densities, fast rotation, strong magnetic fields and many rings and/or moons [22].

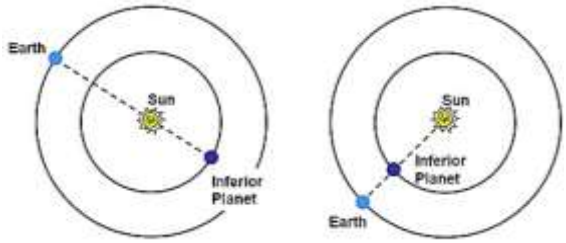

Fig.2. Inferior Planets

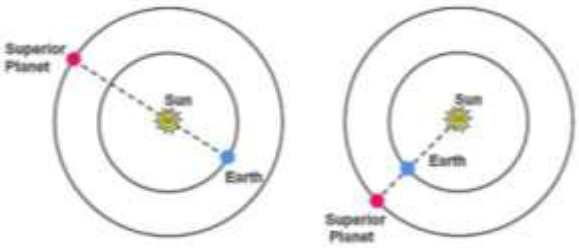

Fig.3. Superior Planets

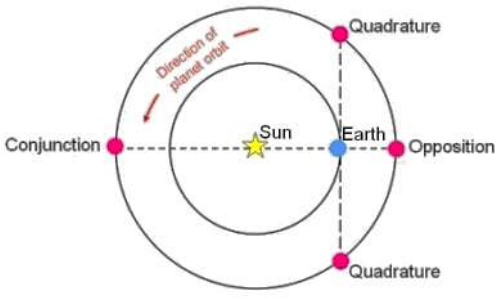

Fig.4. Elongation

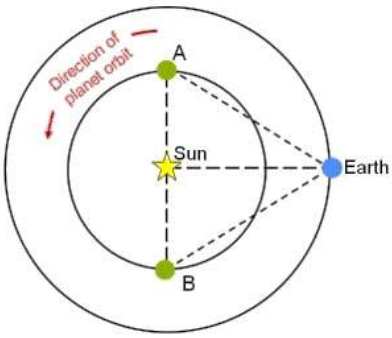

Fig.5. The position of an inferior planet at greatest western elongation (position A) and greatest eastern elongation (position B). In both cases, the elongation measured is less than 90°

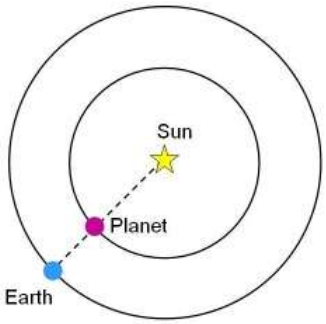

Fig.6. Inferior Conjunction

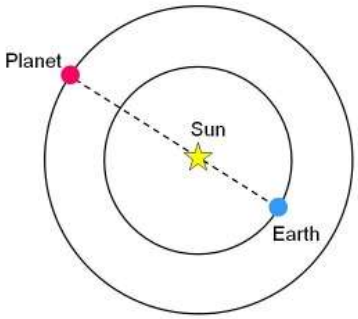

Fig.7. Superior Conjunction

Methodology

Geometry of Planetary Alignment

When the planets of the solar system are aligned with each other then they exert some surprising effects. If more than two planets, the Sun and other planet are aligned with our earth more or less in a line with an angle of 0° or 180°, then the gravitational force on the earth disturbed and affects the surface as well as interior of the earth, mostly at those places which are weaker. The earth is caught in the middle of force of gravity of the Sun and the planet. As the Sun has the strongest gravitational force due to which planets revolve around it, this may change the orbit and the speed of the Earth in its orbit and shift the centre of the solar system [23]. When the speed of the earth changes the motion of tectonic plates may also change, making them more likely to slip.

Earthquake Forecasting

Earthquake forecasting on the basis of planetary alignments has not yet developed to a stage to enable forecast of exact time, place and magnitude of an impending earthquake. It has, however, been observed that there are some particular alignments at the time of many earthquakes in the past. One of the important parameter that must be considered for forecasting of an earthquake with the help of planetary alignment is the triggering distance that depends on the position of relevant planets with regard to the Earth. It is the shortest distance to a particular point on its surface, which is normally measured as Right Ascension and Declination. Right Ascension (RA) is measured eastward from the Vernal equinox in hours (h), minutes (m) and seconds (s) and is similar to the longitude on the Earth as shown in Figure-8. Declination (DEC) is measured in degrees (°), arc-minutes (') and arc-seconds ("), and is similar to the latitude on the Earth. It measures how far overhead an object will rise in the sky, and is measured from -90° (South Pole) to +90° (North Pole) with 0° at the equator [24]. Similarly the direction of planetary forces effectively triggers the earthquake at plate boundaries if these are in line with the planetary forces [16]. For this phenomenon more observational data is required.

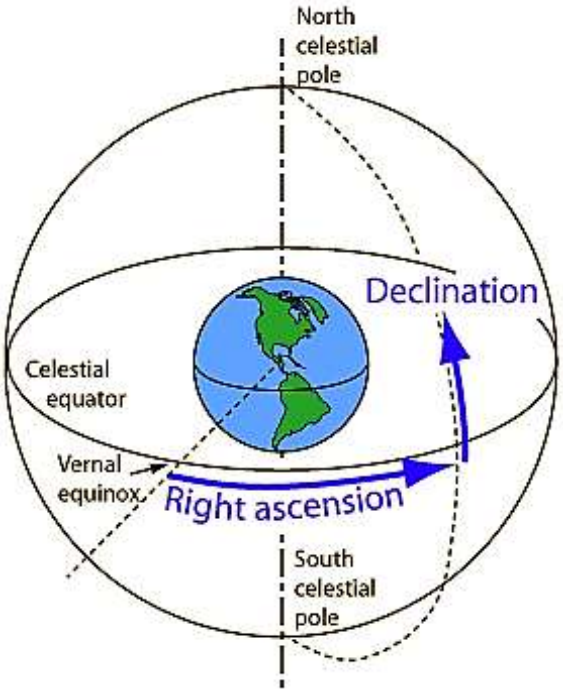

Fig.8. The Right Ascension and the Declination

Alignment of planets and occurrence of earthquakes

It is observed that most of the large earthquakes occurred during alignment of some planets with the earth. Some examples are presented in the following section.

- An earthquake of magnitude 6.9 occurred on 19th July, 1968 at 08:13:00 UTC in San Martin, Peru [25]. At that time the Earth was aligned with the Sun, the Mercury, the Venus and the Mars. All these planets were in a straight line with the Earth as shown in Figure-9 [26].
- In Morgan Hill, California an earthquake of magnitude 6.2 occurred on 24th April 1984 at 21:15:19 UTC. There was a clear alignment of planets at that time as shown in Figure-10 [26]. All the planets were close to each other and definitely affected the gravitational pull on each other and also the gravitational pull of the Sun.
- An Earthquake of magnitude 8.6 occurred on 28th march 2005, 16:09:36 UTC in Northern Sumatra, Indonesia [25]. There was again alignment of planets and this time the earth is adversely affected by the huge gravitational pull of the heaviest planet Jupiter. In this alignment the Mercury, the Venus, the Jupiter and the Earth are aligned with the Sun. As the Jupiter has the highest gravity as compared to the Earth and other planets and the Earth is directly in front of the Jupiter as shown in Figure-11 [26], it experienced a huge gravitational force.

In view of above mentioned examples it seems that there must be some relation between occurrences of earthquakes with planetary movements this requires more observational data for the forecasting of earthquakes.

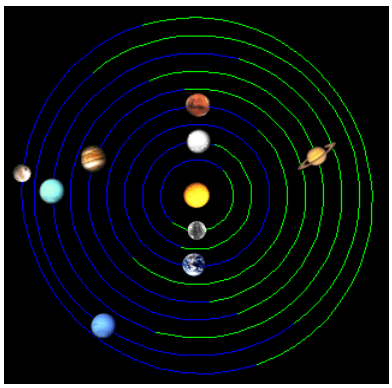

Fig.9. Alignment of the Sun, the Mercury, the Venus and the Mars with the Earth at the time of the Peru earthquake in 1968

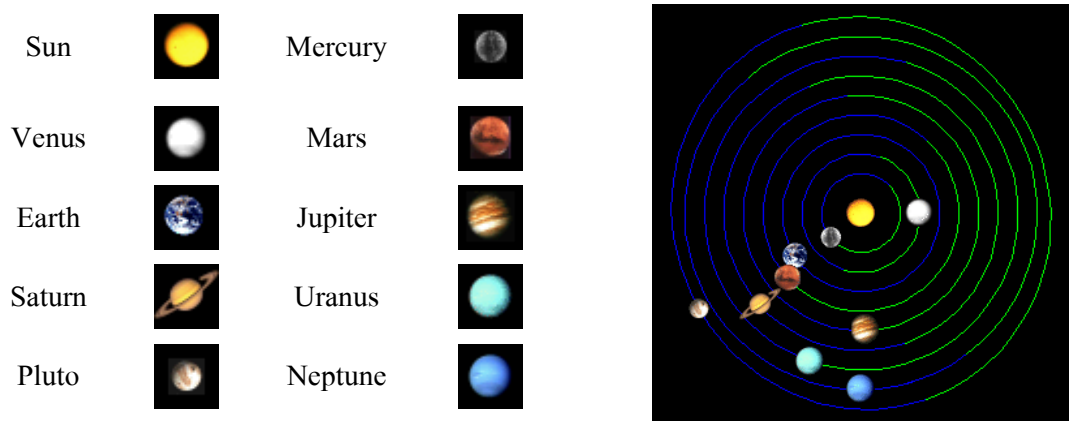

Fig.10. Alignment of the Sun, the Mercury, the Earth, the Mars, the Saturn and the Pluto at the time of California earthquake in 1984

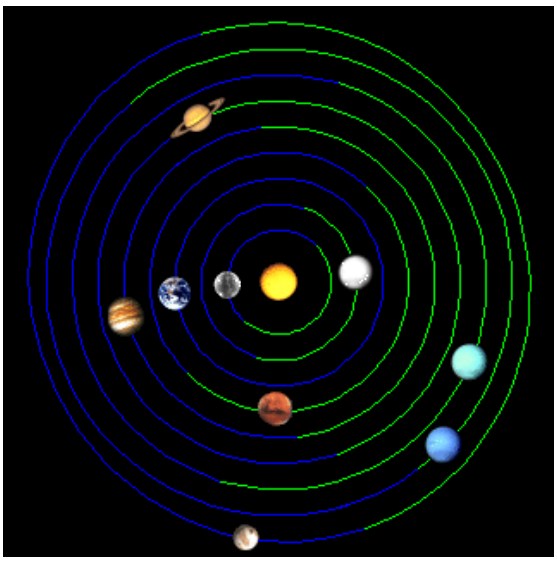

Fig.11. Alignment of the Sun, the Mercury, the Venus, the Earth and the Jupiter at the time of Indonesia Earthquake in 2005

Seismicity in 2009

By scanning the catalogue of earthquake data from USGS [27] and IRIS [25] it was observed that in 2009 the seismicity rate all over the world is high as compare to last year. There are also many strong planetary alignments in the year 2009. After the analysis of data it has been observed that there is a gradual rise in the number of earthquakes having magnitude greater than 6 during the months of August, September and October as shown in Figure-12. There is also a perfect alignment of planets with the Earth and the Sun as shown in Figure-13. In August there are many alignments and in one such prominent alignment involved the Sun, the Mercury, the Venus and the Mars. In another alignment, the Earth, the Jupiter, the Neptune and the Sun are aligned as shown in Figure-14 [26]. Similarly in September and October, the Earth is aligned with other planets in perfect angles. Gradual rise in number of earthquakes having higher magnitudes is clearly shown in the Figure-12.

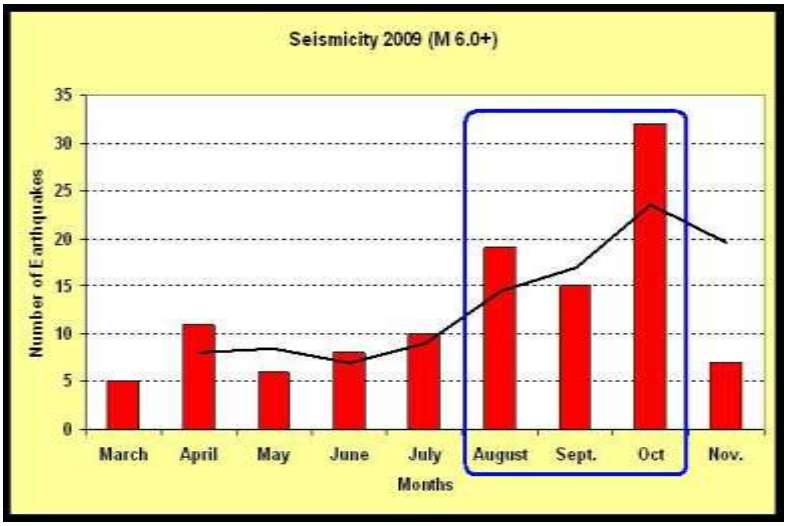

Fig.12. The graphical presentation of earthquakes occurred during 2009

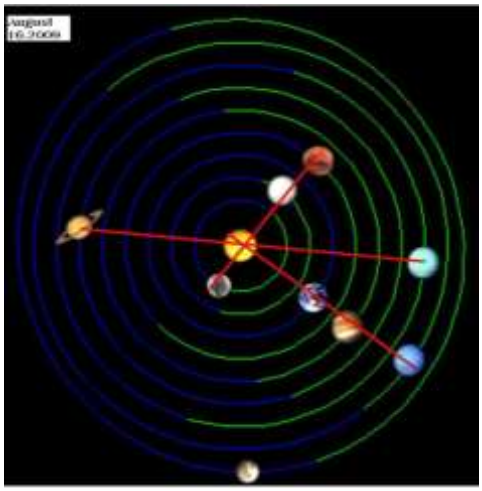

Fig.13. The Planetary alignment during 2009

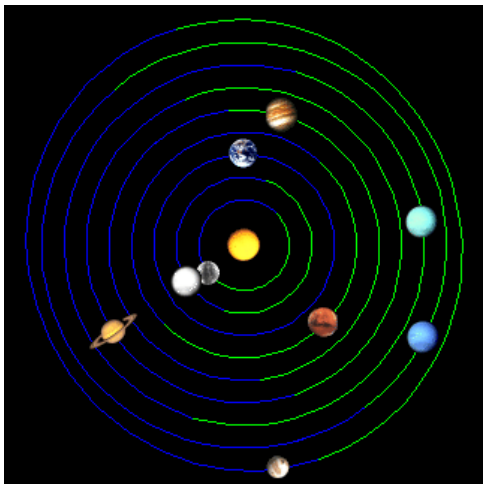

Fig.14. Position of different Planets on December 21, 2012. Future planetary alignments

Now a days there is a lot of talk regarding the events that are yet to happen in the year 2012. The date, December 21, 2012 is considered to be the marking point of all events, starting from

global illumination to catastrophe on the earth with a lot of many other things, forecasted by many ancient people as well as modern scientists. Ancient Mayans had a surprising understanding of the solar system that eventually led them to discover the long count calendar, namely, "The Mayan Calendar" up to December 21, 2012. People who have a strong belief over the wisdom of the ancient culture will be fascinated to know more about this aspect. However, people in the modern world will take some time to realize the significance of 2012 planet alignment [28]. Accordingly, there will be alignment of several planets such as the Mercury, the Venus and the Saturn with the Sun on December 21, 2012 [26] but the Earth will not be the part of that alignment. The Gravitational attraction will be shared between the Sun and planets because of that association. The Jupiter has the strongest effect after the Sun and on that date the Earth will be closer to the Jupiter (Figure-14). There will be more possibilities of earthquakes having greater magnitude in these years because in both figures the Earth will align and gravitational pull of the Sun will be shared because of these alignments. There will be chances of some earthquakes due to the attraction of the Earth and the Jupiter. The areas near to tectonic plate boundaries will expect big earthquakes in the coming years.

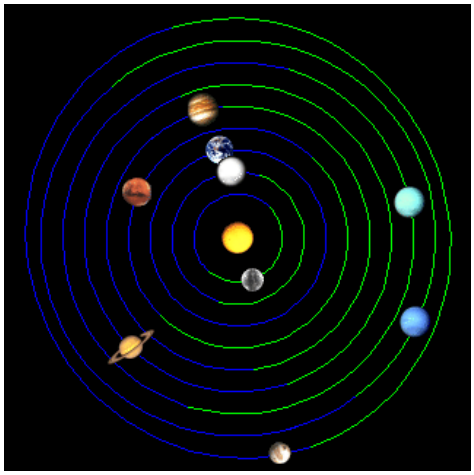

Fig.15. Future alignments of planets on January, 2014

There will be some more alignments in 2014 and 2015 (Figures-15, 16), which will result a strong gravitational struggle between the Earth and other planets of the Solar System [26].

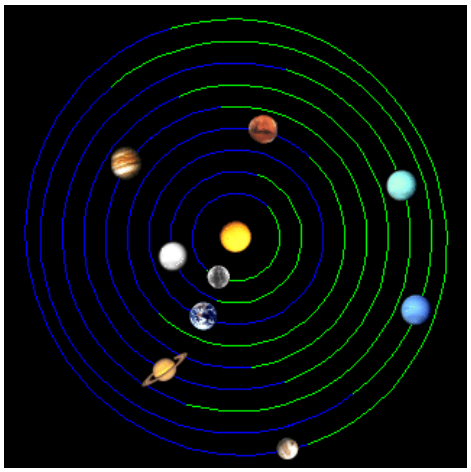

Fig.16. Future alignments of planets on May, 2015

Conclusions

Gravitational Forces between the Sun and planets affect the movement of the Earth and play a major role in earthquake occurrence. Slowing of rotation of the Earth can disturb the movement of tectonic plates that results in increase in the rate of energy accumulation, increase in

tectonic stress result in rupture at plate boundaries. Plate boundaries are the most affected areas where an earthquake due to planetary alignment can be triggered. The magnitude, location and time are dependent on the geometry of planetary alignments. Analysis of pre-historical earthquake data show that there was a perfect alignment of planets in most of the cases when there was a strong earthquake. Increase of occurrence of major earthquake of $M \geq 6$ in 2009 was because of some perfect alignments of the Earth with Terrestrial and Jovian planets. Most of these earthquakes occurred along the tectonic plate boundaries which confirmed that these boundaries are affected by the alignment and gravitational changes. In future, there are chances of alignments in 2012 but these may or may not be as perfect as in the past years like 1968, 1984. Although the predictions about 2012 planet alignment have been prophesied for several years by a number of ancient civilizations, such as the Mayans, Zulus and many others but getting prepared for the future is always a better option than anticipating the event with doubts and without any preparation. This is highly essential for survival of human beings on Earth.

Acknowledgement

The authors are thankful to Dr. Ishfaq Ahmad N.I; H.I.; S.I., for his constant encouragement and patronization of the project. The authors are also grateful to Dr. M. Ahsan Mubarak S.I., for their guidance in preparation of this work.

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GLOBAL GRAVITATIONAL EFFECTS BEFORE AND AFTER STRONG M8.9 JAPAN EARTHQUAKE OF MARCH 11, 2011

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Before and after the powerful Japanese magnitude 8.9 earthquake of 11 March 2011 some gravitational effects were registered in large areas across the Eastern Hemisphere as far as 9,000 km away from the earthquake's epicenter. The gravity anomalies were measured experimentally using ATROPATENA stations, new physical registering devices deployed in Indonesia (Yogyakarta), Pakistan (Islamabad), Azerbaijan (Baku) and Turkey (Istanbul). The stations continuously measure changes in time of the natural gravitational field in three mutually perpendicular directions. It has been established that indications of the Cavendish balance can be influenced by the dynamics of lithospheric stress fields altering the density and mass of large rock strata under the measuring stations before strong earthquakes. The authors believe that those stresses can be carried by tectonic waves. The effects registered provide a theoretical and experimental basis for initiating creation of an international network for monitoring and early warning of seismic hazards.

Variations of the measured values of the gravitational constant G have been repeatedly registered by scientists from a number of countries (1, 2).

The results of research of variations in G were published in World Data Center (3). In (4,5), it is shown that variations of the gravitational constant have a certain cyclicity.

In particular, many years' monitoring of the gravitational constant G has led the authors (4, 5) to the conclusion about variations in time of the measured G values starting from the second digit after the decimal point. According to the authors (5), the observed variations can not reflect the gravitational influence of the Sun, Moon or the planets of the Solar system. The authors (5) do not rule out the possibility of solar activity's influence on variations of the measured G values.

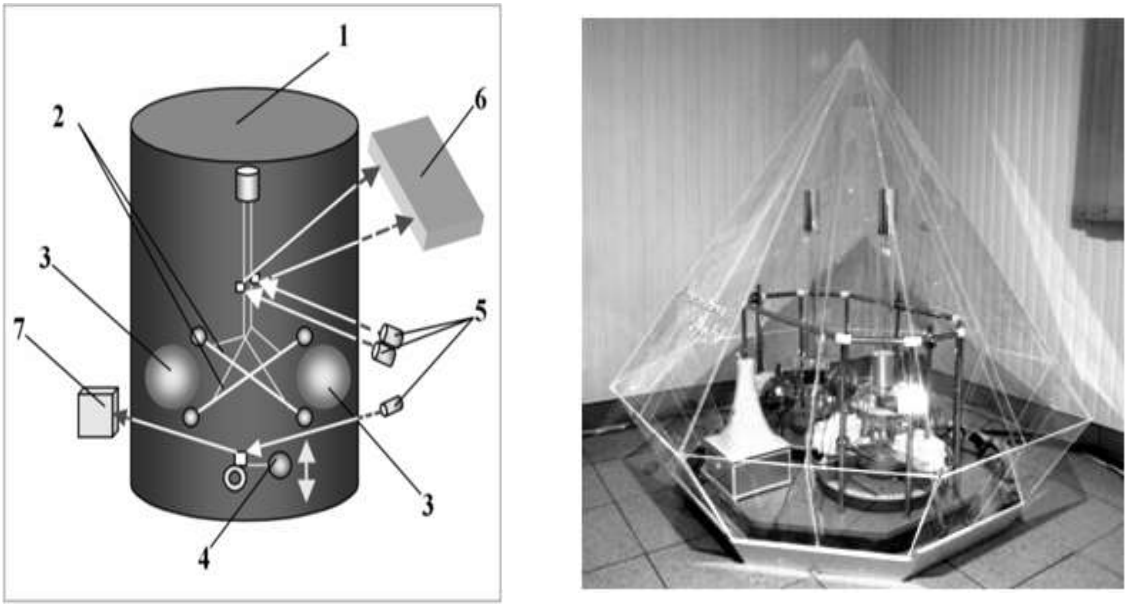
In (6), the possible influence of super-long gravitational waves on indicators of the Cavendish balance is referred to.

However, no research has offered any satisfactory explanation for variations in time of the measured G values despite them being registered by a number of scientists (6).

2.1. Methodology

A new instrument for experimental study of the space-time variations of measured values of G was created, called the ATROPATENA detector /Khalilov E.N., PCT patent, 2005/, (7).

ATROPATENA is a system of sensors closed and isolated from the environment, using the physical principle of the Cavendish balance, with small weights on the ends of two (instead of one) mutually perpendicular balance-beams hung by threads 2. Between the small weights large weights are placed equally spaced 3, Fig.1 (a). The third measuring sensor, the trial mass 4, is hung on a special elastic lever and makes available the possibility of vertical displacements during changes in the relative values of acceleration of gravity, Δg. Variations of Δg are stipulated for lunisolar floods and for the appearance of local gravitational anomalies, which can be caused by the changing of density of rock mass under the instrument as a result of changes in their stress condition, and consequently their mass. As seen in the scheme, on the balance-beams with the weights 2 and on the lever of the vertical sensor 4, there are tiny mirrors on which three laser beams are directed. Being reflected from the mirrors, the beams hit the sensitive optical matrix 6 and 7, where the transformation of optical signal from laser mark into electric signals and their transmission into an analog-to-digital converter occurs. After that, the digital signal is transmitted to a special block of the computer as the next record in a special format. The software, written at the Scientific-Research Institute of Prognosis and Studying of Earthquakes (SRIPSE), automatically records the information in the form of separate files for a period of time determined by the operator.



(a) **(b)**

Fig.1. (a) the ATROPATENA instrument is shown schematically;
(b) – Photo of ATROPATENA CRYSTAL Kh11 Station in Baku (Azerbaijan)

1 – glass body of the detector; 2 – balance-beams with small weights on the ends; 3 – big weights; 4 – trial weight hung on elastic lever; 5 – laser emitters, 6 – sensitive optical matrix for horizontal sensors, 7 – sensitive optical matrix for vertical sensor.

The entire sensitive system is placed into the special, isolated from the environment, glass body 1, where a deep vacuum has been created and is constantly supported (10^{-4} MPa). Temperature sensors accurate to 0.1C° are placed in different sections of the sensitive system and connected to the temperature control block. For excluding the mechanical effects and for better heat insulation, the vacuum body with the sensitive system is placed into transparent plastic body which also allows for visually observing the work of the system Fig.1 (b).

Together with the noted sensors, ATROPATENA is also provided with a digital seismic station using a three-component seismic receiver, the information of which is also transmitted to the computer and is continuously digitally recorded in three channels X, Y, and Z.

The registration of seismic fluctuations is necessary in order to exclude the possible influence of these fluctuations on destabilization of the sensitive system of the ATROPATENA detector and the appearance of false anomalies caused by seismic processes. The remote control of the detector and remote pickup of information minimize the external influences on the sensitive system. All elements of the sensitive system have been made of non-metallic materials to exclude the influence of magnetic fields and electromagnetic radiation on these elements. ATROPATENA is placed in the building of the Scientific Research Institute of Prognosis and Studying of Earthquakes in Baku (Azerbaijan). Since 1 April 2007 the station has been in operation, and has recorded high-quality information about variations of the gravitational field over time in three axes X, Y, and Z, and the seismologic information simultaneously recorded by means of the Tethys-SD wide-band digital seismic station. First, ATROPATENA was provided for experimental research on the possible influence of super-long gravitational waves on indications of the Cavendish balance. However, this detector does not measure changes in the gravitational constant G but rather deviations of the Cavendish balance's indications, being influenced by altered external masses of geological origin. It should be taken into account that astronomical masses such as lunisolar tides affect indications of the Cavendish balance as well. But this influence is very weak and is reflected in the gravitational constant values in the fifth and sixth digits after the decimal point (6).

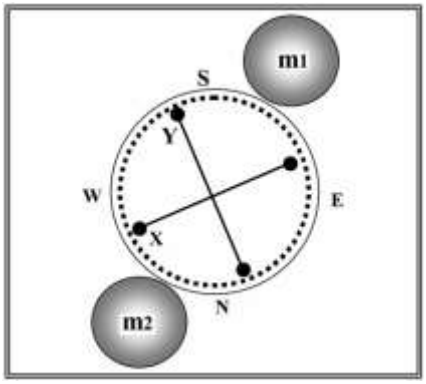


Fig.2. Schematic sketch of actual orientation of the Cavendish balance in the ATROPATENA station

On the gravitograms, the graph G_x reflects the movement of the balance-beam X, and the graph G_Y reflects the movement of the balance-beam Y (Fig. 2.), the graph G_z reflects the changes of gravity, that is, the vertical movements of the trial weight. An increase of values G_X and G_Y means approaching of small weights on the balance-beams to the large weights, and a decrease means moving away from the large weights. On the coordinate axis are shown the conventional units, which reflect the deviation amplitude of small weights on the ends of balance-beams relative to large weights. The registration of values of all three sensors is carried out with discontinuity in one second. Using of red lasers with the length of wave 645 nm and special optical matrixes for registration of the laser mark and its displacements allowed registering the deviations of laser-beams on the angle to 0.1 degree. The whole process of registration takes place in digital form automatically, without participation of the operator, and the received time series are archived by means of a special program. These deviations correspond with variations of gravitational constant G in the third and fourth digits after the decimal point.

ATROPATENA station's measuring parameters

The ATROPATENA station measures the ΔG index which is the difference between the gravitational constant G (initially measured G value) and measured values of the Cavendish balance at the measurement time – G_F:

$$\Delta G = G - G_F$$

The ATROPATENA-AZ station (Baku, Azerbaijan) was used to register gravity anomalies before strong earthquakes, namely in Japan on 7 May 2008 and Sichuan, China on 07, 12, 13 and 17 May 2008 (8). Since only relative changes of the gravitational field reflecting deviations from the initially measured G value are important for researchers, a conventional index of variations of the gravitational field ΔG was taken as a basis for registration and subsequent analysis. To convert the ΔG index into a gravitational constant G measuring unit, the recorded ΔG index should be accepted at the first approximation as the G value starting from the second digit after the decimal point. According to CODATA (9) as of April 2011, the value of the gravitational constant G is $6.674\ 28 \times 10^{-11}$ $m^3\ kg^{-1}\ s^{-2}$, standard uncertainty $0.000\ 67 \times 10^{-11}$ $m^3\ kg^{-1}\ s^{-2}$, relative standard uncertainty 1.0×10^{-4} , concise form $6.674\ 28(67) \times 10^{-11}$ $m^3\ kg^{-1}\ s^{-2}$. So, only two digits after the decimal point remain unchanged in the measured value of the gravitational constant G; from the third digit on, the ATROPATENA stations register periodical spatio-temporal variations that depend on the location of the recording device and its spatial orientation:

$$G_F = 6.67(\pm\Delta G) \times 10^{-11}\ m^3\ kg^{-1}\ s^{-2}.$$

Where G_F is the actually measured value of the gravitational constant at the measurement time. Previous studies have found that ΔG records obtained using the mutually perpendicular Cavendish balance are not always synchronized and often lack a pronounced correlation (8). This fact can also be observed from the records of all the stations before and after the disastrous Japanese earthquake of March 11, 2011.

Along with measuring ΔG, the ATROPATENA stations simultaneously register variations in time of relative values of gravity Δg, using a microgravimeter installed inside the vacuum tank. Δg values are also measured in arbitrary units to facilitate research. If necessary, the measured Δg values can be converted to mGal.

Experiment participants

Among the participants of the experiment were organizations – full members of the Global Network for the Forecasting of Earthquakes (GNFE, London, UK, www.seismonet.org): Scientific Research Institute of Prognosis and Studying of Earthquakes (Baku, Azerbaijan), Center For Earthquake Studies (Pakistan, Islamabad), earthquake forecast research group at the Government of the Yogyakarta Special Region (Yogyakarta, Indonesia), SETAC research and production company (Istanbul, Turkey), The Institute of Geophysics of the Ukrainian National Academy of Sciences (Kiev, Ukraine).

Measurement results

The measuring done with the ATROPATENA stations located in Yogyakarta, Indonesia (station 1); Islamabad, Pakistan (station 2); Baku, Azerbaijan (station 3) and Istanbul, Turkey (station 4) have revealed that all stations registered intense gravity anomalies (deviations from the gravitational constant G) starting from the second and third digit after the decimal point, Figure 3.

Figure 3 shows records (gravitograms) of all ATROPATENA stations on three channels. On March 7-8, the first-channel gravitogram of the station 1 recorded three gravity anomalies located next to each other and marked 1,2,3 followed by a period with no anomalies until March 13, 2011. Starting from March 13, the station went on recording intense gravity anomalies marked 4,5,6. The second and third channels also registered intense gravity anomalies before (March 7-8) and after the earthquake, from March 13. A characteristic feature of the station 1 gravitogram records is the presence of a pronounced period of the constant gravitational field from 13:58 on March 7 to 6:12 on March 13, 2011 designated as an area "A" during which the gravitational field was stable. So,

the gravity anomaly before the Japanese earthquake was registered by the station 1 (Indonesia) three days before the shocks. We have identified a similar area "A" for a relatively stable period of the gravitational field on all gravitograms from all other stations 2-3. As seen in Figure 3, the area "A" is gradually shifting to the right as the distance between the stations and the earthquake's epicenter grows. In our view, the anomalies 1 and 2 are associated with two strong foreshocks with magnitudes 7.2 and 6.3 which occurred on March 9 in the epicenter area of the Japanese earthquake, preceding the strong earthquake of March 11. The gravity anomalies 4-6 are associated with strong aftershocks following the main shock. Due to the large number of strong aftershocks (38 aftershocks with magnitude over 6 from 11 to 17 March 2011 according to USGS), we have been unable at this stage of investigation to identify the registered anomalies with specific aftershocks. Therefore in Figure 3, only identified anomalies' numbers are shown.

The station closest to the epicenter is station 1 in Indonesia (5,950 km), followed by station 2 in Pakistan (6,150 km), station 3 in Azerbaijan (7,650 km), and the station farthest from the epicenter is station 4 in Turkey (9,020 km). Analysis of the records shows that the frequency attribute of the anomalies depends on the distance from a station to an earthquake's epicenter. The highest-frequency anomalies were registered by the Indonesian station – Figure 3 (1), the frequencies of the Pakistan station-recorded anomalies are comparatively lower – Figure 3 (2). The station in Azerbaijan registered anomalies with longer periods and a lower frequency than those in Pakistan – Figure 3 (3).

The lowest-frequency records were registered by the Turkish station – Figure 3 (4). The gravitograms in Figure 3 (1) and 3 (2) reveal all gravity anomalies 1-6. In the gravitogram shown in Figure 3 (3), only anomalies 1 and 3 on the second channel of the station 2 are identified. Anomalies 1-3 and 4-6, in our opinion, can be merged into a single anomaly with a long period as a result of the attenuation of high frequency components at great distances from the epicenter of an earthquake. In the gravitogram shown in Figure 3 (4), the anomalies 1-3 we have identified are merged into a single large anomaly due to the attenuation of high frequency components. Region "A" on different gravitograms is shown as higher or lower values of the gravitational field, which is related, in our view, to different orientations of the Cavendish balance toward the earthquake's epicenter. The shift in the starting time of registration of the region "A" toward increasing is clearly recorded as the distance between the stations and the earthquake' epicenter grows. This may indicate wave-like behavior of the geological factor that causes gravity anomalies.

Parameters of tectonic waves

For a more detailed examination of the displacement of the identified gravity anomaly at stations 1-4, let us have a look at the graphs in Figure 4. For comparison purposes, we have used the channels which best demonstrate the nature of the identified anomalies. Figure 4 shows the shift of the region "A". We have chosen to study the dynamics of anomaly 3 which was registered immediately before the main shock. In our opinion, it is this anomaly that was a harbinger of the main shock since the registration of anomaly 3 was followed by a period of calm, that is, the region "A" during which the catastrophic earthquake of March 11 occurred.

Below is given Table 1 with initial times of registration of the gravity anomaly 3, shown in Figure 4.

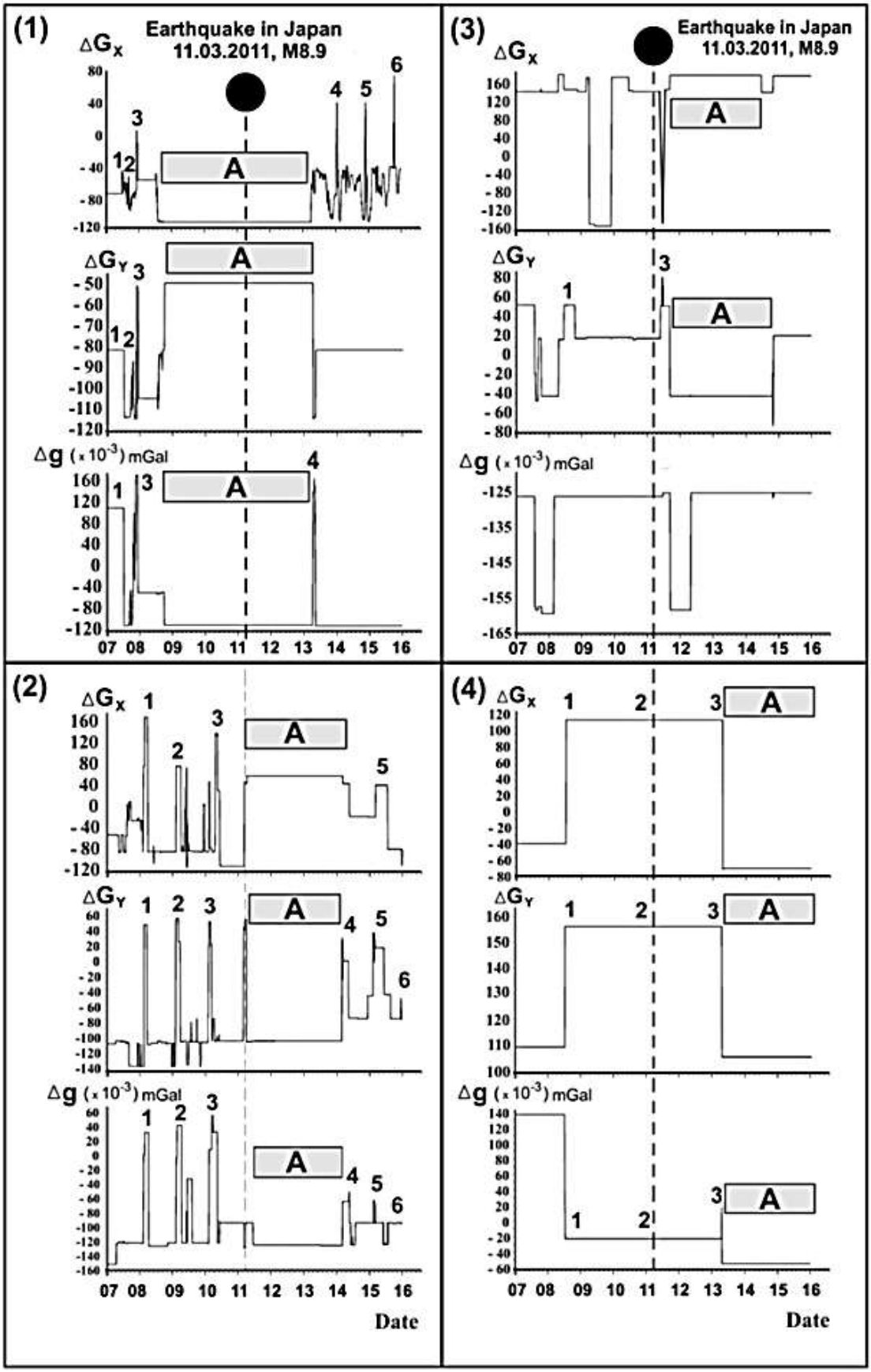


Fig. 3. Records of ATROPATENA stations from 07 to 16 March, 2011
(1); (2); (3); (4) are station numbers; A is the constant gravitational field area

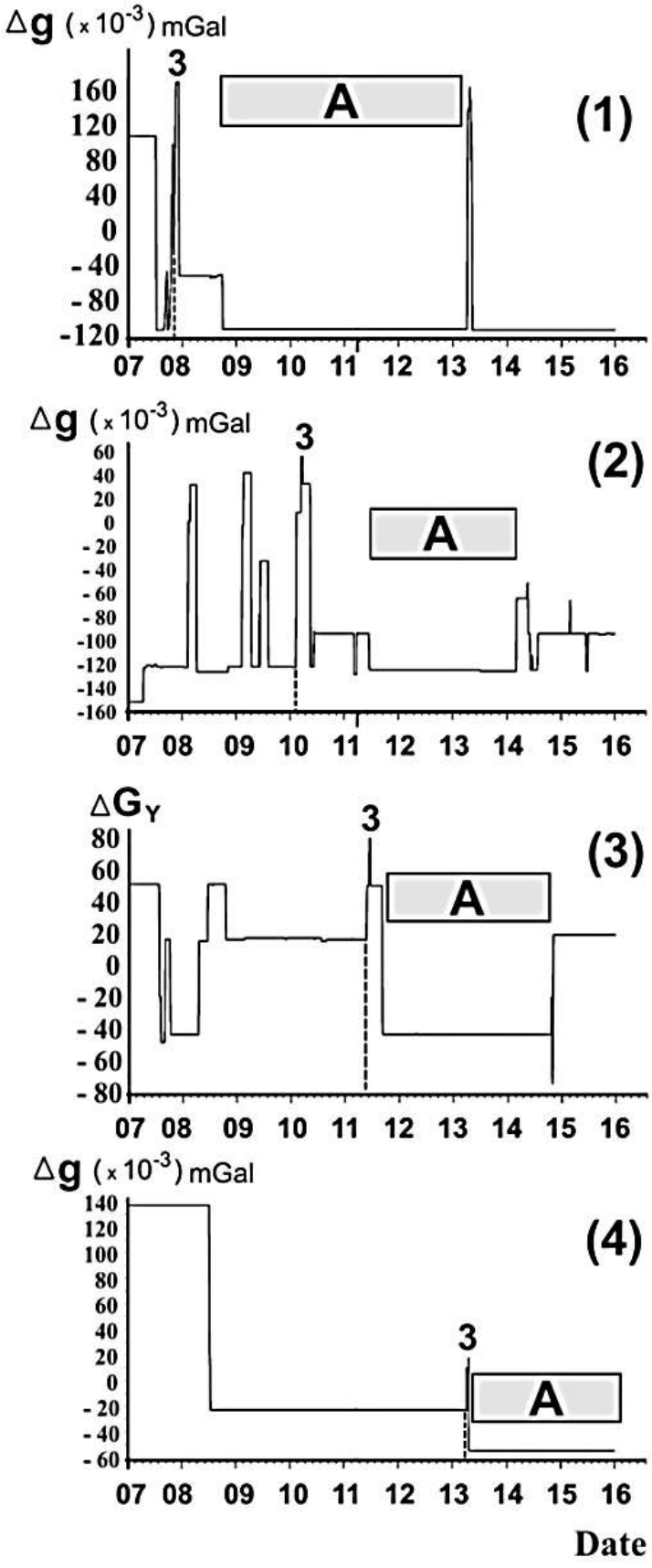


Fig. 4. Stations' gravitogram records
(1) – station 1, third channel; (2) – station 2, third channel; (3) – station 3, second channel; (4) – station 4, third channel; F – anomaly immediately preceding the region A.

Table 1

Station (name and number)	**Region (name)**	**Distance between station and epicenter (km)**	**Date and time of registration of anomaly beginning (dates, hours, minutes)**	**Channel (number)**
ATROPATENA – ID, station 1	Indonesia, Yogyakarta	5950	07.03.2011 20:57	3
ATROPATENA – PK, station 2	Pakistan, Islamabad	6190	10.03.2011 03:35	3
ATROPATENA – AZ, station 3	Azerbaijan, Baku	7650	11.03.2011 8:58	2
ATROPATENA – TR, station 4	Turkey, Istanbul	9020	13.03.2011 06:22	3

As seen from Table 1, the greater is the distance between the recording stations and the earthquake's epicenter, the longer it takes to register the anomaly's initial time.

Consecutive recording of the identified anomaly 3 at all four stations 1-4 makes it possible to calculate the velocity of the anomaly's movement between the stations. Knowing the distance between the stations and the time difference between the initial registrations of the gravity anomaly immediately preceding the region "A", one can calculate the speed of tectonic waves according to the formula: V = S/t, where V is velocity, S is the distance between the stations and t is the difference between the initial times of recording of the gravity anomaly 3.

We have calculated thus the velocity of tectonic waves travelling all the distance from station 1 to station 4. The results obtained reveal a big difference (about 6.5-10 times) in velocities between stations 1-2 and between stations 2-3-4. How can this result be explained ?

Since we do not know the exact time when emission of tectonic waves from the focus of an imminent earthquake begins, the observed picture can be logically explained by the fact that the velocity of tectonic waves moving from the earthquake epicenter to station 1 must be substantially higher than the velocity of tectonic waves moving to station 2. This is based on the fact that while travelling from Japan to Indonesia, the tectonic wave propagates in the crystalline basaltic stratum of the Pacific plate where the wave speed is much higher than the speed of wave propagation within the continental crust of the Eurasian plate. The average velocity of longitudinal seismic waves in the sedimentary layer varies from 1,3 to 3,7 km/s; it is 6,2 km/s in the granite layer and between 7,2 and 7,8 km/s in the basalt layer. As the stations register gravitational effects on Earth's surface, it is obvious that they have to deal with velocities in the uppermost layer. In the young oceanic crust of the Pacific lithospheric plate, the sedimentary layer is very thin (tens to hundreds of meters) and its impact can be neglected. Taking the average speed for the sedimentary layer as 2,5 km/s and for the basalt layer as 7,5 km/s, we can calculate the speed ratio: 7,5 / 2,5 = 3. Given that the tectonic wave has the same nature as the seismic wave, one can use the analogy as to the difference in velocities of seismic waves for the sedimentary and basalt layers. So, it can be presumed that the tectonic wave covered the distance from the epicenter to station 1 three times faster than to station 2. In that case, the velocity of tectonic waves between stations 1 and 2 is 13.5 kmh. The analogy is quite rough since the tectonic wave has a much greater length and lower speed compared with the seismic one. As a result, the difference in velocities of tectonic waves in basalt and sedimentary layers may be higher. As we know the velocity of the tectonic wave, of great interest is the possibility of calculating its other key parameters, namely its period and length.

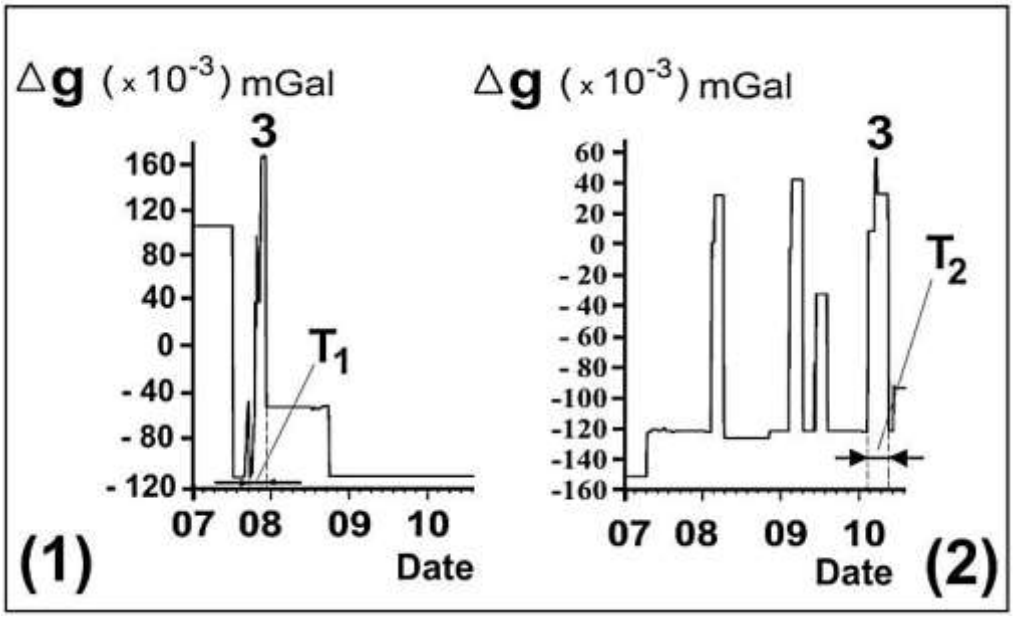


Fig.5. Determining tectonic wave period

Figure 5 shows how to determine the period of a tectonic wave. We identify the gravity anomaly 3 registered at stations 1 and 2 with a tectonic wave, so the anomaly periods T_1 and T_2 are taken as a basis for tectonic wave periods. Period $T_1 \approx 7$ hours and period $T_2 \approx 7$ hours and 12 minutes. Given that the values of the measured periods are similar, we shall accept $T \approx 7$ hours as a tectonic wave period.

We can determine the length of a tectonic wave according to the formula:

$$\lambda = VT$$

where λ is the wave length, V is velocity and T is the period. To calculate the wave length, we use the data of the measured periods and parameters from Table 2.

Results of the calculated velocity are given in Table 2.

Table 2

Stations compared (numbers)	**Distance covered by wave between stations (km)**	**Time difference between initial moments of anomaly registration (Hours:minutes)**	**Velocity of movement of tectonic waves between stations (kmh)**
1 and 2	240	54:38	≈ 4,5
2 and 3	1460	29:32	≈ 49
3 and 4	1370	45:20	≈ 30

The calculated parameters of the tectonic wave are given in table 3.

Table 3

Stations between which parameters of tectonic wave are determined (numbers)	**Inter-station travel velocity of tectonic wave (kmh)**	**Measured period of tectonic wave (hours)**	**Calculated length of tectonic wave (km)**
1 and 2	≈ 13,5	7	94,5
2 and 3	≈ 49	7	343
3 and 4	≈ 65	7	455

So the calculations showed that the lengths of tectonic waves before the catastrophic March 11, 2011 earthquake in Japan ranged from 94.5 km to 455 km.

There is no doubt that further investigation will give us more accurate results and enable us to better substantiate the parameters of tectonic waves. Meanwhile, this pioneering research has provided us with an idea about rough parameters of tectonic waves emitted by the focuses of upcoming strong earthquakes.

Possible physical model

What physical model of manifestation of gravity anomalies can be considered for these experiments? Currently, in our view, the most optimal is the model based on emission of slow stress waves (tectonic waves) from the focus of an imminent earthquake immediately before the shock. The possibility of existence of slow mechanical waves in the lithosphere has been shown theoretically in the works (10, 11) and other studies. Subsequent research and works by E.N.Khalilov (12) corroborate the generation of these waves by the focuses of imminent strong earthquakes and possibility of recording them with the use of the Cavendish balance.

Besides, there are some features in the ATROPATENA station records that can be indirect evidence of the wave origin of the observed gravity anomalies:

1. Before the powerful earthquake in Japan on March 11, 2011 all ATROPATENA stations recorded identified intense gravity anomalies. With the recording stations getting farther from the earthquake's epicenter, the date and time when the initial record for the gravity anomaly was written shift forward.

2. As the distance between the recording station and the earthquake's epicenter grows, less high-frequency gravity anomalies and appearance of low-frequency anomalies can be observed. Records from station 1, Figure 3 (1), reveal signals with the highest frequency. In station 2 records, Figure 3 (2), the anomaly period is appreciably larger. At station 3, Figure 3 (3), the observed record has an even lower frequency and merging of some high-frequency anomalies can be noticed. Finally, only very low-frequency anomalies are seen in the records of station 4, Figure 3 (4). This pattern of frequency change in the station records may be indicative of the attenuation of high-frequency components of the wave as the distance from the epicenter increases and of the predominance of low-frequency components at a maximum distance from the epicenter, which is a characteristic feature of wave-like processes.

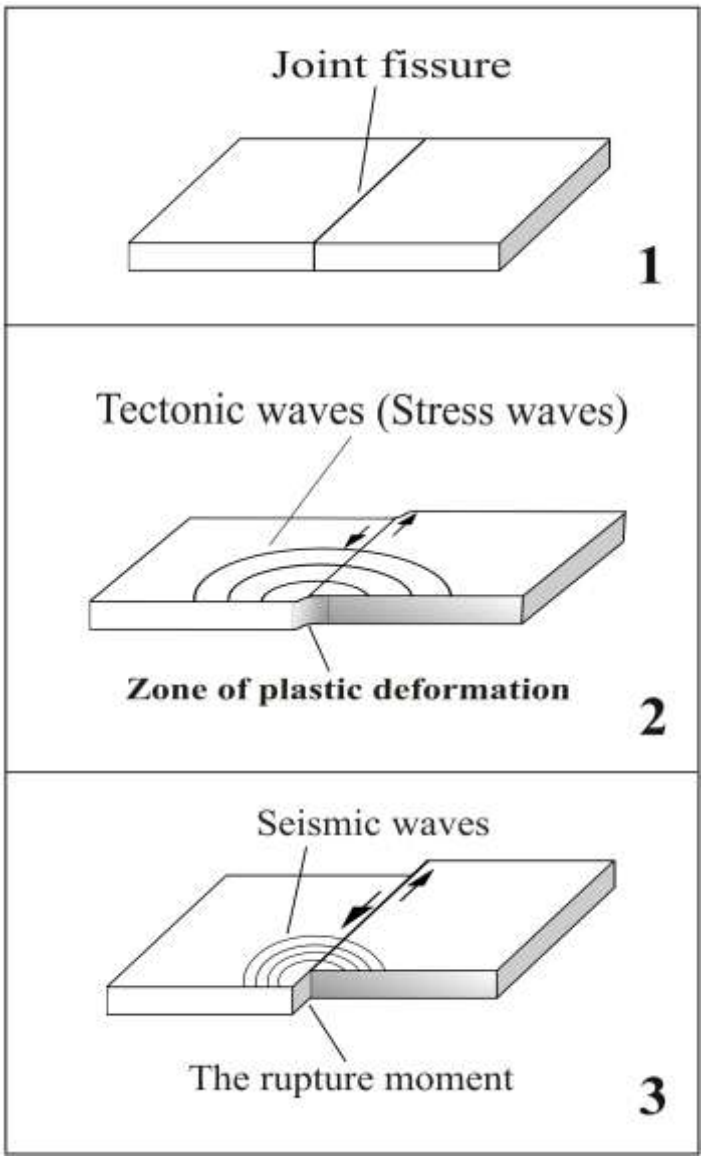


Fig. 6. Tectonic wave generation model
1 - crust fragment with a fissure; 2 - movement of crust blocks along the fissure at the moment of plastic deformation; 3 – moment of rupture and movement of tectonic blocks along the fissure

Let us consider the process of rupture of a crust fragment during the motion of tectonic blocks along the fissure plane as a possible model for the generation of tectonic waves before strong earthquakes. Figure 6.1 shows a fragment of the Earth's crust with a fissure before the deformation process. Figure 6.2 pictures the moment when crustal blocks move relative to each other on the fissure plane at the time of plastic deformation. Plastic deformation precedes the rupture of a continuous medium and is accompanied by alternating voltage which can be a source of stress waves or tectonic waves. At a certain moment of plastic deformation and motion of tectonic blocks, the breaking point for crustal blocks' adhesion strength is reached, followed by a rupture and abrupt movement of the crustal blocks leading to emission of tectonic waves and an earthquake as shown in Figure 6.3. Given that the plastic strain rate is much lower than the rate of motion of the tectonic blocks at the moment of rupture, in the plastic deformation zone there can be formed slow mechanical waves, that is, tectonic waves (stress waves). Plastic deformation of a medium is accompanied by destruction processes, forming of minor cracks which grow and join together as the deformation continues. The formation of cracks leads to emergence of low-frequency seismic waves. This process can be detected by seismic stations, but these waves decay rapidly at a short distance from the hypocenter due to the low energy. That is why station 1, the closest to the

epicenter of the Japanese earthquake of March 11 registered high-frequency oscillations which were decaying with the increasing distance from the epicenter. Stations 2-4 more distant from the epicenter could only record very low-frequency components of the tectonic wave spectrum.

Conclusions

The conclusions drawn by the authors can be divided into two categories: experimental results and the model proposed by the authors.

Experimental results:

- To monitor spatio-temporal variations of the gravitational field, special detectors named ATROPATENA stations have been developed and made. The detectors continuously measure the value of the gravitational constant G in mutually perpendicular directions and relative values of gravity $\Delta\mathbf{g}$.
- Before and after the strong magnitude 8.9 earthquake which hit the Honshu island of Japan on March 11, 2011, variations of the Earth's gravitational field were registered at large distances from the epicenter (up to 9,000 km); they were measured with the ATROPATENA stations in the following locations: Yogyakarta (Indonesia), Islamabad (Pakistan), Baku (Azerbaijan), Istanbul (Turkey).
- Indications of the Cavendish balance when measuring the gravitational constant G are influenced by spatio-temporal changes in external gravitational fields of geological origin, which alter over time indications of the true values of G.
- Measuring the true value of the gravitational constant G on the Earth's surface with accuracy greater than the second digit after the decimal point is not possible due to the spatio-temporal variations of the gravitational field as a result of the impact of geodynamic processes.
- For the first time, the true cause of variations of the recorded values of the gravitational constant G has been identified. These variations were the subject of scientific dispute throughout the last century.

Model:

The authors propose a model of emission of slow tectonic waves (stress waves) in the focal region of an imminent earthquake as a result of plastic deformation of crustal layers immediately before the rupture (abrupt displacement). Tectonic waves are a sort of mechanical waves, altering the density of crust layers in the motion process. Alternating changes in the density of the crust layers lead to periodic changes of the mass and, as a consequence, of the gravitational field within the front of the tectonic wave. The monitoring of spatio-temporal changes in the gravitational field can be carried out using special devices consisting of the mutually perpendicular Cavendish balance and gravimeter. This analysis is preliminary and we are going to carry out further and deeper examination of records of all ATROPATENA stations before and after the catastrophic earthquake in Japan on March 11, 2011. Joining all ATROPATENA stations into a single information structure has made it possible to build a global network for geodynamic monitoring and short-term prediction of earthquakes and its constituent system of earthquake forecasting, which is GNFE (12).

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"ArkNow" SOCIAL NETWORK FOR PREPARATION OF THE POPULATION FOR NATURAL DISASTERS

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Natural disasters, in most cases, are the most dangerous because of their suddenness. World practice shows that it is the beginning of an event when natural disasters cause the maximum casualties and damage. During large-scale natural disasters, emergency services, even in very well-prepared countries are not able to instantly access all emergency areas. The limited technical and transport resources, destruction of roads, communications, energy communications, bridges, etc. become a serious obstacle to rapid response and effective measures to save lives. Under these conditions, the most effective factor is the preparedness of the population for self-survival. People caught in an emergency often panic and simply do not know what to do.

Early acquisition of required knowledge to prepare the public in advance, including psychological preparation, to independently counter possible natural disasters can be safely put in the ranks of the primary tasks of the international community. However, experience shows that most people do not want to spend their time on attending special training courses. In addition, there are no uniform international guidelines and training programs to prepare the public to confront natural disasters. Currently, the most complete and effective instructions for preparing population

for natural disasters are given on the FEMA website (US). Therefore, first of all it is necessary to develop unified international regulations for the preparation of population to act correctly before, during and after natural disasters. This question, in our opinion, should be decided at the UN level. The second, equally important task is to adapt these instructions for different age groups and social strata. For example, for children in nursery and elementary schools, university students, instructions must be written in an understandable form for each age group and their detail and complexity must increase for high school students and employees of companies and enterprises.

It is necessary to adopt specific international and national laws obliging all types of schools and pre-school educational institutions to include instructions for preparations for independent actions before, during and after emergencies in education and training programs.

Administration of all companies and institutions should be required to organize in a mandatory manner trainings to prepare employees for self-survival during natural disasters.

It is necessary to launch an international multilingual TV channel that would air educational films, provide necessary information, train viewers online to act before, during and after disasters. By a UN decision, this TV channel should be required to be broadcast in all countries.

This is a huge job that requires an immediate start to be implemented.

Active development of social networks and other types of online communities has showed their extremely high efficiency for the formation of public opinion and transfer of necessary information to many people in the shortest time possible. Therefore, in our view, it would be very effective to use this experience to prepare the world's population for self-survival during natural disasters and other emergencies.

An example of the first attempt to create an Internet community to prepare of the world's population for natural disasters is the specialized social network ArkNow.net (www.arknow.net) established in 2011 following an initiative of the International Committee GEOCHANGE on Global Geological and Environmental Change (Germany), World Organization for Scientific Cooperation WOSCO (Germany) and Global Network for Forecasting of Earthquakes GNFE (UK).

The goal of the Social Network "ArkNow" (ArkNow.net) is to create an informational and social environment to reduce risks and negative effects of natural disasters on humans.

Objectives of the Arknow.net are:

Providing information about all natural disasters occurring in the world:

Creating informational opportunities for cooperativeness among the ArkNow.net members;

Providing knowledge on how to act in the event of natural disasters;

Giving the chance to send urgent information to international and national rescue services;

Creating an opportunity for people to share their experience of survival and rescue with each other;

Making it technically possible for each ArkNow.net member to transmit online video and photo images from a disaster zone to the ArkNow.net online television system "I See" using various technical appliances (web-cameras, mobile phones, professional camcorders etc.)

Creating a technical opportunity for ArkNow.net members to transmit information from disaster zones to be placed in the SOS information section;

Giving unbiased commentaries on the occurring natural events from independent professional experts;

Providing information on the latest technologies for protection and rescue of people during natural disasters and on personal protective equipment.

Such social networks need to be supported by authoritative international organizations and governments for rapid and effective development.

NATURAL CATACLYSMS AS A GLOBAL FACTOR OF INFLUENCE ON THE WORLD ECONOMY

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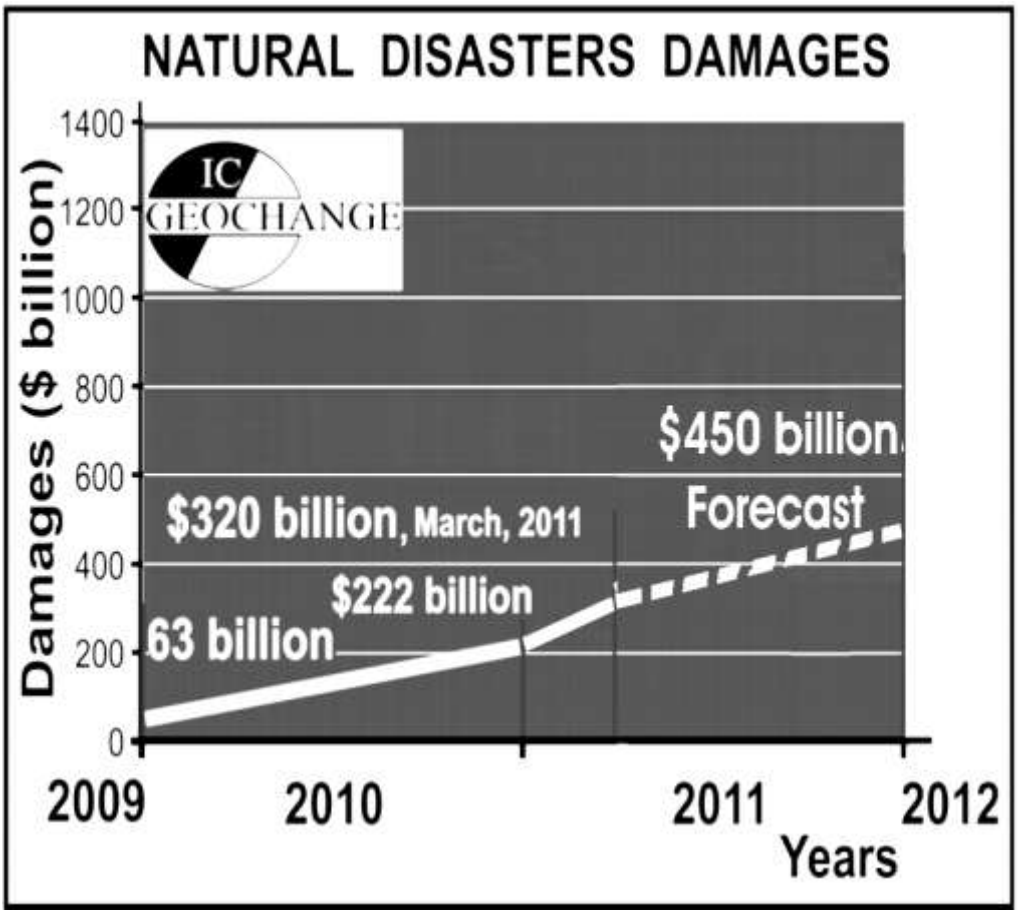
Natural cataclysms have a devastating effect on the stable development of the world economy, causing enormous economic damage to countries in which they occur.

Disregarding the significant impact of natural factors on the global economy during the sharp increase in the number and energy of natural disasters can greatly exacerbate the negative developments in the global economic system.

Analysis of the growth dynamics of the economic damage caused by natural disasters leads to very disappointing conclusions. If the economic losses from natural disasters in 2009 totaled $ 63 billion, according to the largest Swiss insurance company Swiss Re, in 2010 they amounted to $ 222 billion, three times the economic loss for the year 2009. Meanwhile, economic losses from natural cataclysms in the first quarter of 2011 alone exceeded $ 320 billion, most of which related to the economic damage inflicted on Japan by the strong earthquake with M8.9 and devastating tsunami that occurred March 11, 2011. The direct economic damage alone caused to the Japanese economy is $ 280-309 billion.

By 15 September 2011, the global economy's losses from natural disasters according to the lowest estimates by the International Committee GEOCHANGE have exceeded $ 400 billion. This figure takes into account the economic damage inflicted on the Japanese and world economy as a consequence of the catastrophic earthquake and tsunami, from March to September 15, 2011. If the trend for the number and energy of natural cataclysms to grow continues, by early 2012 the world economy will suffer disaster losses exceeding $ 450 billion.



Conclusions and suggestions

- In the first place, the negative impact of natural disasters affects the insurance sector, involving the global banking system and destabilizing thus the entire global financial system.
- Taking into account the observed tendency of the significantly increased number and energy of natural disasters worldwide, appropriate preventive measures must be taken to stabilize the world economic system. For this purpose, it is suggested that UN-sanctioned international legal norms and laws be developed and adopted to effectively coordinate both the insurance sector and the entire global financial system in times of large-scale natural disasters. It is necessary to improve the international legal rules governing the provision of financial support and humanitarian aid to countries and regions affected by natural disasters.

SEISMICITY AND SEISMIC PROTECTION IN UKRAINE

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Experience of catastrophic earthquakes that occurred one after another in Haiti 12/01/2010, with Mw = 7.0, in Chile 01/12/2010 with Mw = 7.0 and in Japan 11/03/2011, with Mw = 9.0, makes seismologists to re-evaluate their effects and to compare the situation with the seismic protection in these countries with the situation in Ukraine. These earthquakes are confined to the powerful seismically active zone of the planet. Earthquake 11/03/2011 in Japan, with Mw = 9.0 is one of the biggest destructive event at the last time not only in Japan but in the world.

Seismologists have to pay attention of this global disaster. The seismogram of this earthquake that occurred at 05:46:23 UTC Near East Coast Honshu and was recorded at Kiev IRIS station (Kiev, Ukraine) is shown in Fig. 1.

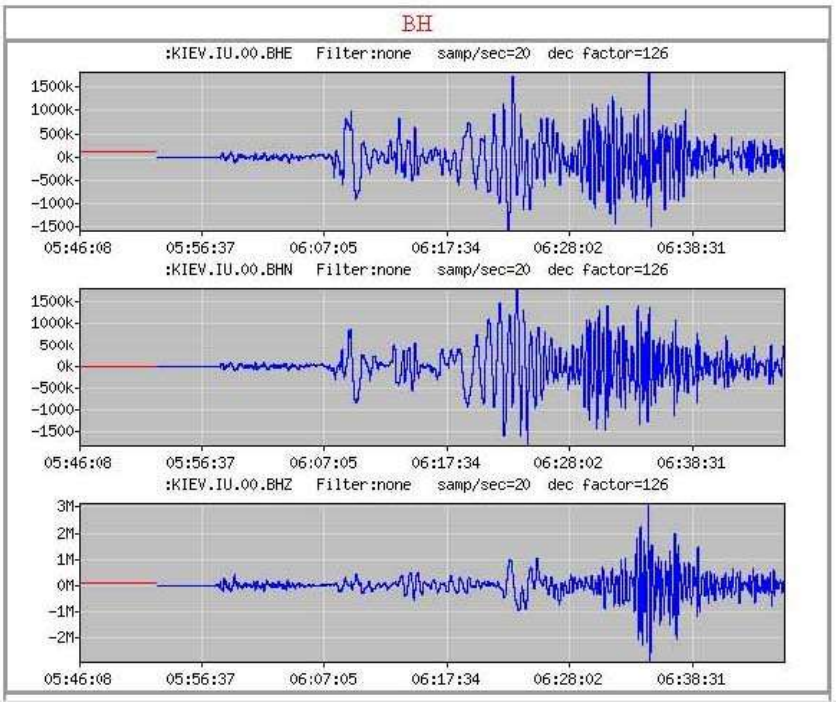

Fig. 1. The wave form recorded at Kiev IRIS station (Kiev, Ukraine) of 11.03.2011 earthquake in Japan with Mw = 9.0, $\Delta=73.84^0$, h=21.9 km, $\varphi=38.29^0$N and $\lambda=142.49^0$E.

Unfortunately, as seen from a comparison of two maps, presented in Fig. 2 of Maximum seismic hazard (MSH) map of the territory near east coast Honshu [1], the intensity of seismic manifestations of the earthquake was, in fact, higher than predicted by seismologists to map of the Japan MSH.

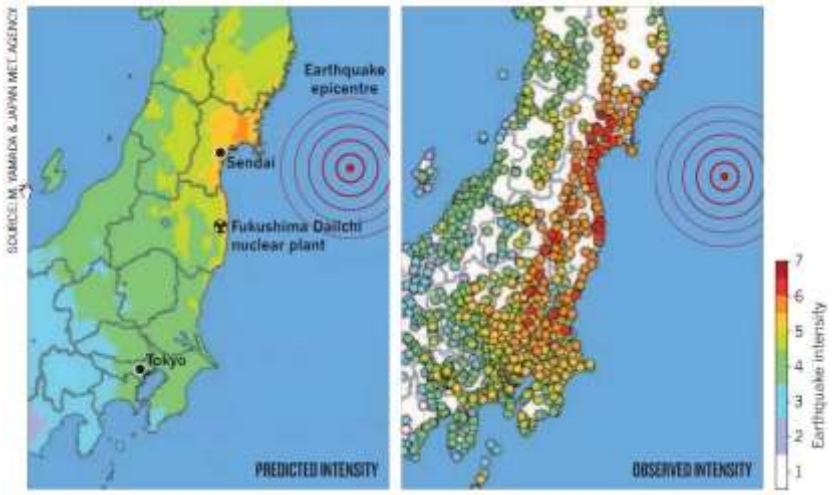

Fig. 2. a) predicted maximum intensity seismic hazard map near east coast Honshu in Japan, b) the observed intensity data map for earthquake that occurred at 05:46:23 UTC 11/03/2011 [1]

We have to note, that Japan catastrophic earthquake was happened in the world active tectonic belt associated with the zone of collision of the thin Pacific Plate with the Eurasian Plate, as seen in Fig. 3, where Japanese seismologists estimated rupture zone and mechanism of earthquake preparation [2,3].

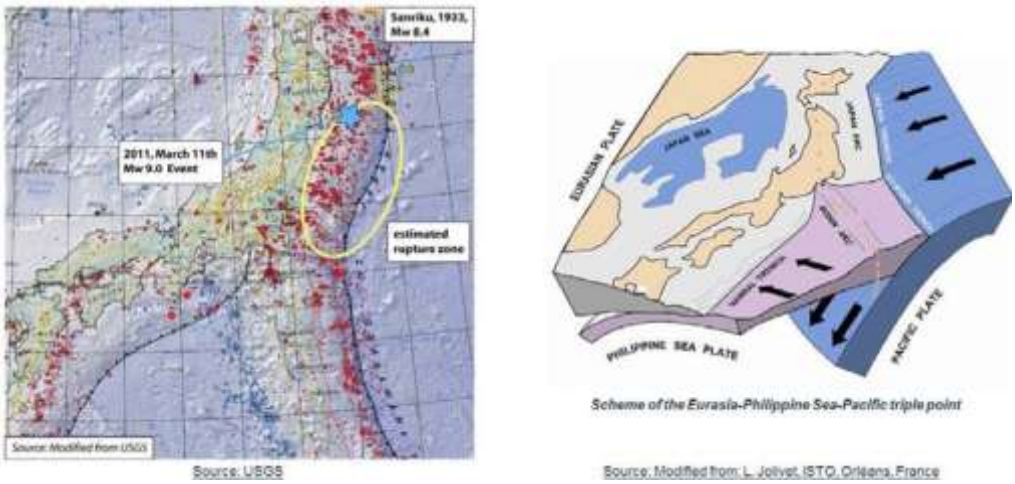

Fig. 3. The seismic map of estimated rupture zone of the thin Pasific Plate collision with the Eurasian Plate and the origin of 11.03.2011 earthquake. In the right side of figure the scheme of the Eurasia-Philippine-Sea-Pacific triple point is shown [2, 3]

Earthquake in Haiti, as seen in Fig. 4 [4], occurred within a seismically active zone associated with the zone of collision of the Caribbean plate with the South America plate. The earthquake near Chile is with the feat of the Nazca plate under the South American continental plate. In both cases, the earthquake occurred in areas where strong seismic events are not uncommon, which made seismologists and leadership of both countries in advance to shape up for strong earthquakes.

Evidently, as seen from a comparison of maps of general seismic zoning (GSZ) of the territory of Haiti, presented in Fig. 5 [6], and maps of macroseismic manifestations of the 01/12/2010 earthquake, as presented in Fig. 6 [7], the intensity of seismic manifestations of the earthquake was, in fact, higher than predicted by seismologists to map of the Haiti GSZ.

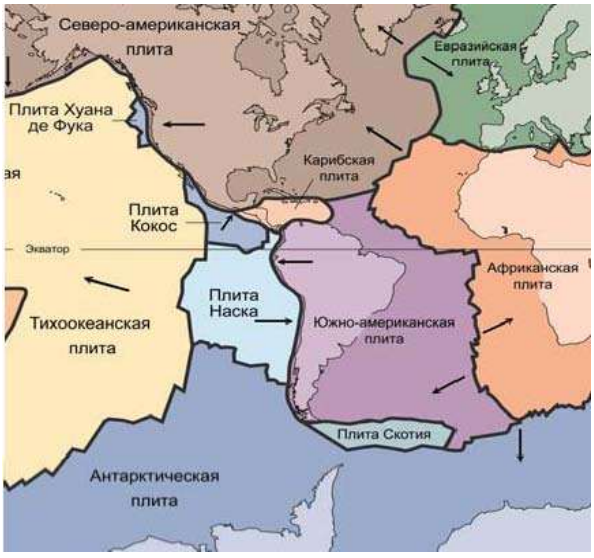

Fig. 4. Lithosphere plates in the western hemisphere of the Earth (clipping from maps of [5])

The level of projected acceleration of seismic vibrations The level of projectd acceleration of seismic vibrations on the map, which, with probability 90% will not be exceeded over the next 50 years, corresponds to the average acceleration of seismic vibrations in the 7-balls earthquake. In fact, during the 12/01/2010 earthquake, as seen in Fig. 6, in the Port-au-Prince capital city of Haiti were observed 9 balls macroseismic effects (on 12 point scale). Clearly, projected onto the 7-ball impact homes and buildings could not remain 9-balls intact.

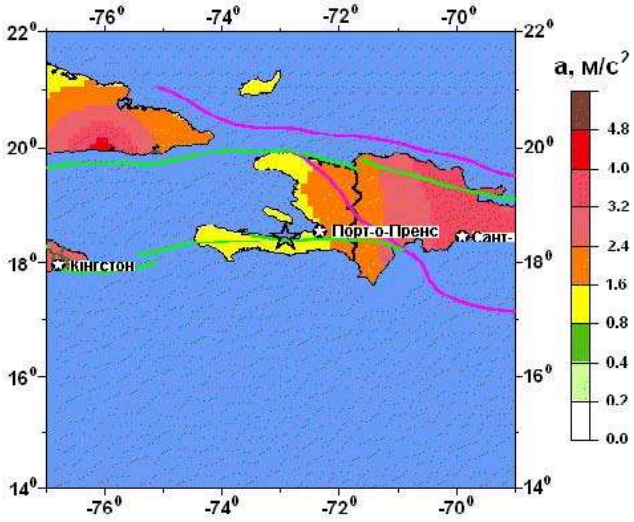

Fig. 5. General seismic zoning map of the Haiti island and the neighboring areas [6].
Color denotes the projected value of acceleration of seismic vibrations in m/s², which is likely 90% will not be exceeded over the next 50 years, which corresponds to the average period of occurrence of the maximum earthquake every 500 years

As a result, the main shock and several hundreds of aftershocks have killed more than 280 thousand people, several million people lost their homes and jobs. According to the Inter-American Development Bank's the losses caused by the earthquake could reach 14 billion dollars [8]. In addition, the experience of similar past disasters is well known that after their income level of the population is reduced on average by 30%, despite the assistance provided by the international community.

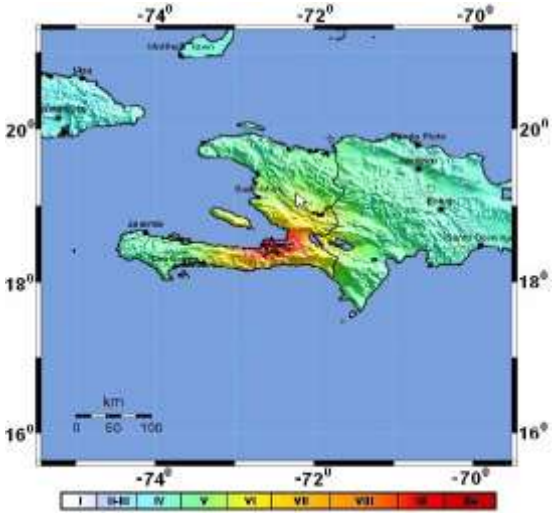

Fig. 6. Map of 01/12/2010 earthquake with Mw = 7.0 macroseismic manifestations on the Haiti island [7].
Color denotes the intensity of the recorded seismic tremors in the points of modified Mercalli scale.

The earthquake near the coast of Chile, was much more powerful, but according to official information, the number of its victims was much lower (780 people), primarily because the country for many years considerable attention devote for earthquake-protection design and construction, as well as for the protection from tsunamis. Especially intensive, this work is carried out after the 22/05/1960 quake with Mw = 9.5, which is considered as the strongest since 1900, when the registration of seismic events in the world have been widely used the instrumental techniques. Comparison of the earthquakes effects in Haiti and Venezuela shows the importance of properly assessing the level of Seismic risk of the sites of existing and planned buildings and structures.

Adopted at this time in the world the concept of seismic protection includes the need for protection from earthquakes by each investor, owner and developer who are building houses and industrial buildings in seismic zones. At the same time, it should be noted that self-investors, owners and developers are unable to obtain the seismological information about the magnitude of the parameters of the maximum seismic effects, which with a given probability of exceeding can be realized at the site of the existing or projected development, and is needed for its seismic protection. This task must be decided by the State. In particular, the Ministry of Regional Policy and the building of Ukrainian together with the National Academy of Sciences have developed and introduced into operation at 2007, State Building Codes B.1.1:12-2006 "Building in seismic regions of Ukraine" [9], where in Appendix A, the table of communities with specification of seismic shaking projected intensity, and in Appendix B – the general seismic zoning maps, which shows the predicted intensity of seismic shaking on a MSK-64 macroseismic scale, which is 90, 95 and 99 percent will not be exceeded over the next 50 years. In the main text of this document provides rules for the use of seismic data as well as rules for the protection of structures and buildings in the different seismic conditions [9].

The territory of Ukraine to the south and south-west is comprehended by the influence of powerful seismically active zone of the planet, which resulted from the collision of large tectonic plates: Eurasian, African, Arabian and Indian. The belt stretches from the Azores through the Mediterranean and Black Sea, Caucasus, Central Asia and further to the Hindu Kush, Tibet - the island of Sumatra, and further south, where it connects with the Pacific planetary seismically active zone. Influence from this zone extends to the western regions of Ukraine, Bukovina, and south-western part of the Odessa region, south of Mykolaiv, Kherson, Zaporozhye regions and the territory of Crimea. The belt includes the Carpathian arc with strong subcrustal earthquakes in the Vrancea area, which in the past 5 times shaken not only the territory of Ukraine, but even Moscow and St. Petersburg. Earthquakes in the territory of Ukraine were in the past, recorded by seismic stations and are felt by the people at present and, unfortunately, will be in the future. Seismic risk in Ukraine is high also because of insufficient knowledge of local seismicity and the understatement of the real seismic hazard assessment regulatory by document SNIP-II-7-81 "Building in seismic areas" [8], which operated in Ukraine until 2007. Determination of the real parameters of seismic hazard requires instrumental seismological observations of the local seismic activity and of the powerful remote seismic events. In the conditions of increasing anthropogenic loads and a significant depreciation of fixed assets in Ukraine the risks associated with the hazardous effects of earthquakes significantly increased, which, in turn, increases the level of technological risk in different sectors of the economy. Accompanied by faults, landslides, mudflows, tsunamis and other hazards, earthquakes can cause considerable material and social consequences.

In recent years, with a sufficiently short time intervals, there were a catastrophic earthquake (12.05.2008 in China with Mw = 7.8; 05.10.2008 in Kyrgyzstan with Mw = 6.6; 06.04.2009 in Italy with Mw = 6.3; 13/01/2010 at the Haitian with Mw = 7.0; 26.02.2010 in Japan with Mw = 7.2, 27/02/2010 in Chile with Mw = 8.8; 04.03.2010 in Taiwan with Mw = 6.4; 11.03.2011 in Japan, with Mw = 9.0 etc.), which led to deaths and huge financial losses. In most cases, the destruction of structures and buildings is due to underestimation of the real seismic hazard of areas. Losses from earthquakes can be substantially reduced with appropriate technical and organizational preparations for them. Properly determining the level of seismic hazard and its inclusion could to avoid casualties and material losses minimized.

In preparation for future earthquakes in the Ukraine it is current studies of the seismic resistance of existing buildings and structures in areas where the real seismic hazard on the new seismic GSM-2004 maps proved to be higher than specified on the regulatory CP-78 map [9] current up to 2007. The input data should serve on observations of local and teleseismic earthquakes at seismic stations located in studied areas, or as close as possible to them. The world's modern science-based concept of effective seismic protection include: the identification of quantitative parameters of real seismic hazard and risk reducing, the vulnerability of populated areas by improving the seismic resistance of existing buildings and structures, development and implementation of earthquake-resistant construction norms that meet the real seismic hazards, monitoring of seismic design and regular maintenance of buildings and facilities, raising awareness

by education and training, early warning of the emergence of a strong earthquake and rapid response, rehabilitation victim populations and areas; insurance against the effects of earthquakes.Experience in the field of seismic protection of such developed countries as Japan, USA, Canada, France, Italy and others, shows that the basis of seismic protection in Ukraine should be the introduction of earthquake-resistant design and construction of housing and industrial facilities on the basis of objective knowledge about the quantitative parameters of real seismic hazard in their areas of deployment and on concrete construction sites.

Knowledge of the real seismic hazard, along with reliable data on the seismic vulnerability of structures is necessary for earthquake resistant design and develops measures to reduce the seismic risk. The main link, which provides objective data for activities of protection against earthquakes, is seismic observations. Institute of Geophysics of NAS provides activity of a seismic stations network, which actually performs the role of the national seismological network for providing information for all seismic protection works. The network provides standardized data on seismic manifestations on the territory of Ukraine. On these data the evidence-based forecasts of seismic hazard values are determined. It is necessary for central and local authorities to ensure the stable development of the seismic regions, as well as for the research institutes of other ministries and agencies working in related industries of earthquake-resistant design and construction.

According to the Cabinet of Ministry of Ukraine ruling from 28.06.1997, № 699 in the IGPh of NAS of Ukraine the National Center for Seismic Data and the two regional centers: Carpathians (Lviv) and Crimea (Simferopol), which continuously receives the data of instrumental observations from the seismic network and geophysical stations of Ukraine - are operate. At present, the observation network consists of 37 seismic and geophysical stations, including reference seismic station "Lviv", "Uzhgorod", "Mizhhirria", "Kosiv", "Kiev-IRIS», "Simferopol", "Yalta", "Sevastopol", "Rahov", "Kamianets' Podolsky, magnetic observatory Dymer", "Odessa", "Ivano-Frankove" and several regional stations. In 2009, opened two new seismic station: "Nicholaev" and "Shutskoe." Results of seismic observations are widely used in solving problems in key directions of fundamental research of IGPh of NAS: the study of the tectonics, structure, geodynamics, and evolution of continental and oceanic lithosphere; construction three-dimensional integrated geophysical and petrophysical models of geological structures in order to predict mineral development and introduction of new technological systems for processing and interpreting geophysical data; geophysical studies of the environment in order to predict seismic hazards and other threats to natural phenomena.

Geodynamic processes that are constantly changing stress-strain state of geological environment, not only in seismically active zones, but as it is now scientifically proven, in the territories of ancient platforms of planet, requires permanent monitoring tools.

The integration of seismic and other geophysical studies can learn communication geophysical fields with the preparation of strong earthquakes sources.

Conclusion

Earthquake-resistant design and development of anti-seismic measures require knowledge of the quantitative parameters of the real seismic hazard and seismic data on the vulnerability of structures. The main link supplying objective data for activities to protect against earthquakes are seismological observation. To obtain reliable baseline data is necessary to ensure the further expansion (increase in the number and uniformity of the distribution) network of seismic stations and its re-equipment by modern equipment and software.

At the state level is necessary to provide a centralized ordering and funding for the regular (once per 10 years) updating maps of general seismic zoning of the territory of Ukraine and for the improvement of regulations on earthquake-resistant design and construction, taking into account new data on the geodynamic situation in the country's territory and using new improved methods of quantification of real seismic hazard on the construction and maintenance sites.

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ASSESSMENT OF THE SEISMIC SITE EFFECTS BASED ON EARTHQUAKE RECORDINGS AND *IN SITU* BOREHOLE MEASUREMENTS IN BUCHAREST, ROMANIA

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1. SEISMIC MEASUREMENTS PERFORMED IN THE FRAME OF THE NATO SFP PROJECT 981882

The latest results in the shear wave velocity measurements were obtained in the frame of the NATO SfP Project 981882 in the years 2006-2007 and they were reported by [4] and [5], see Table 1. The mean seismic velocities computed for the 10 particular sites in Table 1 are representative values for the 6 types of Quaternary sedimentary layers in Bucharest City, the 10 sites being spread mainly in the city centre (see Fig. 1). The mean seismic velocities in the Table 1 can be correlated with averaged Vs values obtained by direct measurements and cited by other sources.

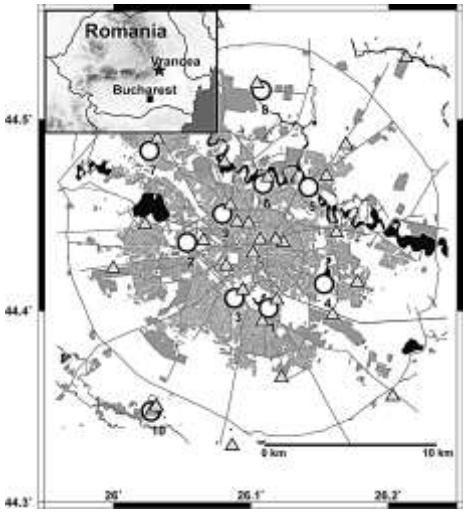

Fig. 1. Map with area under investigation. *The metropolitan region of Bucharest, Romania, is mainly inside the characteristic ring road with a diameter of about 20 km. Residential and industrial areas are indicated in grey; lakes, channels and rivers in black. The ten borehole sites are shown as circles and numbers which correspond with those from Table 1. Sites with broadband instruments during the URS experiment [6] (Ritter et al. 2005) are indicated with triangles.*

Mean weighted values for V_p and V_s are computed for each site (borehole) according to the following formula:

$$\overline{V}_S = \frac{\sum_{i=1}^{n} h_i}{\sum_{i=1}^{n} \frac{h_i}{V_{Si}}} \quad (1)$$

In equation (1) h_i and V_{Si} denote the thickness (in meters) and the shear-wave velocity (in m/s) of the *i-th* layer, in a total of *n* layers, found in the same type of stratum [2] and [7]. According to the same code, the weighted mean values $\overline{V}_S$, computed for at least 30 m depth, determine 4 classes of the soil conditions:

1. Class A, rock type: $\overline{V}_S \geq 760$ m/s;
2. Class B, hard soil: $360 < \overline{V}_S < 760$ m/s;
3. Class C, intermediate soil: $180 < \overline{V}_S < 360$ m/s;
4. Class D, soft soil: $\overline{V}_S \leq 180$ m/s;

All the $\mathbf{V_{S\text{-}30}}$ values in Table 1 belong to type C of soil after this classification, after [2] and [7].

Table 1.

Mean weighted seismic velocities for the first 6 (of 7 types) of Quaternary layers in 10 boreholes in Bucharest City. A description of the geologic layers is found in [8] and [9]

Geologic stratum type	1		2		3		4		5		6		
	Mean weighted seismic velocities [m/s]												
	Vp	Vs	Vp	Vs	Vp	Vs	Vp	Vs	Vp	Vs	Vp	Vs	V_{S30}
1.Tineret Park TINP	180	140	570	220	856	299	---	--	1666	398	---	---	*263*
2.Ecology Univ. EUNI	300	120	1180	220	1250	241	1610	354	1850	390	2042	401	*286*
3.Astronomy Inst. INAS	200	120	914	260	1200	330	1440	350	1900	390	2124	433	*283*
4.Titan2 Park TITAP	290	160	800	250	800	250	980	350	1576	381	1850	450	*299*
5.Motodrom Park MOTO	650	200	650	200	1320	320	1827	393	1980	410	2050	410	*288*
6.Student Park STUP	490	210	490	210	1361	342	1570	370	1607	375	1820	400	*295*
7.Bazilescu Park BAZI	500	160	500	160	1484	317	1850	390	2103	408	---	---	*294*
8.Romanian ShootingFed. FRTIR	670	210	1440	330	1440	350	1718	400	1900	400	---	---	*327*
9.Geologic Museum GEOM	340	180	1250	310	1511	322	1935	376	1950	380	---	---	*320*
10. NIEP site NIEP	370	250	1710	350	1710	350	1810	320	1739	337	2090	410	*326*
All sites.	*325*	*169*	*854*	*252*	*1243*	*320*	*1530*	*367*	*1832*	*386*	*2005*	*417*	

The mean weighted seismic velocities for the first 6 (of 7 types) of Quaternary layers were computed for all the 10 sites, in order to be compared with seismic velocity values obtained from previous seismic measurements and to be used as input for modelling with the widely applied program SHAKE 2000. Using SHAKE 2000 we compute spectral acceleration response and transfer functions for every site in which *in situ* measurements were performed. The acceleration response spectra correspond to the shear-wave amplifications due to the models of sedimentary layers down to: a). 50 m depth; b). 70 m depth; c). 100 m depth.

2. SPECTRAL ACCELERATION COMPUTED FOR 50 M DEPTH MODELS

Different methods of ground response analysis have been developed including one dimensional, two dimensional, and three dimensional approaches. Various modelling techniques like the finite element method were implemented for linear and non-linear analysis. Extended information on these analyses is given in [10] Here we apply an equivalent linear one-dimensional analysis, as implemented in the computer program SHAKE2000 [3]. The *static soil properties* required in the 1D ground response analysis with SHAKE2000 are: maximum shear wave velocity or maximum shear strength and unit weight. Since the analysis accounts for the non-linear behaviour of the soils using an iterative procedure, *dynamic soil properties* play an important role. The shear modulus reduction curves and damping curves are usually obtained from laboratory test data (cyclical triaxial soil tests). The variation in geotechnical properties of the individual soil layers should be assumed constant for each defined soil layer.

In-built shear modulus reduction curves and damping curves for specific types of layers are used in SHAKE2000 based on published geotechnical tests [3]. As input data the interval seismic velocities V_S (in m/s) as well as the natural unit weight (in kN/m^3) and thickness of each layer (in m) were used.

The recorded motion of the 27.10.2004 earthquake (Mw= 6) at K2 accelerometer station PRI in Bucharest was used as seismic input motion. All 3 components (one vertical and two horizontal components) were available. This accelerometer station is placed in the borehole near the City Hall site at 52 m depth. The strong motion PRI_EW (east-west component) was used for modelling as it was the highest signal from the two horizontal components. The strong motion was applied at the base of all geologic models constructed down to 50 m depth as "inside" motion.

The results of the linear modeling with SHAKE 2000 program for the 10 boreholes are presented in the Fig. 2 as graphs of spectral acceleration. In Fig. 2 the maximum values of the spectral accelerations occur around the 3 main the periods: T_1 = 0.13 s; T_2 = 0.2 s; T_3 = 0.55 s. The highest values occured at the period T_2 = 0.2 s, and they are between 0.22 g and 0.48 g. If we consider a comparison of the values at surface, they are between 0.22 g at Romanian Shooting Fed. (northern part of Bucharest) and 0.48 g (Ecologic Univ. in the central part of Bucharest), as it is shown in [1] and [11].

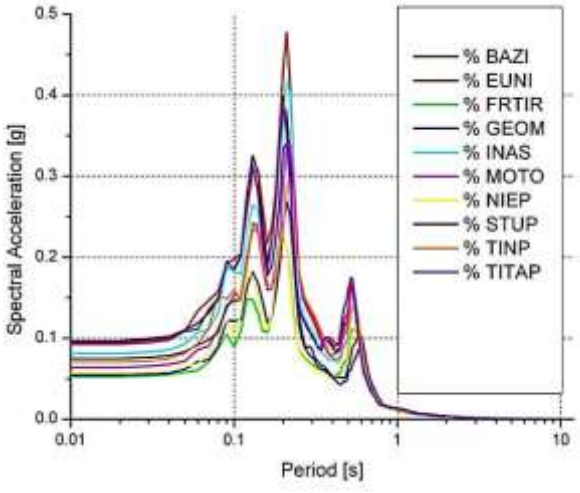

Fig. 2. Spectral acceleration response computed with the input strong motion PRI_EW for the 10 sites in Bucharest, down to 50 m depth

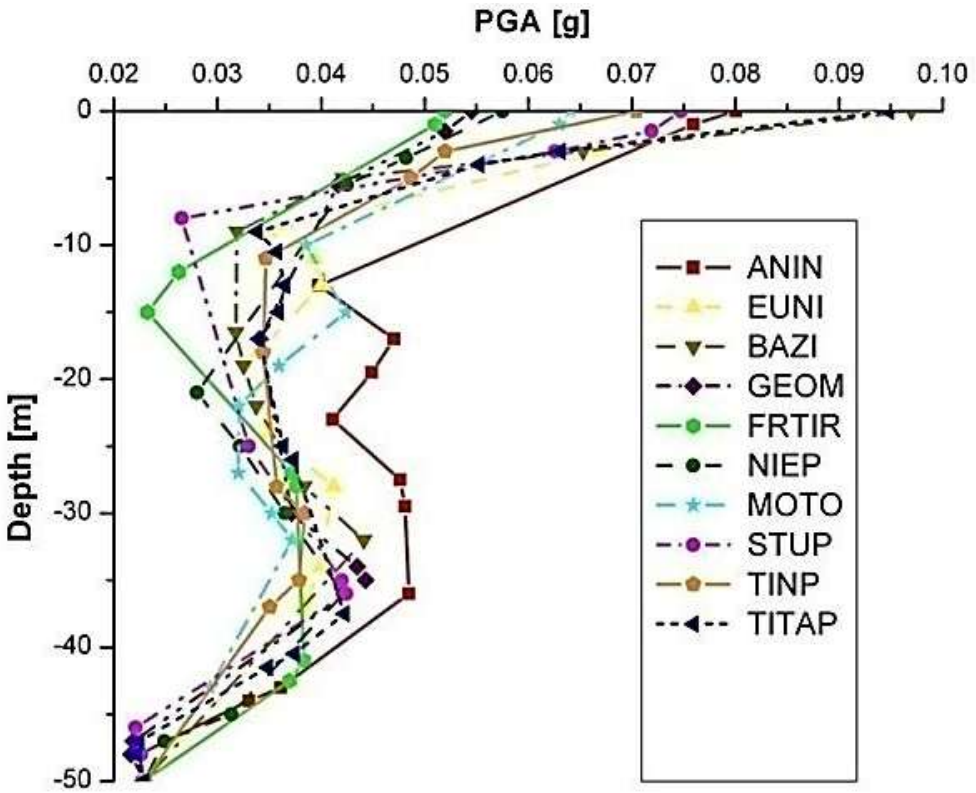

Fig. 3. PGA variation with depth as result from equivalent-linear modelling in the 10 boreholes in Bucharest, down to 50 m depth

The values of acceleration at surface are presented in the Fig. 3 and they are between 0.055 – 0.080 g for the first 7 out of the 10 boreholes. For the last 3 sites values as large s 0.08 – 0.095 g resulted from modeling (Ecologic Univ.; Titan 2 Park; Bazilescu Park). These high values are greatly influenced by the thickness of the Quaternary layers 1 and 2 from the surface and also by the physical and dynamic characteristics of all layers, [1] and [11].

3. SPECTRAL ACCELERATION GRAPHS COMPUTED FOR 70 M DEPTH MODELS

In the second stage the recorded motion of the 27.10.2004 earthquake (Mw= 6) at accelerometer station UTCB1 in Bucharest was used as seismic input motion. All 3 components (one vertical and two horizontal components) were available. This accelerometer station is placed in the borehole UTCB Tei site at 78 m depth. The strong motion TEI_EW (east-west component) was used for modelling as it was the highest signal from the two horizontal components. The strong motion was applied at the base of the geologic models constructed down to 70 m depth as "inside" motion. Spectral acceleration graphs for the 10 chosen models down to 70 m depth are presented in Fig. 4, as well as the spectral acceleration of the strong motion applied in the lower part of the figure.The spectral acceleration peaks values varies from 0.15-0.25 g at Student Park, Geologic Museum and F.R.Tir to 0.3 g at NIEP-Magurele in the south. Maximum values of 0.4 g are present at Ecologic Univ. and Titan2 Park, lower than the values obtained in the Fig. 2 for the 50 m geologic models. The variation of peak acceleration in the depth is presented in the Fig. 5 for the 10 sites and they are between 0.023 g (at 70 m depth) and it can reach 0.045 - 0.08 g at surface, lower than the maximum values presented in the Fig. 3 for the 50 m geologic models.

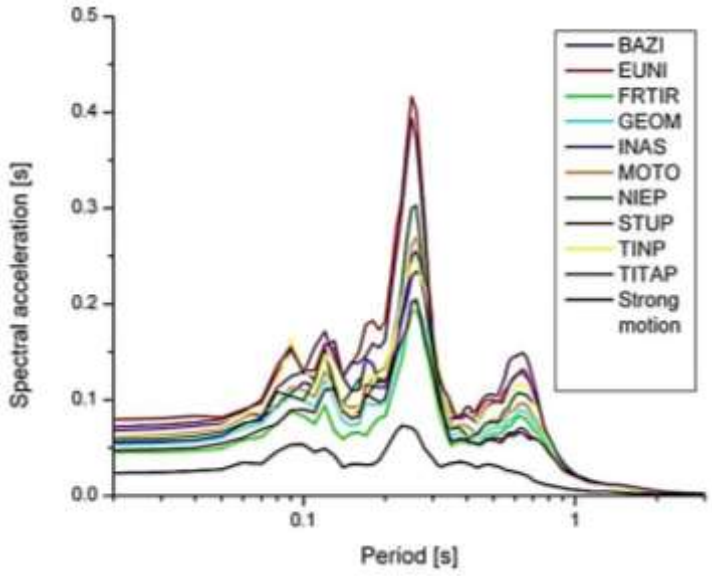

Fig. 4. Spectral acceleration response computed with the input strong motion TEI_EW for the 10 sites in Bucharest, down to 70 m depth

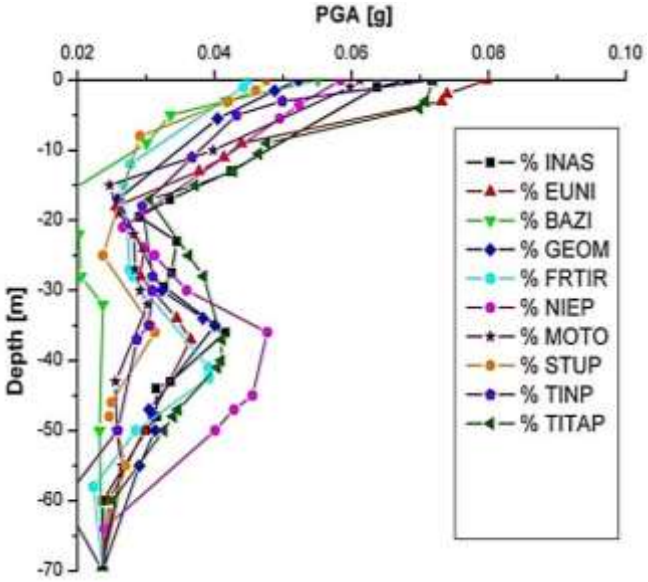

Fig. 5. PGA variation with depth as result from equivalent-linear modelling in the 10 sites in Bucharest, down to 70 m depth

4. CALIBRATION OF THE 70 M MODEL WITH A REAL SIGNAL RECORDED AT SURFACE

In Fig. 6 the spectral acceleration of the original strong motion recorded at 78 m (curve 2) and the resulting spectral acceleration obtained by modelling at surface (curve 1) are presented. The spectral acceleration of the strong motion recorded at surface in the same site (curve 3) is compared with the spectral acceleration obtained by modelling (curve 1) and a very good match is obtained, although the second has lower values especially around the first peak at 0.1 s.

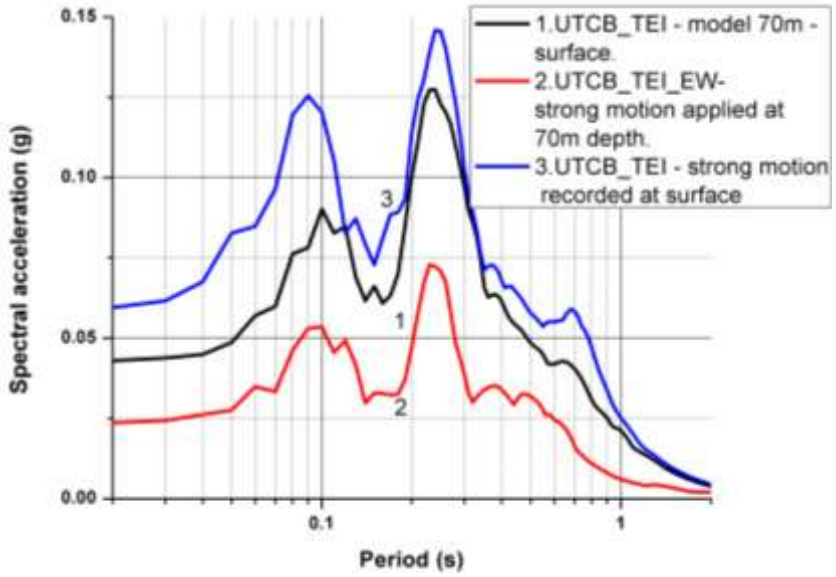

Fig. 6. UTCB(TEI_EW) Spectral acceleration calibration of the model 0 - 70 m (curve 1) with the signal recorded at surface (curve 3) in the same place

5. SPECTRAL ACCELERATION COMPUTED FOR 100 M DEPTH MODELS

In the third stage the recorded motion of the 27.10.2004 earthquake (Mw= 6) at accelerometer station INCERC in Bucharest was used as seismic input motion (BBI_EW, EW component. This accelerometer station is placed in the borehole at INCERC site at 140 m depth. The strong motion BBI_EW (east-west component) was used for modelling as it was the deepest recorded signal in a borehole. The strong motion was applied at the base of the geologic models constructed down to 100 m depth as "inside" motion. Spectral acceleration graphs for the 7 chosen models down to 100 m depth are presented in Fig. 7, as well as the spectral acceleration of the strong motion applied in the lower part of the figure.The spectral acceleration peaks values varies from 0.060 - 0.100 g at Bazilescu Park and Geologic Museum. Maximum values of 0.110 g are lower than the values obtained in the Fig. 4 for the 70 m geologic models.

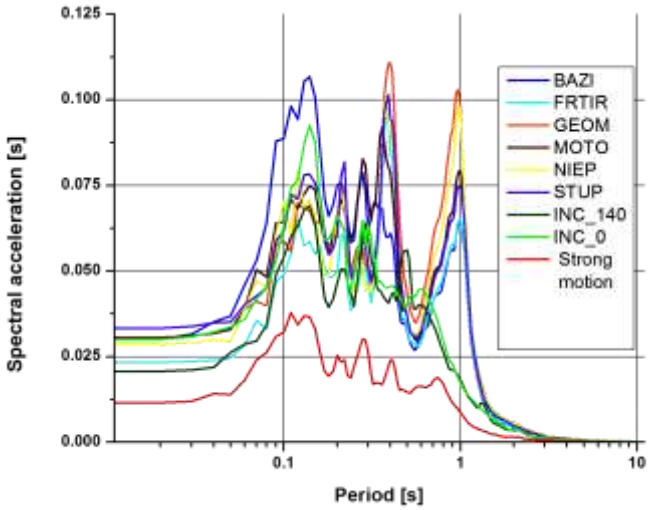

Fig. 7. Spectral acceleration response computed with the input strong motion INC_EW for the 7 sites in Bucharest, down to 100 m depth

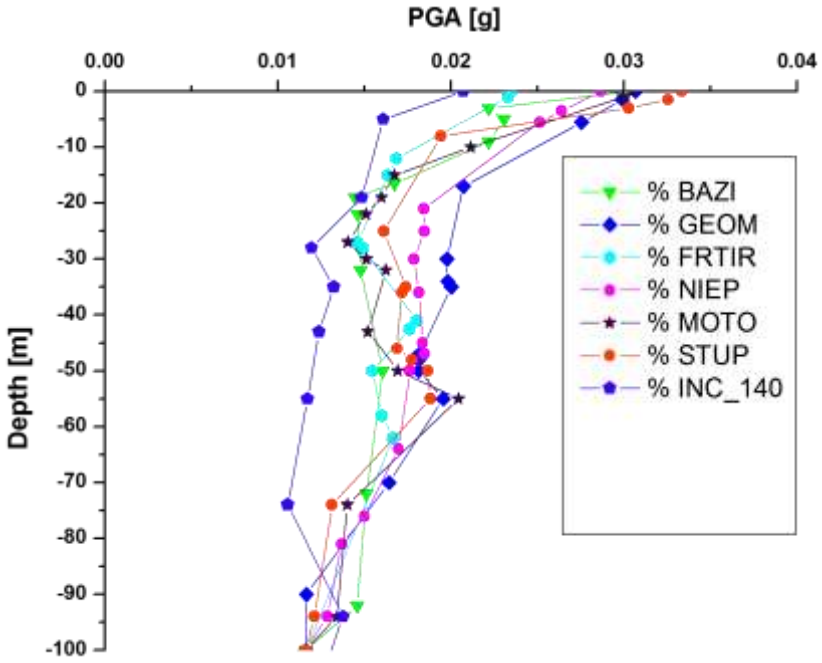

Fig. 8. PGA variation with depth as result from equivalent-linear modelling in the 7 sites in Bucharest, down to 100 m depth

The spectral acceleration graphs in Fig. 9 have 2 peaks: one at 0.15 s and the second at 0.3 s, at the same periods as the spectral acceleration of the original strong motion (red curve). The absolute value reaches 0.095 g at 0.15 s, which means an amplifications of 3 times of the original signal through the shallow sedimentary layers.

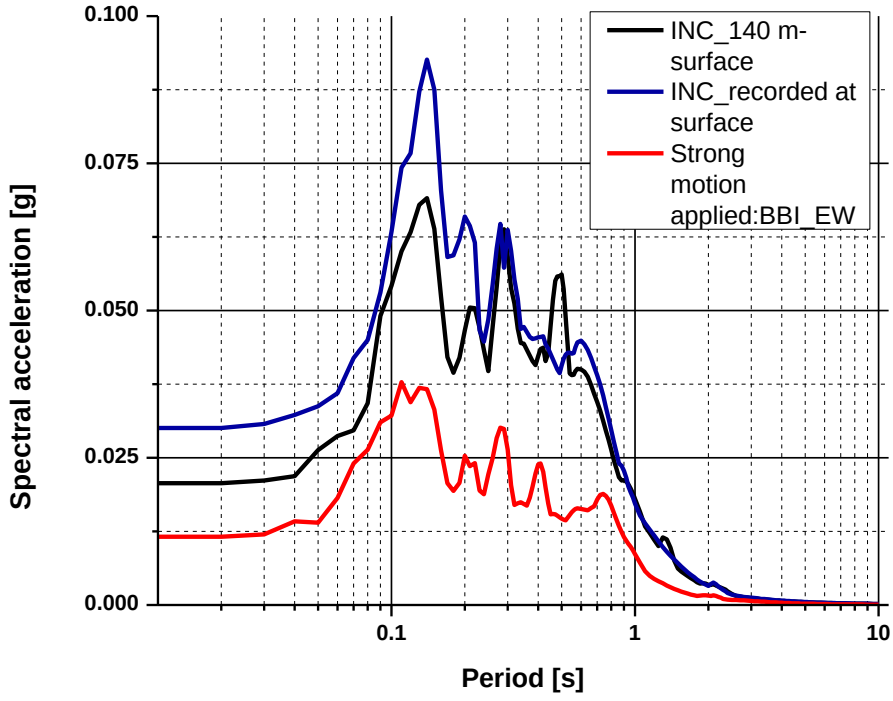

Fig. 9. Spectral acceleration calibration of the model 0 - 100 m, INCREST_TEI-140 m, with the signal recorded at surface in the same place; red curve - strong motion applied to the model; black curve - spectral acceleration model at surface; blue curve - spectral acceleration recorded at surface

In Fig. 9 the spectral acceleration of the original strong motion recorded at 140 m (red curve) and the resulting spectral acceleration obtained by modelling at surface (black curve) are presented. The spectral acceleration of the strong motion recorded at surface in the same site (blue curve) is compared with the spectral acceleration obtained by modelling (black curve) and a good match is obtained, although the second has lower values especially around the first peak at 0.15 s.

Conclusions

1. The spectral acceleration graphs in Figs. 2, 4 and 7 demonstrates that the computed models have the peaks at the same periods as the spectral acceleration of the original strong motion applied at the base of the model. The absolute values of the peaks show an amplification of about 3 times of the original signal through the shallow sedimentary layers in the geological model.

2. The acceleration graphs in the depth in Figs. 3, 5 and 8 show some variations between the depth of the models and 20-25 m. After that a sharp increase of the acceleration occurs from this level to the surface.

3. A strong peak which appeared at higher periods, between 0.5-0.6 s (Fig. 2) and 1 s (Fig. 7) is considered as an artifact of the computer program. It represents the dominant period for a package of sedimentary layers with a depth of the model adopted. However due to the fact that the depth of the model does not coincide with the engineering bedrock in our examples, the real motion recorded at surface does not show this peak (Figs. 6 and 9). This demonstrates that this peak is an artifact and should not be considered for further analysis.

4. The fact that the characteristic period around of 1-1.15 s, corresponding to a depth of the engineering bedrock around 100 m, is not present on the original recorded motion at surface in the Fig. 9 shows that this bedrock is not present here and it is probably much deeper. Other geological observations placed the bedrock at 500-1000 m depth in the Bucharest area, coinciding with the upper interface of the Cretaceous limestones [12].

Acknoledgements

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MAGMA STIMULATION AND RISING EARTHQUAKES: PRECURSORS OF VOLCANIC WINTERS – ICE AGE THAT WE MAY AVERT – OTHER NECESSARY PREPARATIONS

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Magma stimulation and rising earthquakes: precursors of volcanic winters - ice age that we may AVERT - Other necessary preparations

Several studies since the '70ies show a correlation between weak solar cycles and raised magma and volcanic activity. Present data show not only a weak solar cycle and a rise in earthquakes - volcanic eruptions – cloudiness - storms, but that most probably next decades will be worse. The proposed explanation is that planet positions disperse electricity from the galactic centre to the planets from its course to the sun, so Earth's magma is charged and is rising its disturbance. Volcanic winters occuring during solar minima, is a FREQUENT but not discussed enough phenomenon. Climate fluctuation has been remarked by Meton, and Archimedes constructed a computer such as that of Antikythera, to foresee the planets' orbits and influence on our climate: when they pass through the flow of galactic electricity from the center of the Milky-way to the Sun, they divert magma stimulating galactic plasma to Earth and other planets, less to the Sun, thus weak solar cycles. That's why during weak solar cycles, as now, solar flare electricity finds Earth stimulated and causes stronger quakes. Last time similar to today's solar low activity, was the beginning of the 19th century, when the 1815-20 Tambora volcanic winter occured...

First we propose worldwide lightning-rod NETS around faults (for faults in sea, nets on buoys) and active volcanoes, to disperse magma stimulation by galactic electricity and AVERT devastating earthquakes and cooling volcanic eruptions/clouding.

Second proposal: a test with a fire-resistant cap or grid hold by zeppelins, some hundred meters above extra active volcanoes, in order to prevent volcanic ash to reach troposphere, and thus spread all over Earth with predictable catastrophic consequences, similar to those volcanic winters that provoked the collapse of Mayans, Aztecs and Incas with cannibalism.

Third, we propose an extented spread of soot over icecaps and other glaciers, in order to decrease albedo and melt them, as already, at least the 90% of Earth's ice in Antarctica raises.

Last series of actions needed is decentralization of all present Babylons, to autarky villages and afforestation of ALL open places, even plains, to have food and wood in case of the worst scenarios.

If research focus on galactic electricity, we may stop the dangerous magnetic poles shift or its implications!

Keywords: volcanic winter, cosmic rays, lightning-rods, Antarctica, global cooling, ice age, Mayans, Aztecs, Incas, cannibalism, crater cap, autarky, afforestation.

1. SOLAR CYCLE CORRELATION WITH MAGMA AND VOLCANIC ACTIVITY

"Now, thanks to the involvement of scientists from other fields of science including biology and astrophysics in preparations for the report, it has become apparent that the currently observed

events are of galactic scale and are directly related to THE POSITION OF THE SOLAR SYSTEM IN OUR GALAXY, the Milky Way. It is this position that has a major impact on the formation of geological megacycles during which planet-scale biodiversity change is observed"[1]. Professor E. Khalilov, who forecasted TWO days ahead and alerted many governments about the devastating 2011 Japan megaquake. Also:

A 2011 Oak Ridge National Laboratory report warned of a 33 percent likelihood that a [DIVERTIBLE] solar flare could lead to long-term power loss over a nuclear reactor's life. With 440 nuclear power plants in 30 countries, and 250 research reactors, there are nearly 700 potential Fukushimas waiting to be unleashed [2]: Another reason for PROVIDENCE!

Several studies since the '70ies show a correlation between weak solar cycles and raised magma and volcanic activity [3, 4], [Fig. 1a].

Present data show not only a weak solar cycle and a rise in earthquakes - volcanic eruptions – cloudiness – storms - floods, but that most probably next decades will be worse, and there is an anxiety of a possible new Little (?) ice-age [5, 6, 7, 8, 9, 10, 11, 12], [Fig. 1, 2, 3, 4].

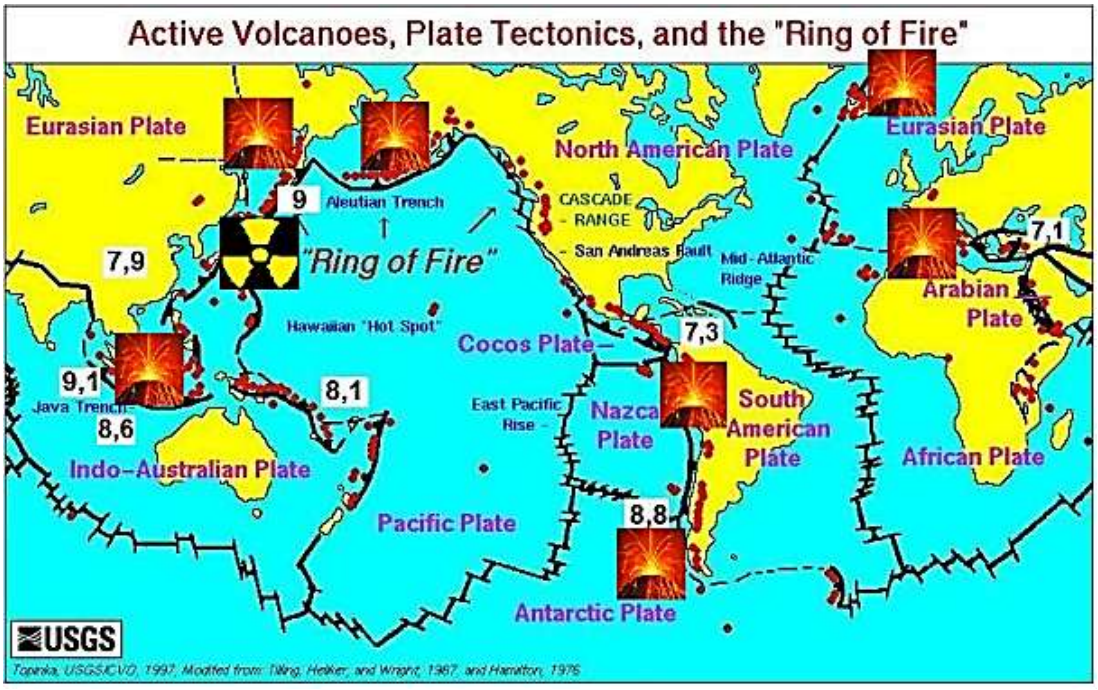

Fig. 1. Last big earthquakes and raising volcanic activity

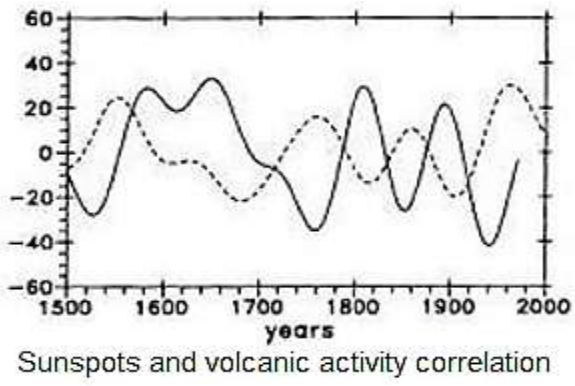

Fig. 1a: Sunspots and volcanic activity correlation. From: [4]

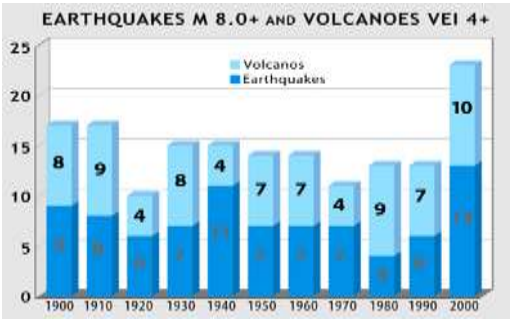

Fig. 2: Earthquake-volcanic activity rise. Source USGS Earthquake Hazard Program, Smithsonian Global Volcanism Program.

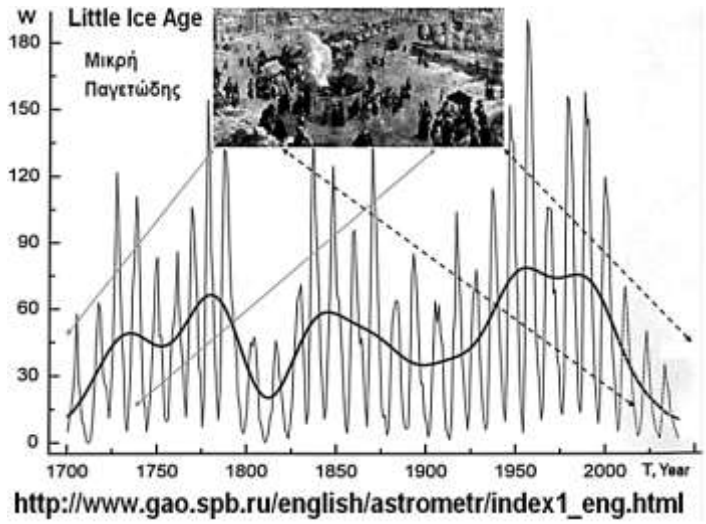

Fig. 3. Next solar cycles forecast by H. Abdusamatov [7]

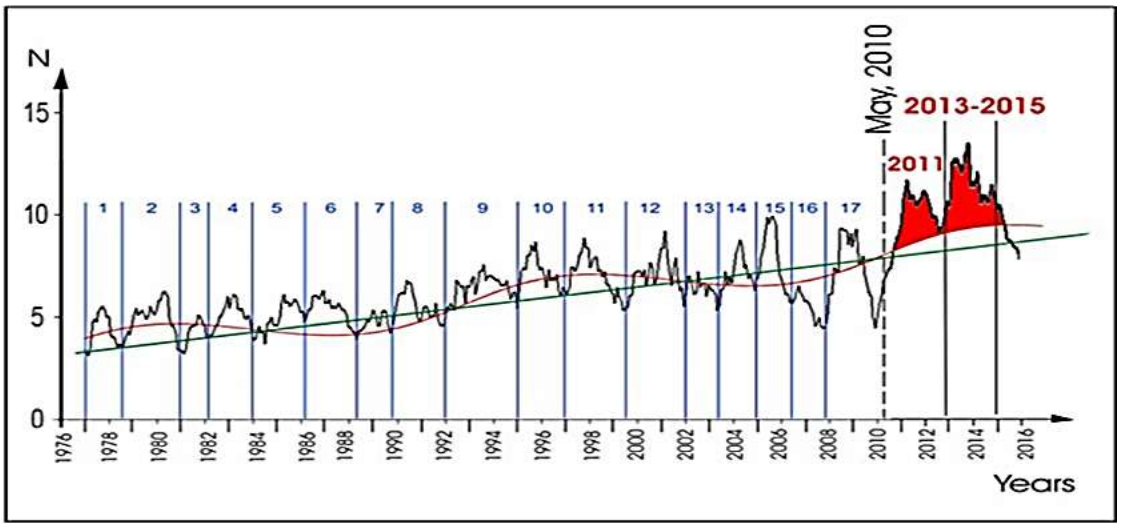

Fig. 4: Great natural disasters forecast by Geochange-report.org

We propose as reason the present planet positions that disperse electricity from the galactic center of the Milky-way to the Sun, they divert magma stimulating galactic plasma to Earth and other planets, less to the Sun, thus weak solar cycles. That's why during weak solar cycles, as now, solar flare electricity finds Earth stimulated and its charged magma causes stronger quakes, volcanic eruptions-clouding. [13, 14, 15, 16] [Fig. 5, 6, 7].

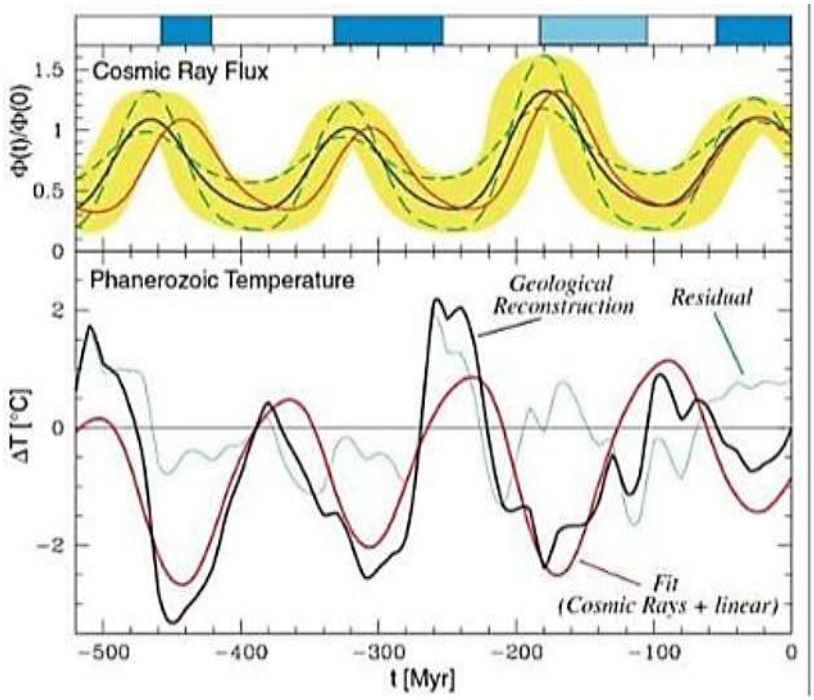

Figure 5: Comparison between the reconstructed cosmic ray flux and the quantitative temperature reconstruction over the Phanerozoic: The top panel describes the reconstructed Cosmic Ray Flux variations over the past 500 Million years using the exposure ages Iron Meteorites. The bottom panel depicts in black, the reconstructed tropical ocean temperature variations using isotope data from fossils. The red line is the fit to the temperature using the cosmic ray flux variations. The top blue bars indicate ice ages. The notable fit implies that most of the temperature variations can be explained using the cosmic ray flux, and not a lot is left to be explained by other climate factors, including CO2. This implies that cosmic rays are the dominant (tropical) climate driver over the many million year time scale. From: [19].

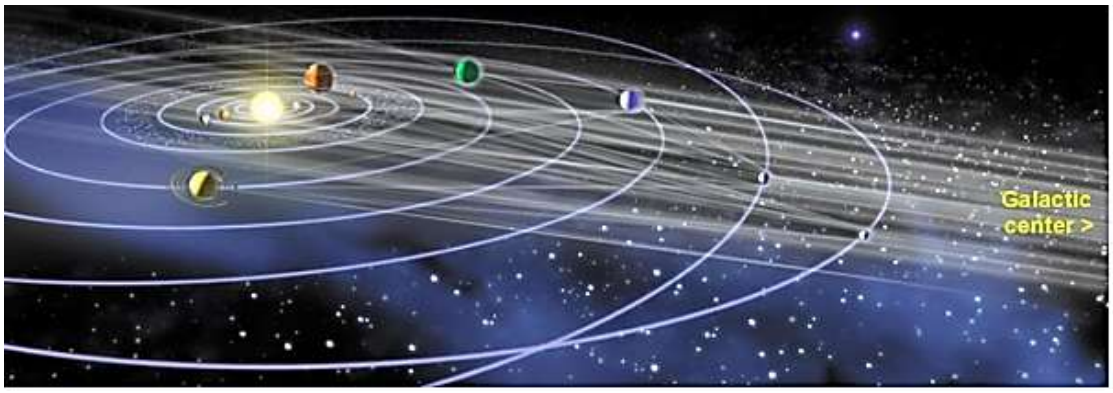

Fig. 6. Current planet positions, while the emmiting galactic centre is to the right of the picture (writer's depiction).

As Heraclitus had noted that extraterrestrial 'thunderbolt steers the universe' ('τα πάντα οιακίζει κεραυνός'), ancient greek Astronomer Meton had also attested that whenever sun had many sunspots, more downpours occured on Earth ('ηλίου σημεία μέλανα, ύδωρ'): we now know that a more active sun warms the Earth, and warmer oceans cause more long rains, instead of the storms alternating with droughts that we have during cooler periods.

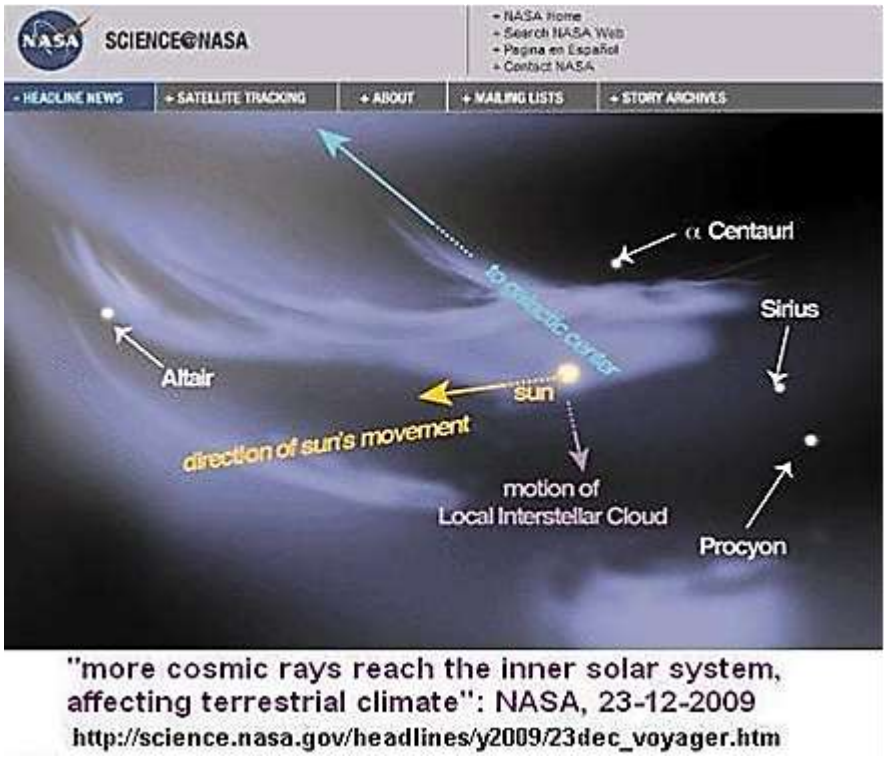

Fig. 7. The galactic cloud where our solar system travels

2. VOLCANIC INCIDENTS

Volcanic winters is a FREQUENT [Fig. 8, 9] but not discussed enough phenomenon. Cold climate fluctuations probably had been remarked by Archimedes, who constructed a computer [17] such as that of Antikythera, to foresee the planets' orbits and influence on our climate. [Fig. 10, 11].

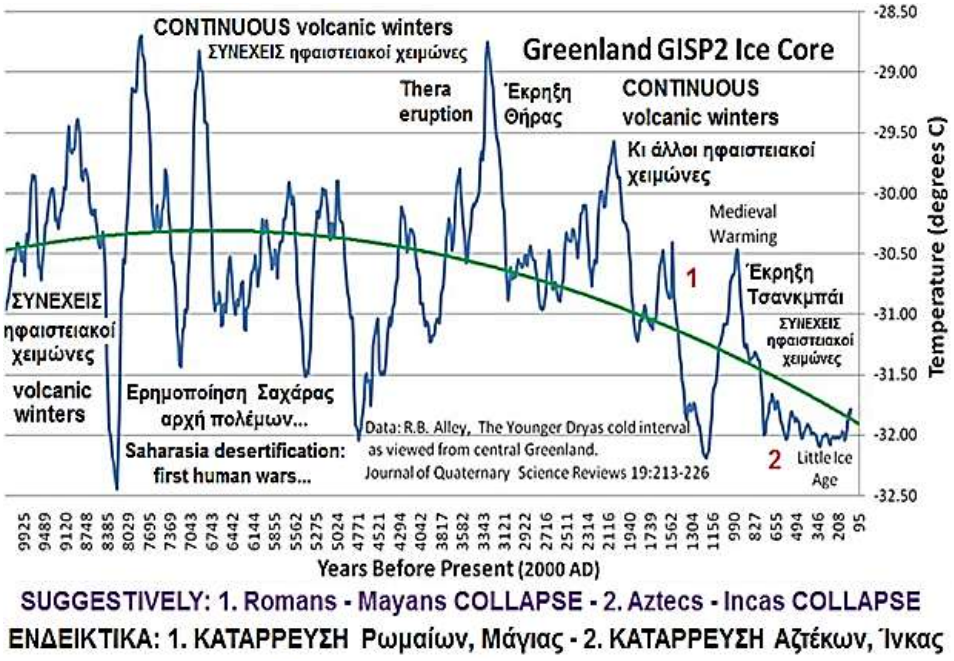

Fig. 8. Continuous volcanic winters, temperature and civilization falls.

1446 (n.d.)	1699 (n.d.)
1448 (possible eruptions in Alaska)	1742 (Shikotsu, 1739)
1453 (Kuwae, Vanuatu, SW Pacific)	1783 (n.d.)
1495 (n.d.)	1816 (Tambora, Lesser Sunda Isl.)
1587 (Kelut, Java, 1740, Shikotsu, Japan)	1817 (Tambora, 1815)
	1818 (Tambora, 1815)
1601 (Huaynaputina, Peru)	1819 (Tambora, 1815)
1641 (Parker, Philippines)	1836 (Coseguina, Nicaragua)
1642 (Parker, Philippines)	1837 (Csiguina, Nicaragua, 1835)
1643 (Parker, Philippines, 1641),	1884 (Krakatoa, west of Java)
1666 (possible eruptions in Japan),	1912 (Novarupta, Katmai Alaska same year)
1667 (Shikotsu, same year)	
1669 (Shikotsu, Japan, 1667)	1968 (n.d.)
1675 (Gamkonora, Halmahera, 1673)	1978 (n.d.) , 1981 El Chicon
1698 (n.d.)	1992 (Pinatubo, Philippines)

Fig. 9. Some of the volcanic eruptions that kept Little Ice Age 600 years long.

Fig. 10. Archimedes' murder

Fig. 11. Antikythera computer reconstruction

The inhabitants of ancient Thera 3.650 years ago, had already double or triple exits to their houses, in case of a blockage during quakes [Fig. 12]. They showed similar PROVIDENCE and were saved, leaving the island after the precursory big quakes, and escaping the huge volcanic eruption, that caused a worldwide devastating 5year volcanic winter [18]. While other peoples in the Middle East collapsed, Greek Thereans came back to their island and continued their magnificent contribution to the famous peaceable Aegean civilization!

Fig. 12. Double exits in ancient Thera houses.

Fig. 13. Pompeiian arena addiction - improvidence...

Fig. 14. Deforestator Mayans-Aztecs-Incas collapsed

On the contrary, the arena addicted Pompeians 1700 years later, scorned fatalistically both the precursory quakes and the raising volcanic activity, and were almost all burned... [Fig. 13] (The same thing happened during the 1902 Pelee eruption in Martinique...).

Last similar to the present solar condition time was the 1815-20 Tambora volcanic winter...

What must we expect now if a sudden volcanic winter occurs, when 7 billion people on Earth are both unsuspected and unprepared, most of them trapped in cement babylons???... Cannibalism and epidemics will be worse than the Little Ice Age (1300-1900) plagues, due to the aforementioned volcanic winters... There is also a possibility that Earth enters a new big Ice Age...

3. PROPOSALS

First we propose Worldwide Lightning-rod Nets around faults (for faults in sea, nets on buoys) and active volcanoes, to disperse magma stimulation by galactic electricity and AVERT devastating earthquakes and cooling volcanic eruptions/clouding.

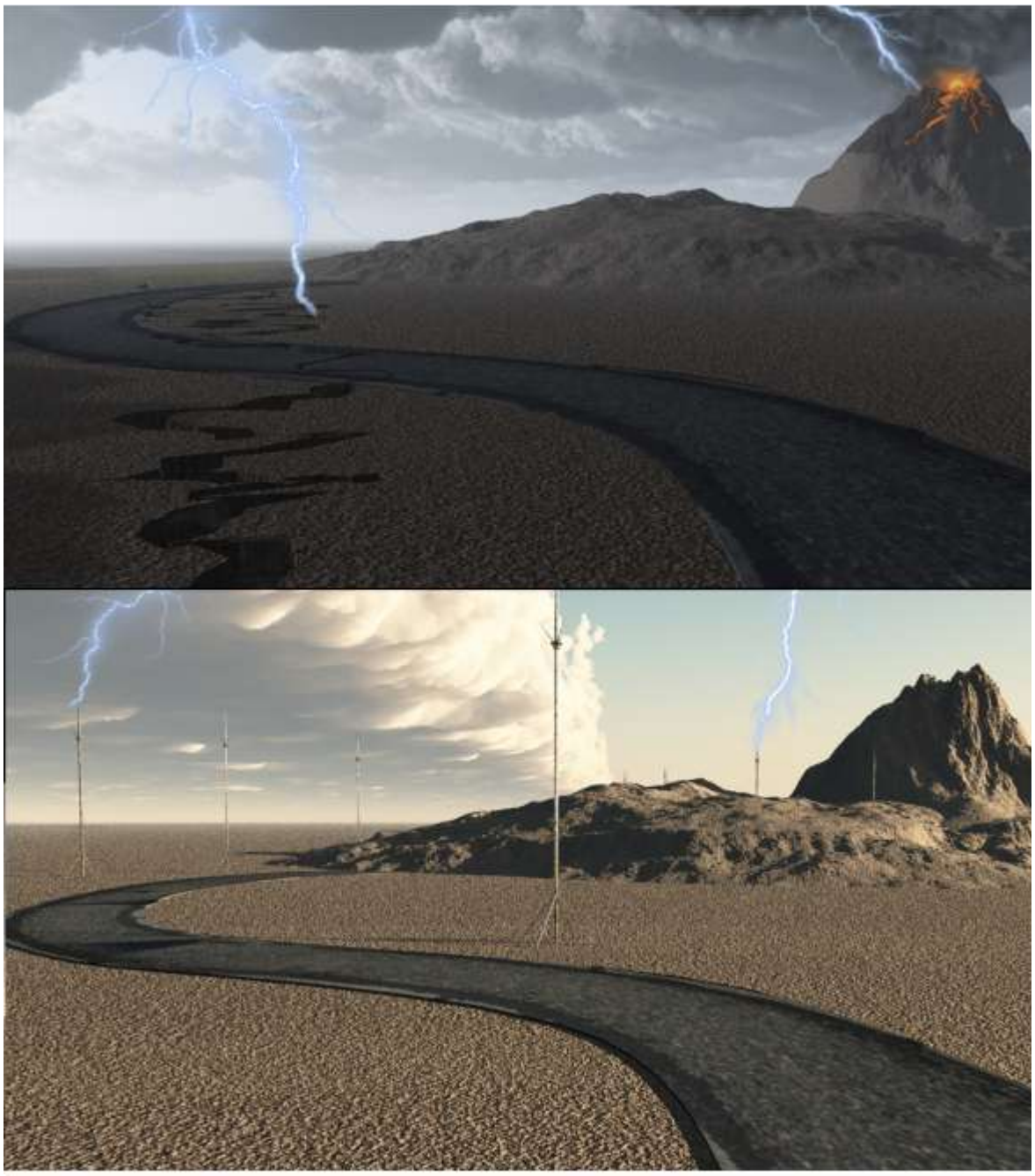

Fig. 15. Magma de-stimulating lightning-rod NETS around active faults/volcanoes

Second we propose a test with a fire-resistant cap or grid hold by zeppelins [Fig. 13], some hundred meters above extra active volcanoes, in order to prevent volcanic ash to reach troposphere, and thus spread all over Earth with predictable catastrophic consequences.

Fig. 16: Buoys can held lightning-rods across active sea faults

Fig. 17: Fire-resistant crater cap or grid instead of volcano NON-nuclear bombing

Fig. 18. Soot melts ice

Third we propose an extented spread of soot over icecaps and other glaciers, in order to decrease albedo and melt them.

Last series of actions needed is decentralization of all present Babylons, to autarky villages and afforestation of ALL open places, even plains, to have food and wood in case of the worst scenarios.

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TRACES OF AN ANCIENT CIVILIZATION AT THE BOTTOM OF THE CASPIAN SEA

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Development of human society in the course of the whole history of mankind significantly depended on a lot of natural factors such as climatic conditions, soil fertility, and availability of water sources, the vegetable world and the animal world. However perhaps only natural calamities distinguished by its unpredictability and scope exerted fatal impact on development of civilizations. There are many examples in the history of mankind that evidence destruction and dark oblivion for many centuries and sometimes millenniums of the whole civilizations as a result of natural calamities. It is enough to remember Pompeii, the ancient city that was destructed as a result of eruption of Vesuvius volcano during two days, i.e. August 24-25, 79 A.D. and had remained under thick layer of volcanic ashes for many centuries. And this city was found and revealed for future civilizations in 1594.

Meanwhile the legendary Atlantis firstly mentioned by Plato, the great philosopher doesn't leave indifferent the minds of many scientists. How many other cities like "Atlantis" are buried under water? Ruins of ancient and legendary Sabail castle look out of sea water near Baku City and these ruins are sometimes called a Baku Atlantis. This site is known to Baku citizens as "Sabail", "Bayil stones", "Caravanserai" or "Bayil Gesri". Some scientists think that Sabail was a most impregnable fortress of the Southern Caucasus region that couldn't be taken by storm even by the army of Genghis Khan. When describing the fortress the scientists mention that the fortress has the shape of extremely oblong rectangular with uneven lines of lateral walls. Investigations conducted using the space photograph of high resolution allowed the authors to acquire accurate outlines of "Sabail" fortress. It is supposed that this shape repeated outlines of the rock that serves as foundation for almost the whole fortress. The masonry walls of about 1.5 m in thickness connect 15 towers. Maybe the fortress submerged under sea waters after the most powerful earthquake occurred in 1306.

Investigations show that the level of water in the Caspian Sea was exposed to periodical fluctuations and resulted in significant change of coastline of the Caspian Sea and area of water surface of the Sea /2/.

However is Sabail fortress the only ancient structure swallowed by the deep of waters of the wild Caspian Sea?

Investigation of shelf of Absheron peninsula using space photographs allowed scientists to find an extraordinary structure on the bottom of sea, near the eastern boundaries of Absheron peninsula i.e. Shikhov bay-bar and the shape of this structure reminded the ruins of an ancient fortress (Fig. 1). Authors temporarily titled this structure as "Zyrinskaya fortress".

Closer viewing of the picture allows us to see clearly the perimeter and the interior design of the structure (Fig. 2). Special filters providing for viewing of the space photograph in various spectral ranges have been used in order to improve visual capacity of the obtained picture (Fig. 3). As you see from the space photograph the walls of the ancient structure are clearly showing up. The structure has oblong shape and stretches in the North-eastern direction. Ruins of several walls that have lateral and cross cut orientation in regard to exterior walls are clearly distinguished inside the structure. There is a semicircular structure near the southern wall, in the central part of the conditional fortress. However it can have square shape but looks circular as a result of silt or sand drift.

Detailed investigations and direct archeological digs will provide for more accurate description of the shape of interior structures of the fortress. Authors managed to some extent to get common understanding of possible spatial design of a number of components of the ancient fortress using methods of three-dimensional graphics. Outcomes of three-dimensional graphical treatment of the space photograph are described in Fig. 4.

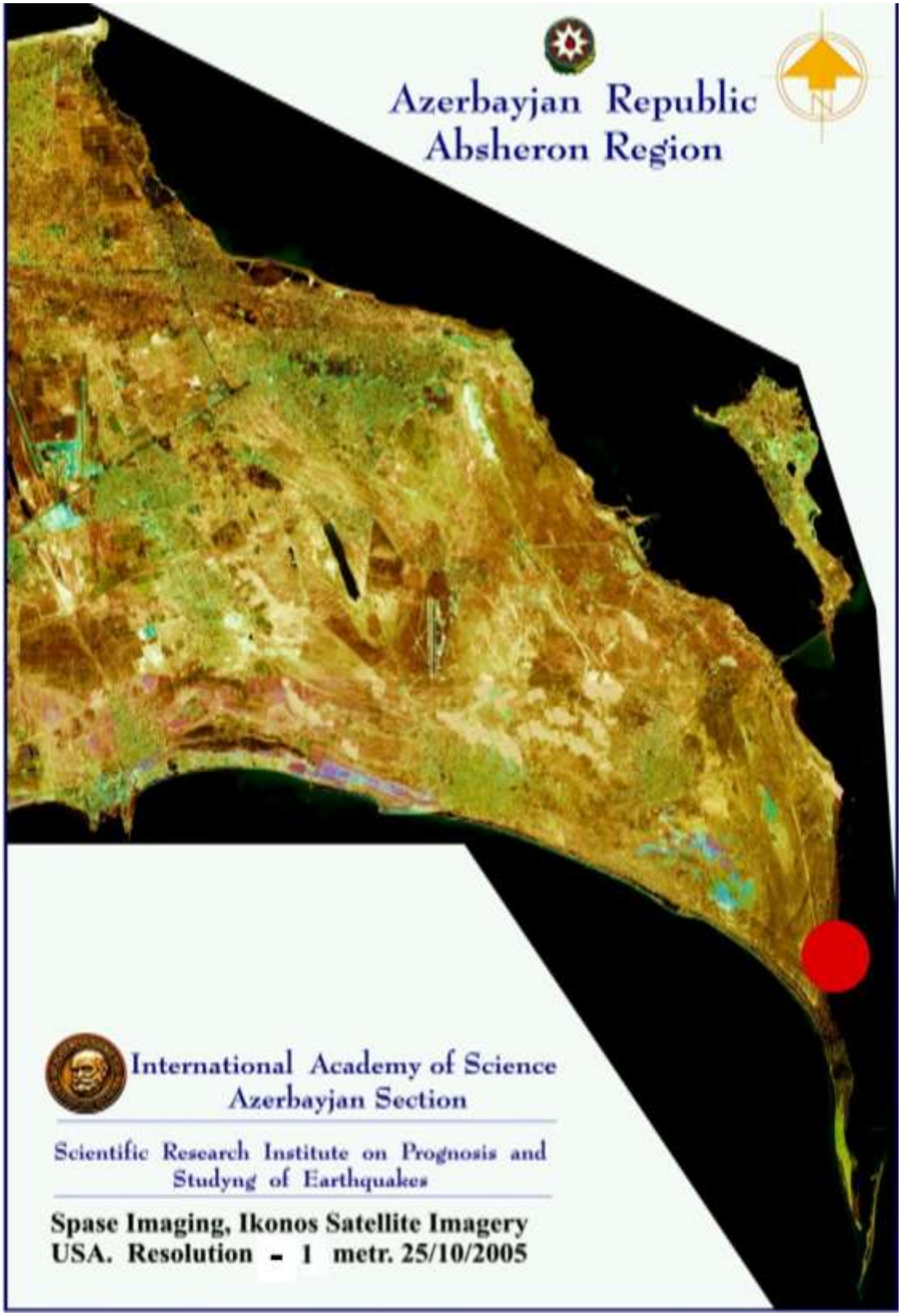

Fig. 1. Space photograph of the eastern part of Absheron peninsula: the underwater detection area of the ancient structure is marked with red circle

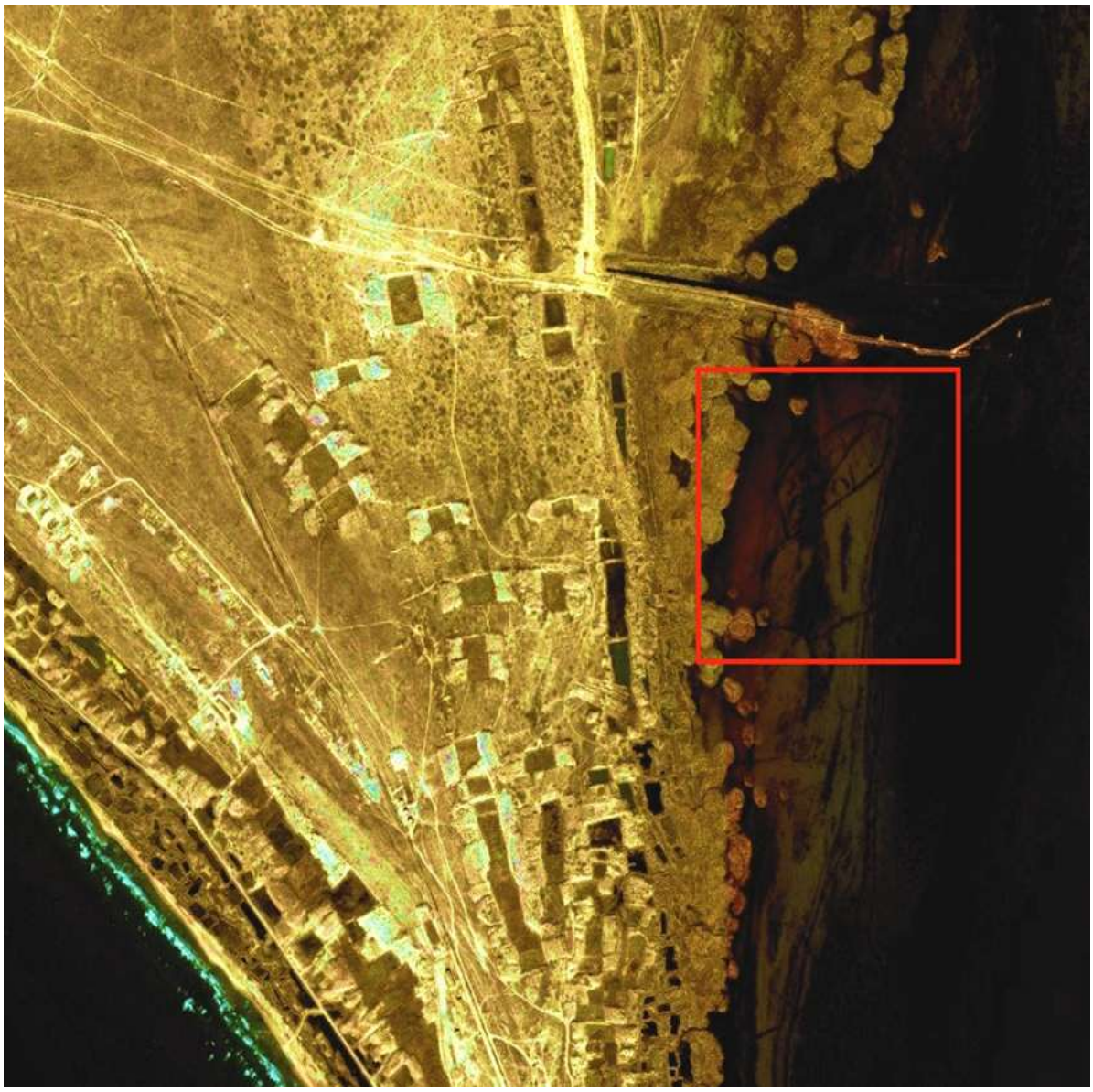

Fig. 2. Photograph of the detection area of the ancient structure

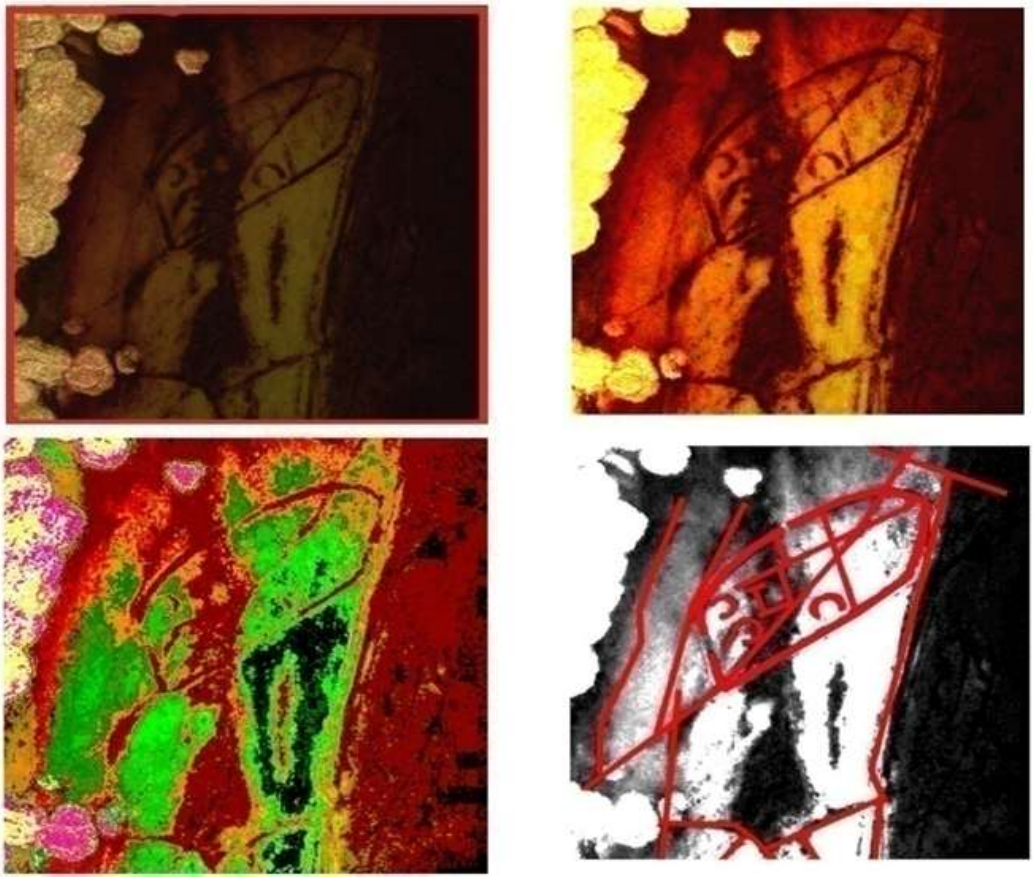

Fig. 3. Review of the space photograph in various spectral ranges located on the bottom of the Caspian Sea

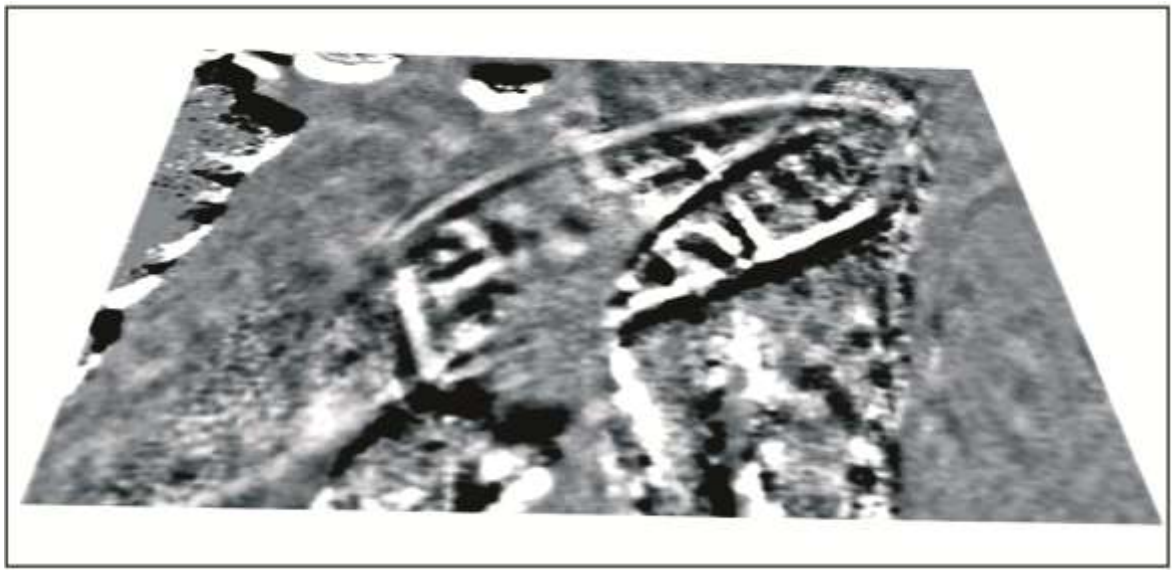

Fig. 4. Outcomes of treatment of the space photograph using methods of three- dimensional graphics

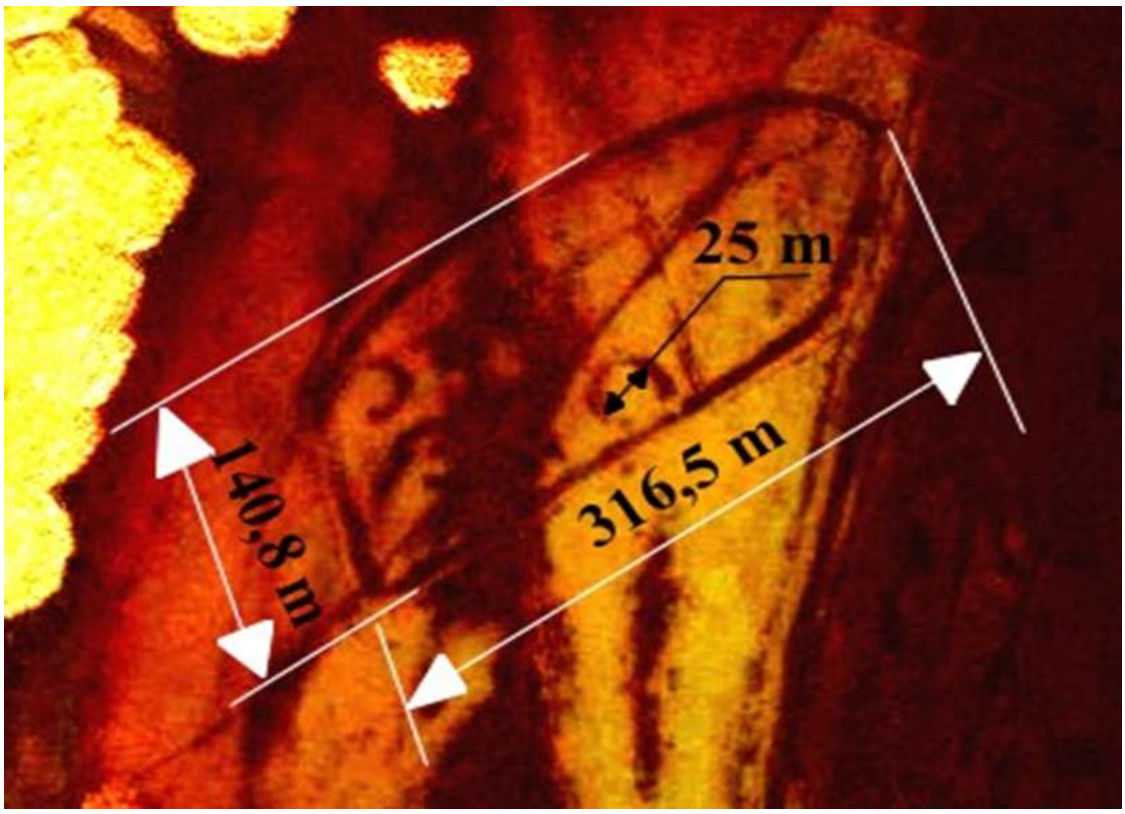

Fig. 5. The scheme with sizes Zyrinskaya fortress

Implementation of special software allowed for identification of precise parameters of Zyrinskaya fortress. You can see on the Fig. 5 that the length of fortress equals to 316 meters, and the width of fortress equals to 140 meters. Perimeter of exterior walls of the fortress amounts to 823 meters.

The area of interior part of the fortress equals to 38960 square meters. Diameter of semicircular interior structures equals to 21-25 meters. Thickness of external walls is equal 2-2,5 meters. It is clear that the eastern wall of the fortress is not even, and it represents an uneven oval that is slightly inclined in the eastern direction. The northern wall of the fortress has also an oval shape, and the southern wall is even. The oval shape of the walls could be imposed by local relief. Thus the first step in the area of revelation of new traces of the Caspian Atlantis has already been implemented. Investigations in the area of decoding of the space photograph are continued. Meanwhile the historical facts evidence in favor of existence of remnants of ancient settlement on the bottom of the Caspian Sea. For instance Sara Ashurbeyli writes in the work /3/ that "All the exiting legends about flooding of a whole city by waters of the Caspian Sea were probably derived from an actual fact of lowering of level of continent and submergence of a settlement or a city under the sea waters as a result of earthquake". In the work /4/ academician Lens writes that he heard from local inhabitants in 1830 that "long time ago the sea shore located at a distance of 13.258 miles far from Beyuk and Dash Zira islands, and Pirallahi and Chilov islands were parts of the continent; and once the sea suddenly flooded significant part of the coastline, and the coastline acquired its present shape". S.Ashurbeyli thinks that /3/ "the tracks of barrow trucks on rocks of Beyuk Zira island that submerge under sea waters can serve as evidence to flooding of the area between Baku and Beyuk Zira island many centuries ago". Judging from direction of the tracks this route led along island towards Shykh village and Shykh bay-bar i.e. the last point of the southern coast of Baku bay.

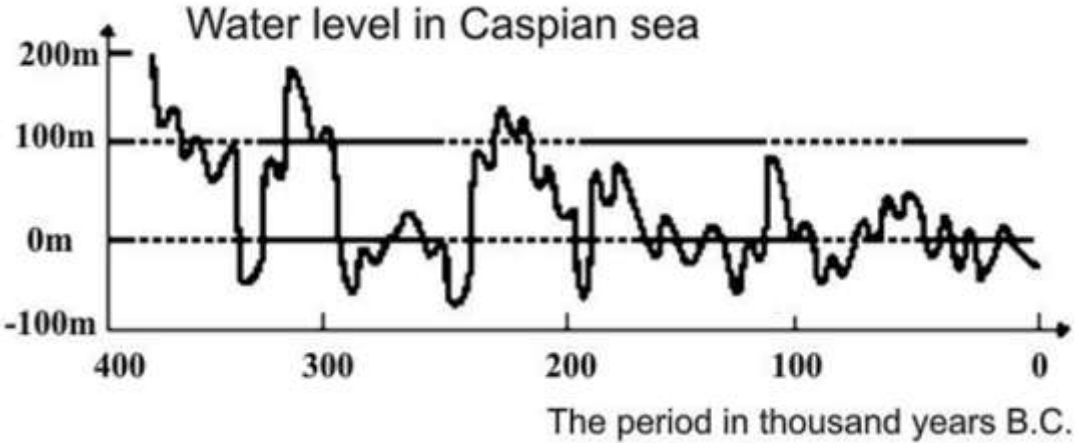

Fig. 6. Changes in level of the Caspian Sea during the last 400 thousand years /2/

Indeed the geological data confirm availability in the historical past of the Caspian Sea of both global transgressions and regressions in terms of scale of geological time and space (Fig. 6), and relatively small cycles of rising and consequent lowering of level of the Caspian Sea in terms of scale (Fig. 7).

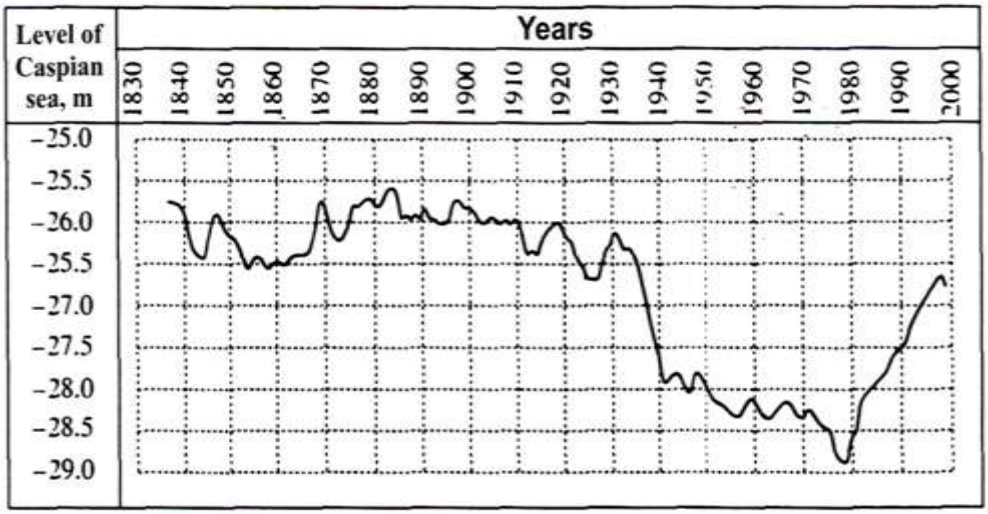

Fig. 7. Changes in level of the Caspian Sea during the last 170 years (Ivanova T.P., Trifonov V.G., 2002)

Meanwhile we have not found any notes in historical sources that would confirm availability of an ancient fortress in the detection area of underwater ruins.

The next successive step of relevant investigations shall consist of archeological digs.

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ACTIVE BRACE CONTROL OF FRAME STRUCTURES UNDER EARTHQUAKE EXCITATION

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Introduction

Structural vibrations resulting from earthquakes cause serious damages on civil buildings. Also, valuable devices and non-structural elements can be damaged during big unstable vibration. Thus, structural control concept may be implemented to important structures in order to prevent structural and non-structural damages. There are various types of structural control, such as active, passive, hybrid and semi-active. Passive control devices are more economical according to active control. Passive control helps to damping of vibration with mechanical materials. Especially, passive tuned mass dampers was placed to several important structures under wind excitation and several studies showed that optimum passive tuned mass damper are effective on reducing earthquake indicated structural vibration [1-3].

Active control devices apply time varying forces to structures in order to protect them from unstable excitations like earthquakes. But, active control systems may be expensive and may need big control forces and big power supplies. Semi-active systems, which may be accepted as active system with lower efficacy, consume less power than active ones. Hybrid systems, which are the combination of active and passive systems, may be more effective on force and power reduction. In that case, when tuning active control devices, control force value must be considered in order to keep it at a minimum level. The time delay is also a problem for active control systems. In the tuning process, a realistic time delay must be considered. Otherwise, the system may be unstable under random vibrations and this situation will be the failure of the protection system. In this paper, an active brace controlled single storey frame structure was investigated under earthquake loadings. At the end of the analysis, time and frequency domain results were compared for the uncontrolled and the controlled structure. Several studies about active control of structure were mentioned here. Wong and Hart investigated the controlled response of inelastic structures and presented an active tendon controlled frame structure as a sample [4]. Lu and Skelton proposed a method for integrated design of passive and active elements including active braces [5]. Arfiadi and Hadi controlled three-dimensional buildings with passive and active systems such as active tunes mass dampers, passive tunes mass dampers and active braces by using genetic algorithm as a function optimizer [6]. In order to demonstrate the practical applicability of active control, experimental tests using a full scale three storey building equipped with active braces were conducted on the shake table at the National Center of Research on Earthquake Engineering (NCREE), Taiwan [7]. Lu and Zhao investigated active brace controlled structures with controllers extended by introducing the saturated control method [8]. Gluck and Ribakov developed an active controlled viscous damping device with amplifying braces [9]. Arfiadi and Hadi used a continuous bounded controller for active brace controlled structures and proved their study by applying different earthquake excitations with various intensities [10]. Han and Tsopelas developed a passive/active brace system (PAB) which is the combination of a piezoelectric stack actuator and a viscoelastic damper [11]. Pnevmatikos and Gantes investigated structures with diagonal braces combined with active variable stiffness devices that have an ability to activate or deactivate the braces [12]. Nigdeli and Boduroğlu investigated active tendon controlled structures with PID controller in order to prevent earthquake indicated big vibrations [13]. Torsionally irregular single storey structures with active tendon control were investigated by Nigdeli and Boduroğlu under earthquake excitations [14]. In this study, a single storey frame structure equipped with a diagonal active brace was analyzed under earthquake excitations. The Proportional Integration Derivative (PID) type controller was used for obtaining the control signal. The time delay effect was also considered in order to obtain realistic results. For more economical and practical results, the amount of the control force was

held at a minimum level. The controlled and the uncontrolled structure results were compared including the rotations and moments at the conjunction of the beam and the columns.

Frame structure model and equations of motion

Model of the frame structure with active brace control is shown in Fig. 1. In Fig. 1, m_c, L_c and EI_c represent the unit mass per length, the length and the rigidity of the columns, respectively. Also, m_b, L_b and EI_b represent the unit mass per length (including storey mass), the length and the rigidity of the beam, respectively. The frame structure has three degrees of freedom. These freedoms are the lateral displacement of structure respect to the ground (x) and the rotations at the beam column conjunctions (θ_1 and θ_2). The equations of motion of an uncontrolled single-span single storey linear frame structure subjected to earthquake loading can be written as

$$M\ddot{x}(t) + C\dot{x}(t) + Kx(t) = -\begin{Bmatrix} m_t \\ 0 \\ 0 \end{Bmatrix} \ddot{x}_g(t) \tag{1}$$

where M, C, K are mass, damping and stiffness matrices, respectively. Total mass of the building and ground motion acceleration are shown as $\ddot{x}_g(t)$ and m_t, respectively. $x(t)$ is the vector of the freedoms. $\ddot{x}(t)$ and $\dot{x}(t)$ are the derivatives of $x(t)$. The M, K, C matrices and x(t) vector for three degrees of freedom system are given in Eqs. (2), (3), (4) and (5), respectively.

$$M = \begin{bmatrix} \frac{156}{210}m_cL_c + m_bL_b & \frac{11}{210}m_cL_c^2 & \frac{11}{210}m_cL_c^2 \\ \frac{11}{210}m_cL_c^2 & \frac{1}{105}(m_cL_c^3 + m_bL_b^3) & \frac{-3}{420}m_bL_b^3 \\ \frac{11}{210}m_cL_c^2 & \frac{-3}{420}m_bL_b^3 & \frac{1}{105}(m_cL_c^3 + m_bL_b^3) \end{bmatrix} \tag{2}$$

$$K = \begin{bmatrix} \frac{24EI_c}{L_c^3} & \frac{6EI_c}{L_c^2} & \frac{6EI_c}{L_c^2} \\ \frac{6EI_c}{L_c^2} & \frac{4EI_c}{L_c} + \frac{4EI_b}{L_b} & \frac{2EI_b}{L_b^2} \\ \frac{6EI_c}{L_c^2} & \frac{2EI_b}{L_b^2} & \frac{4EI_c}{L_c} + \frac{4EI_b}{L_b} \end{bmatrix} \tag{3}$$

The damping matrix was generated by using the Rayleigh damping proportional to the mass and stiffness matrix. In Eq. (3), α and β are the coefficients of the Rayleigh damping [15, 16, 17].

$$C = \alpha M + \beta K \tag{4}$$

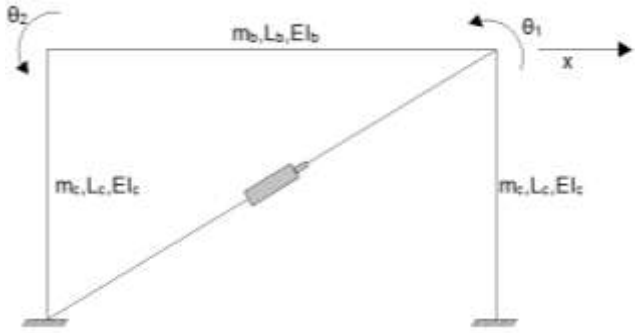

Fig. 1. The Frame Structure with Active Brace Control

$$x(t) = [x\theta_1\ \theta_2]^T \quad (5)$$

The equations of motion of an active brace controlled single-span single storey linear frame structure subjected to earthquake loading can be written as seen in Eq. (6). In this equation, u and α_0 are the control signal and the angle of active brace with respect to ground, respectively.

$$M\ddot{x}(t) + C\dot{x}(t) + Kx(t) = -\begin{Bmatrix} m_t \\ 0 \\ 0 \end{Bmatrix}\ddot{x}_g(t) - \begin{Bmatrix} u \\ 0 \\ 0 \end{Bmatrix}(\mathrm{Cos}\alpha_0) \quad (6)$$

The control signal is the force applied from active braces and the multiplication of the control signal with the cosine of the angle between ground and the brace is the control force. In order obtain the control signal, PID type controller was used. The equation of the PID controller can be seen in Eq. (7). In this equation, K_p(Proportional gain), T_i (Integral time) and T_d (Derivation time) are controller coefficients. By using the control algorithm, the error signal (e(t)) can be transformed into control signal. The error signal is taken as the velocity of the lateral motion. The controller coefficients were tuned by using a trial method by considering the maximum control force value.

$$u(t) = K_p\left(e(t) + \frac{1}{T_i}\int e(t)dt + T_d\frac{de(t)}{dt} \right) \quad (7)$$

In order to obtain realistic and trusted results, a 20 ms time delay of the control system was assumed. The block diagrams of the controlled and uncontrolled structure were developed by using Matlab Simulink. Runge-Kutta method with 1e-3 step size was used for the numerical analysis.

Table 1.

Properties of the structure and the PID controller

Symbol	DEFINITIONS	Numerical Value
m_t	Total mass of the structure	5250 kg
m_c	Mass of the columns per length	250 kg/m
m_b	Mass of the beam per length(including storey mass)	750 kg/m
L_c	Length of the columns	3 m
L_b	Length of the beam	5 m
EI_c	Rigidity of the columns	15000000 Nm^2
EI_b	Rigidity of the beam	15000000 Nm^2
α_0	Angle of the active brace respect to the ground	31 º
T	Period of the structure	0.15 s
α	Coefficient of the Rayleigh damping	3.1961
β	Coefficient of the Rayleigh damping	$5.5795x10^{-4}$
K_p	Proportional gain	-47200 Ns/m
T_i	Integral time	15 s
T_d	Derivative time	0.01 s

Numerical example

The frame structure was analyzed under various earthquake excitations. The damping of the structure was assumed as 5% for the first two modes. The properties of the structure and the PID controller can be seen in Table 1. In Table 2, the maximum responses such as the lateral

displacement (x), the rotations at the joints (θ_1,θ_2), the total acceleration ($\ddot{x}+\ddot{x}_g$), the shear force at the columns (V) ,the moments at the joints (M_1, M_2) and the control force (F_c) can be seen under different earthquake excitation for the uncontrolled and the active brace controlled cases. The earthquake records were downloaded by NGA database of Pacific Earthquake Engineering Research Center (PEER) [18].

Table 2.

Maximum responses of the frame structure

Earthquake records		x (cm)	θ_1,θ_2 (rad)	$\ddot{x}+\ddot{x}_g$ (g)	V (kN)	M_1,M_2 (Nm)	F_c (kN)
Duzce (1999) BOL090	Uncontrolled	0.8427	0.0025	1.3623	61.7522	323.4508	-
	Controlled	0.7190	0.0022	1.1887	52.6511	229.1013	9.6200
El Centro (1940) ELC180	Uncontrolled	0.4372	0.0013	0.7555	32.0814	270.8723	-
	Controlled	0.3227	0.0010	0.6333	23.6787	160.0795	5.4415
Erzincan (1992) ERZ-NS	Uncontrolled	0.4906	0.0015	0.7447	35.9052	113.3049	-
	Controlled	0.4488	0.0013	0.7124	32.8373	69.6165	3.0420
Landers (1992) LCN000	Uncontrolled	1.1734	0.0035	2.0915	86.1456	785.5621	-
	Controlled	0.6227	0.0019	1.3842	45.7781	549.1632	13.6792
Loma Prieta (1989) LGP000	Uncontrolled	1.1221	0.0034	1.9046	82.3054	480.2536	-
	Controlled	0.6108	0.0018	1.1334	44.7806	295.4865	10.3414
Kobe (1995) KJM000	Uncontrolled	1.3290	0.0040	2.2160	97.4460	510.1252	-
	Controlled	0.8105	0.0024	1.4427	59.3987	350.3847	12.5385
Northridge (1994) SYL360	Uncontrolled	0.9209	0.0028	1.5310	67.5206	346.9131	-
	Controlled	0.7304	0.0022	1.3307	53.5471	275.2702	10.2412

In Fig. 2, the time history of the lateral displacement of the structure under Loma Prieta earthquake is given with the comparison of the controlled and the uncontrolled cases. Under Loma Prieta excitation, the maximum displacement is reduced from 1.1221 cm to 0.6108 cm (45.6% reduction).

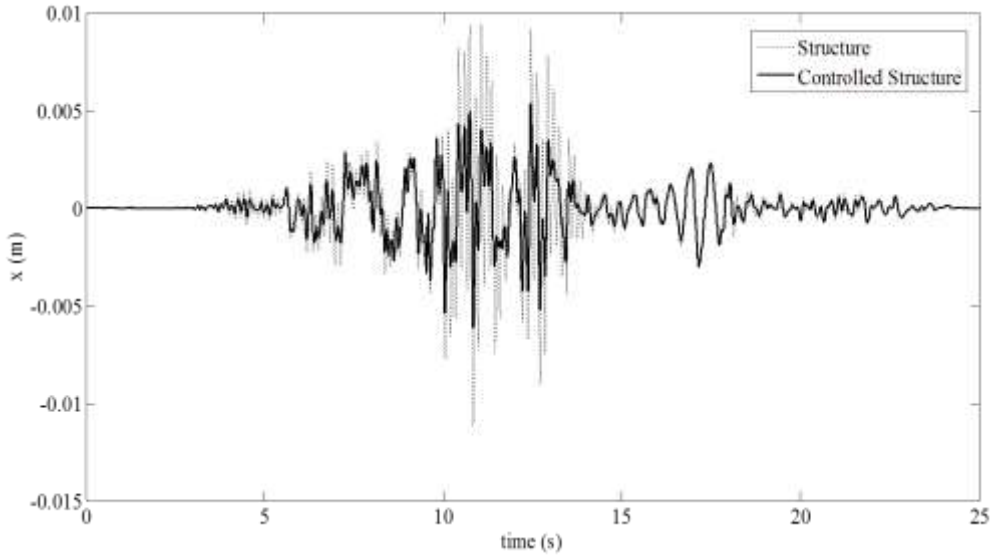

Fig. 2. The lateral displacement of the frame structure under Loma Prieta earthquake

In Fig. 3, the time history of the rotations at the joints under Loma Prieta earthquake is seen. The maximum rotation is reduced from 0.0034 rad to 0.0018 rad (47% reduction).

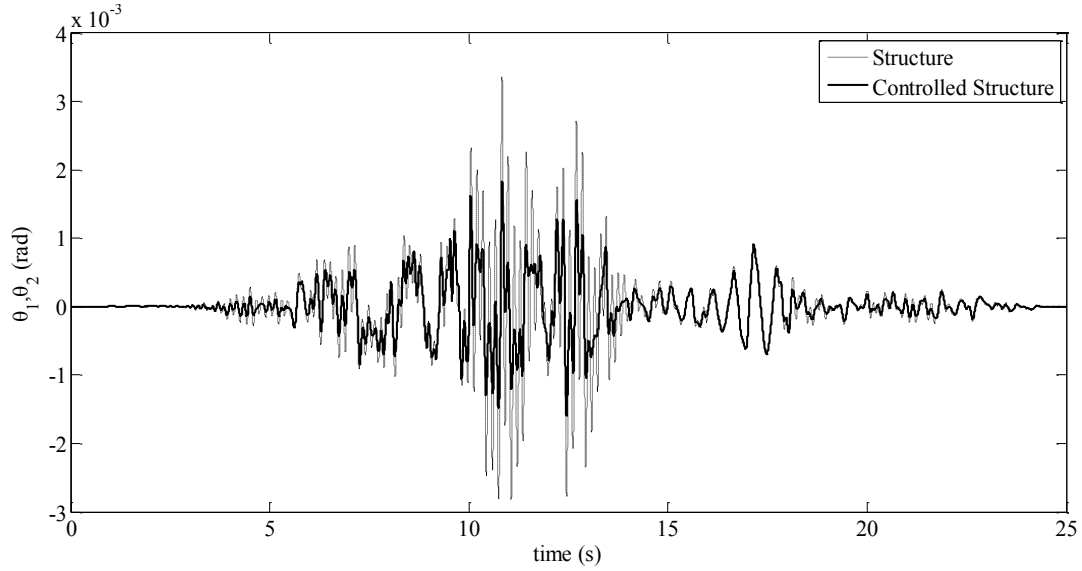

Fig. 3. The rotations at the joints under Loma Prieta earthquake

The shear force of the columns can be seen in Fig. 4 under Loma Prieta loading. The maximum shear force is reduced from 82.3054 kN to 44.7806 kN (45.6% reduction). In Fig. 5, the time history of the moments at the joints can be seen under Loma Prieta earthquake. The maximum moments are reduced from 480.2536 Nm to 295.4865 Nm (38.5 % reduction).

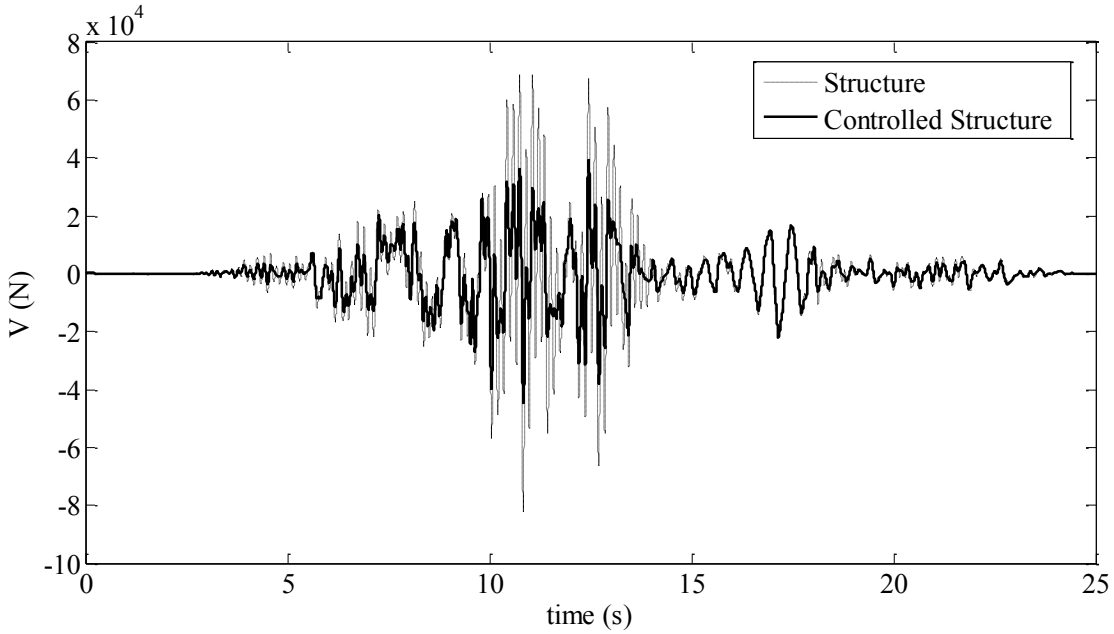

Fig. 4. The shear force under Loma Prieta earthquake

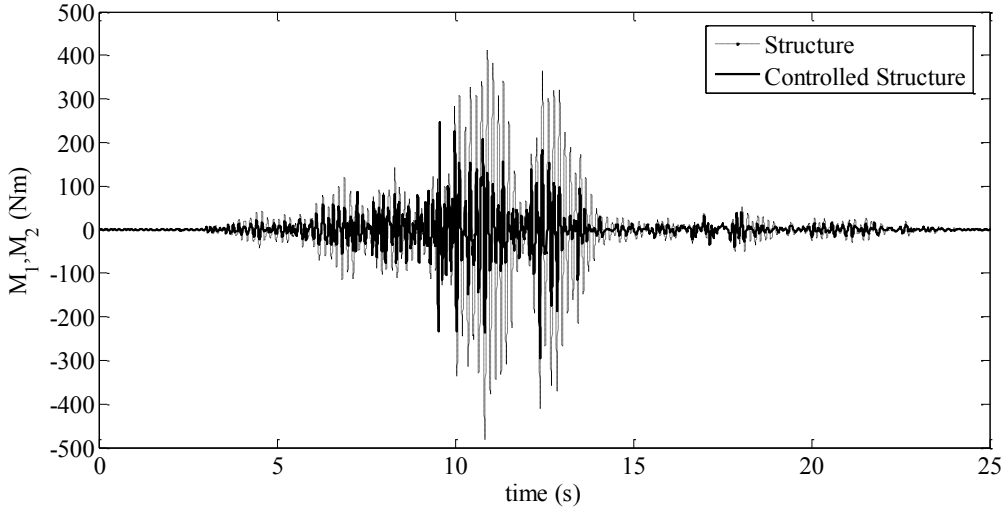

Fig. 5. The moments at the joints under Loma Prieta earthquake

The transfer functions of the frame structure can be seen in Fig. 6 for the lateral motion (TF_x) and the rotations at the joints (TF_θ), respectively. These transfer functions represent the ratio between Laplace Transforms of the accelerations of the frame structure and the ground excitation. The values of the first peaks representing the resonance state of the structure are reduced with the help of the active control.

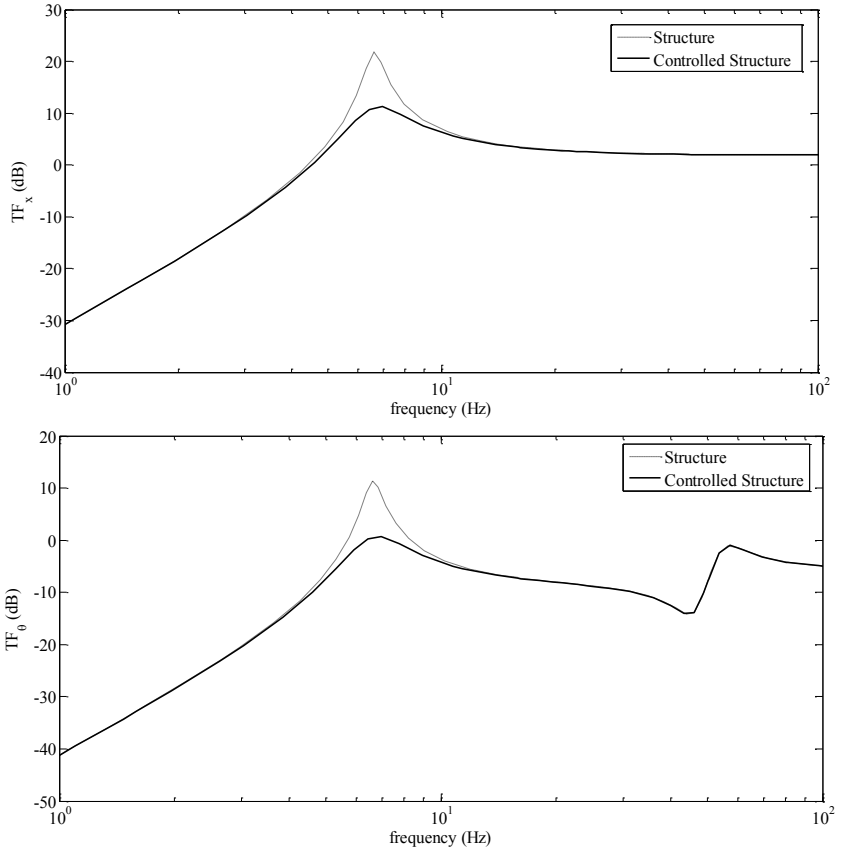

Fig. 6. The transfer functions of the frame structure for the uncontrolled and the controlled cases

Conclusion

The PID controlled active braces for the frame structures are effective on reducing earthquake indicating structural vibrations. The analysis results under different earthquakes prove that the control system is secure and effective for various conditions even a 20 ms time delay is considered. Also, frequency domain analyses show that the structure can be trustable for different random excitations. With the reduction of the lateral displacements, second order effects are reduced. Also, the active control concept is successful on reducing total acceleration of the frame structure. For the feasibility of the method, the control force must be in an applicable range. The results of maximum control force are well enough to maintain. The maximum control force is 13.6792 kN for Lander earthquake excitation. The actuator must apply this force with 100% efficiency in order to minimize time delay value.

Damages at frame structures may be prevented with active braces because of the reduction at the shear force and moments under different earthquakes. Also, the reaching of moments to plasticity capacity may be prevented.

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INFORMATIVE PARAMETERS OF VIBROSEISMIC WAVE FIELDS IN FRACTURED AND FLUID-SATURATED MEDIA

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Seismic heterogeneity of the earth's crust is its fundamental property. It is typical of many earth's crust zones: preparation zones of natural disasters (earthquakes and volcano eruptions), fracture zones, etc. This type of heterogeneity is characterized by local inhomogeneities with different geometric parameters, contrast, structural organization, and distribution density. In particular, the geodynamic processes of generation and development of a seismic destruction source zone in seismic prone zones are considered to be associated with fracturing processes. Taking into account this, it is natural to use the space-time function of the density of cracks in a destruction source zone and in zones of anomalous geophysical fields at the earth's surface as a quantitative characteristic of the basic process generating anomalies-precursors. An integral function of the form $\theta(x, y, t) = div\vec{U}$ (where $\vec{U}$ is the geophysical field recorded at the earth's surface) was proposed as such a function by A.S. Alekseev. With the help of this function, one can approximately describe the density of cracks in the medium [1]. The function *θ(x, y, z, t)* can be called the *function of medium's dilatancy.* The creation of a method to determine the function *θ(x, y, z, t)*, specifically, a method of vibroseismic monitoring of seismic prone zones, is an important problem of active seismology.

Informative parameters of the seismic wave field in active monitoring

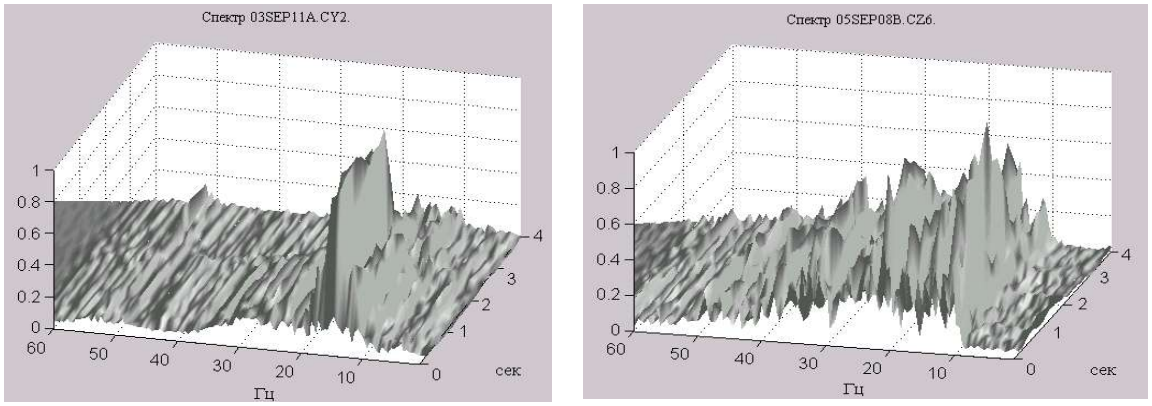
The most detailed data on the structure of medium's zones with time-varying fracturing can be provided by the seismic method of observing P- and S-waves from powerful controllable vibroseismic sources. The efficiency of the vibroseismic monitoring method on the basis of this approach is justified theoretically and methodologically in [2]. With the help of this method, the presence of cracks in destruction zones and the change in their volume density in the periods between monitoring sessions can be determined from the changes in the anisotropy coefficients and wave propagation velocities. The main idea of this paper is to increase the list of informative parameters of seismic wave fields taken as controlled ones in the problem of active monitoring of fluid-saturated and fractured media.

Parameters of wave field nonlinearity

Medium's fracturing is a physical basis for the development of nonlinear propagation processes of seismic oscillations in destruction source zones. This is the reason for taking into account the parameters of wave field nonlinearity characterized by the appearance of higher harmonics which enrich the initial sounding vibroseismic oscillation. In this paper, the transformation of wave fields is analyzed by studying vibrational seismograms obtained by vibrational sounding of regions adjacent to the mud volcano Shugo (Taman mud volcano province). Seismic signals were recorded along longitudinal profiles at the traverses "vibrator-recording seismic station-mud volcano" and "vibrator-volcano- recording seismic station". In the latter case, the volcano was located between the vibrator and seismic station [3].

Spectral-time functions (STFs) were calculated for vibrational seismograms obtained at both variants of recording [4]. Some forms of functions for the both investigated variants are presented in Fig. 1. The sounding distance was R=3290 m for the vibrator and seismic station located at the profile in front of the Shugo volcano and R=3380 m for the volcano located between the vibrator and seismic station. A comparison of the two obtained STFs clearly shows the contribution of the volcanic construction to the broadband enrichment of the oscillation spectrum: a tenfold extension of the dominant oscillation spectrum is observed. Such effects can be related to the transformation of radiated signals on nonlinear structures of the geological medium at the propagation of seismic waves in fluid-saturated formations, such as effluent channels of mud volcanoes. A numerical

estimate of the influence of the fracturing process in the medium on nonlinear effects of propagation of oscillations was obtained for the following model case. Uniformly scattered and chaotically oriented voids of spheroidal shape are taken as the initial model of fracturing.



a b

Fig. 1. Spectral-time functions of vibrational correlograms obtained at:
a) R=3290 m (the volcano is on one side of the vibrator and seismic station);
b) R=3380 m (the volcano is between the vibrator and seismic station)

The shape of the voids is determined by the parameter α, which is equal to the ratio between the rotation axis length of a spheroid and the length of its second axis. The distribution of the relative volume of voids between its minimal value α_{min} and maximal value α_{max} is described by the function φ(α). It is assumed that the length of an elastic wave with the highest frequency propagating in the medium being modeled is much greater than the linear dimensions of the largest voids. In a fractured medium there appear harmonics of doubled frequency. Their level is determined by the coefficient B, which depends on the character of the medium's fracturing and its elasticity parameters, the Mach number $M = U_x \omega / c_P$, and the wave travel length x, in which case the level of the second harmonic increases proportionally with x [5]. The nonlinearity coefficient is determined by the ratio between the amplitudes of the second and first harmonics of the harmonic oscillation behind the fractured medium by the following expression:

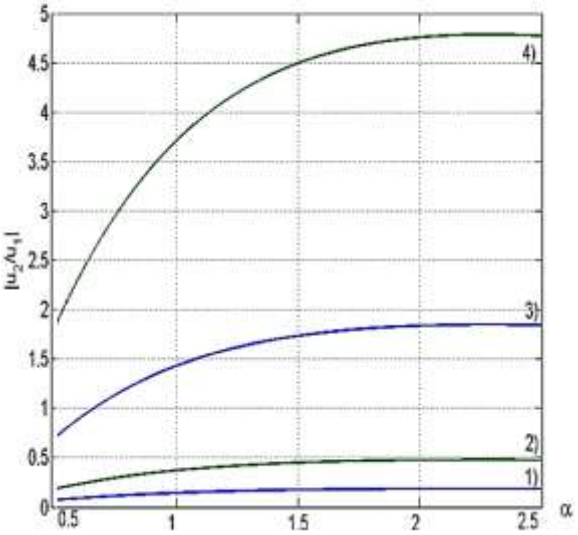
$$\frac{u_2}{u_1} = \frac{1}{8}\frac{U_x B k_p^2 x}{M_0} \qquad (1)$$

where $k_p=\omega/c_p$, U_x – amplitude of compressional wave $u_x(0,t)= U_x \sin\omega t$

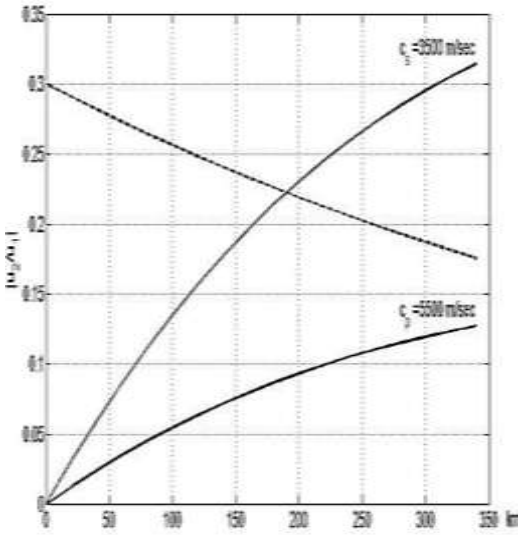
This phenomenon was noted earlier as accumulating nonlinearity in a nonlinearly elastic medium [6-9]. In accordance with equation (1), an analysis of the nonlinearity coefficient as a function of the characteristics of the medium's fracturing, the amplitude of oscillation velocity U_x of medium's particles, and the distance x was made. Water-saturated fractured granite with the following elasticity parameters was chosen as the medium: Young's modulus $E=2.216\cdot10^9$ Pa, the Poisson's coefficient ν=0.44296, the static pressure $p_0=10^3$ Pa, the frequency=10 Hz, and the propagation velocity of the P-wave in granite C_p=2500 m/s. For these parameters, In Fig. 2a, curves 1 and 2 show the nonlinearity coefficient of the monochromatic wave shape versus the ratio between the ellipsoid axes describing an elementary fracture. In the process of construction, the axes were given by the parameters d_{min}, d_{max}, and d_{vert}. The first two parameters correspond to the minimal and maximal horizontal sizes of spheroids, and d_{vert} is the linear vertical size.

The change in the ellipsoid sizes is described by a function of the form $\varphi(\alpha)=1/\alpha$, where α varies from $\alpha_{min}=d_{min}/d_{vert}$ to $\alpha_{max}= d_{max}/d_{vert}$. The curves 1,2 were constructed for the x- wave travel length x = 10 km; the curves 3,4 – for 100 km. The vibroseismic oscillation velocity of the medium's particles $U_x=30*10^{-9}$ m/s corresponds to curves 1 and 3, and a velocity of $70*10^{-9}$ m/s corresponds to curves 2 and 4. Fig.2b presents curves for the nonlinear effect "accumulation" versus distance at given seismic velocities in a "source-receiver" distance range of 0.3÷355 km. It follows from an analysis of Figs. 2 that the ratio between the second and first harmonics can increase several times as the sizes of fractures increase and the wave travel path increases.

The field of scattered waves randomly distributed in time and space contains much information about medium's heterogeneity. It is necessary to determine their especially high sensitivity to fine structural changes of the complex medium in destruction source zones and thereby extract additional information about the geodynamic processes. The appearance of scattered waves in vibrational seismograms after head waves is shown in Fig.3b. In contrast to the vibrational seismograms obtained for the vibrator and seismic station located at the profile in front of the volcano (Fig. 3a), one can easily see a more complicated structure of seismograms obtained for the seismic station located behind the volcano. It is evident that this is caused by the passage of vibroseismic oscillations through the volcano body.



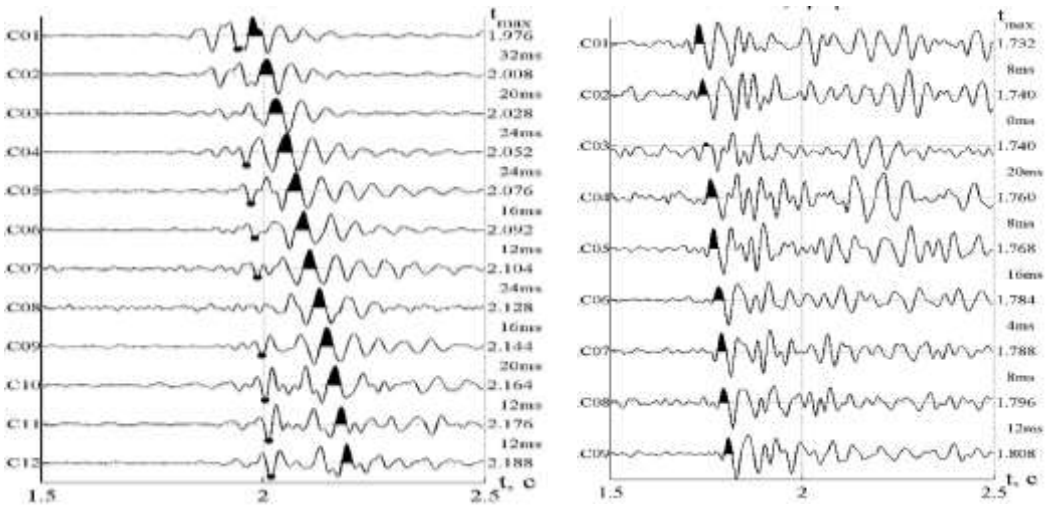
a) *The nonlinearity coefficient of the monochromatic wave shape versus the ratio between the spheroid axes, α, modeling cracks in granite. Wave travel path: plots 1) and 2 for x=10 km, 3) and 4) for x=100 km. Oscillating speed: 1) and 3) -$U_x=30*10^{-9}$ m/s; 2) and 4)- $U_x=70*10^{-9}$ m/s.*



b) Coefficient of nonlinear distortions versus distance at different seismic velocities. Attenuation of this coefficient due to wave energy absorption in the medium is shown by a dashed line. The data are for the radiation regime of harmonic oscillations at a basic frequency of 10.3 Hz.

Fig.2 The nonlinearity coefficient of the compressional monochromatic wave as a function of the characteristics of the medium's fracturing

Fractals of scattered waves

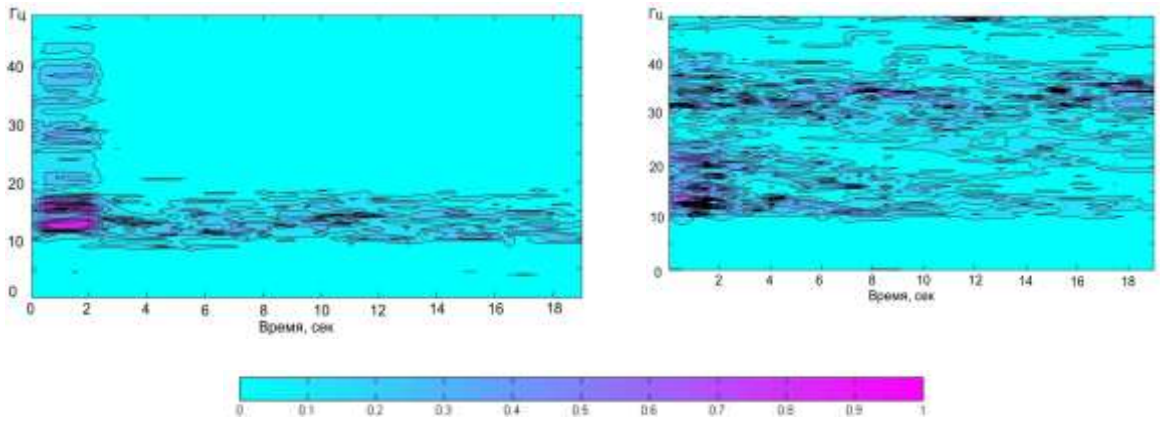


a) b)

Fig.3. Vibrational seismograms obtained at the traverse "vibrator–Shugo volcano":
a) R=3290 m (the volcano is on one side of the vibrator and seismic station);
b) R=3380 m (the volcano is between the vibrator and seismic station)

Fig. 4 presents the fractals of seismograms, which are projections of STFs (Fig. 1) on the "frequency–time" plane, to show the wave field structure in the frequency-time range. The amplitude values of STFs are shown by different colors.

A 2D representation of the parameters of seismic waves in frequency and time shows, first of all, compactness of the distribution of the frequency-time parameters of dominant waves (head waves shown by purple color) recorded at the profile in front of the volcano. On the contrary, the wave pattern recorded by the seismic station behind the volcano is characterized by the "smearing" of these parameters on the "frequency-time" plane. Thus, the transient character of the field between these two states caused by the development of the processes of fracturing and fluid-saturation can be characterized by means of the fractals considered. They, together with other parameters, can be an efficient instrument for tracking these processes.



a b

Fig. 4. Fractals of vibrational seismograms obtained at the traverse "vibrator–seismic station–Shugo volcano*": a) R=3290 m (the volcano is on one side of the vibrator and seismic station); b) R=3380 m (the volcano is between the vibrator and seismic station)*

Variations of wave shapes in the zone of tectonic fractures

Shape variations of the main seismic wave types are an additional informative feature characterizing the influence of destruction zones on passing seismic waves. This is the case, first of all, for S-waves. Earlier, N.N. Puzyrev noticed that the influence of anisotropy on the passage of P- and S-waves is different. Therefore, it was soon realized that the anisotropy itself is a very "bright" characteristic of the medium that can be efficiently studied on the basis of multiwave seismics [10, 11]. Waveform variations were studied in experiments on vibrational sounding of tectonic fractures in Novosibirsk region. The arrangement of sensors on both sides of the fracture is shown in Fig. 5.

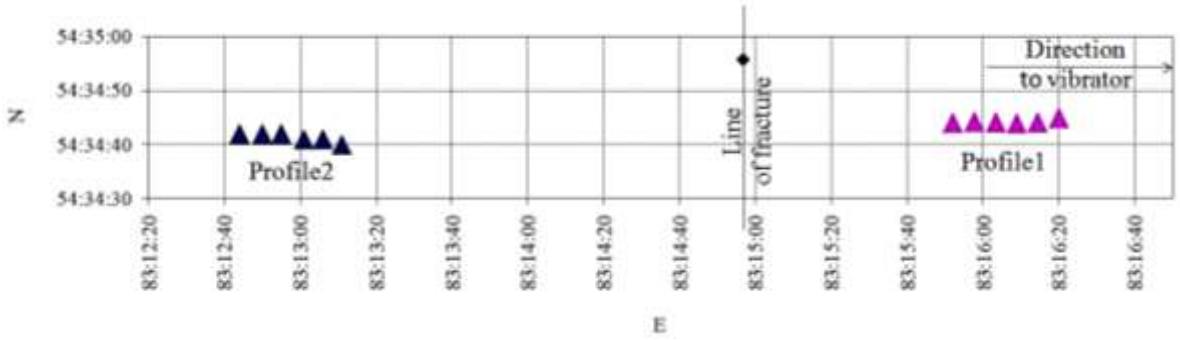


Fig. 5. Profiles of arrangement of sensors on the fracture sides

Fig. 6 shows vibrational seismograms obtained by the CV-40 vibrator for the Z-component with seismic receivers located on both sides of the fracture at distances 36.1 km ((profile 1)and 39.5 km (profile 2), 86.9 km (profile 3) and 92.9 km (profile 4). When comparing the seismograms one can clearly see destruction of the waveforms of the main wave types caused by the fracture structures.

This disruption can be estimated quantitatively by measuring the correlation of waveforms recorded in front of the fracture and behind it. Table 1 presents estimates of the correlation coefficients of the vibrational seismograms along the X and Z-component for two fracture zones - ("profile 1-profile 2" and "profile 3- profile 4").

Table 1.

Cross-correlation coefficient of waveforms

Sensor components	profile 1	profile 2	profile 3	profile 4	Sensor components	profile 1	profile 2	profile 3	profile 4
x1	1,000	1,000	1,000	1,000	z1	1,000	1,000	1,000	1,000
x2		0,124		0,177	z2			0,620	0,433
x3	0,325	0,167	0,210	0,220	z3	0,513	0,293	0,798	0,509
x4	0,387	0,120	0,091	0,181	z4	0,376	0,333	0,836	0,560
x5		0,177	0,163	0,097	z5			0,840	0,357
x6	0,313	0,144	0,131	0,163	z6	0,424	0,206	0,789	0,377

Correlation coefficients of the form K(x1,x1), K(x1,x2),…K(x1,x6); K(z1,z1), K(z1,z2), …and K(z1,z6), that is between the seismograms obtained by the first sensor and the seismograms obtained by the other sensors in zones with P- and S-waves (Table 1), were calculated.

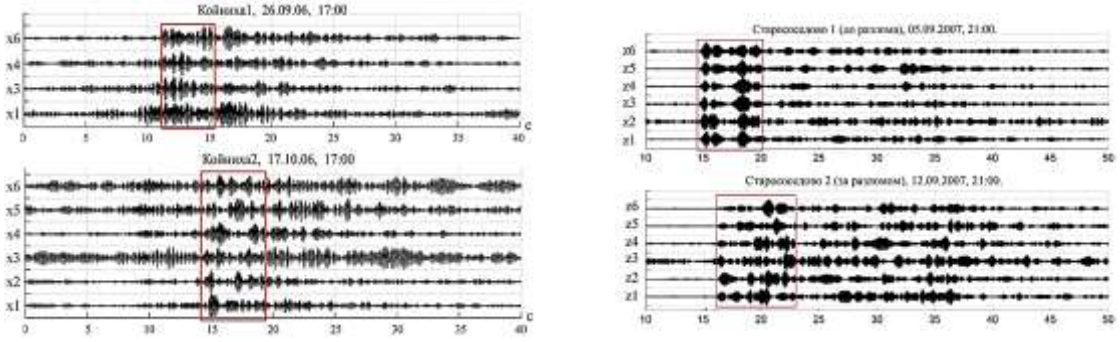


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Fig.6. Vibrational seismograms recorded on both sides of the fractures in two zones: a) profile 1and profile2; b) profile 3 and profile 4

One can see from this table that whereas in the column "profile 3" (in front of the fracture) the cross-correlation coefficient values are within 0.620–0.840 (on components Z), for "profile-4" (behind the fracture) the range of values of the corresponding estimates is 0.377–0.560 (on components Z).

Similar estimates obtained along the Z-component for the profile 1 and profile 2 are 0.424–0.513 and 0.206–0.333, respectively. The corresponding estimates obtained along the X-component f are 0.313–0.387 and 0.124–0.177, respectively. Thus, there is an evident tendency for a decrease in the waveform correlation in seismograms introduced by the fracture.

Conclusion

The results presented are based on the multidisciplinary approach developed by Academician A.S. Alekseev to solve the problem of active seismic monitoring of the processes of fracturing and dilatancy developing in seismically and volcano prone zones. In addition to the approach consisting in the tracking of changes in the anisotropy coefficients of the medium and the propagation velocities of P- and S-waves, it is proposed to take into account the dynamic characteristics of the wave field. These make it possible to take into account the waveform variations and nonlinear transformation of wave fields associated with the geodynamic processes developing in destruction source zones.

This approach is supported by the results of experimental investigations on vibrational sounding of mud volcanoes in the Taman mud volcano province and the tectonic fracture in Novosibirsk region. The efficiency of using these parameters of the wave field to solve the problem of active seismic monitoring is shown. In this case, the problem of estimating the dynamics of development of geodynamic processes in the destruction source zone becomes a multiparametric problem, which can be solved by pattern recognition methods.

Acknowledgments

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VIBROSEISMIC TECHNOLOGY OF DETECTION AND MONITORING OF SEISMIC- VOLCANO- PRONE ZONES

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Introduction

Different kinds of geophysical precursors are used in earthquake prediction to reduce the probability of unexpected catastrophic earthquakes. Several years prior to such earthquakes, some anomalies often occur within geophysical fields, such as crustal deformation, seismicity and electric conductivity. Zones that manifest such anomalies will migrate within a 200–300 km distance from the epicenter of a subsequent earthquake. The migration mechanisms for different anomalous zones, and the interrelations among them, reflect the evolution of seismotectonic stress fields, which could contain valuable information.

Over the past 30 years, the data has been collected from a number of different scientific disciplines and from several different countries, including China, Japan, USA, Greece, Turkey, and Russia. However, the use of multidisciplinary resources in earthquake prediction, and the results from them, raised new, important questions with regard to determining the interrelationships among seismicity processes, variations in geophysical fields, and the sources of anomalies within

Main properties of the integral precursor

Earthquakes occur through the massive rocks failure, which begins in the source zone. Therefore, study of the pre-failure processes and monitoring of these processes are of major importance for earthquake prediction. An investigation of the rock failure in samples of various materials in laboratory, as well as at large scale (in particular Earth crust blocks during earthquakes), reveal the general regularities of the rock failure process.

Step-by-step development of this process in time is the most general principle. Some kinetic laws and concepts of the rock failure were established by S. N. Zhurkov and his colleagues [1]. The relationship describing step-by-step transition from small cracks to larger cracks, when

smaller cracks reach some critical value, in accordance with the concentration criterion of S. N. Zhurkov, has the form

$$K^* = \frac{1}{\sqrt[3]{N}L}, \tag{1}$$

where N is the number of cracks of size L per unit volume, K^* is the critical average distance between cracks, measured in the units of average cracks length. When the average distance between cracks becomes smaller than a certain critical value, there is an abrupt reorganization of the entire system of cracks, with increasing of average crack sizes (in some geometrical proportion) and decreasing of average volume concentration. Cracks tend to localize in the area of a future macrofracture. These phenomena are typical for any scale and any regime of loading.

Some geophysical fields can be affected by the microcracks opening. In particular, gas and fluid permeability increases in those areas of the Earth's crust where this process takes place. As a consequence, the groundwater level, the intensity of gas flows, and the electrical resistance can change. Loosening of rocks resulting from the increasing of total cracks volume must also cause local gravity anomalies. Thus, the crack-density function as a measure of rock failure criteria has some advantages. One more advantage is that the crack-density function can be more accurately and reliably determined from multidisciplinary data, owing to its presence in the models of various geophysical fields - the complementary principle [2, 3]. The results from numerical modeling of dilatancy zones suggest that cracks of some scale level can be formed at distances of 200–300 km from the source of a future earthquake. Although the earthquake development process is "slow" and lasts up to several hundreds of years it is an energy-intensive process. Considerable rheological changes in the medium take place, and anomalous zones within different kinds of geophysical fields are forming. Cracks opening in zones with increased shearing and tensile stresses is the most basic mechanism of change in the medium. Such zones are formed in the vicinity of the sources of future earthquakes, if the spatial distribution of forces is nonuniform.

Many seismologists consider that the initial stage of crack opening and the subsequent state of the medium when rock failure develop are connected with the dilatancy of the medium [4, 5, 6].

Dilatancy is the nonlinear loosening of rocks caused by crack formation from shear. This process takes place when tangential stresses exceed a certain threshold. A dilatancy zone includes points within an elastic medium, for which the following condition is satisfied:

$$D_\tau \equiv \tau - \alpha(P + \rho g z) - Y \geq 0, \tag{2}$$

where ρ is the density of rocks, g is the gravitational acceleration, α is the coefficient of internal friction, Y is the cohesion of rocks, z is the depth of a point, P is the hydrodynamic pressure

$$P = -\frac{1}{3}(\sigma_{11} + \sigma_{22} + \sigma_{33}), \tag{3}$$

where σ_{ij} are the stresses and τ is the intensity of tangential stresses:

$$\tau = \frac{\sqrt{3}}{2}[(\sigma_{11} - \sigma_{22})^2 + (\sigma_{22} - \sigma_{33})^2 + (\sigma_{33} - \sigma_{11})^2 + 6(\sigma_{12}^2 + \sigma_{13}^2 + \sigma_{23}^2)]^{1/2}. \tag{4}$$

Condition 2 coincides with the Schleicher-Nadai's criterion of rock failure due to of shearing loads and describes the beginning of the rock rock failure process. It can also be used at the "rock

pre-failure" stage (when loading constitutes up to 60–90% of the critical value) for describing the shape of areas with rapid crack growth.

To demonstrate the complex character of dilatancy zones, we use the simplest model of the Earth's crust, which is taken as a uniform, isotropically-elastic half-space. This complexity manifests itself even when a point force is a source of tectonic stresses. Exact solutions for elastic displacements and stresses, from a point source satisfying the conditions of zero stresses at the surface $z = 0$, were used to model the stress field in an elastic half-space [7]. The domain surface $D_\tau = 0$ from equation 2 for the double force source at a depth of 15 km is shown in Figure 1. Here, the parameters of the elastic half-space are as follows:

$$v_p = 6000 \text{ m/s}, \quad v_s = v_p/\sqrt{3}, \quad \lambda = \mu = \rho\, v_s^2 = 3.48 \cdot 10^{10} \text{ Pa},$$
$$\rho = 2900 \text{ kg/m}^3, \quad g = 9.9 \text{ m/s}^2, \quad Y = 3 \cdot 10^6 \text{ Pa}, \quad \alpha = 0.5$$

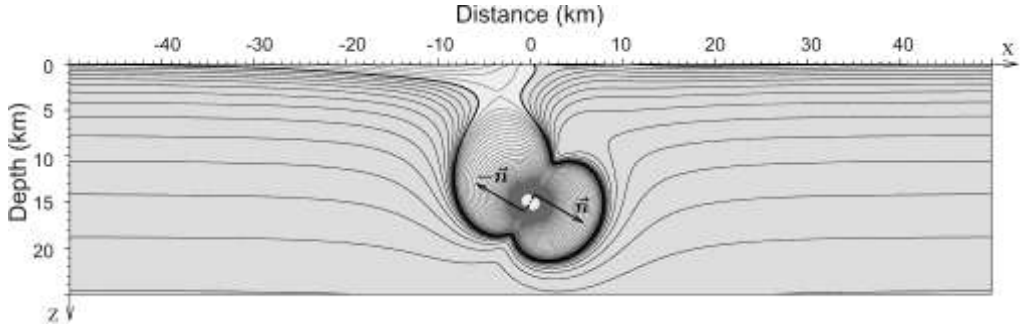

Fig. 1. Exact solutions for elastic displacements and stresses from a point source satisfying the conditions of zero stresses at the free surface shows that there are the two dilatancy zones - "source" zone in the vicinity of the elastic dipole application point and the "surface" zone in the layer near the free surface. Shapes of "source" and "surface" dilatancy zones in the plane $y = 0$ ***(15 km - source depth, double force*** $M_0 = 3 \times 10^{20}$ N***, n=(cosφ,0,sinφ),*** $\mathbf{p} = (0,1,0)$***, φ=30°.***

Double force is specified in the form of a moment tensor, $\mathbf{M} = M_0\mathbf{np}$, where M_0 is dipole momentum (scalar), **np** is dyad characterizing the orientation of a force (**n**) and the arm of a force ($\mathbf{p}$).

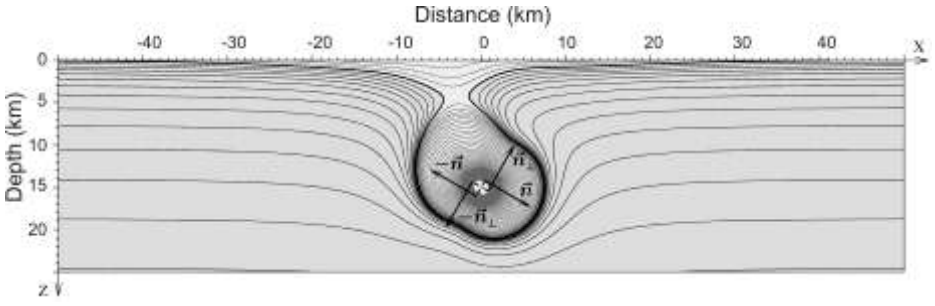

Fig.2. Same as in Fig. 1 but for double force couple
$M_0 = 6.75 \times 10^{20}$ N**,** $\mathbf{n}_\perp = \mathbf{p}, \mathbf{p}_\perp = \mathbf{n}$**, n=(cosφ,0,sinφ),** $\mathbf{p} = (0,1,0)$**, φ=30°.**

The domain surface $D_\tau = 0$ from equation 2 for the double-force couple source at a depth of 15 km is shown in Fig. 2. The double-force couple is set in the form of a moment tensor, $\mathbf{M} = \frac{1}{2} M_0(\mathbf{np} + \mathbf{pn})$. In this case, the conformable matrix is symmetric.

Tangential stresses inside the domain $D_\tau \geq 0$ dominate over compressional stresses. The resistance of the medium to shearing forces is overcomed due to cohesion. Conditions favorable to the increase in the number of cracks are modeled. Note that the mechanisms of crack opening and the rheological changes of the geological medium in the zone $D_\tau \geq 0$ are not described by the used solutions. The solutions are valid only for determining the transition from the elastic state to the state of nonlinear loosening.

The interesting feature in Fig. 1 is the formation of two dilatancy zones, which are the "source" zone in the vicinity of the source point and the "surface" zone in the upper part of the model. Here, the stress field from the source affects mainly the tangential stresses while the compressional stresses and the hydrostatic pressure just slightly contribute due to the proximity of the surface.

The behavior of the surface dilatancy zone varies, depending on the following parameters: h (the source depth), M_0 (the source intensity), the angle φ (the force orientation in the source), and Y (cohesion of the medium's elements). It can vanish with increasing source depth or merge with the source zone as the source intensity increases. In some cases, the horizontal size of the surface zone is 200 or more kilometers, with a complex shape when projected onto the Earth's surface. It is easy to verify that the pattern of displacement in dilatancy zones along the surface can be complex, particularly when influenced by several sources distributed in space whose intensity varies over time.

Since anomalous geophysical fields are naturally related to surface dilatancy zones, the location of the dilatancy zones must be determined as reliably as possible, to effectively investigate the sources of these anomalies.

The condition of loosening crust rocks, taking into account the mechanisms of crack formation by tension of the medium, can be written in the form of a new criterion:

$$0 \leq D_\sigma \equiv \begin{cases} \frac{1}{2}\sigma_1(1-\sin\varphi) - \frac{1}{2}\sigma_3(1+\sin\varphi) - Y\cos\varphi, & \text{if } -\sigma_3 \geq \sigma_p, \\ -\sigma_3 - \sigma_p, & \text{if } -\sigma_3 < \sigma_p, \end{cases} \tag{5}$$

where, σ_1 and σ_3 are the largest and smallest principal stresses, respectively; φ is the angle of internal friction; Y is the cohesion, and σ_p is the strength of the rocks. This criterion determines dilatancy zones under conditions in which the medium can withstand large shearing stresses, but offers less resistance to tensile forces.

Note that so far, the existence of surface dilatancy zones under real conditions should be considered a hypothesis. The use of this hypothesis for practical analysis of anomalies within various geophysical fields is an attempt to find reasons for the evolution of these anomalies, and to clarify the mechanisms of their interrelation.

Monitoring of the crack-density variation in the source zone is of special importance for short-range earthquake prediction. This monitoring should not be separated from observations of the surface dilatancy zone and the anomalous fields associated with it. First, the location of the future source is not yet known exactly, and its determination is closely related to the behavior of surface anomalous zones. Second, the reliability and accuracy of estimating the crack-density function in the source zone depends on the information about field anomalies in surface zones.

Before proceeding to the scheme for estimating the integral precursor in the source using multidisciplinary monitoring, it is reasonable to consider the mechanism of interrelation between the crack-formation processes in the source and surface dilatancy areas. Generally, a stress field is an energy-charged medium in which the interrelation between the source and surface zones is

realized. The lines of largest tangential stress (or largest tensile stress) provide an estimate for the predominant orientation of cracks that occur in zones of the source and surface types. When dilatancy zones of the two types are combined into one zone, there is a joint area of fracturing. This area combines the surface zones of anomalous fields with the source zone, in which the development of the rock failure process can directly influence the change in the geophysical anomalies. When dilatancy areas are separated, the source zone can retain its direct influence on the anomalies of some fields (for example, on the values of the velocities v_p and v_s) by a joint area of introduced anisotropy within the medium. The anisotropy coefficients can be expected to vary in a special way during the crack growth process, because the orientation of the axis of symmetry remains the same. This can simplify the problem of estimating the average number of cracks by a high-resolution vibroseismic method [7, 8, 9].

Multidisciplinary model of integral precursor and combined inverse problems

An analysis of crack-system development at earthquake sites prior to seismic activity shows that earthquake prediction of rock failure should include a determination of the major space-time characteristics of the crack systems at these sites. Such investigations should be performed in the dilatancy zones where the crack systems are developed.

Observations of geophysical anomalies enable to determine the crack-density function. It was assumed in the previous section that the crack-opening processes in dilatancy zones are related to the mechanisms forming anomalous fields. Qualitatively, the formation of anomalies in gravitational, electric conductivity, ground water level, gas and fluid permeability fields can be explained by crack opening. It is evident that special investigations are needed to obtain quantitative models of geophysical fields in fractured media [6].

In the process of deformation prior to the failure, loosening is characterized by the volume expansion (dilatation) $\boldsymbol{\Theta}$ =div$\mathbf{U}$ where the divergence is calculated from the elastic displacement vector. It is assumed here that the vector components are sufficiently smooth (differentiable) functions. If we consider a small volume V_0, which is V_1 after the deformation, then $V_1=V_0(1+\boldsymbol{\Theta})$. If the medium's density is ρ_0, after deformation it is $\rho_1=\rho_0/(1+\boldsymbol{\Theta})$. For the large, deformed volumes, this loosening is considerable. It generates an anomaly in the gravitational field $V(x,y,0)=V^0(x,y)$, which we can use to solve the inverse problem

$$\Delta V=-4\pi\rho_1\,\boldsymbol{\Theta}, \qquad V\big|_{z=0}=V^0(x,y), \tag{6}$$

to determine the density $\rho_1(x,y,z)=\rho_0/(1+\boldsymbol{\Theta})$, and the loosening $\boldsymbol{\Theta}$ (if this inverse problem can be solved uniquely and the initial density is known). The main difficulty—the one that leads us to consider multidisciplinary (combined) statements of inverse problems—is that the inverse problem (6) does not have a unique solution. It is ill-posed, an attempt to find a three-dimensional function $\rho_1(x,y,z)$ using a known two-dimensional function $V^0(x,y)$. This is impossible without additional information.

The significance of combining inverse problem statements is in the use of additional information from the solution to state a new inverse problem for the same physical quantity. The approach to determining the characteristics of cracking (the integral precursor) using data from geophysical anomalies also can utilize the idea of the surface dilatancy zone. Let us introduce a medium's volume expansion (loosening) function $\theta(x,y,z,t)$. This function can be considered piecewise continuous; and it is assumed to be equal to the total relative volume of cracks in the medium's unit volume. The number of cracks in the unit volume can be determined by the formula $N=\theta(x,y,z,t)/\theta_L(x,y,z,t)$ where $\theta_L(x,y,z,t)$ is the relative average volume of a crack of length L. In problems of crack-number monitoring, this quantity is determined from the estimate of the medium's mechanical parameters, the average crack sizes at the previous scale level of process development in the source, taking into account the concentration criterion (1).

Let us consider a combined inverse problem for the gravitational and electric data, for the problem of the groundwater level evaluation, and the seismic method for measuring the effective anisotropy coefficients of cracked rocks, on the basis of the complementary principle of geophysical methods [2] to obtain reliable estimates of the function $\theta(x,y,z,t)$. Each of these methods is based on measurements at the surface $z=0$ of the corresponding geophysical field

$$U_\nu(x,y,0,t_k)=U_\nu^0(x,y,t_k), \tag{7}$$

here, $t_k=kT_\nu$, with T_ν the time interval between the recording times of field values during monitoring.

Methods for solving direct and inverse problems exist for all geophysical fields that are used in the problem of earthquake prediction. In direct problems, the equation for the field

$$L_\nu(U_\nu,\alpha_\nu,\beta_\nu)=f_\nu(x,y,z,t), \tag{8}$$

the surface conditions

$$l_\nu(U_\nu,\alpha_\nu,\beta_\nu)|_s=h_\nu(s,t) \tag{9}$$

and the initial data

$$U_\nu(x,y,z,t)|_{t=0}=U_\nu^0(x,y,z). \tag{10}$$

are assumed to be given. Here $\alpha_\nu(x,y,z),\beta_\nu(x,y,z)$ are the physical and geometrical characteristics of the medium; $f_\nu(x,y,z,t)$ are the external volume sources of the field; and $h_\nu(s,t)$ are the sources at the surface *S*. The statement of the combined inverse problem is illustrated by Fig. 3.

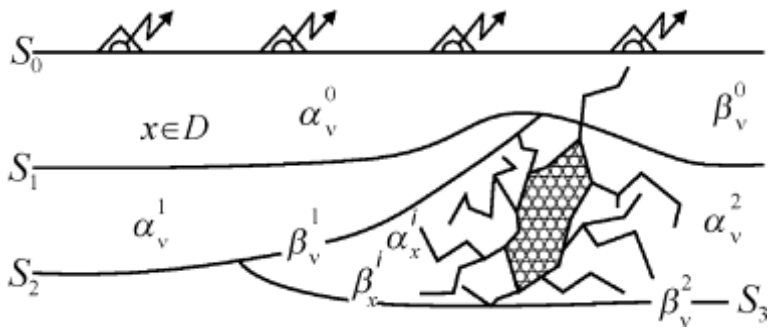

Fig. 3. Statement of the combined inverse problem. The physical and geometrical characteristics of the medium $\alpha_\nu(x,y,z),\beta_\nu(x,y,z)$***, the field sources and the surface surfaces*** S_i

Numerical methods for solving direct problems exist of any above-mentioned fields. These methods use specified geological medium's characteristics $\alpha_\nu(x,y,z),\beta_\nu(x,y,z)$, the field sources, and the surface *S.* In inverse problems, the following information is known: the field $U_\nu^0(s_i,t)$ at a series of points s_i at the surface S and the sought-for characteristics of the

medium α_ν, β_ν, or other elements of the problem (the shape of the surface S, some sources f_ν or h_ν).

The model of a multidisciplinary (combined) inverse problem is used to determine the integral precursor $\theta(x,y,z,t)$, i.e., the relative crack-density function [10].

In this case, all geometrical and physical parameters of the medium, with the exception of the function $\theta(x,y,z,t)$, are considered to be known, and the function $\theta(x,y,z,t)$ is considered to be independent of time during each field measurement $t_k = kT_\nu$.

An optimization method is used to solve the combined inverse problem (. Let $\beta_\nu(x,y,z,t,\theta)$ represent the operator to calculate the field $U_\nu(x,y,z,t)$ in the direct problem for the method with the number ν. The problem consists in determining $\theta(x,y,z,t)$ from the condition of minimum of the functional:

$$I(\theta) = \min_{\theta \in M_\theta} \sum_{\nu=1}^{m} \gamma_\nu [U_\nu^0(x,y) - B_\nu(x,y,0,t_k,\theta)]^2, \tag{11}$$

where γ_ν are the weight coefficients for individual methods, M_θ is an a priori set of possible solutions θ; $U_\nu^0(x,y)$ is the measured field, and $\beta_\nu(x,y,0,t_k,\theta)$ is the modeled field.

Optimization method traditionally means considerable computational difficulties. They are associated with simultaneously solving a large number of direct problems for different fields. Besides, the functional that is being minimized often has many local minimums making searches for the global minimum difficult. To solve such problems successfully, one should use high-performance computers and good initial approximations to the sought-for functions. The seismic method using powerful vibro-seismic sources can yield more detailed data about the medium structure, including an evolution of fractured zones. Employing observation systems with multiple overlaps, these sources provide resolution similar to well-known results in seismic prospecting. Here, we will not consider the capabilities of active seismology using powerful vibrators, signals from which can be recorded at distances of up to 500–1000 km. Rather; we shall consider vibroseismic sounding of dilatancy zones as necessary instruments to increase the reliability and accuracy of the obtained information.

Scheme of vibroseismic monitoring of seismic prone zones

The Siberian Branch of the Russian Academy of Sciences has gathered unique experimental data from field observations (Alekseev et al., 2005; 2004; 1996; 1995). Seismograms have been obtained at distances of up to 400 km, and records of mono-frequency signals have been obtained at distances of up to 1,000 km, by using vibrators with a force of 50, 100, and 250 tons. Among the important problems for active seismology are the methods for vibroseismic monitoring of seismic-prone zones and, in particular, a method for determining the function $\theta(x,y,z,t_k)$. To determine $\theta(x,y,z,t_k)$, the Deep Seismic Sounding (DSS) scheme can be used, together with the Common Depth Point (CDP) scheme, at profiles 150–200 km in length over the source of an impending earthquake. At the stage of long-range prediction, the period between soundings can be equal for 6 months to one year. At the stage of short-range prediction, soundings must be more frequent, and observation systems must be more detailed. We assume that the medium's properties vary only slightly between measurements. These small variations can be made the major elements of variability of seismic cross sections, with the help of the "interframe correlation" method (i.e., by the subtraction of sequential images of the medium and analysis of increments).

An analysis of experiments on rock failure shows that the variability in crack sizes is larger than the variability in the dominant orientation of cracks [11]. Sometimes crack sizes vary abruptly

during the transition to the next scale level of rock failure [1]. This property enables us to simplify and refine the algorithms for processing vibroseismic observations.

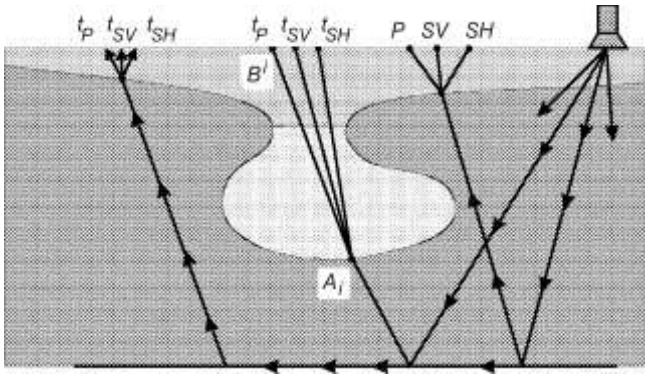

Fig. 4. The general scheme of monitoring of the medium using vibrational source. Vibroseismic observation profile of P, SV, and SH waves for the monitoring function $\theta(x, y, z, t_k)$ ***in the dilatancy zone. This function characterizes the development of systems of cracks in the earthquake source and in anomaly zones of of geophysical fields. To determine*** $\theta(x, y, z, t_k)$***, the Deep Seismic Sounding (DSS) scheme can be used together with the Common Depth Point (CDP) scheme at profiles 150–200 km in length over the source of a preparing earthquake.***

A general scheme of monitoring is shown in Fig.4. Automatic data processing using this scheme assumes the development of migration methods and the solution of inverse dynamic problems for the total system of equations for elasticity theory in an anisotropic medium:

$$\frac{\partial \sigma_{ij}}{\partial x_j} + \rho \frac{\partial \Phi}{\partial x_i} = \rho \frac{\partial^2 U_i}{\partial t^2} \tag{12}$$

with the generalized Hooke's law

$$\sigma_{ij} = C_{ik}(\nu_s, K_s, K_f, \theta)\varepsilon_{kj}, \tag{13}$$

here, σ_{ij} are the stresses; ε_{kj} are the deformations; Φ is the gravitational potential; C_{ik} are the effective parameters of anisotropy for the fractured medium; ν_s is the Poisson's coefficient for the imbedding (elastic isotropic) medium; K_s is the modulus of volume deformation in the imbedding medium; K_f is the modulus of volume deformation for the liquid or gaseous phase in the porous half-space; and θ is the volume density of cracks.

Equations 12 (often lacking the term with the gravitational potential) and Hooke's law (equation 13) are widely used in geophysics to describe seismic waves in fractured media. There are several formulations of the generalized Hooke's law, with the anisotropy coefficients approximating the wave processes in fractured media at low frequencies [12,13]. The density of cracks θ is present explicitly in Hooke's law (equation 13); it depends on the assumed shape of cracks. The following formula is given in [14]: $e = \dfrac{2NA^2}{\pi P_e}$. This formula defines the density of cracks *e* for densely packed *N* parallel-plane elliptic cracks of the area A with perimeter P_e. It is valid for any plane cracks with a convex boundary shape.

Equations 12 and 13 form the basis for the seismic data processing in seismic prospecting and seismology. In practice, simplified kinematic approaches have been used so far.

The observation scheme of waves reflected and refracted from the Moho surface in the Earth's crust, using vibro-seismic sounding of the source and surface dilatancy zones, is shown in Figure 4. The presence of fractures in these zones, and the changes in their volume density during the periods between monitoring sessions, can be determined from the changes in the anisotropy coefficients and wave propagation velocities. The transverse wave S splits into SV and SH waves at the boundaries of dilatancy zones. The depth and shape of the boundaries, as well as the wave propagation velocities, can be determined (by well-known methods) from the lags Δt_{SV}, Δt_{SH} in the arrivals times of the corresponding waves at the points B^i_{SV}, B^i_{SH}, ant the source located at the point A^i.

For the fractured model of the type [14] the velocities of all three wave types v_P, v_{SV}, and v_{SH} are determined by the formula $v = \frac{v_0}{\sqrt{1+ef(\gamma)}}$, where v_0 is the wave velocity in the medium before the appearance of cracks, $f(\gamma)$ is one function for all types of waves [13,15] and γ is the angle between the direction of wave propagation and the direction normal to the orientation of plane cracks. The quantity e from equation 13 and equation 14 is the sought-for function $\theta(x, y, z, t_k)$. It can be determined not only from seismic monitoring data, but also from routine seismologic observations of the velocities $v_P(t_k)$, $v_{SV}(t_k)$, and $v_{SH}(t_k)$ at seismic stations.

The estimation of sensitivity of the method of active monitoring of changes in the elastic characteristics in the interior Earth's crust zone was made using mathematical modeling (Kovalevsky, 2006). The model of the Earth's crust-mantle system in the form of a layer at a half-space with different velocity values of elastic waves is considered. The mathematical statement of the problem is made in the in the approximation of the wave equation. It is assumed that the vibrational source is a point and harmonic one, with a constant oscillation frequency, and that the zone of changes of the characteristics in the medium is spherical. The wave field in the medium is calculated in the ray approximation. Wave field variations in the medium and at the free surface are determined for the case of small velocity changes in the spherical region by calculating the beam pattern of a fictitious 3D source in diffraction approach. As a result of the modeling the estimation of sensitivity of active monitoring method with harmonic vibrational signals was done.

It was shown that the relationship between the relative variations in velocity within the zone of parameter variation and those of the amplitudes of the recorded signal is as follows:

$$\frac{\delta c}{c} = 3\cdot 10^{-3}\alpha\frac{\delta u}{u}\left(\frac{R_{V-Z}R_{Z-S}}{r_0 R_{V-S}}\right)\left(\frac{\lambda}{r_0}\right)^2. \qquad (14)$$

here $\delta c/c$ are the relative variations in wave velocities in the zone of parameter variation, $\delta u/u$ are the relative variations of the signals amplitude recorded on the free surface, R_{V-Z} is the distance between the vibrator and the zone of parameter variation, R_{Z-S} is the distance from the zone of parameter variation to the recording point (seismometer), r_0 is the radius of the zone, λ is the wavelength, , and α is the reflection coefficient, lying within 0.15–1 for the model and the wave velocities in the core and mantle. Experience shows that variations in the amplitudes of mono-frequency signals at distances of 100–400 km from the vibrator, at the existing microseismic noise level, can be determined with an accuracy of 10^{-2}. Therefore, monitoring at the frequency

$f = 6\ Hz$ (character wavelength $\lambda = 1$ km) and at typical source-recorder and source-anomaly distances of 50–100 km, and for the zone of parameter variation with a radius of 1–10 km, gives the following estimates of the relative variations in seismic wave velocities:

$$\begin{aligned} r_0 &= 1 \text{ km}, \quad \delta c / c = 10^{-2} - 10^{-3}, \\ r_0 &= 10 \text{ km}, \quad \delta c / c = 10^{-5} - 10^{-6}. \end{aligned} \tag{15}$$

The obtained estimates show that the sensitivity of the active monitoring method is very high for seismologic methods. This suggests its potential effectiveness tracing changes in the stressed-deformed state in dilatancy zones of the future earthquake.

Conclusion

This paper describes the formation of surface dilatancy zones, which can cause variations in geophysical fields—earthquakes precursors. This process is illustrated by using an example of point sources of the following types: double force and double pair of forces. The necessary condition for the creation of dilatancy zones is the Earth's surface that is free from stresses. In this case, dilatancy zones are formed from any distribution of forces, creating a nonzero component of shearing stresses. Therefore, most earthquakes are accompanied by the creation of such zones. It should be noted that the existence of surface dilatancy zones under real conditions at this point should be taken as a hypothesis. Using this hypothesis—for practical analysis of extensive accumulated data on the monitoring of anomalies at various geophysical fields—is an attempt to find reasons for the evolution of these anomalies and elucidate the mechanisms of their interrelation. A mathematical model of an integral earthquake precursor is developed. Physically, it represents the space-time function of crack density in a zone of the highest stresses and on the Earth's surface, which manifests itself in anomalous geophysical fields. Mathematically, the integral precursor is determined using the optimization method of a multidisciplinary (combined) statement of the inverse problem for the corresponding geophysical fields (the field of displacements and deformations on the Earth's surface, electric conductivity field, anomalies of the gravitational field, the groundwater level, etc.). A vibro-seismic monitoring scheme of dilatancy zones is discussed in detail. Estimates of the accuracy obtained with the use of this scheme, which employs powerful vibrators and recording systems capable of long signal accumulation, are presented. We show that it is possible to detect the relative changes in seismic wave velocity about 10^{-5} - 10^{-6} in the internal zone with radius 10 km using vibromonitoring system with 100 tons vibrator and recording system with 50-100 km offset. These estimates show the high resolution of active vibro-seismic monitoring compared to standard seismological methods for the probing of seismic-prone zones within the Earth's crust.

Acknowledgments

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DISPLAYING OF THE FIELDS INDUCED BY A FAULT IN AN INTERACTIVE MODE: APPLICATION TO THE EL-ASNAM EARTHQUAKE (ALGERIA, 10/10/1980, M=7.2)

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We present a computer program in an interactive mode, enabling to display the response of a fault (or a serial of faults) in terms of displacement, strain, and stress fields. The sources are embedded in an elastic half space (at a given depth), and are required their sizes (length, width, dislocation) and their focal mechanisms (strike, dip, rake). Using Okada's subroutine, computations are made at nodes of a 0.5Ç0.5 km grid. Our code is validated by using published cases. Three models of the El-Asnam earthquake (Algeria, 10/10/1980, M=7.2) are studied in detail, taking into account the complexity of the deformation. The calculated displacements are in good agreement with those observed. The generalized Angelier's parameter A_φ confirms the compressive state of the region. The calculated fields are superimposed on *Google Earth* maps by several KMZ files. This software can be used for both educational and research purposes.

Keywords: displacement, fault, interactive mode, strain, stress.

1. INTRODUCTION

The theory of dislocation was used by Steketee [15] to compute the static change caused by fault movement. In his turn, Chinnery [6] used this work for calculating the field of displacement

by analytical expression. Okada [12] generalized these expressions to deduce those of deformation field.

In this work, we use the Okada's code DC3D [12] to study the response of a fault in terms of displacement, strain, and stress.

The programme we present allows computing the displacements and deformation related to a single or a serial faults. The stress field is given by Hooke's law. It is interactive, written in Fortran77 language and compiled under Linux platform, using Shell scripts. As input, it is required the earthquake parameters; the output consists of the displacement, strain and stress fields.

The models were constrained by geodetic measurements (Ruegg et al. [14], Meghraoui and Doumaz [11]) .

An example of calculation of the generalized shape parameter from Angelier [2], which represent the tectonic regime of the area of study, is also presented.

2. FAULT MODELING

Modeling includes examples of hypothetical faults and also an application on a real case (10/10/1980 El Asnam earthquake, M =7.2). We present the steps of modeling in order to illustrate how the programme runs.

2.1. Major Routines

The program includes two major routines.

2.1.1. Routine 1

It requires the sources parameters: strike, dip, rake, length, width, depth, and geographical coordinates of the upper middle point of the fault.

2.1.2. Routine 2

It uses the Okada's subroutine in order to compute the displacement, strain. Stress fields are deduced from Hooke's law. The calculations are made at the nodes of a 0.5x0.5 km horizontal grid, at a given depth.

2.2.Validation of the program

The program is validated through published examples.

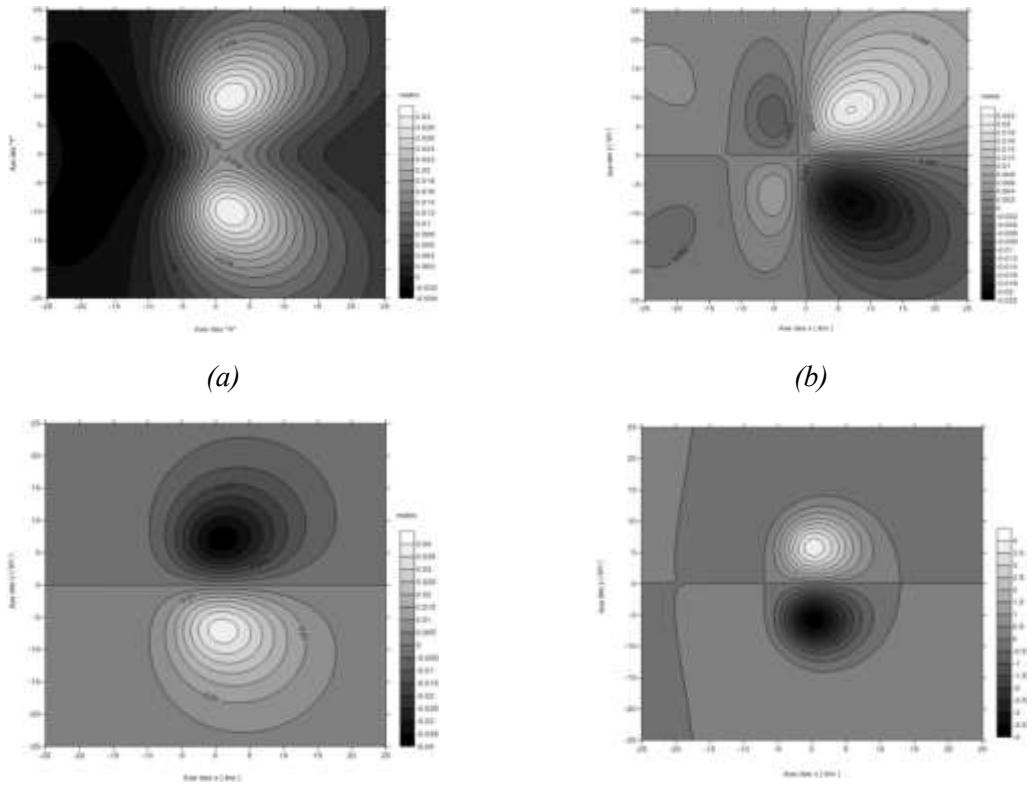
2.2.1. Test 1

It is given by Okada [12] and consists of a strike-slip fault, located at 6 km depth, with dip = 40°, length L=12 km, width W=8 km, and a uniform slip U=50 cm. The fields are calculated on the surface (Fig.1).

2.2.2. Test 2

It is provided by Boughacha [5] and consists of a rectangular fault with (dip, strike) = (60°, 45°), dimension (20 X 10 km) and a dislocation of 1 meter.

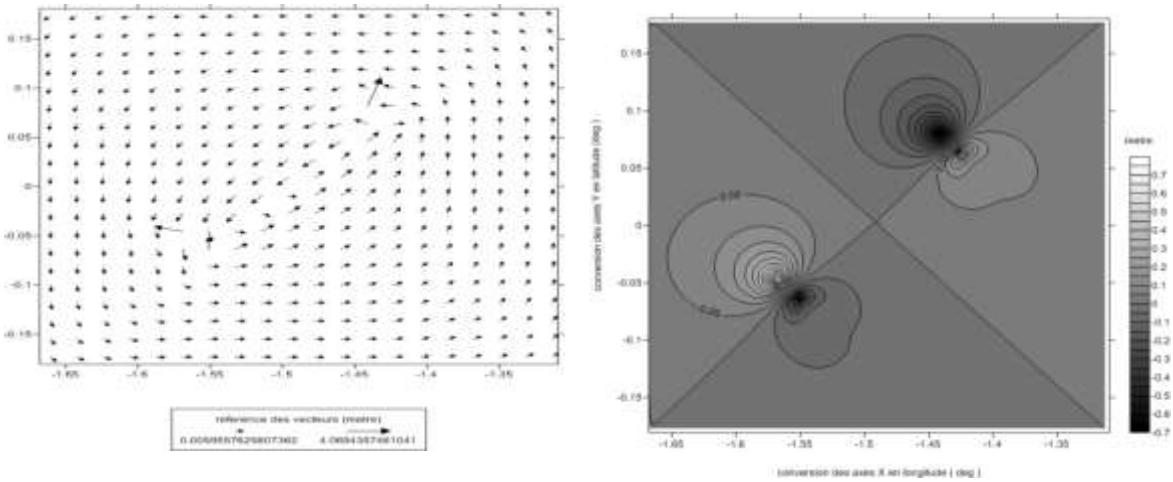
Like in the first test, the fields are computed on the surface. It is displayed in vector mode for the horizontal component of displacement, and contouring map for the vertical component of displacement (Fig.2).



(a) *(b)*

(c) *(d)*

Fig.1. Displaying of the displacement field calculated on the surface, compared with that obtained by Okada [12]: *a) horizontal component U_x, b) horizontal component U_y, c) vertical component U_z, d) dilatation (10^{-6})*



(a) *(b)*

Fig.2. Displaying of the displacement field calculated on the surface, compared with that obtained by Boughacha [5]: *a) Horizontal component of displacement in vector mode, b) Contour map of vertical component*

2.2.3. Test 3

It refers to the model of Ruegg et al [14] related to the El Asnam (Algeria) earthquake of 10 October 1980. This model consists of 4 panels (Table 1+ Fig.3) illustrating the vertical

movement induced by this earthquake. The maximum observed and computed values are respectively 5.71 and 5.15 m, consolidating the validity of the program.

Finally, we can say that the results of all tests are concordant.

Table 1.

Fault panel data for the model in this study

	Coordinates (UTM, zone 31)		Depth	Dimensions (km)		Orientation		Fault Slip (m)	
Panel	**X (km)**	**Y (km)**	**Z (km)**	**L**	**W**	**Dip (°)**	**Strike (°)**	**Sinistral**	**Reverse**
1	353.19	4001.46	11.28	10.0	10.0	70	57.5	1.0	1.0
2	357.03	4007.12	11.26	6.0	12.5	60	44.1	2.0	3.0
3	362.60	4015.03	12.14	10.0	14.9	54	40.5	1.0	8.0
4	375.56	4024.12	12.14	8.0	13.0	54	67.0	0.0	3.0

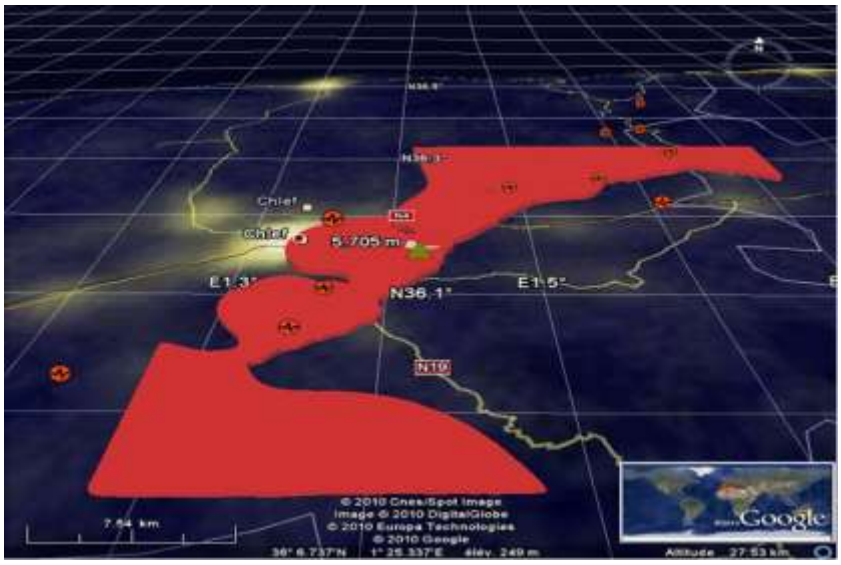
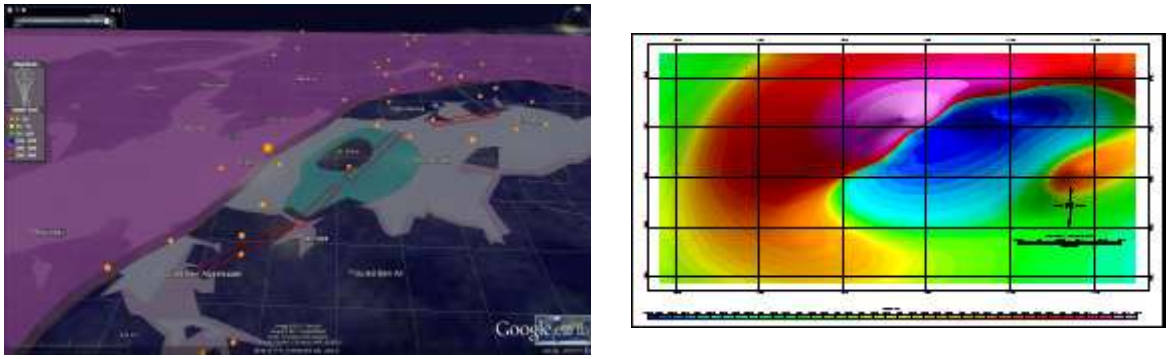


Fig.3. Vertical co-seismic displacement induced by the El Asnam earthquake (Algeria, 10/10/1980, M=7.2): the computed field is represented by red color (positive). The green triangle indicates the displacement observed (5.15 m) by Ruegg et al [14], in agreement with that calculated by our model (5.71 m).

Fig.4 shows the values of displacement for the same model (Ruegg et al [14]) at 5 km depth. We represent the same field in two visualization modes: the *Google –Earth* mode in which the maximum value of displacement is indicated by green triangles, and the *Shaded-relief* mode in which the maximum value is indicated by purple (positive value) and blue (negative values), respectively .

We observe that the values of the displacement decrease in depth (the green triangles show a maximum value of 0.22 m and a minimum value of -2.60 m).

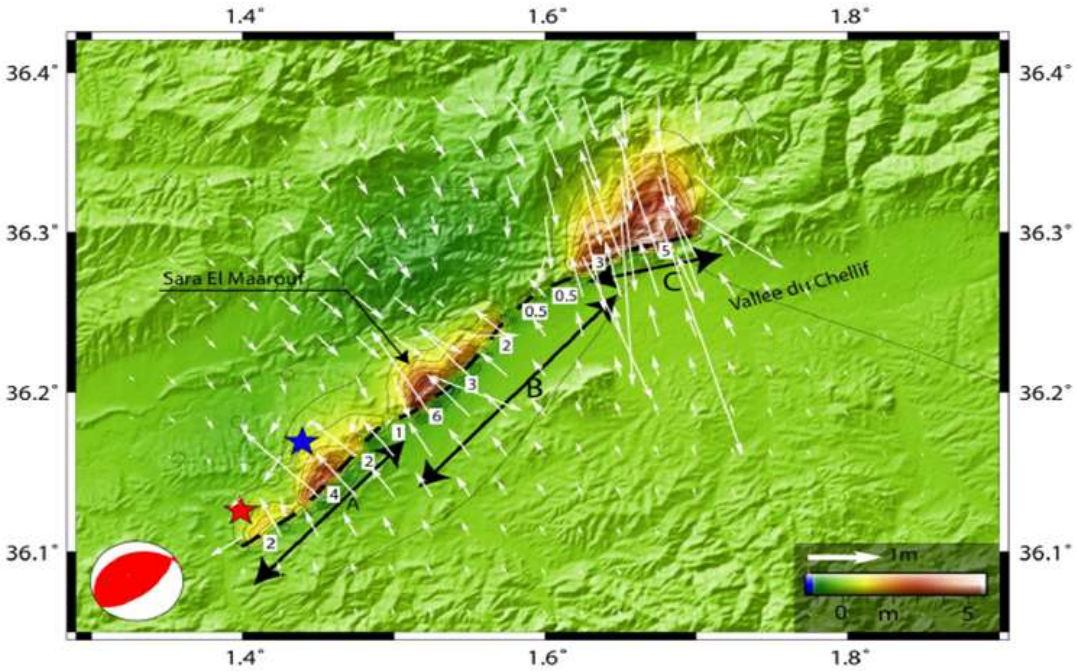
The positive values of displacement are represented by purple color in *Google –Earth* mode (Fig.4-a) and purple-red color in *Shaded-relief* mode (Fig.4-b).



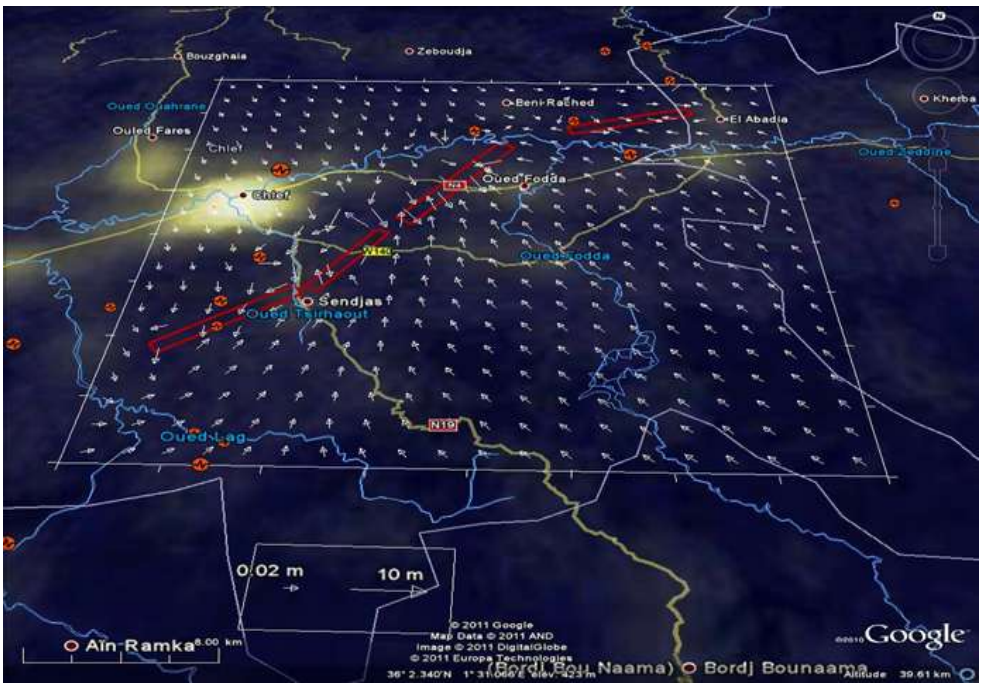
(a) *(b)*

Fig.4: Vertical co-seismic displacement induced by the El Asnam earthquake at 05 km depth in two modes: *a) the Google-Earth mode in which the computed field is represented by purple color (positive). The green triangles indicate the maximum and the minimum displacement observed (0.22 m and –2.6 m); the red rectangle represents the fault trace; the orange circles indicate the USGS aftershock location. b) the Shaded-relief mode representing the same computed field. We assign the purple and blue colors to the maximum and the minimum, respectively.*

The horizontal displacement at the surface of the El Asnam earthquake is represented in vector mode (Fig.5–b). Our computing method is constrained by the computing method based on the Poly3D software used for the same earthquake by Bellabes [3] (Fig.5-a). Our results are concordant with those found by Bellabes [3].



(a)



(b)

Fig.5. Horizontal displacement computed from: *a) the Bellabes modeling [3] based on Poly3D software: the A, B, and C sections show the different panels used; the beach ball represents the focal mechanism of the El Asnam earthquake. b) Our modeling: the red rectangles represent the trace of fault; the result is in agreement with that calculated from the Poly3D software [3]*

3. DISPLAYING THE TECTONIC REGIME OF THE EL ASNAM EARTHQUAKE

The Angelier's shape parameter Φ [2] is a reduction of the general tensor T, deduced from the diagonal form of the stress tensor (principal axes), using the following steps.

1 – We extract σ_3 from the diagonal elements

2 – We divide the diagonal tensor by the quantity $(\sigma_1 - \sigma_3)$ which is called *the maximum stress difference*

3 – Finally, we express T in the following form

$$T = k_1 I + K_2 T_\varphi$$

where $k_1 = \sigma_3$, I is the identity matrix, $k_2 = \sigma_1 - \sigma_3$, T_φ is the matrix reduction parameter, given by

$$T_\phi = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \phi & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

such as

$$\Phi = (\sigma_2 - \sigma_3)/(\sigma_1 - \sigma_3)$$

We can now write the generalized shape parameter including information about

– the shape of stress tensor

and

– the vertical axis of principal stress

enabling to have the fault type.

We must define a coordinate system $(\sigma_\alpha , \sigma_\beta , \sigma_\gamma)$ in the stress space enabling to view geometrically the parameter Φ (fig.6).

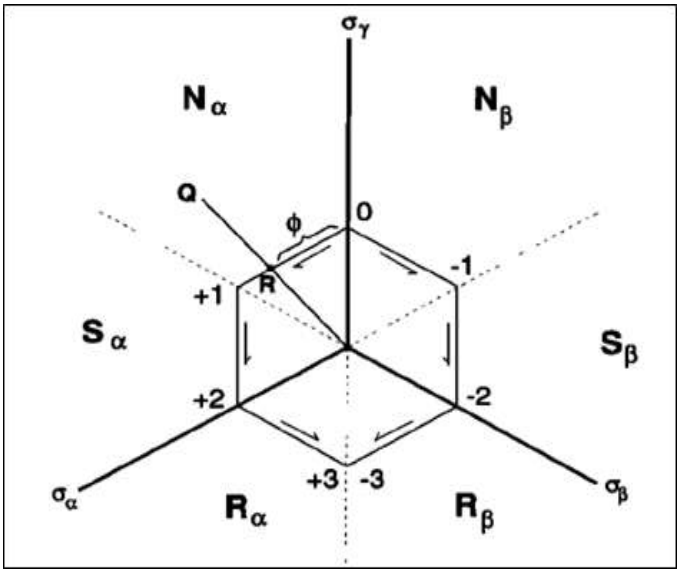


Fig.6. Geometry of space stress: view from below. The Anderson fault parameter, A_φ, is the distance along the hexagon from the projection of the σ_γ axis. The numbers at the corners indicate the values of A_φ (Simpson [16]).

The relation between ϕ and A_φ is given in the following manner: if the type of fault is normal, strike-slip or reverse, then we assign the numbers n = 0, 1, and 2, respectively. Following (Simpson [16]), this relation takes the form:

$$A_\varphi = (n + 0.5) + (-1)^n (\phi - 0.5)$$

A_φ varies from 0 to 1 for a normal fault, from 1 to 2 for a strike-slip fault, and from 2 to 3 for a reverse fault (Fig. 6).

An application of A_φ is made for the El Asnam region (Algeria) through Fig.7, using the parameters of the 1980 earthquake, confirming the compressive regime in this area.

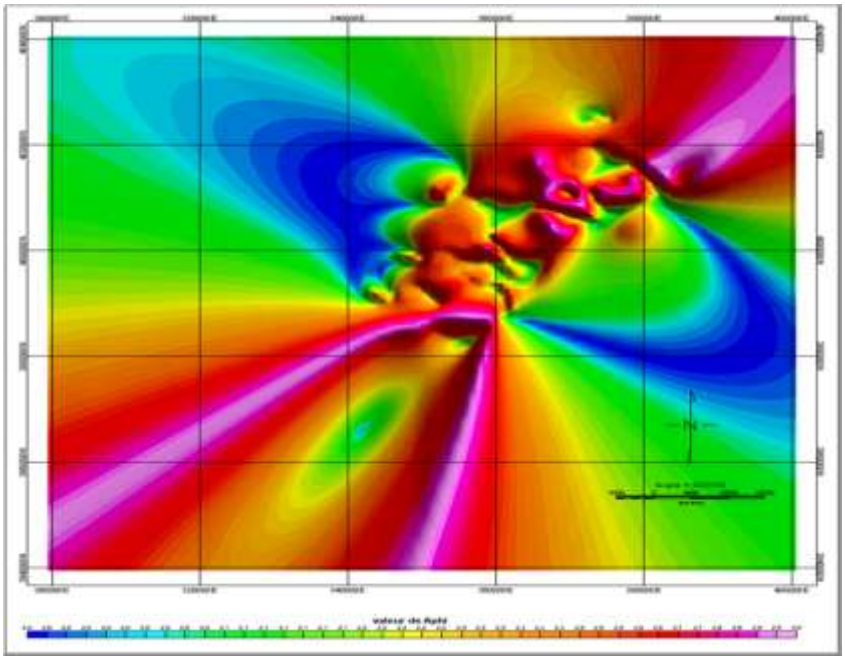


Fig.7. Fault type parameter of the El Asnam region. A_φ values are ranged between 2 and 3 confirming the compressive state of this area.

4. Conclusion

The present software can be used to compute the elastic fields induced by one or more faults in a very short period of time. Input consists of fault parameters; output consists of elastic fields (displacement, strain and stress). It is interactive and accessible to everyone, for both academic and purposes research. It can also be used for more complex problems such as GPS data inversion, or solving problems related to stress tectonic regime, by using the A_{φ} function.

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DIFFERENTIATION OF LOCATION OF SEISMIC SOURCES IN GEOCHEMICAL FIELDS FLUIDS

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In Azerbaijan the area Shamahi is most seismically active region on the southeast termination of the megantiklinorium of Big Caucausus. The centre of the last sensational earthquake which has occured 12.19.2008 of year with magnitude Mpv=5.2 was near to village Damirchi. This site concernns to southeast slope of a Mikhtokian ridge. For the period 1980-2008 in the given centre repeatedly occured earthquakes with maqnitude Mpv=4.0ç4.8 and above [Qasanov, 2003; Mamedli, 2006, Keramova 2005, Keramova, Kerimova (Abdulrazagova), 2007 and etc.]. Considering scientific and practical importance seismoproqnostic in the given territory, here, since 1980 on present time (2011 year) experts (RCSS of ANAS) spend complex works as various methods (seismological, geophysical, seismogeochemical). The purpose of these researches: a) carrying out of stationary, b) all-the-year-round monitoring of fields of the various nature on objects of supervision; c) studying of influence of seismic processes on objects of supervision; g) revealing of informative harbingers of earthquakes; d) development the express train-methods of operative diagnostics of the dangerous seismic centres on various fields; e) an estimation of seismic conditions in region in a real mode of time.

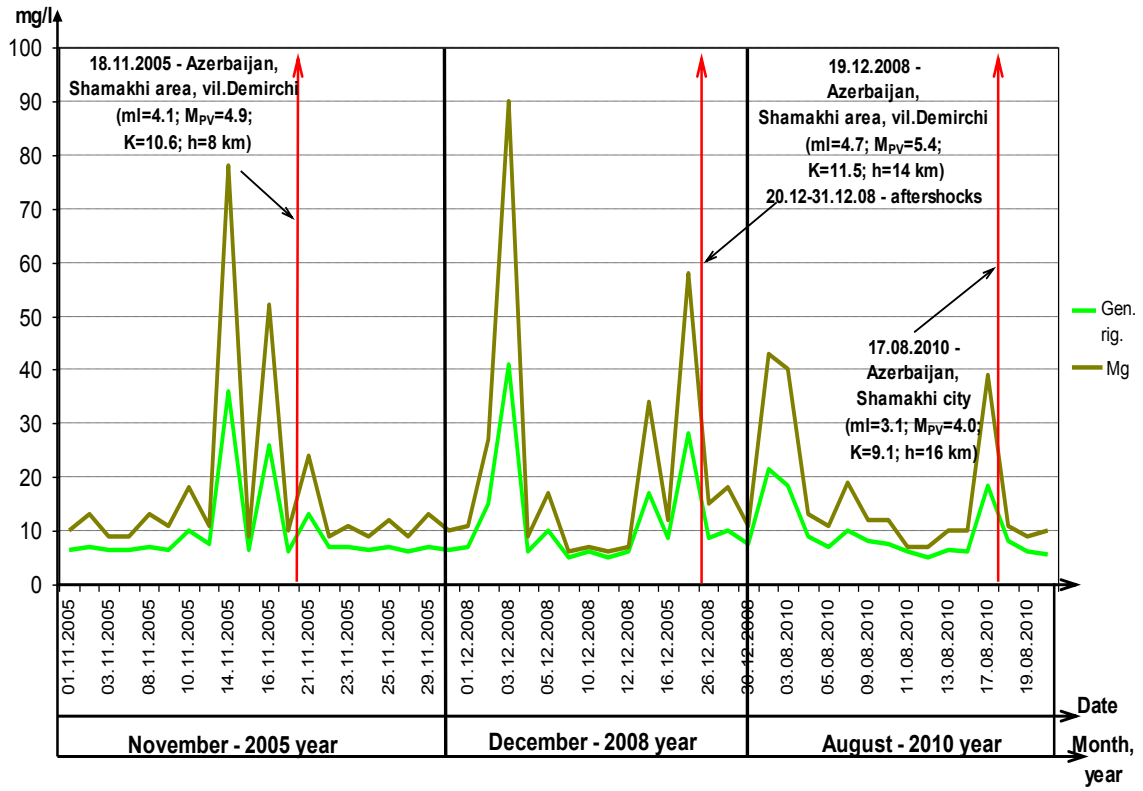

Fig. 1. Zone of Vandam's fault, Shamakhi area, Mikhtokyan's hypocentre of earthquakes (Absheron - well "Shihov № 1")

It is known that within one seismogenic zone can be allocated several different types of seismic sources. Therefore with the assessment of seismic hazard in a particular region, it is very important to develop methods that will allow quickly differentiate and predict "dangerous" seismogenic source, ready for the implementation of the earthquake in a short period of time. One of them is seismic geochemical method. For a long period of time (1979-2011) in seismically active zones of Azerbaijan Seismogeochemical Branch of Republican Centre of Seismic Survey of Azerbaijan National Academy of Science (RCSS ANAS) conducts a year-round seismic geochemical monitoring of fluids. Based on the obtained data of the analysis, the following important facts were established: a) short-period (1÷16 days) abnormal perturbation of the geochemical field of fluids at the sites of observation occurs only at the final stage of the earthquake preparation, i.e. the period of time, which was left before the realization of the predicted seismic event corresponds to (1÷16 days); b) informative seismogeochemical parameters are individual for each seismic source. Proceeding form this fact, all combinations of indicator elements were arranged on the identification charts, which we conventionally called geochemical "portraits" of earthquakes, preparing for implementation.

On the basis of a comprehensive systematic, generalized and analyzed seismic and geochemical materials, has been created "Atlas of the identification of seismic sources on geochemical fields of fluids of Azerbaijan". On the basis of certification of implemented hypocenters listed in seismological "Catalogue of earthquakes in Azerbaijan" (RCSS ANAS), have been created – geochemical "portraits" of the earthquakes. On this basis also have been established important facts: a) on seismogeochemical abnormalities by mechanism can be detected different types of seismic sources; b) the period of time in which abnormalities reflect the strength (magnitude) and location of the seismic source in space.

The longer an anomaly in the fields of geochemistry of fluids endures, the further is the location hyposenter and the higher is the value of the magnitude of the forthcoming seismic event. Empirically was established the "range-bound" of the distances for the predicted earthquakes in the Caspian Sea and within the Anatolian-Iran-Caucasus tectonic blocks: a) local ($\Delta \leq 50$ km), weak ($Mpv \geq 4.0$), which occurred in the Caspian Sea and in Azerbaijan; b) distant ($\Delta \geq 500$ km), but strong $M_{LH} \geq 6.0$, sources which are in neighboring countries (Russia - Dagestan, Chechen Republic; Georgia, Armenia, Turkey, Iran). Moreover, within one seismogenic zone on geochemical fields of different types of fluids can be localized different types of earthquake sources and identify their association with different tectonic structures. In particular, for Shamakchi seismogen zone have been established criteria in seismogeochemical fields of fluids given region. This criteria correctly differentiate hipocenter of the earthquake before realization to geomorphological attributes, for a mountain and foothill part of region (fig.1.-4.). Researches in RCSS of ANAS with the purpose of differentiation earthquake's senters in others seismogen zones of Azerbaijan and water area of Caspian sea to seismogeochemical fields of fluids proceed.

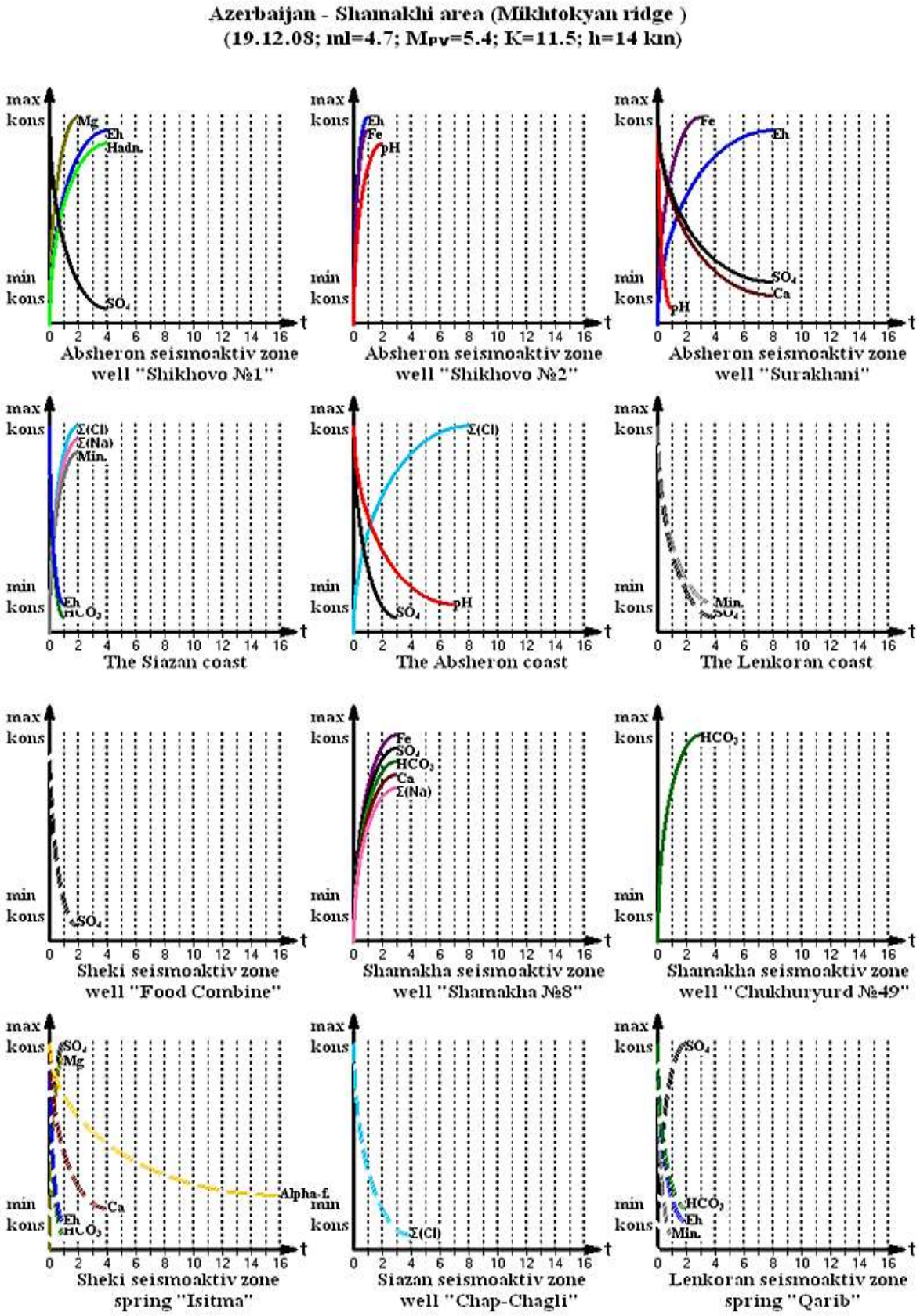

Fig. 2. Seismogeochemical "portrait" of earthquakes

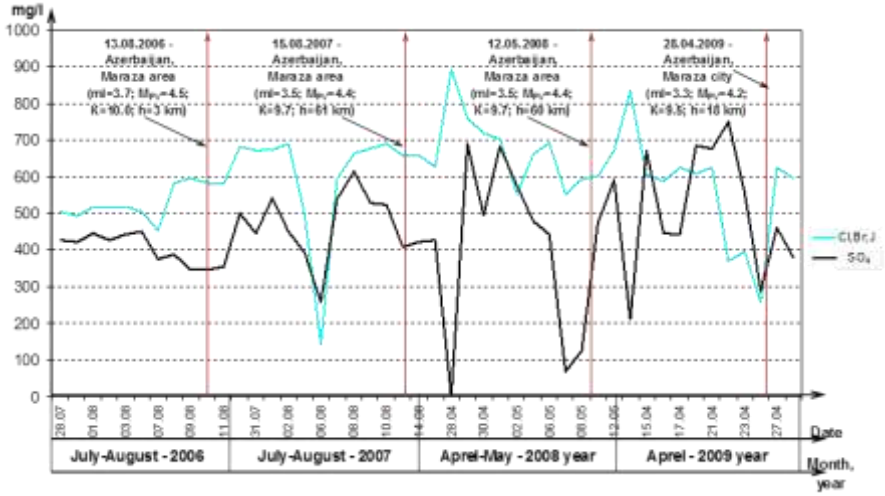

Fig. 3. Zone of Vandam's fault, Maraza's hypocentre of earthquakes (Shamakhi area - well "Shamakhi № 8")

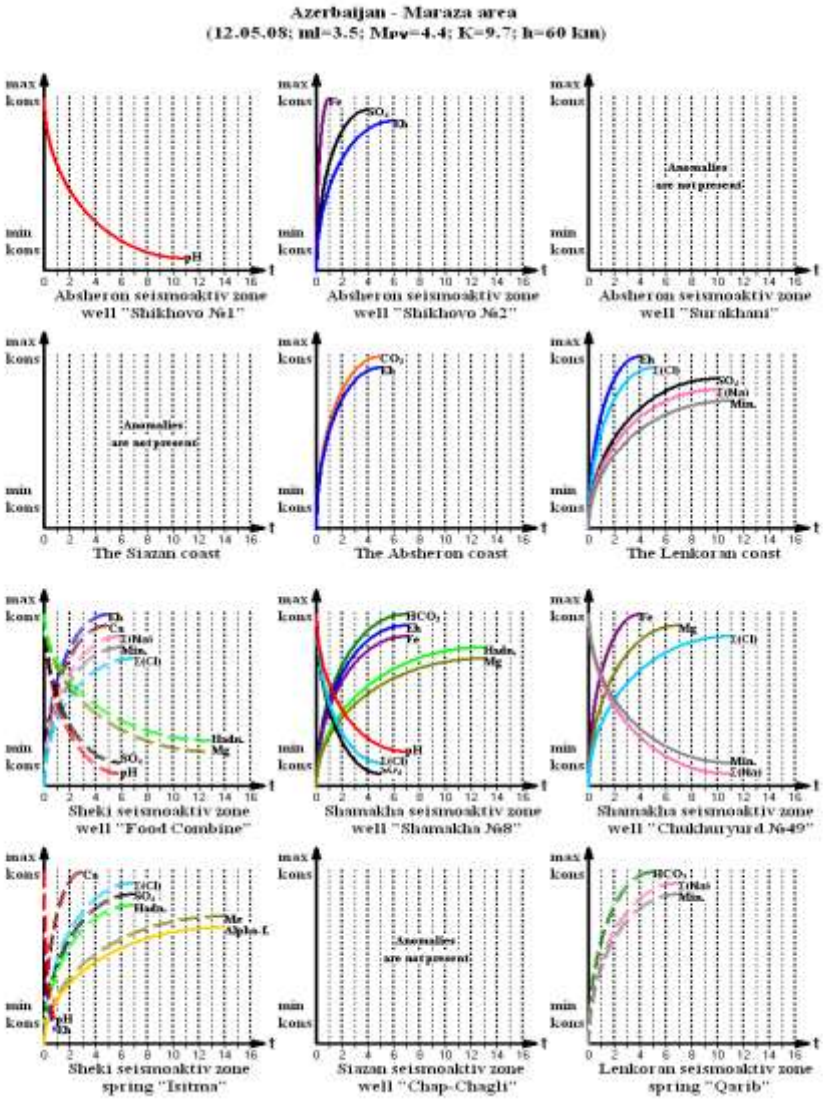

Fig. 4. Seismogeochemical "portrait" of earthquakes

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NEW TECHNOLOGY OF OPERATIVE EVALUATION OF SEISMIC SITUATION ON GEOCHEMICAL FIELDS OF FLUIDS OF AZERBAIJAN

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This work is devoted to the new technology for the rapid assessment of seismic conditions (calculation of time ranges, earthquake magnitude and location of the hearth) in real time on geochemical fields of fluids. Its code name is **"SEISMOGEOCHEMICAL-on-line".** These are – first developed rapid methods for identifying "dangerous" earthquake source zones with seismic geochemical methods. They were tested for the strong and devastating earthquakes on the basis of the factual materials of seismic geochemical monitoring in Azerbaijan during 1979-2011. The objects of monitoring are the fluids of seismic zones of Azerbaijan and the sea water of the shore of the Caspian Sea.

It is known that for the correct prognosis of strong earthquake it is necessary to indicate 3 main parameters: the strength (magnitude) of a future seismic event, location of the source and time of its implementation. For today in the world reliable mathematical methods of forecasting of key parametres of hypocenter are not developed. In Branch of Seismogeochemistry of Republican Senter of Seismic Survey (RCSS) are made the first steps for the decision of the given problem are made. The region of an estimation of seismic conditions includes water area of Caspian sea, Azerbaijan and frontier territory of the adjacent countries (Russia-Dagestan, The Czechen Republic; Georgia, Armenia, Turkey, Iran). Seismogeochemical all-the-year-round researches in Azerbaijan are carrying out in RSSC of ANAS from 1979 to present time (2011 year). Objects of monitoring are fluids of seismoactive zones of Azerbaijan, and also - seawater of coast of Caspian Sea. These fluids are presented by underground waters, gases, and also - emanations of radioactive elements of local sites of a surface. They enter in seismogeochemical observation network of RSSC of ANAS. Thus, the investigated underground waters differ among themselves on genesis, conditions of migration, stratification depth, temperature, ionic-salt and gas structures, and also intensity of radioactive radiation. The territory, on which carried out seismogeochemical monitoring, is seismically active. It includes Absheron archipelago, Shamakhi, Sheki, Siyazan and Lankaran areas of Azerbaijan, and also - coast of Caspian Sea in Absheron, Siyazan and Lankaran areas of Azerbaijan (fig.1.). After strong Caspian-Baku earthquake (11.25.2000; Mpv=6.3; K=14) on the basis of the analysis and interpretation of seismogeochemical monitoring data for the period 1986-2003, we have been developed and introduced essentially new technologies of operative seismological forecasting not only for Azerbaijan and water area of Caspian sea, but also all Anatolian–Iranian-Caucasian tectonic block.

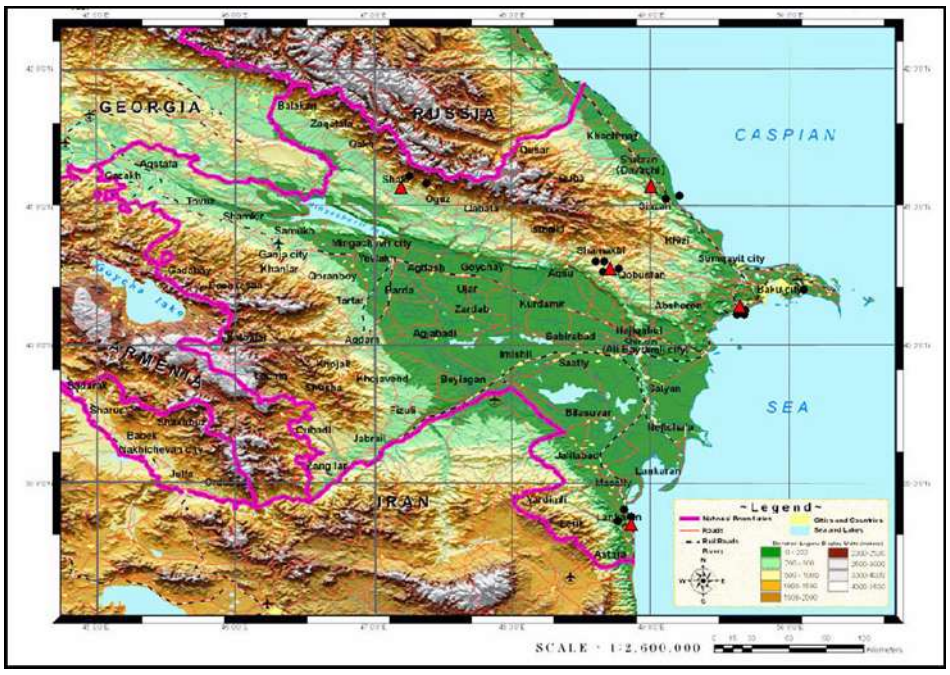

Fig. 1.Phyzical map of Azerbaijan Republic

Legend:

Stations of the seismogeochemical supervision

We were beginning researches in a new direction. It is operative, in on-line regime, diagnostics of "dangerous" hypocenters of earthquakes which begun preparing to realization on anomalies in geochemical fields of fluids.

Scientific novelty of seismogeochemical researches in Azerbaijan, consist of, that for fluids of observant RSCC NASA network, the epicenters of strong and catastrophic earthquakes Anatolian-Iranian- Caucasian tectonic block and water area of Caspian sea seismological and geochemical materials are in a complex systematized, generalized and analyzed.

For the first time in world practice on seismoforecasting operations are created new technologies (**"SEISMOGEOCHEMICAL-on-line"**) of interpretation actual seismogeochemical material in on-line regime. They include the following the express-methods: a) developing and testing of formulas for identification of anomalies in geochemical fields of fluids which arise during preparation of seismic events of various power; b) preparation of algorithms and software for automatic revealing and formatting of geochemical anomalies under the developed and tested formulas "auto filter of seismogeochemical anomalies"; c) developing and testing of formulas for calculation of magnitude of preparing earthquake; d) for the concrete seismic hypocenters prepared "Atlases of identification of the hypocenters of strong and catastrophic earthquakes on geochemical fields of fluids".

With these requirements, proposed technology for the rapid assessment of seismic conditions on geochemical fields of fluids of Azerbaijan reflects the results of creating mathematical and software security. They consist of the developed and implemented rapid methods:

1. Express-method of revealing the anomalies (formulae) at daily processing of data (197 parameters) of seismic geochemical monitoring for operative evaluation of seismic situation in the region.

2. Express-method of calculation of diapason of the magnitude (formulae) of the forecasted earthquake.

3. Express-method of identification of seismic centre on anomalies in geochemical fields of fluids. It allows determining 2 parameters: a) "diapason" of location of centre zone which is going

to be realized; b) diapason of time which is left for realization of the forecasted earthquake in the interval of 1ç16 days.

4. Empirically was determined the "diapason, i.e. horizon of time of forecast" of seismic event on anomalies in geochemical fields of fluids. It equals 1ç16 days.

As a result of experimental works there were determined the following important regularities:

- at preparation of earthquakes of different magnitude the anomalous disturbance of geochemical field on the time of appearance and in combinations of elements – indicators for different seismic centres has individual geochemical "portrait";
- at repetitive realization of earthquake in the same centre with analogous seismic parameters (magnitude, depth), its geochemical "portrait" is stable, i.e. it is the etalon for this earthquake source;
- within the concrete tectonic fault, in different years, in the same centre zone, in the final stage of preparation of the earthquake of the equal diapason, the anomalies of identical parameters are formed. Their combinations are the "etalons" for concrete center zones within the concrete tectonic faults.

On basis of the determined regularities have been created:

a) "Atlas of etalons for identification of seismic centres on geochemical fields of fluids of Azerbaijan";

b) "Atlas of geochemical "portraits" of seismic centres of Anatolian-Iranian-Caucasian tectonic block" for all realized strong and catastrophic earthquakes for the period of 1997-2011.

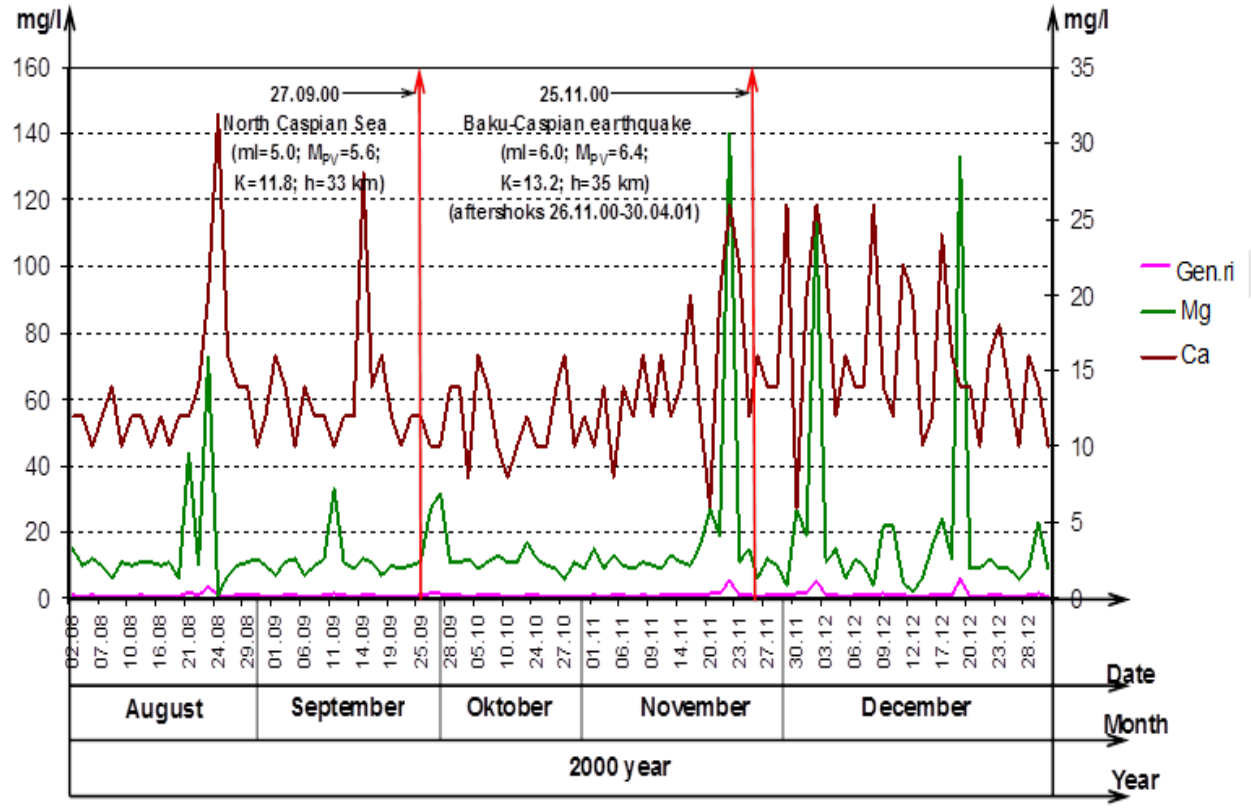

Fig. 2. All-the-year-round seismogeochemical variation in the underground warter –well "Shamakhi №8" -2000 y. (Azerbaijan - Shamakha seismik area)

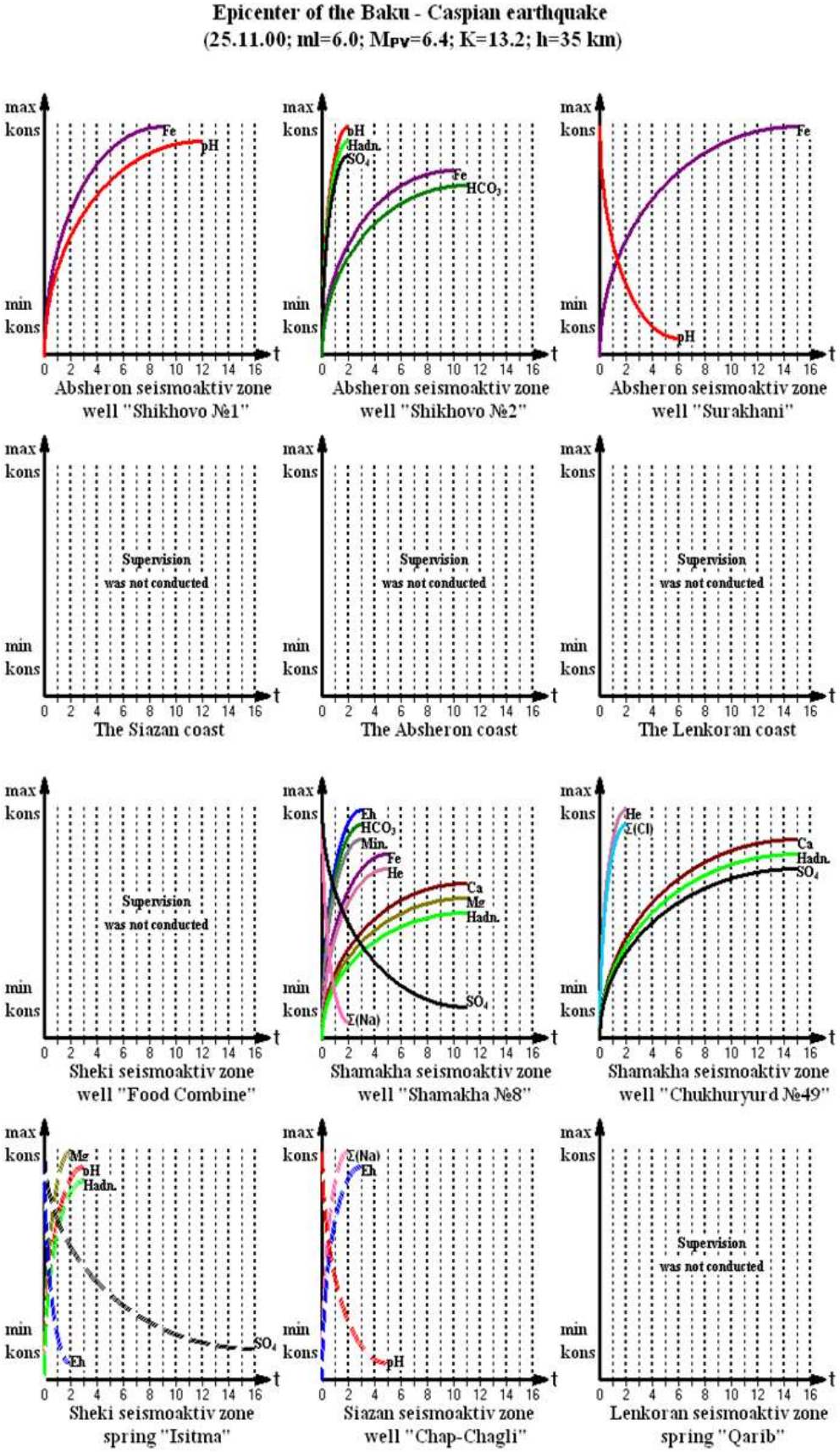

Fig. 3. Seismogeochemical " portrait" of earthquake

They represent geochemical "portraits" of the seismic epicenters, before realized within the limits of Great Caucasus meganticlinorium, partially-Kura depressions, Northern Caspian Sea, Southern Caspian Sea, Middle Caspian Sea, and also in territories, adjacent with Azerbaijan, the states: Russia - Dagestan, Czechen Republic; Georgia, Armenia, Turkey, Iran (fig.2-5.).

All specified region concerns to the Anatolian-Iranian-Caucasian tectonic block. In this territory there were many strong and catastrophic earthquakes: 1990-NW Iran, Rudbar; 1999 – Turkey, Izmir; 2000 – Caspian-Baku; 2003 – SE Iran, Bam and etc. Seismogeochemical data daily enter to department of urgent reports of Seismogeochemical Branch. Here are used all listed express-methods and made operative estimation of seismic conditions in Caspian Sea, Azerbaijan and the adjacent states during 1-16 days prior to realization of earthquakes. About 70ç 80 percent of these forecasts is correct (fig. 6.-7.).

Mistakes, which arise for today at an estimation of seismic conditions in real time, are connected to the following main reasons:

1) is necessary the extensive regional seismogeochemical network of stations covering all seismogen zones in the countries, adjacent with Azerbaijan (Russia-Dagestan, Georgia, Armenia, Iran, Turkey);

2) is necessary the statistic of the geochemical information, which will reflect the period of preparation of the seismic epicenters of the specified region.

Clearly, that the decision of the present questions – it is a challenge demanding the complex analysis of laws of seismic, tectonic, geophysical and geochemical processes with attraction of experts, living in the territory of Anatolian-Iranian-Caucasus tectonic block.

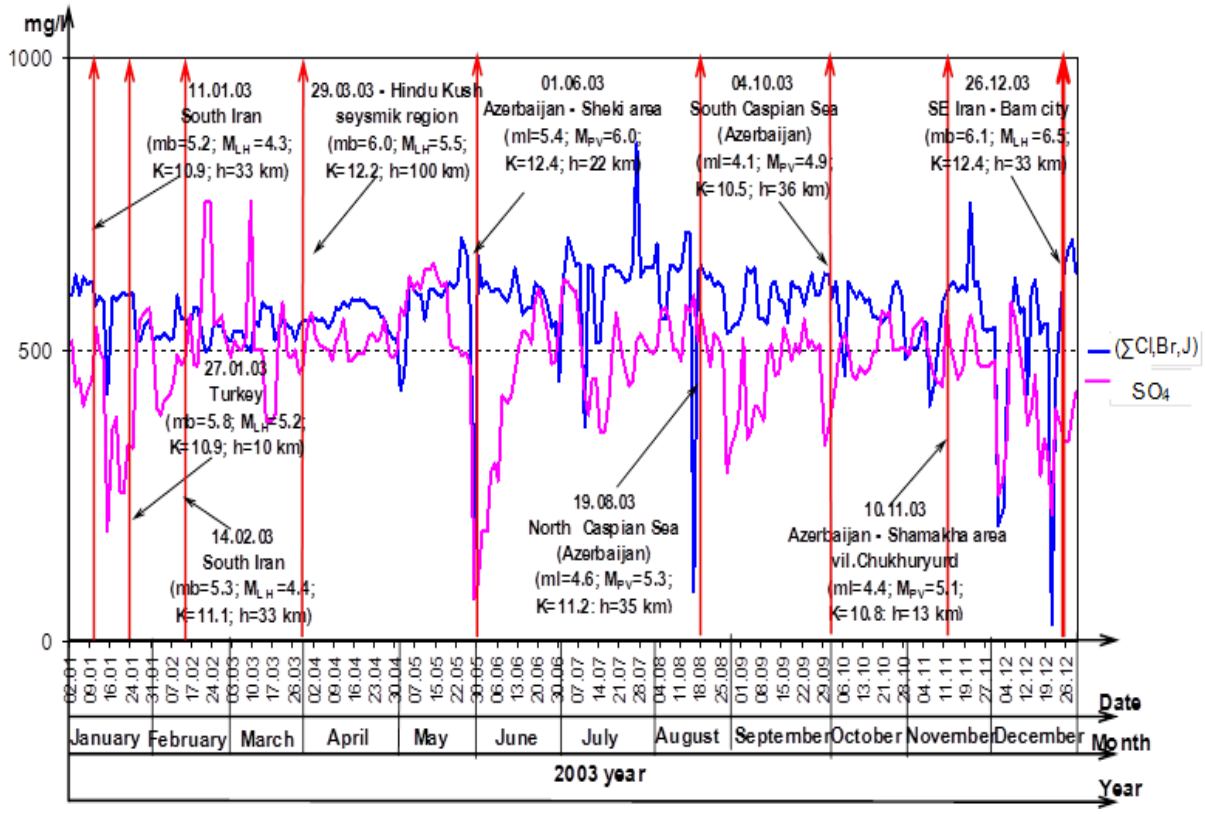

Fig. 4. All-the-year-round seismogeochemical variation in the underground warter well "Shamakhi №8" – 2003 y. (Azerbaijan - Shamakha seismik area)

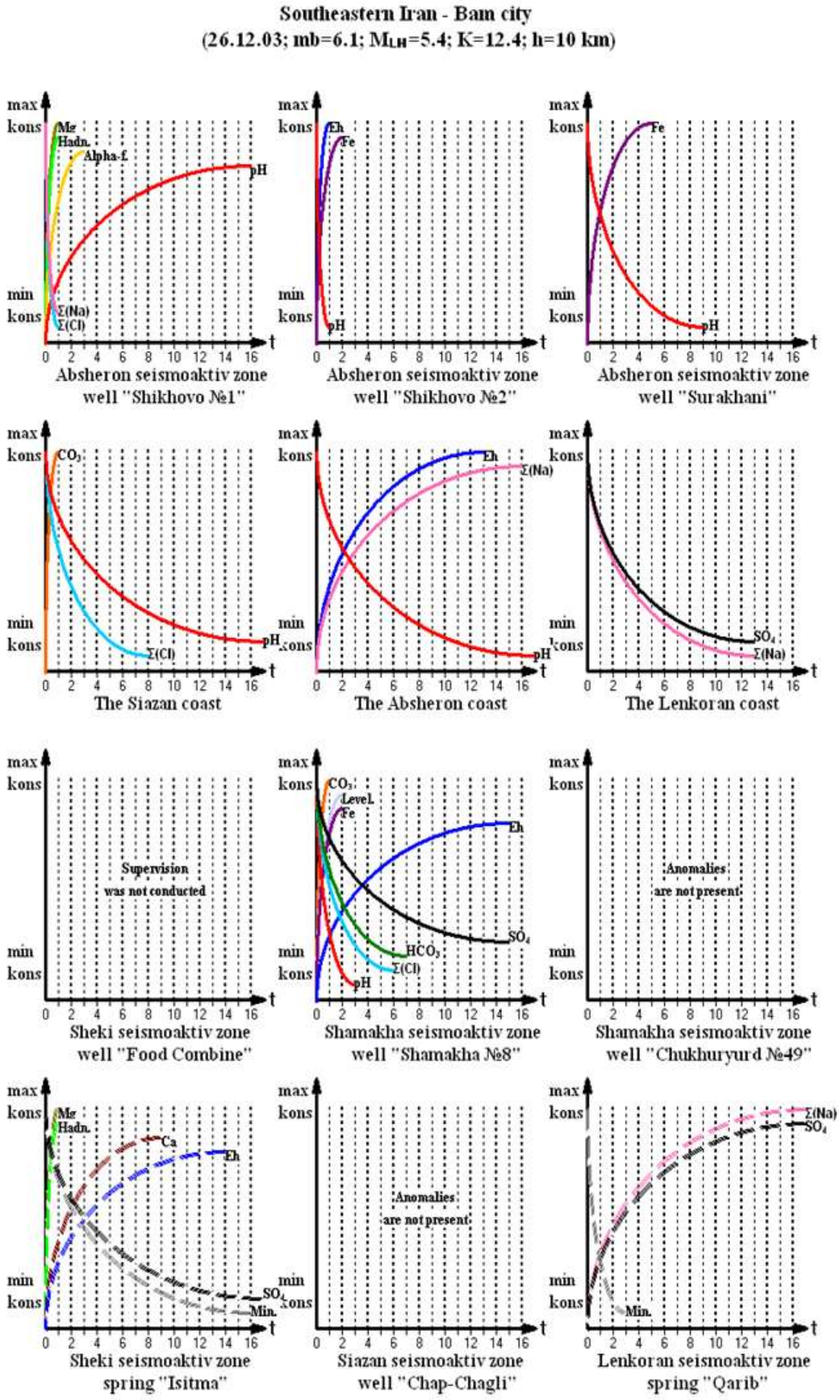

Fig. 5. Seismogeochemical "portrait" of earthquakes

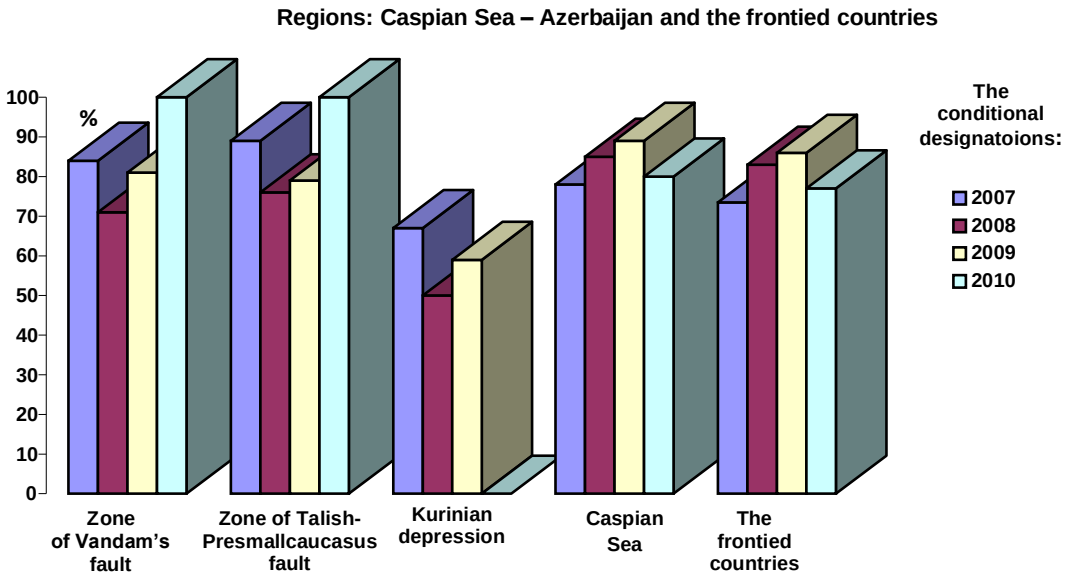

Fig.6.

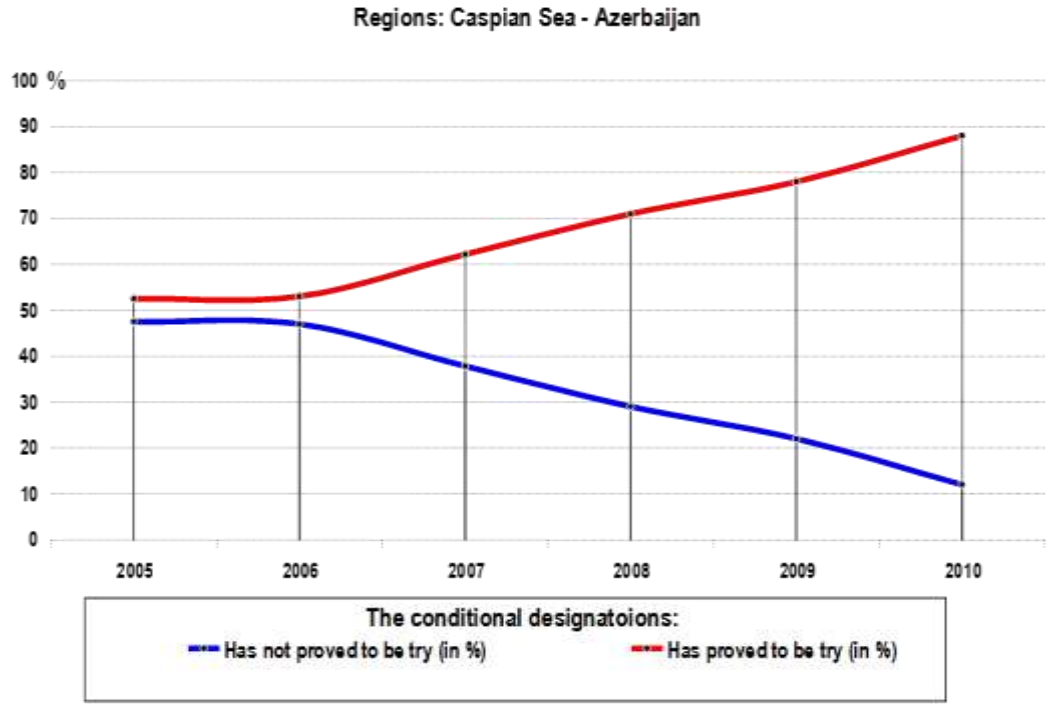

Fig. 7. The schedule of an estimation of seismic conditions of seismigeochemical fluids of Azerbaijan (2005 - 2010 yy.)

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ESTIMATION OF Q_S AND SPECTRAL DECAY PARAMETER IN SOUTHEASTERN IRAN, USING STRONG MOTION DATA OF RIGAN EARTHQUAKES (2010 & 2011)

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As a wave is propagated through real materials, wave amplitudes attenuate as a result of the different processes responsible for energy dissipation. This can be summarized as scattering and intrinsic absorption. Intrinsic anelasticity associated with small-scale crystal dislocations, friction, and movement of interstitial fluids. The scattering attenuation associated with anelastic process of redistributing wave energy by reflection, refraction, and conversion at irregularities in the medium [1]. Numerous studies have been carried out in different parts of the world to determine the seismic wave attenuation properties of the medium.These studies generally show low values of Q_0 (less than 200) for tectonically and seismically active regions, high Q_0 values (greater than 600) for seismically inactive stable regions and intermediate values of Q_0 for moderate regions.

The spectral decay parameter κ is useful for describing the high frequency ground motion spectra and has been used extensively to simulate ground motion acceleration from moderate and large earthquakes. Anderson and Hough [2] defined κ to describe the shape of the high frequency spectra. In this model the high frequency fall-off results from attenuation along the propagation path and near the surface. In the present study the Q_S and spectral decay parameter kappa, κ,has been estimated for the Rigan region based on the strong ground motion data which was recorded on the Iran Strong Motion Network (ISMN) installed by the Building and Housing Research Center (BHRC). The results are utilized for a better understanding of seismotectonic and seismic risk analysis in engineering seismology.

Tectonic setting

The Iranian plateau is a relatively wide zone of compressed deformation along the Alpine-Himalayan active mountain belt that is entrapped between two stable platforms, the Arabian plate in the southwest and the Turan platform (Eurasia) in the northeast. The Iranian plateau includes some major seismotectonic provinces that are delineated and discussed by several authors [3, 4, 5, 6]. Iran is one of the seismically active areas of the world and is frequently affected by destructive earthquakes, imposing heavy losses to human lives and widespread damage. The most recent and active deformation in the Central-East Iran Seismotectonic province is dominated by major N-S or NNW-SSE right-lateral strike slip faulting with some NW-SE reverse faults and some E-W left-lateral strike-slip faults (Fig. 1). According to Walker et al. [7], in the south of 34˚N, the shear is taken up on right-lateral strike-slip faults that end in the thrust faults whose displacements lie away toward their ends. The Kuh-Banan, Nayband, Gowk, Bam, Sabzevaran, and Rafsanjan faults are the main active faults of Kerman province in southeastern Iran, west of Lut Desert (Fig. 1). Central

Iran is not a linear seismic zone. It is characterized by scattered seismic activity with large-magnitude earthquakes, long recurrence periods, and seismic gaps along several Quaternary faults. The earthquakes in central Iran are generally shallow (less than 25 km) and are usually associated with surface faulting [5]. Several large earthquakes have occurred on the right-lateral strike-slip fault systems along the western margin of Dasht-e-Lut. In the last 30 years, several destructive earthquakes have occurred in the Central-East Iran seismotectonic province Fig. 1.

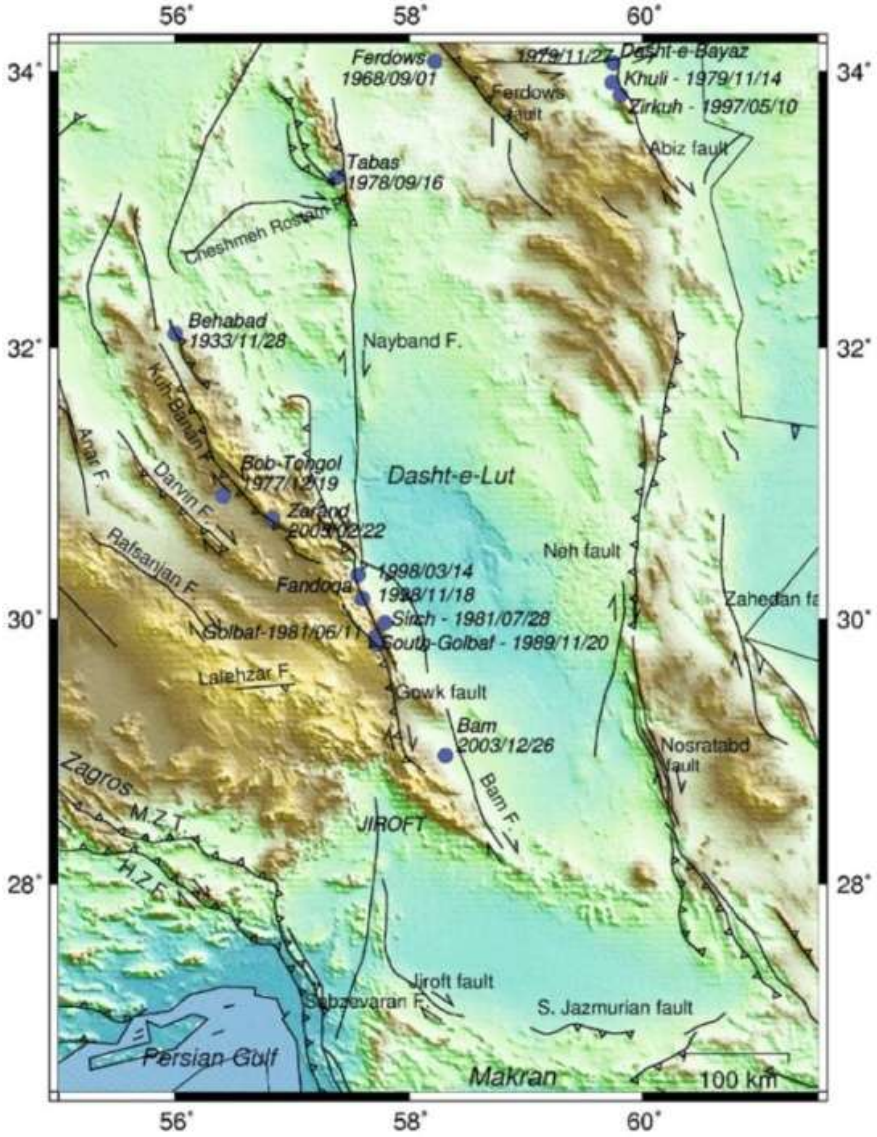

Fig. 1. Epicentres of destructive earthquakes in East of Iran [8]

Data

The study is based on the data recorded by three component strong motion array of ISMN. Only horizontal components (Longitudinal and Transverse) of these data are used in this study. Accelerographs are Digital SSA-2 with the threshold of 10 Gals at the sampling rate of 200 sample per second. This configuration yields a flat acceleration response between the frequencies of 0.01 to 50 Hz. December 20, 2010 earthquake at 18:41:59 (UTC) with magnitude M_w=6.5(NEIC),located in 28.32ºN_59.19ºE, and January 27, 2011 earthquake at 08:38:28 (UTC) with magnitude M_w=6.2(NEIC), located in 28.24ºN_59.13ºE, occurred in Rigan region, Southeastern Iran. These earthquakes recorded on the 24 and 8 stations of ISMN with maximum accelerations equal to 124 cm/s^2 for the Transverse component recorded at Rigan station and 195 cm/s^2 for the Longitudinal component recorded at Sarzeh station, respectively. Fig. 2 shows the locations of these two earthquakes used in this study as well as the stations of ISMN.

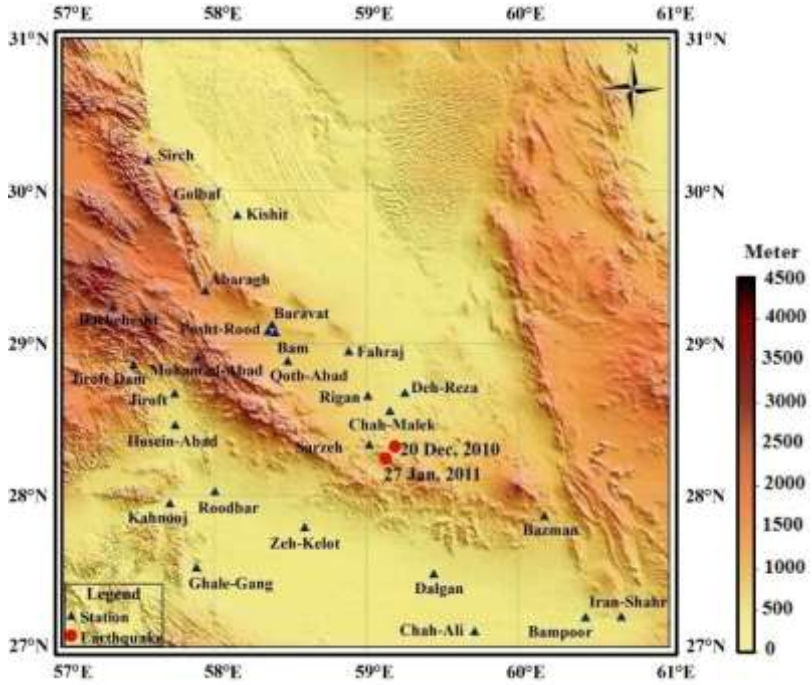

Fig. 2. Location of December 20, 2010 earthquake and January 27, 2011 earthquake and the stations of ISMN in Rigan region

These earthquakes have average focal depth of about 17 km. We used the accelerographs with epicentral distance of less than 100 km and strong signal to noise ratio for a relatively accurate determination of the quality factor. The recorded data on Rigan, Fahraj, Chah-Malek, Deh-Reza and Sarzeh stations used in this study. After base line correction, each accelerograph is filtered using the Butterworth band pass filter of four poles. Six frequency bands are used for this purpose. Low cut-off and high cut-off of these frequency bands are given in table 1.

Table 1.

Central frequency components of band pass filter with low and high cut-off frequencies

Low Cut-off [Hz]	Central Frequency [Hz]	High Cut-off [Hz]
1.0	1.5	2.0
2.0	3.0	4.0
4.0	6.0	8.0
6.0	9.0	12.0
8.0	12.0	16.0
12.0	18.0	24.0

Methodology

In this study, Spectral decay method [9, 10, 11, 12] is used for estimation of Q_S. The Q_S is related to frequency as $Q = Q_0 f^n$, where Q_0 is the value of Q at 1.0 Hz and n is frequency parameter. The observed spectral amplitude, $U_i(f,r)$, at hypocenteral distance, r, is described as:

$$U_i(f,r) = S_i(f)\ A(f,r) \tag{1}$$

$A(f,r)$ is the attenuation function that describes the decay trend of the observation with distance and $S_i(f)$ is a scaler which depends on the size of the earthquake. A homogeneous attenuation model is adopted to parameterize $A(f,r)$:

$$A(f,r) = r^{-\gamma} \exp\left(\frac{-\pi f}{\beta Q_S} r\right) \tag{2}$$

where f is the frequency and β is the velocity of Shear wave which have been taken as 3.2 km/sec in east of Iran [8]. The geometrical spreading function is represented as $r^{-\gamma}$. Substituting equation (2) to equation (1) gives:

$$U_i(f,r) = S_i(f)\, r^{-\gamma} \exp\left(-\frac{\pi f}{\beta Q_\beta} r\right) \tag{3}$$

Taking natural logarithms of the equation (3), we get:

$$Ln(U_i(f,r).r^{\gamma}) = -\frac{\pi f}{\beta Q_S} r + Ln(S_i(f)) \tag{4}$$

At epicentral distance of less than 100 km, a spherical geometry $\gamma = 1$ is considered for body waves. The Q_S is obtained from the slope of this linear equation, $Ln(U_i(f,r).r^{\gamma})$ versus r. Then, Q_S is calculated for each designated central frequency as:

$$Q_\beta = \left(-\frac{\pi f}{\beta b}\right) \tag{5}$$

Regarding equation (4), shear wave windows are needed in this method. To determine the shear wave window, Kinoshita algorithm [13] is used for horizontal components. Fig. 3 shows an example of Kinoshita algorithm for determination of Shear wave window.

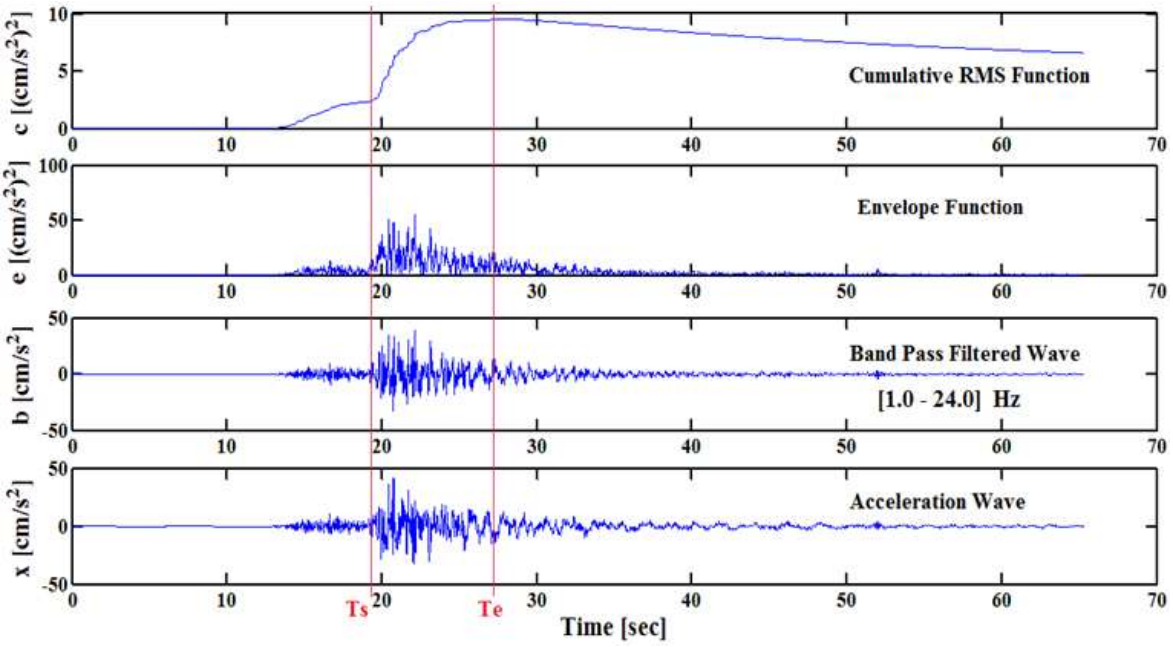

Fig. 3. An example of selecting the direct shear wave window by using Kinoshita algorithm (1994) for Transverse component of January 27, 2011 earthquake at 08:38:28 with magnitude M_W=6.2, located in 28.240°N 59.130°E recorded in Chah Malek station. T_s and T_e stand for the estimated onset and end times of the direct S-wave

For this purpose, the data of two horizontal components (Longitudinal and Transverse) were used. The time series, *x(n)*, of both components (*n* is the sample number) were processed in the following manner. First, *x(n)* was band pass (1.0-24.0 Hz) filtered to obtain *b(n)*. For the selection of Shear wave section in *x(n)*, an acceleration envelope was computed:

$$e(n) = [b^2(n) + H^2(b(n))]^{1/2} \tag{6}$$

where *H(b(n))* is the Hilbert transform of band pass filtered time series *b(n)*. Typically, *e(n)* increases with the arrival of the Shear wave phase and abates with its passage. To elucidate this characteristic, the cumulative RMS function was calculated from *e(n)*:

$$c(k) = (\frac{1}{k}\sum_{n=1}^{k} e^2(n))^{1/2} \tag{7}$$

where $k = 1,...,N$ and *N* is the number of samples of acceleration wave. The end time (Te) of the Shear wave window was assigned as the point on the time axis where *c(k)* starts to decrease, as illustrated in Fig. 3. The onset time of the Shear wave arrival (T_s), was visually estimated.

After applying a 10% cosine taper to both ends of the filtered Shear wave window, we extracted spectral amplitudes of the direct Shear wave in each frequency band from Fast Fourier Transform (FFT) on horizontal components. Fig. 4 shows the Q_S values for Transverse component at central frequencies of 1.5, 3.0, 6.0, 9.0, 12.0 and 18.0 Hz.

The plot of Q_S versus central frequencies is shown in fig. 5. The average Q_S values of Rigan region for all frequencies are mentioned in table 2. The Q_S mean values, vary from 91 at 1.5 Hz to 507 at 24 Hz for Longitudinal component and 104 at 1.5 Hz to 518 at 24 Hz for Transverse component. The frequency dependent relationships of Q_S, are $Q_S = (102)\, f^{(0.58)}$ and $Q_S = (96)\, f^{(0.60)}$ for Longitudinal and Transverse components, respectively.

Table 2.

Average Q_S at different central frequencies, also Q_0 and n values

Central Frequency [Hz]	**Longitudinal Componente Q_S**	**Transverse Componente Q_S**
1.5	91	104
3.0	339	228
6.0	255	292
9.0	348	348
12.0	434	415
18.0	507	518
Q_0	102	96
n	0.58	0.60

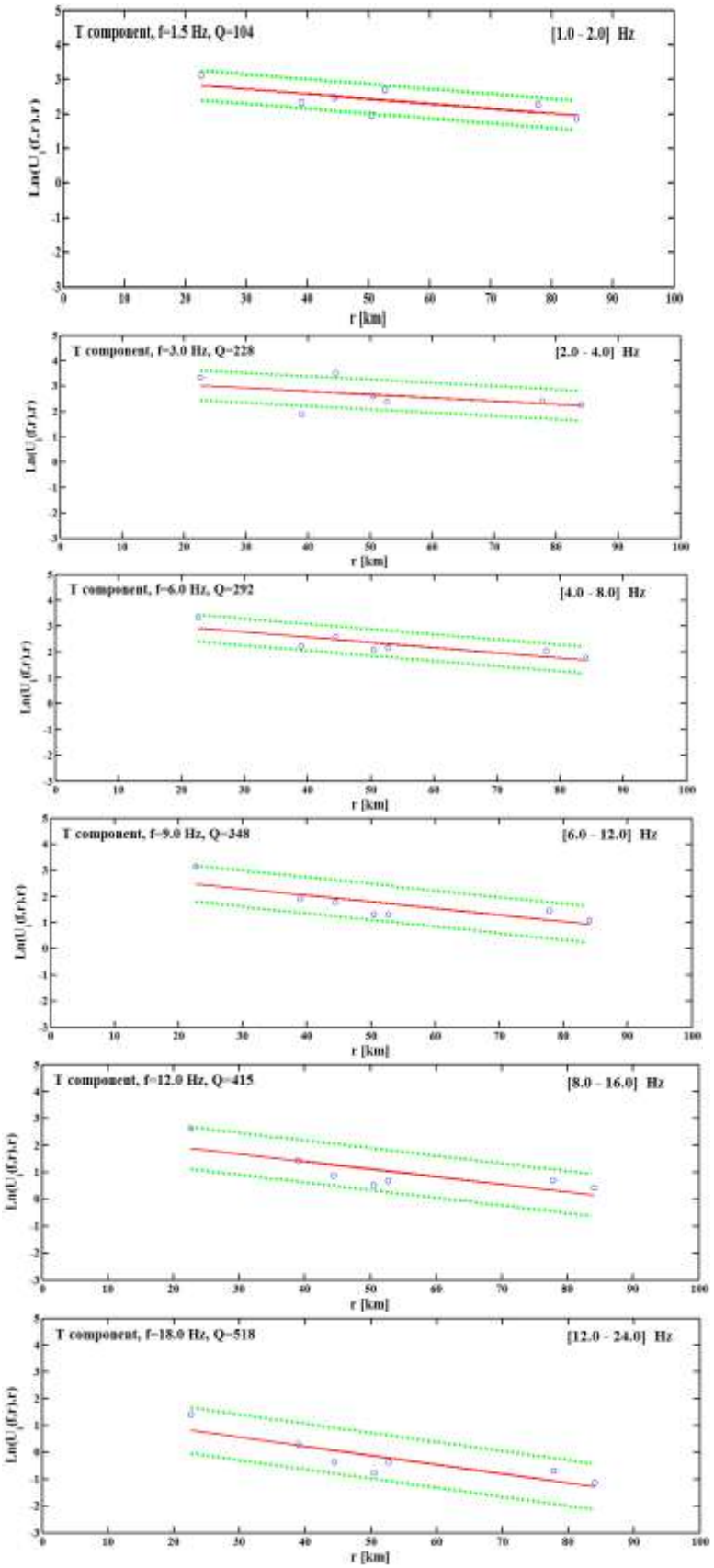

Fig. 4. Estimation of Q_S in Rigan region at six central frequency. The solid line is regression fit and dashed lines are standard deviations of regression in each regression analysis

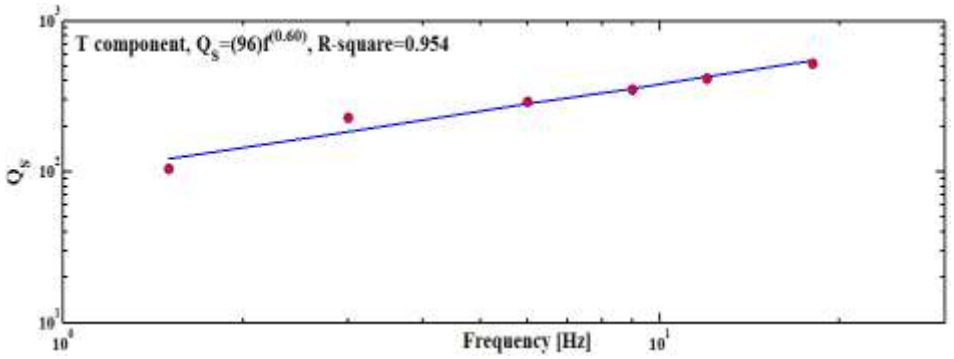

Fig. 5. The plot of Q_S versus central frequencies for Transverse component. The best-fit line from the least-squares estimate is indicated by the solid line

The frequency dependent relationships of Q_S by spectral decay method carry out in different region such as, Northeastern Sonora, Mexico ($Q_S = 83.8\, f^{0.90}$, [14]), back-arc region of the Hellenic arc ($Q_S = 55\, f^{0.91}$, [15]), Central Italy ($Q_S = 34\, f^{1.30}$, [12]), region of Marche, Italy ($Q_S = 86.1\, f^{0.70}$, [11]) and Avaj region, Iran ($Q_S = 63\, f^{0.99}$, [16]).
The acceleration spectrum, *A(f)*, at high frequencies can generally be described as:

$$A(f) = A_0 e^{-\pi k f}, \qquad f > f_E \tag{8}$$

where A_0 depends on source properties, epicentral distance (R), and other path related factors. f_E is the frequency above which the spectral shape has an exponential decay and κ is the spectral decay parameter [2]. To estimate κ from the selected recordings, the acceleration spectra were calculated finding the Fast Fourier Transform of a window containing S-wave arrivals and linear least square fits to the spectra were obtained. The values of the slopes were converted to the spectral decay parameter, κ, and subsequently plotted against the epicenteral distance to evaluate distance dependence (Fig. 6).

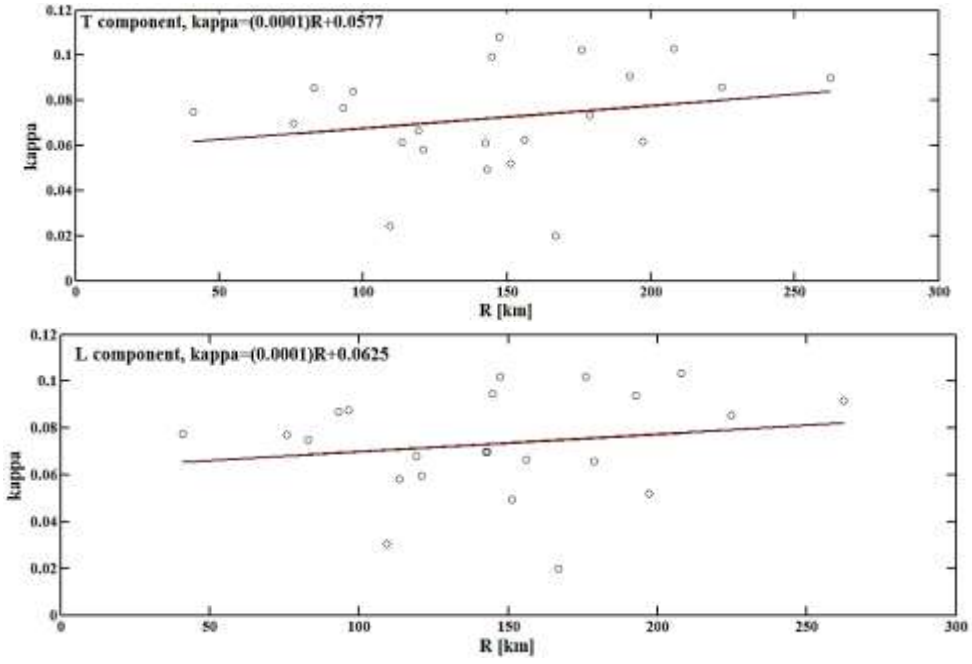

Fig. 6. Dependence of spectral decay parameter on epicenteral distance (R) for Transverse and Longitudinal components

The spectral decay parameter, has been estimated at 23 stations (Table 3). There is a considerable amount of scatter in the individual measurements of κ. This comes from variability in the high frequency spectrum as radiated at source or highly variable attenuation in the source region. The interception of κ, at zero distance, is controlled by attenuation near the surface, while an increase of κ with distance is an effect of lateral propagation. This is important for the simulation of strong ground motion for engineering applications based on stochastic models.

Table 3.

Estimated κ on horizontal components and its average value for different stations

Station	Spectral Decay Parameter		
	L component	T component	Average
Abaragh	0.020	0.020	0.020
Bazman	0.030	0.024	0.027
Kahnooj	0.049	0.052	0.051
Kishit	0.052	0.062	0.057
Barvat	0.058	0.061	0.060
Roodbar	0.059	0.058	0.059
Jiroft Dam	0.066	0.074	0.070
Ghale-Ganj	0.067	0.062	0.064
Posht-Rood	0.068	0.066	0.067
Hosein-Abad	0.070	0.061	0.065
Mohamad-Abad	0.070	0.050	0.060
Zeh-Kelot	0.075	0.086	0.080
Fahraj	0.077	0.070	0.073
Rigan	0.078	0.075	0.076
Golbaf1	0.085	0.086	0.086
Qotb Abad	0.087	0.077	0.082
Dalgan	0.088	0.084	0.086
Sirch	0.092	0.090	0.091
Iran Shahr	0.094	0.091	0.092
Chah-Ali	0.095	0.099	0.097
Jiroft	0.102	0.108	0.105
Bampoor	0.102	0.102	0.102
Darbehesht	0.104	0.103	0.103

Conclusions

In this study, Q_S has been estimated for Rigan region using by Spectral decay method. The following conclusions are reached:

1. The average Q_S values and their frequency dependent relationships show that the Rigan region is highly heterogeneous.
2. The frequency dependent relationships of Q_S are estimated as $Q_S = (102) f^{(0.58)}$ and $Q_S = (96) f^{(0.60)}$ for Longitudinal and Transverse components, respectively.
3. The frequency dependent relationship Q_S in Rigan region is similar to that for the Avaj region in Iran, Northeastern Sonora in Mexico, back-arc region of the Hellenic arc, Central Italy and region of Marche in Italy.

4. In this study we found the minimum value of κ, 0.020 sec at Abaragh station and the maximum value of 0.105 at Jiroft station. The distance dependence relationships of κ are $\kappa = (0.0001)R + 0.0577$ and $\kappa = (0.0001)R + 0.0625$ for Transverse and Longitudinal components, respectively.
5. The S-waves attenuate more at short distances (r<90 km) because κ tends to increase in this distance range. This result is in agreement with a previous study [17] that reports lower values of Q in the upper crust compared with Q in the lower crust.

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EARTHQUAKE FORECASTING BY GRAVITY VARIATIONS PRECURSORS RECORDED AT ATROPATENA SYSTEM

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The study of gravity anomalies in the perspective direction of short-term forecasting of earthquakes is the most important aspect of researches in the field of geodynamics. Recently, significant anomalies were observed not only near the epicenter, but also in the region very far from the epicenter before the occurrence of strong earthquake. Such anomalies in the epicenter region are known as "source precursor" and those far away from the epicenter as "field precursors" (Ma Zongjin, 1980). Such precursors have been noticed by different seismologists, ranging from behavioral changes in animals to changes in Lithosphere Atmosphere and Ionosphere. One of these types of earthquake precursor is due to changes in gravitational field and this is noticed as "field precursor" (Walsh and Rice, 1979). The variations in gravitational field may be stipulated by a number of geophysical and tectonic reasons (V.Khain and E.Khalilov, 2006 and E.Khalilov, 2007). These are i) Stress conditions of the earthquake preparation zone when approached to the critical level, it causes either squeezing/compaction of the rocks or stretching resulting decreases of their density. ii) The critical stresses in earthquake preparation zone causes active movements of fluids in the layers of the Earth and as a result either it increases or decreases the level of subsoil waters that has been observed in the shafts and bores before the occurrence of earthquakes. iii) When the stresses approach to a critical size, it results in mass cracking of rocks in earthquake preparation zone, which eventually causes breaking of rocks iv) High and low density area appears due to deformational processes arising in the central earthquake preparation zone before the occurrence of strong earthquake.

Probably, there are also other factors involved in changes of gravity, but all of them do not have large radius of range regarding earthquake preparation zone of strong earthquake. It is due to fact that this effect of changes of gravity, connected directly with the geodynamical processes in earthquake preparation zone, is observed in the radius from tens to thousands of kilometers from station of registration. The system ATROPATENA, designed to monitor such type of variations of gravity, one of such system is installed at Islamabad, Pakistan. The Global Network for Forecasting of Earthquakes (GNFE) includes its ATROPATENA stations in Baku, Azerbaijan, Yogyakarta, Indonesia and Istanbul, Turkey and number of other stations are yet to be installed on different parts of the globe. Current study is based on the analysis of one and half year (January 2010 to June 2011) anomalies registered at ATROPATENA Network and presented success of earthquakes forecast.

ATROPATENA SYSTEM

The ATROPATENA system (Fig. 1) consists of two Torsion detectors to register variations in gravitational field in two horizontal directions – NS and EW and a gravimeter to detect the variation in vertical component of gravitational field. Two sets of small masses are attached at the end of two bars of low density material. These small masses and one vertical gravimeter are placed in a jar. The system of detectors is completely isolated, due to it's highly sensitiveness, from the environment by means of vacuum and registered very weak displacements of sensitive elements of the system. The system is set in equilibrium by two heavy masses placed outside the jar, to eliminate the effect of any small changes in gravitational field, not related to any geodynamic phenomenon. As a whole the system ATROPATENA registers the variations of gravitation field in three perpendicular directions – X, Y, Z.

Recording these variations is done by using laser beams and optical matrix. There are small mirrors attached to each bar and gravimeter. The displacement of the bars is noted by using laser beams directed on these small mirrors. The laser beams reflected from mirrors to the optical

matrixes. Then these changes in positions are recorded by the sensitive cameras attached on back of optical matrixes. The analogue signals are then converted to digital form by software Power Graph is transferred to the computer for recording.

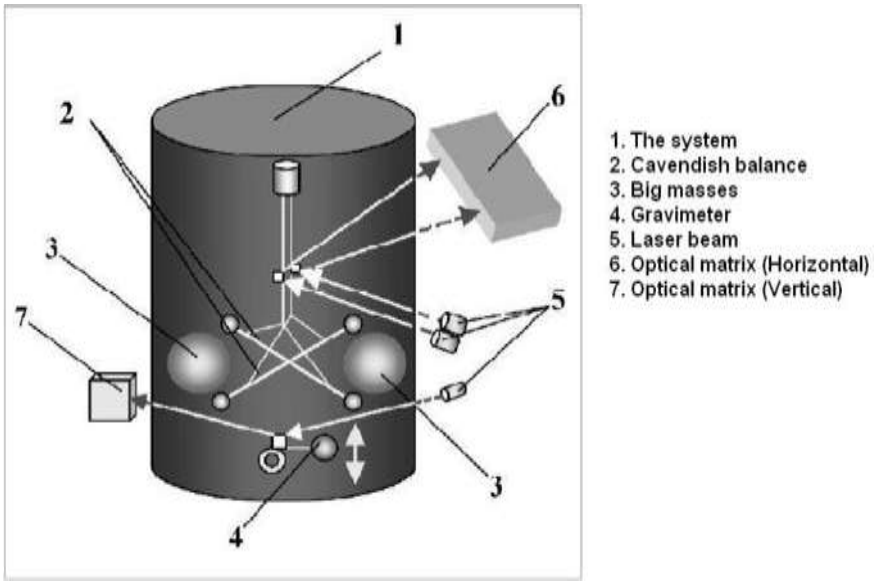

Fig. 1. Schematic diagram of ATROPATENA

DATA RECORDING AND UPLOADING TO SERVER

These gravity variations signal generated before the occurrence of strong earthquakes are recorded at GNFE Network by seismic software after every 1-2 seconds. The recorded signals are then stored in Microsoft SQL server locally. After every ten minutes, the recorded data from the network is being uploaded to database server through TCP after automatic formatting as shown in Fig.2. The data is now available to download by using web site (www.gnfedata.org) and ready to analyze.

DATA ACQUISITION AND ANALYSIS

The acquisition of data is achieved by using the web site already mentioned above and detail description of how the data is uploaded from the GNFE Network. This data from January 2010 to June 2011 from ATROPATENA systems installed at Islamabad, Pakistan, Baku, Azerbaijan, Yogyakarta, Indonesia and Istanbul, Turkey were analyzed by using Power-graph software. The unusual Low-frequency changes in the gravitational field registered at the system were observed before the occurrence of strong earthquakes. This phenomenon was observed when the epicenters are at large distances (in the radius from one thousand to tens of thousands km) but we have taken the radius $\simeq$ 8500 Km in order to ensure precise location from the registering station. There were some peculiarities during registration of signals, which allow the increase of accuracy of the forecast.

The statistic of results shows that the gravitational signals were registered in 90% of cases, on the average 7-15 days before the occurrence of strong earthquakes. It is also observed "vibration of the record" – relatively high-frequency oscillations of gravimeter readings which is stopped right away after the earthquake. However, in some cases before the occurrence of distant strong earthquakes, the changes of anomalies of gravity have more complicated character.

The anomalous signal registered on the ATROPATENA Network was analyzed on biannual basis starting from January-June 2010. The forecasts of earthquakes were made on the basis of arrival times that indicate the region of pending earthquakes. A total of 54 anomalies were recorded at the above said stations. 28 out of 56 were forecasted and successful forecasts were 22 on the

basis of strong precursor gravity variations. Only six forecasts were unsuccessful. The statistical results of six months data reveal that the forecasts were successful about 77%.

Fig. 2. Network of System ATROPATENA

Similarly, pre-earthquake signals observed on ATROPATENA stations during next six months period from July to December 2010 were analyzed. Arrival times of anomalies on these systems indicate the region of pending earthquakes. A total of 104 anomalies were recorded during the period and out of these 84 were forecasted. 63 out of 84 were successful forecasts were 63 and 21 forecasts were unsuccessful. The statistical results of six months data reveal that the forecasts were successful about 78%.

Table 1.

Showing Summary of Six months Earthquake Forecasts (Jan 2010-June 2011)

Months	Recorded Anomalies	Weak Anomalies	Forecasted Anomalies	Successful Forecasts	False Alarms	Percentage of Success
Jan-June10	54	26	28	22	06	77 %
Jul-Dec10	104	20	84	63	21	78%
Jan-June11	66	33	33	26	07	75%
Jan,10– June,11	**224**	**79**	**145**	**111**	**34**	**76.6%**

The Last six months January to June 2011 data was analyzed. A total of 66 anomalies were recorded and out of these 33 were forecasted. Out of 33 the successful forecasts were 26 and seven forecasts were unsuccessful. The statistical results of last six months data reveal that the forecasts were successful about 75%.

The summary of analyzed data is shown in Table-1 and bar graph is shown in Fig.3. The result shows overall success ratios as 76.6% during period Januray-2010 to June 2011 which is good success ratio for the successful forecasting of earthquakes. However if we take into account the record from United State Geological Survey (USGS) there are large number of events as compared to anomalies registered at ATROPATENA in the study area. In fact this is due to less number of stations of GNFE network.

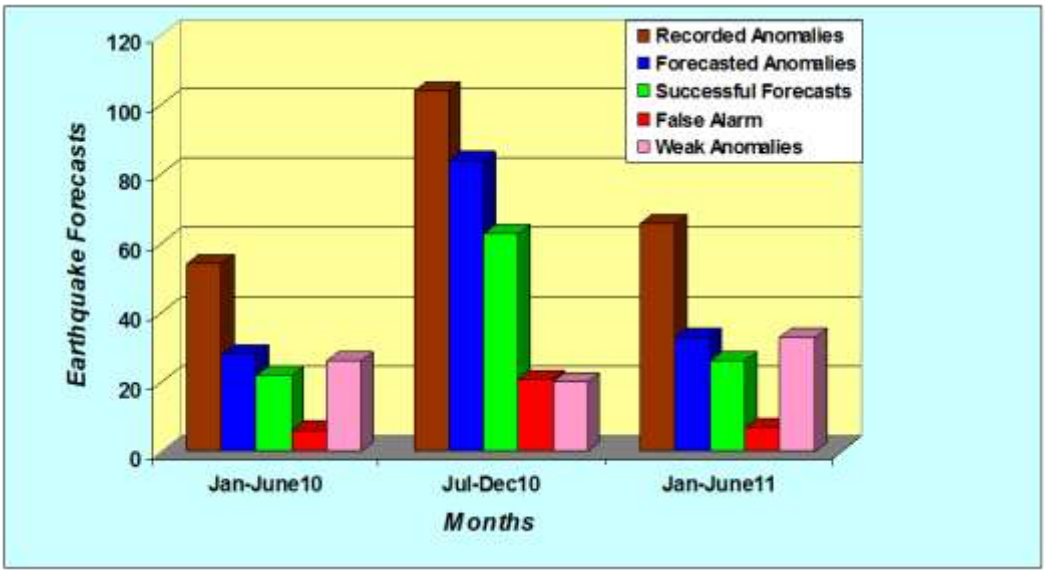

Fig. 3. Graph Showing Summary of Six Months Earthquake Forecast (Jan 2010-June 2011)

Conclusions

The results of one and half year (Jan-2010 to June-2011) data show that anomalous signals recorded at ATROPATENA systems behave as precursors before the occurrence of major earthquakes. The data was analyzed and earthquakes were forecasted for different regions on the basis of arrival time of anomalies recorded on different stations. The forecasted earthquakes occurred in Indonesia, Japan, China, Taiwan, Central Europe, Iran, Pakistan and Hindu-Kush region of Afghanistan. The result indicates over all success ratios as 76.6% which is a good achievement for successful forecasting of earthquakes. However there is still need to supplement other geophysical data. The precise and successful forecast will be increased if more ATROPATENA stations throughout the globe are installed. The successful forecasting of earthquakes will help to save thousands of lives and properties from the natural disasters.

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EARTHQUAKE PREDICTION – WORLD-WIDE TASK

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Introduction

Prediction of earthquakes – the Holy Grail of seismology and its most important task – seems to be an unattained task of generations of seismologists. Although there are a lot of scientific methods (many of them are mentioned in the paper Neumann & Kalenda 2010) none of them can be used as a standard for routine earthquake prediction.

New methods and/or improvements of old ones have been put into operation in the past few years. So, many prediction groups exist at the same time all around the world, but many of them try to predict only local earthquakes, although for example precursors of the event on Boxing Day 2004 on Sumatra (M=9.1 (NEIC 2010)) were observed everywhere on the globe (Nuannin et al. 2005, Rüder et al. 2005, Zakharenkova et al. 2006, Zhao et al. 2006, Sobolev & Lybushin 2007, Wei & Chen 2009, Qian et al. 2009, Liu et al. 2010).

Methods currently used for EQ prediction

Now (2010) only a few methods of the wide spectrum of possible ones are used in the active EQ prediction.

Local methods with a limited impact and therefore observable in only a small area of focus of an earthquake include electromagnetic methods, radon gas methods, earthquake clouds, and thermal anomalies (IR). As these methods are observable in only a limited area, they can help with localisation of an imminent earthquake. The first method is used in Greece in the VAN variant (Varotsos & Alexopoulous 1984a, 1984b, Varotsos et al. 1987, VAN 1996, Eftaxias, et al. 2003, Varostos et al. 2007, Thanassoulas 2007, Sarlis et al. 2008). A particularly intensive research is carried out on the western coast of N. America by the QakeFinder group (Cutler et al. 2007, QuakeFinder 2010) or in Japan (Hayakawa 1999, Hayakawa et al. 2009, Uyeda et al. 2009).

A volunteer – G.Giuliani (2004) – was measuring the radon gas in L'Aquilla, Italy.

Earthquake clouds are sometimes observable before strong shallow earthquakes (Uda & Maeda 2006, Gup & Xie 2007, Guo & Wang 2008, Irrational Geographic 2009).

Big expectations are coming with remote satellite observations (Tronin 2010) of ground deformations measured by SAR or InSAR interferometers (Interferometric Synthetic Aperture Radar)

(Kuzuoka & Mizuno 2004, Chini et al. 2008), surface temperature (IR anomalies) (Saraf & Choudhury 2003, Ozounov et al. 2006, Pulinets et al. 2006, Saraf et al. 2008, Wu & Liu 2009, Wei et al. 2009), ionosphere disturbances (Molchanov et al. 2006, Parrot et al. 2006) and gas emission (Okada et al. 2004).

Global methods comprise all methods, which indirectly or directly measure the stress in rock mass, because so called "stress waves" or "tectonic waves", which originate in the focus area of the future earthquake, have a small attenuation and are detectable everywhere on the globe (Kalenda et al. 2010). Li et al. (2003), Shi et al. (2009) or Crampin & Gao (2009) showed that earthquake can be predicted, but it is necessary to measure the stress in the rock mass and to make numerical models.

Direct or indirect stress measurement methods include hydrofracturing (Amadei & Stephansson 1997), borehole stress/strain meters (Johnston et al. 1987, Hart et al. 1996, Liu et al. 2008, Sun et al. 2008, Li 2010, Ouyang 2010), strainmeters or laser deformometers (Agnew 1986, Zğrn 2001), stressometers (Huang X.N. et al. 2010), water level measurement (Huang, F.Q et al. 2010), tilt measurement (Braitenberg 1999, Braitenberg et al. 2006, Ouyang 2010), measurement of movement of active faults by spatial dilatometer (Stemberk et al. 2010), measurement of splitting of S-waves (Crampin et al. 2008, Crampin & Gao 2009), microseismicity measurement (Gorbatikov et al. 2004, Li, Y. et al. 2010), measurement of gravity (Chambat & Valette 2008, Khalilov 2009), and measurement of rock-mass resistivity (Qian et al. 2009).

Other methods without clear physical background, which determine the measured anomalies preceding the earthquakes, are used too. The MDCB method (Wang et al. 2002, 2003) or earthquake resonance measurements (Wei 2007) are some of them.

Prediction groups in the world

Although governments and official seismologists (mainstream) say that earthquakes are unpredictable (Geller 1997, Geller et al. 1997), many groups and individuals work on this topic on all continents. Even well known scientists show that we can estimate the time of main shock by direct of indirect measurement of stress (Crampin et al. 2008a, 2008b, Gao & Crampin 2008, Crampin 2009 Crampin & Gao 2009, Shi et al. 2009, Hayakawa et al. 2009, Freund et al. 2006).

The first groups of predictors or geophysicists used first of all local methods, which can determine all the necessary parameters – time, localisation and magnitude.

The QuakeFinder group on the western coast of the USA in California uses the EM method to detect the anomalous "noise" before earthquakes, mainly on the San Andreas fault (Bleier et al. 2009). This group cooperates with F.Freund, who makes the analyses on the rock samples in the laboratory (Freund et al. 2006).

An amateur in geophysics but a professional scientist E. Glass makes his worldwide predictions on the basis of EM pulses, detected as "ear tones", which correlate with tidal influence on the triggering of the earthquakes (EDG 2010).

The most active in Europe and especially in Greece was the VAN group, which was led by Varotsos Alexopoulo Nomicos, until the 90s of the last century (Varotsos et al. 1984a, 1984b, 1987, 2007). After R. Geller's criticism of their work (Geller 1996) they have not attempted to predict earthquakes officially and they have studied only the physics of the possible connection between earthquakes and electromagnetic emission (Sarlis et al. 2008).

An amateur in geophysics but a scientific technician G. Giuliani (2004) predicted the L'Aquila earthquake on April 6, 2009 with his own radon meters, which were distributed in the epicentral area. But the scientific authorities including Enzo Boschi, the chairman of Italy's National Institute for Geophysics and Vulcanology, dismissed Giuliani's predictions: "Every time there is an earthquake there are people who claim to have predicted it," he said. "As far as I know, nobody predicted this earthquake with precision. It is not possible to predict earthquakes."

In Central Europe there are two groups of scientists that measure the rock mass deformations. One group around Košťák and Stemberk (IRSM AS) measures long-time sequences of movement and rotation on active faults (Stemberk et al. 2003, Stemberk and Košťák 2007). They found that the tectonic frame is coherent in the whole Central Europe (Stemberk et al. 2010)

and the periods of higher stress than average, accompanied by lateral movement of blocks, are alternated by periods of lower stress than average, accompanied by vertical movement of blocks (Briestenský et al. 2007, Košťák et al. 2007).

The second group around Kalenda (IRSM AS) and Neumann measures the micro deformations in abandoned mines or caves by vertical static pendulums (Neumann 2007, Neumann and Kalenda 2010). They found the so called "stress waves" or "tectonic waves" with periods of days and weeks, which precede the strongest earthquakes (Kalenda et al. 2009, Kalenda and Neumann 2010) (see Fig 1).

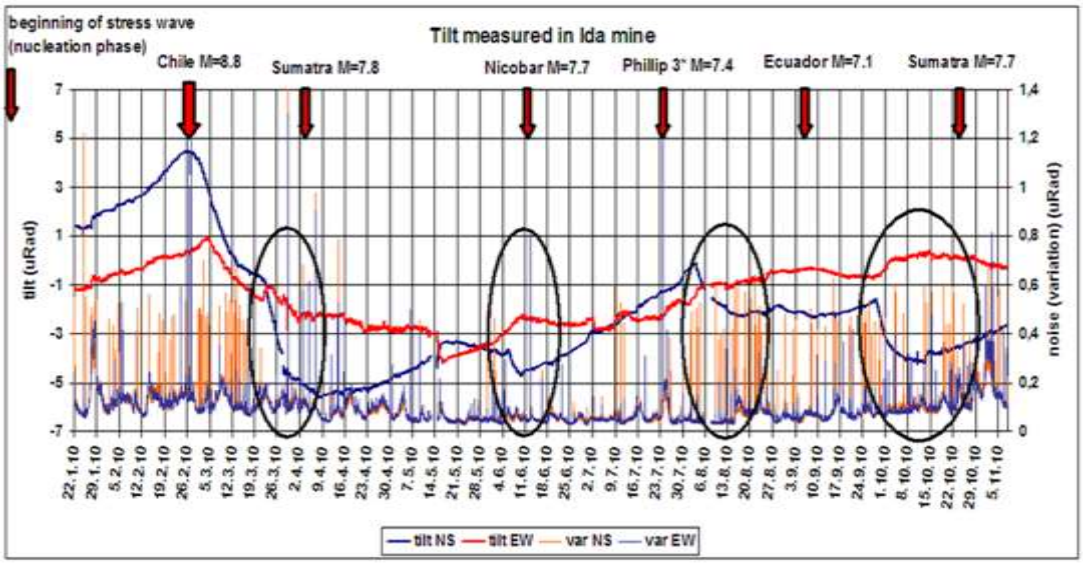

Fig. 1. The tilt and noise of pendulum in Ida mine, Czech Republic in 2010

One very active group of predictors is working in Baku around prof. Khalilov (2009), who made a completely new apparatus – differential rotational gravimeter – Atropatena (Khain and Khalilov 2008). Such a gravimeter is able to measure changes of gravity field, which are connected with the changes of rock mass density and with the pressure in the crust too. The results show that so called "tectonic waves" in the massif are detectable and it is possible to localize the epicentral area with the help of the network of such apparatuses.

On the Indian peninsula there are people, who use various methods for earthquake predictions. One of them is Mr. Shan R. Shanmugasundaram, who tries to predict earthquakes based on the Earth surface deformation, measured with the help of sunshine. But nothing is known about the physics in the background of the observations.

The group of A.K. Saraf is observing local IR anomalies that precede the earthquakes (Saraf & Choudhury 2003, Saraf et al. 2008, Saraf et al. 2009).

In China there are many groups of scientific or amateur predictors. The most powerful group was established by prof. Li Jun-zhi at the University of Technology, Beijing in October 1976, immediately after the Thangshan earthquake. This group is using a multicomponent observation and they make earthquake prediction based on the fingerprint recognition technique (Li et al. 2003). The direction to the epicentral area is measured by crustal stress. The anomalous period is recognized by infrasound and the time of the imminent earthquake is determined by animal behavior (budgerigar). They use other methods like inclination, geomagnetic activity by 3-needle geomagnetic device, gravity, atmospheric pressure and ground temperature.

The Earthquake Research Team of the Dianye Middle School was established in 1995 by the North China Power (Group) Corporation. Liu Gen-shen, the head of the Earthquake Research Center has given more than 600 predictions per year, especially in the area of China and adjacent areas, based on measurement of a telluric current, abnormal behaviour of animals, earthquake clouds observed from ground level and fingerprint recognition technique. Sun Wei, who cooperates with this Research Center, installed his crustal stress monitoring system in Aug. 2003, and later

also installed the inclination instrument, 3-direction geomagnetic instrument, and the resonance instrument (Sun & Okubo 1998, Sun 2007, Sun & Sun 2008). In 2005 Liu discovered the characteristics of the set of precursors corresponding to an EQ occurring in a specific location have similarities, and began to use this phenomenon to predict the location of EQs corresponding to same characteristics of the set of precursors.

In China there are other institutions, which make earthquake predictions, such as the Institute of Crustal Dynamics, China Earthquake Administration (Huang, X.N. et al. 2010 – piezomagnetic stressometer), the Institute of Geophysics, China Earthquake Administration (Qian et al. 2009 – electro-resistivity of rock mass), China Coal Research Institute (Wang et al. 2002, 2003 - MDCB). Especially the last one is very active and makes predictions for the Chinese mainland and adjacent areas every week (see Fig. 2).

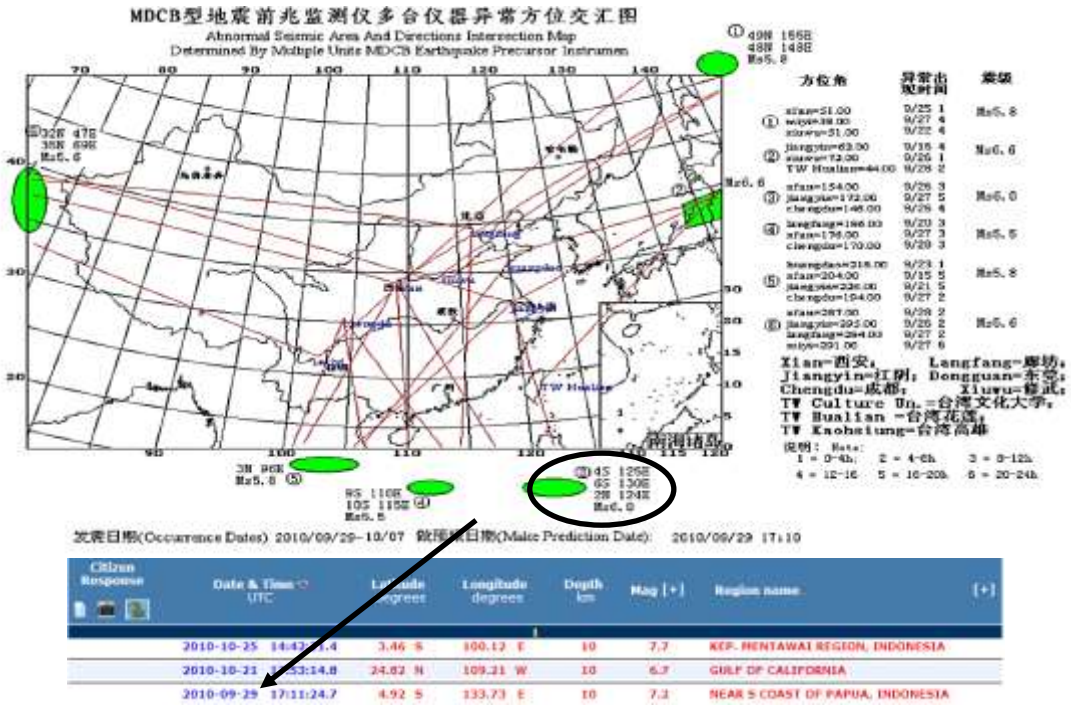

Fig. 2 Week predictions of Dr. Wang and MDCB group and comparison with EMSC (2010) bulletin

The other very active predictor is Dr. Z. Shou (2010), who predicts the epicentre areas on the basis of earthquake clouds, which were theoretically solved by F. Freund et al. (2009).

S. Uda (Japan) uses the same prediction techniques as Z. Shou, using pictures, which are made by remote meteo-satelites (Uda & Maeda 2006). He is able to estimate the magnitude of a future earthquake on the basis of the length of the EQ cloud.

Y.Sue (2009) calculates the probability of occurrence of earthquakes on the basis of their connection with tides.

One centre – world-wide network: Proposal of Prediction centre

If we want to predict earthquakes correctly then all these methods must be connected to one centre, because some of the above mentioned methods are particularly significant and are able to detect precursors of the strongest events (M>8) everywhere on the Earth (Crampin 2010 talk at the ISRM conference in Beijing (not in Proceedings)), but they are not able to localise such strongest events with the adequate accuracy. Such global methods are mainly based on the indirect measurement of stress in the rock mass or stress variations, because the "stress waves" have small attenuations, as their wavelength is larger than circumference of the Earth (Kalenda et al. 2010). Therefore, the time or period of an incoming earthquake must be estimated or assessed on the basis of global methods with the help of the asperity model (Wyss et al. 1981, Wei 2007, Wei & Chen 2009). Therefore only the strongest earthquakes would be predicted.

On the other hand, the local methods cannot distinguish the local phenomena from the global ones. Therefore, many big anomalies are visible in only a small area of the future small or moderate earthquakes and they cover both smaller and larger anomalies from more distant but strong events.

Data of the global methods should be pre-processed in their own centre and only the information about an incoming strong earthquake would be sent to the world centre together with the additional information (magnitude range, direction of stress wave, amplitude vs tectonics, time of beginning of anomaly, etc.).

The accurate epicentral area must be recognised on the basis of local methods in the time window, which was evaluated by the global methods. The cross-correlation of many local methods is necessary. As there are many places in the critical state on the globe, more than one epicentral area could be recognised. It only depends on the stress state and the velocity of accumulation of the energy, which of them will be destructed first. The stress state will then be redistributed and the stress in some areas of the critical state will drop and/or in others will rise much closer to the strength limit.

The models, used in the prediction centre, make it possible to estimate the areas, in which the stress will increase and the areas with the stress drop. Models must be based on all of the forces, which move the lithosphere plates, including triggering forces like tides, solar irradiance, hurricanes, precipitation, IR anomalies, etc.

Prediction evaluation and result validation

Since the periods of "stress waves" are days up to weeks long and depend on the volume of asperity (and therefore on the magnitude of the earthquake) (see Fig. 3) it is necessary to make the prediction of earthquakes every day if we want to predict the strongest earthquakes with the magnitude greater than 6. For M7 earthquakes it would be necessary to make the prediction at least once per 3 days and for M8 earthquakes once per week.

In the first step, the data of global methods must be evaluated and interpreted. If the stress anomaly appears, the magnitude and possible localization must be estimated.

In the second step, the local methods must be used to scan the whole globe to recognise possible local anomalies – precursors.

In the third step, the results of all the methods must be put together to model the stress state on the Earth's surface and to estimate the areas in the critical state and their volume. The magnitude of the future mainshock of all possible areas could be evaluated (depending on time).

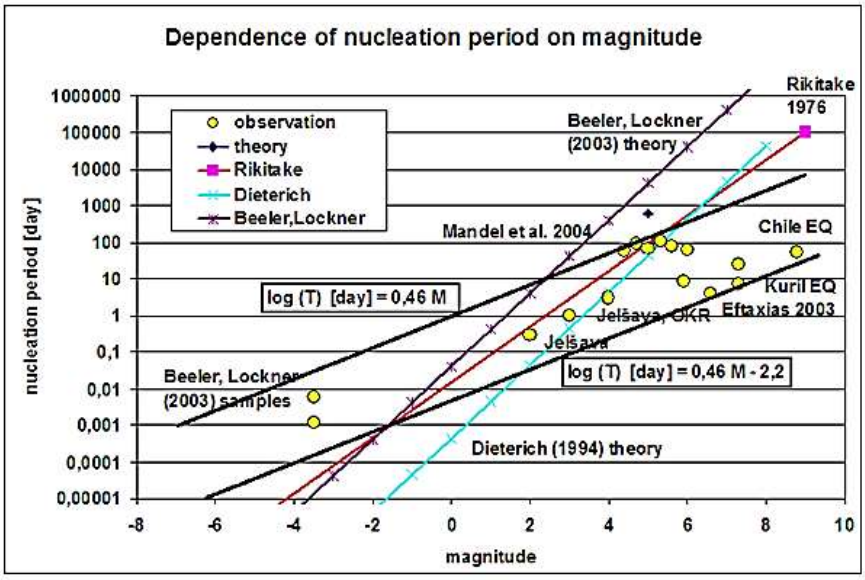

Fig. 3 Dependence of the nucleation period on magnitude

In the fourth step, the prediction is made for all of possible areas of the mainshock.

In the fifth step, the imminent precursors are hunted in the predicted areas (foreshocks, IR anomalies, radon gas anomalies, animal behaviour, EQ clouds, …).

In the sixth step, the alarm is sent to the officials.

In the seventh step, the redistribution of stress is calculated after the mainshock and new possible areas of aftershocks are evaluated.

In the eighth step, the new prediction is made.

This scheme of data processing must be processed at least once a day and every time after the mainshock (since the step 7), because the stress changes every time.

Each prediction must contain the information about the time window; the predicted area and the magnitude range (should be unlimited from the upper side). Then the probability of each prediction could be made. The predicted area could be the whole Earth if the precise epicentral area cannot be evaluated or recognised.

After the end of the predicted time window or after the predicted mainshock, the accuracy of prediction must be evaluated and the statistical test must be made. Such results should be open for the scientific community.

All the predictions and primary data, which were used for this prediction, and results would be archived for the next generations.

Conclusion

The main scientific task "Are earthquakes predictable?" has already been solved (F.Xie ed. 2010). Many methods show that there are precursors before main shocks. On the basis of the indirect stress measurement, it is possible to estimate the stress-state of the rock mass and therefore to forecast the earthquake (Crampin & Gao 2009). On the basis of the asperity model (Sun 2007) and continuous stress measurement (Kalenda & Neumann 2010), it is possible to recognise the asperity, which is approaching the failure, and to predict the earthquake.

The world-wide prediction network must be made. This network would consist of sub-networks of stress-measurement to recognise the time and possible magnitude of an incoming earthquake and of sub-networks of local methods, which are able to determine the focal area. The hierarchical approach to the data acquisition, evaluation and interpretation with world-wide use of local as well as global methods must go hand in hand.

The prediction network must be made hierarchically (according to the methods), geographically (according to the responsibility of local authorities) and scientifically (statistic tests of results and verification of the data quality).

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THE FORECAST OF EARTHQUAKES TODAY: CHALLENGES AND ANSWERS

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The statement of the problem of the forecast of strong earthquakes which till now are unexpected or have been "predicted" a post factum is discussed. Existing strategy and tactics of the decision of this problem are critically considered; opportunities and restrictions in a view of understanding seismic process as reflection of action of the general laws of evolution nonlinear far-from-equilibrium geodynamic systems are analysed. It is shown that there are neither theoretical nor empirical bases to hope for an opportunity of the forecast of earthquakes with necessary accuracy and reliability.

Traditionally believe, that for the reliable and accurate forecast it is necessary and sufficiently to improve methods of research and knowledge of the mechanism of process and a structure of geomedium. But already for a long time nonlinear systems, which in conditions far from equilibrium evolve essentially unpredictably, deterministically-chaotically, are known. The seismogeodynamic systems are those. In a basis of failures of forecasts of earthquakes that: seismicity is shown in fractal rough-discrete medium; destruction evolves from a microlevel to a macrolevel; a fracture in any volume of any rank unpredictably reorganizes conditions of occurrence of the subsequent destructions; process is extremely dependent on the slightest changes of initial conditions.

Unstable relations of the centers of earthquakes with parameters of geomedium, bifurcations of seismic process, high-probable evolution of any micro- or mesofracture to a seismogenic macrofracture, unpredictability of transition seismoactive area to instability with "choice" any one

of several, vaguely various on a degree of readiness of "candidates" for the centers are important. Character of process as a whole, its separate stages, the attractor, scenarios of transitions from a stage up to a stage can be expected. But reliability and accuracy of predictions of concrete events are far enough from requirements of practice. Even minimally necessary requirements to the forecast basically are inaccessible. There is insuperable "a horizon of predictability", achievable earlier, than necessary quality of the forecast.

Strategy of forecasting consist in revealing certain precursor-anomaly. But for the reliable forecast such anomaly should be single and be contrastly individual on an extensive surrounding background. However, as a rule, in real geomedium some anomalies slightly conceding to most reliable of them in sizes and intensity are found out.

Detection of last one reduces probability of the miss of dangerous event, but other anomalies reduce definiteness of the forecast as the main anomaly now is not individual and low-contrast on a surrounding non-uniform background.

Steadily reliable predictions of a place, time and magnitude of concrete event with a required accuracy are impossible. The alternative is obvious: certain, but the inadequate forecast of concrete event on the basis of unrealistic model of geomedium or realistic model of medium with inevitable uncertainty of the forecast.

Keywords: earthquakes, geomedium, discreteness, fractals, nonlinearity, unpredictability

1 INTRODUCTION

The initially only practical problem of the forecast of earthquakes the last decades has far exceeded these frameworks. Now it is a part of a question: what (and why) possibly (or not) to predict (and to restore) in sciences about the Earth, in natural sciences in general. Optimists in this question those who is convinced of high potential of technology: updatings of empirical methods and the factual basis. Pessimists accent the past unsuccessful experience, but they do not answer a question: why the success cannot be reached by experience in the future? Arguments of those who base on the theory of nonlinear dynamics are more forcible and difficultly refutable: in conditions far from equilibrium not only the complex, but also the relatively simple systems of an extensive class, evolve by the special mode: essentially unpredictably, deterministically-chaotically. The majority if not all natural systems, including seismogeodynamical ones, belong to this class. Authors of presented article support such point of view. The reasonings supplementing our previous publications on this theme, are presented below.

2 STATEMENT OF THE PROBLEM

The forecasting of an earthquake often still is defined even by professionals as the specification of: 1) the time, 2) location, and 3) magnitude of a future seismic event. In such representation it would be possible to consider this problem already solved for any area even without special researches, besides with the accuracy as great as possible; but reliability of the forecast it will be close to a zero. A quite reliable forecast, but with infinitesimal accuracy is equal possible also.

Obviously: a forecasting is meaningful, only if minimal requirements to quality of results are installed precisely enough. Predictability or unpredictability of earthquakes, reports on the confirmed forecasts should be considered from such positions. Necessity of achievement of a proper level of accuracy and reliability is the main problem. Here accuracy is the maximal values of admissible mistakes on each of 3 parameters, reliability is probability of realization of the forecast with the nominated accuracy. Naturally: requirements to reliability and accuracy may be varied for different parameters and purposes of forecasting; increase of accuracy inevitably conducts (at the reached level of studying)to decreasing of reliability, and on the contrary. It is important to understand, that at not enough high accuracy of the forecast, for example, places or magnitude of earthquakes, even the exact prediction of time of event is deprived practical sense.

Let on the diagram of quality of a forecast (Fig. 1): on a horizontal line - reliability (R), on a vertical line - accuracy (A), a curve 1 - dependence of accuracy upon reliability. If the set values both of accuracy *Amin* and reliability *Rmin* minimally correspond to requirements for some concrete purposes, on the diagram the areas of the forecast are allocated: *unsatisfactory* on

reliability (I), on accuracy (II), both on reliability and accuracy (III), *satisfactory* both on reliability and accuracy (IV). For improvement of quality of the forecast (i.e. for displacement of a curve 1 into the area of IV without decrease in requirements of accuracy and reliability) traditionally consider necessary to improve methods of registration, processing, interpretation of the received data and knowledge of the mechanism of process and structure of geomedium which were considered as extremely complex. As it is assumed, all this will provide, basically, unlimited improvement of quality of the forecast. But such prospect is ambiguous in a view of researches of seismic process as reflexions of the general laws of evolution of nonlinear far-from-equilibrium systems [1]. As Russian geophysicist A.V. Nikolaev warned, nonlinear dynamics promises us not only a lot of discoveries (of "openings"), but also a lot of "closings". What was revealed actually?

It was found out, in particular, that mechanisms of geological processes, on the basis of knowledge about which we build forecasts, in many cases are not too complex; they, basically, are cognizable. But in conditions far from equilibrium when geocatastrophes take place, these mechanisms generate in principle ineradicable randomness, unpredictability of dynamics. It is possible to expect a certain character of the process as a whole, of its separate stages and attractor, of scenarios of transitions from a stage to a stage. But reliability and accuracy of predictions of concrete events are rather far from requirements of practice. Moreover, each next step to the reliable forecast (Fig. 1, curves 2, 3) is more and more expensive; later its cost appears excessive high. At last it is found out: even minimally necessary requirements of accuracy and reliability of the forecast basically are inaccessible. There are horizons of accuracy (*HA*) and reliability (*HR*) of the forecast which are insuperable on a principle by any methodical improvements. And border *HA*-*HR* in many cases is reached earlier, than necessary quality of the forecast will be attained.

"Opening" of such horizon became for naturalists very painful "closing". They with the traditional methods of forecasting on the basis of linear representations about a reality have been pushed aside in «reservation» of weak unequilibrium. There forecasting is possible, but there are no catastrophes, the forecasting of which is the vital necessity.

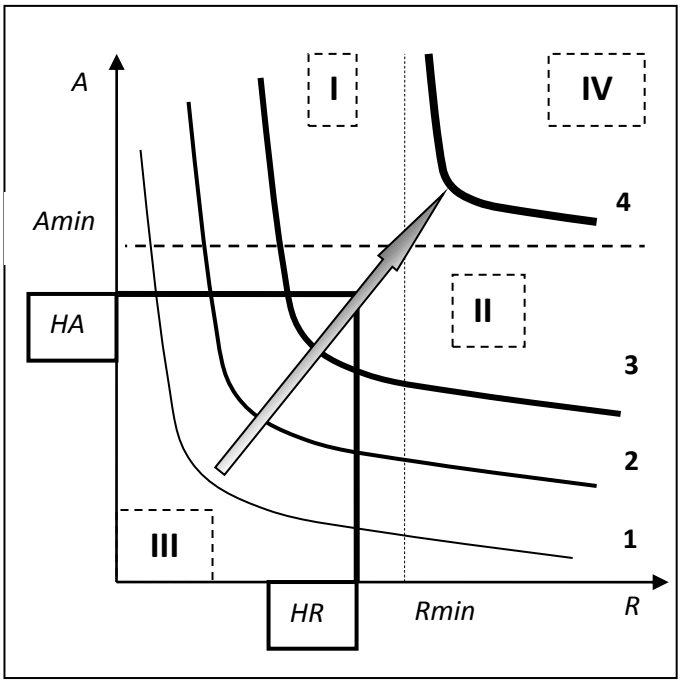

Fig. 1. Ratios of reliability (R) and accuracy (A) the forecast and its areas of unsatisfactory (I- III) and satisfactory (IV) quality. The explanation in the text.

Natural sciences have found oneself before a fundamental challenge, the constructive answer on which is not formulated yet. There are clear tendencies to not notice a problem, to work within the bounds of former, linear representations. Observations go on, the facts are collecting, methods are improving; from time to time there are reports on successes, even about achievement of the theoretical and methodical decision of a problem. But destructive earthquakes still are unexpected, "predicted" a post factum, besides unsatisfactory on accuracy.

3 TACTICS AND STRATEGY

Earlier the authors already have shown [2, 3] doubtfulness of hopes for efficiency of such ways to the accurate and reliable forecast, as physical modelling, researches of temporary sequences of events, use of geochemical and geodetic anomalies-precursors. The reasons of failures - impossibility to consider rough discreteness and self-similarity of geomedium, instability of connections of its parameters with the seismic focuses, befurcateness of seismic process, its dependence on the slightest changes of initial and current conditions, rather probable evolution of some small fracture in big seismogenic fault, unpredictability of transition seismoactive area to instability and "choice" of the most prepared "candidate" for the seismic focuses from several not very various on a degree of readiness.

Geophysical monitoring reveals anomalous "consolidation" - a coherent behaviour of geophysical fields in the area of the preparing earthquake. But alongside with the anomalies, regarded a post factum as precursors, are recorded also other variations, not much smaller or slightly greater on amplitude, but not anticipating any strong earthquakes. At the same time a lot of strong earthquakes were not preceded by any obvious attributes.

Now it is clear: what was tactics the forecast, i.e. what factors considered what parameters of dynamics were traced what methods were used, strategy is aimed at as much as possible distinct recognition of the certain anomaly-precursor. For the reliable forecast this anomaly should be only one, contrasting with a surrounding homogeneous background within the limits of enough big territory. It means abstract continuous, or (in physical models) the quasy-continuous medium with one isolated stress-overloaded macrovolume (Fig. 2, *a*).

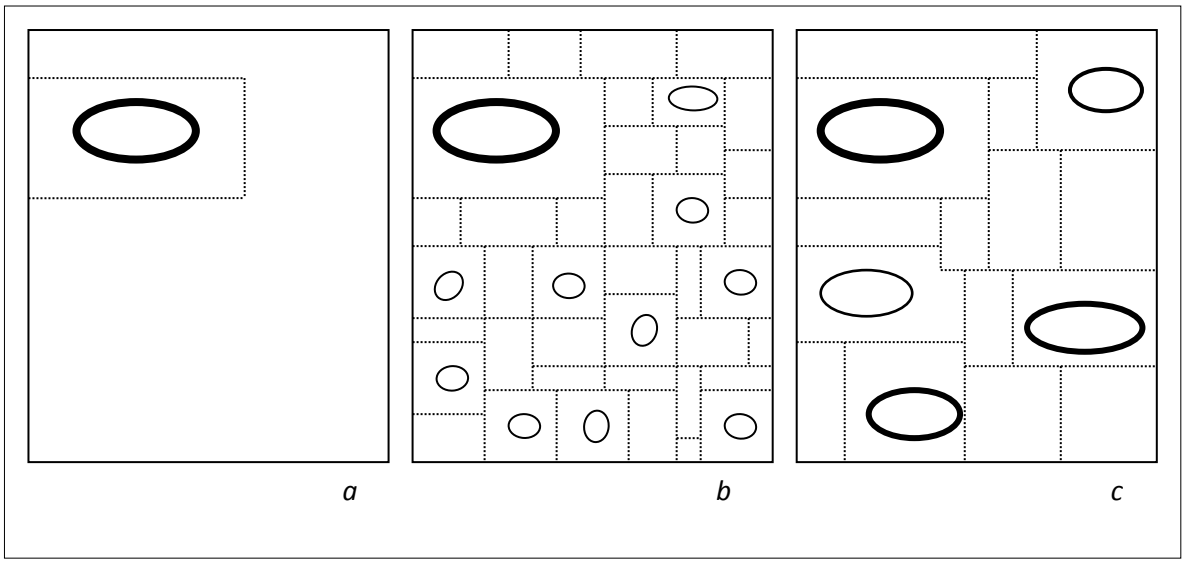

Fig. 2. Anomalies-precursors of earthquakes (ovals) in models of geomedium: continuous (a), quasy-continuous (b) with an macroheterogeneity, rough-discrete (c). The explanation in the text.

The same is meant in attempts to reveal potential seismic focuses by physical modelling of deformations. It is assumed, if the system of macrofaults and regional stress-loading in the model microgranular medium basically adequately to natural situation, allocations of maxima of intensity of local pressures near to each large fault will be *steadily* adequate to it also.

However, even if originally real medium could be quasy-continuous, later in conditions of enough intensive stress-loading, it should inevitably be self-reorganized into the hierarchically-discrete medium - with a ratios of the linear sizes of elements on adjacent ranks on the average 3,5 : 1 [4]. It at natural great amplitudes of the sizes of concrete blocks in any structural level, should lead that the greatest anomalies will not be solitary. All this complicates identification of any one of anomalies as the most probable predecessor of strong earthquake. Besides on a way to occurrence seismogenic macrofault each of micro - and mezofractures stimulates plural casual reorganizations of stress-deformed conditions at all subordinated structural levels. This is the additional reason of unpredictability of allocation, orientations and sizes of vectors of later dislocations.

In these circumstances careful enough monitoring should reveal alongside with anomaly-precursor of strong earthquake, a great number of other anomalies-precursors of more or less weak events, taken place in different times. Macroanomaly-precursor of strong earthquake will be localized, hence, not within a quasy-homogeneous background. It will arise after (in time) and among (spatially) of previous (and later - of subsequent) anomalies not of only "microscopic", but of several «mezoscopic» ranks.

Hence, in an experimental model even if some large faults correspond with natural ones both on orientation and on location, their *condition* (ability to perceive stress-loading, character of their reaction to that, competition as drains of energy among themselves and with others faults not very smaller) will be cardinally and unpredictable dependent on the slightest details of the initial structure and on character of stress-loading. Accordingly, all of disturbances of the modelled regional stress-field, their connections with allocation of real earthquakes and the potential seismic focuses will be unpredictably unsteady. Real predictability of the evolution of dynamic systems strongly dependent on the slightest details of prehistory, is extremely *unstable*. Therefore earthquakes happen actucally as unforeseen.

It is expected also at studying, for example, radon exhalations from a massif, penetration of which decreases at compression, and increases at unloading. A great number of locations with uncontrastly different of amplitudes of recorded fluctuations of concentration of radon in coarsely-discrete self-similar structure of geomedium complicate unequivocal identification of the most reliable anomaly-precursors. The method of geodetic and geophysical monitoring of deformations on a site of delay of blocks displacements on a large fault assumes a preliminary choice of one of several such sites. This at small contrast of their differences in coarsely-discrete self-similar structure of geomedium, in conditions of its self-organized criticality can indicate alternately the different "candidates" mutually competing during nonmonotonic dynamic and structural preparation.

4 PHYSICAL MODELLING OF SEISMOGENIC STRUCTURE

A fundamental problem of physical modelling of dislocations,stresses and seismogenic structure in the Earth′s crust leads to serious reassessment of previously obtained scientific and practical results [3]. A structure assignated in experinents simulating the appearance and development of dislocations does not have the self-organized fractal coarse discreteness of the natural geomedium, i.e., self-similarity between units, into which it is divided. A fractal structure initially assigned would produce an extremely unstable modelling result, whose probability of similarity with one actually occuring among those theoretically possible tends to zero.

The paradigm of the "lump" structure of a geological medium [5] coupled with the conceptions of nonlinear dynamics and the fractal geometry of nature stimulates us to revise many established opinions in theoretical and experimental geodynamics.

Traditionally a fractured structure of a particular region and a real loading orientation were set in physical models. The obtained pattern of the disturbed regional stress field was correlated with seismic events in order to forecast seismicity.

A full similarity a local stress field in a model and in a portion of the Earth′s crust is impossible. since the model automatically does not reproduce many pecularities of the structure of the Earth′s crust portion and systems of faults and stress fields. The mechanical properties of separate units and values of friction coefficients at different sections of fault zone with vertical or inclined movements of basement units in the Earth′s crust, quasy-viscous friction, as well as

plastic deformation present in blocs (in addition to elastic deformations), development of faults, etc. were not taken into account.

However, as believed, if the main features of the system of fault and external stress field are chosen correctly and conform with natural values, then stable and large areas of increase and decrease of local stress values must also take place in the Earth′s crust in a particular region; the same concerns the orientation of the main stresses around large fractures.

At the same time, stably adequate results may be obtained only if the modeled process is not sensitive to conditions assigned in the model, when small inaccuracies in their assignment and/or their insignificant variations lead to a proportionally small variation in results.

I.e., modelling is reasonable only for relatively insignificant deviations of the system from a balanced state, for example, within the limits of elasticity or with small values of plastic deformation. when we may consider a nonlinear process as linear in some reasonable approximation. With large plastic or even fracturing deformations, the situation changes dramatically: in general, extremely unstable behavior, i.e., strong and unpredictable dependence upon the smallest variations of initial conditions, for example, on reorientation of a stress axis typical of nonlinear systems, will appear.

The model structure in experiments imitating the appearance and evolution of fracturing dislocations does not reflect and cannot correctly reflect due to obiective reasons one of the most important features of the structure of the natural geological environment: its well recognized natural coarsely discrete fractal structure, which has been thoroughli examined within recent years [5-21]. This includes in particular, self-similarity of unit subdivision, i.e., a geomedium which is "lumpy" in some respects at levels of various scales is constructed in a similar way. Thus, the condition of similarity to the structure of real rock bodies, which is fundamentally important in recognized problems, is not fulfilled in modeling.

In real rock bodies, according to numerous field observations and experiments, an insignificant (3,5:1), on average, ratio between the linear dimensions of units of adjacent ranks has been observed within a wide range (several orders of magnitude).

The constant appearance in experiments of a step-wise transition from a coarsely discrete medium to a quasy-uniform one has not been found at any scale (rank) level in real rock bodies, in general. Respectively, the rare macro anomalies in a stress field of low rank are not clearly outlined against a quasy-homogeneous background and they are located among numerous anomalies differing in sizes of, at least, one or two meso-scale ranks. To examine the considered pecularities the ideas and metods of a fractal set appeared to be useful. V.S. Zakharov [8] recently investigated the relationships between the fractal dimension of a fault network and the seismicity distribution over a vast territory from the Alps to Kamchatka and the Kuriles. He obtained quantitative characteristics of self-similarity between a seismic process and fault formation within a range of two-three orders of magnitude of spatial scales.

The conception of self-organized criticality [17] accents two important aspects. First, the naturality of self-similarity, i.e., it is not introduced from outside due to artificial cutting, as in experiments, but its spontaneous appearance due to pecularities of internal relationships of dissipative system of lithosphere.

Second, self-organization implies not a momentary, or single-act event but a particular process, i.e., stages of forming a self-similar structure in some macro volume of the medium at any rank from micro levels to mesoscopic and macro levels. Hence, taking the discrete and bifurcating nature of fracturing into account results, in conclusions on the nonlinear nature and extreme dependece of the process upon initial conditions and on the fundamental impossibility of the model reproducing a real secvence and pecularities of some particular acts of fault formation (location, orientation and displacemtnt amplitude) with any method of loading.

If the results of modelling linear processes, during increase in adequacy of initial structure, becomes steadier, in case of nonlinearity the picture appears opposite: choosing in model of more adequate initial structure leads to less steady result, and the chance it will be similar to some actual result among other theoretically possible results, tends to zero.

In a real experiment, it is impossible to assign a quite adecquate structure. This is technically unrealizable: the ability to divide small models into units of various ranks is limited. This is impossible, simply in principle. The structure is not placed into a real natural body from

outside. It develops there becous by natural, i.e., by multicyclic, nonlinear, and unpredictable process of deformation and destruction and with repeated reorientations of stress axes at every structural level. This proctss and structure formed at any stage also cannot be reconstructed in principle.

This shows that even if the largest model faults in general correspond to natural ones in orientation and relative location, their state will be extremely and unpredictably variable depending on the smallest details in any previous evolution. The components of such a variable state are the strikes and dips of particular segments of a fault plane and their junctions with each other and with fractures that are joined or crossing them. This is associated with the ability of large fractures to bear loads of a comparable scale, the nature of their responce to its influence the conditions of their competition as sources of energy release between each other, and with fractures of a higher rank that are moderately different in size. Accordingly, the patterns of a disturbed regional stress field, the location and configuration of its anomalies, their ratios with the distribution of earthquakes that have occured, and the location of the forecasted potential seismic sources will be unpredictably variable.

Even if an adequate coarsely discrete fractal structure were possible to assign in the model, the result of the experiment would be extremely unstable and inadequate, in this case, regardless of how accurately, relative to natural faults , we managed to reconstruct the initial configuration and orientations of large model discontinuities in the experiment.

Any statements sometimes represented about the nature of geological deformations which are not casual and not chaotic, but, on the contrary, as if are rather regular and ordered, without taking into account nonlinearity of deformation, contradict the basic consequences of the concept of discretely structured geoenvironment. The main point of this contradiction was revealed in a paper where a probable scenario for the appearance of a "turbulent" spatiotemporal structure, which nontrivially, i. e., in one volume, simultaneously, but at different scale levels that combine the features of both a regular and chaotic and unpredictable nature was presented [22]. The noted scenario in turn illustrates the widely known fundamental conclusions that the same system depending on the conditions used may show either predictable or chaotic behaviour; both these types of behaviour are realbzed, not only separately, but together as well. Disorder in a partucular range perfectly coincides with order in some other range [23, 24]. Thus, an unambigous contrast between chaos and order does not correspond to modern ideas on the complex behaviour of nonlinear systems, including self-organized critical geomedium.

5 OPPORTUNITIES AND RESTRICTIONS

Thus, achievement of demanded quality of forecasts is complicated by the following: seismicity take place in the rough-discrete fractal geomedium; destruction evolves from a microlevel to a macrolevel; the split of any volume of any rank reorganizes conditions of occurrence of the subsequent displacements unpredictably; process is extremely dependent on the slightest changes of initial conditions. So, in experiment the modelled structure of medium cannot be similar real *in all details*. But just they are playing a main role for appearance of instability and inadequacy of experimental results because of extreme dependence of behaviour of nonlinear system on the initial conditions set always to some finite accuracy.

In the forecast of earthquake two problems should be solved, but the decision of one of them in the certain sense will "resist" the decision of another. It is necessary: 1) to avoid a false alarm when the predicted strong earthquake does not happen or it is weak. The problem may be solved by discovering of anomaly-precursor with greatest "*a margin of reliability*": there is only one anomaly contrasting to homogeneous, rather safe background; 2) do not miss strong earthquakes, opportunity of which can be specified by anomalies-precursors with the parameters a little "not matured" up to the most reliable ones and therefore not shown together with them. It is necessary to display the detailed structure of the background which actually, certainly, is non-homogeneous and consists of anomalies of different sizes and intensity. I.e., it is necessary to have "*a margin of a number*" of anomalies, each of which though is not the most reliable, but, depending on difficultly knowable factors, may be precursor of strong earthquakes also.

Thus are thinkable two types of situations. In **the first** of them (Fig. 2, *b*) a great number of anomalies though unequal in the sizes and intensity, but significantly more weak on such attributes

than the most reliable anomaly-precursor can be discovered. This justifies their inclusion in a safe background. Hence the place of forthcoming strong earthquake is predicted quite definitely. In the **other** situation (Fig. 2, *c*) some anomalies, slightly conceding in the sizes and intensity to the most reliable can be discovered. Obviously: the probability of omission of dangerous event is decreasing, but definiteness of its forecast is decreasing also as anomaly-precursor now is not one, and the surrounding background is heterogeneous. In view of bifurcate character of process of preparation, of its extreme dependence on the slightest changes of conditions and conformably of spatial-temporary variability of an recorded picture, definition of a place, force and time of forthcoming earthquake is unreal.

Of two assumed situations **the second** is real. It conforms to widely accepted model of rough-discrete fractal geomedium and to representations about the deterministic-chaotic character of its self-structurization in conditions far from equilibrium. Thus predictions of a place, time and force of concrete events with a required accuracy and reliability are impossible. **The first** situation where only one anomaly-precursor is shown on a homogeneous background, i.e. quasy-homogeneous real medium, inside which only one macrofault, is unreal: preparation for this by all means includes reorganization of the initial structure, occurrence a lot of micro- and mezofaults.

Thus, the alternative is clear: the certain, but inadequate forecast of concrete event on the basis of unrealistic model of geomedium; or the realistic model of geomedium with inevitable uncertainty of the forecast.

In connection with told we will consider an example of strategically traditional, but tactically new approach to forecasting earthquakes [25]. Its author admits nonlinearity, randomness of seismic process, instability of changes of the geomedium near the maturing seismic focuses and, as consequence, low informativity of local precursors. Hopes are set on others, high-informative (reliability about 90 %) long-range precursors. They reflect reaction of geomedium on passage of low-velocity long-periodic tectonic waves out of the maturing seismic focuses of the strong earthquakes distant from seismic stations on 10 000 km and more. Origin of waves is explained by reorganizations of the stress-deformed condition of lithosphere and by viscoelastic reaction of astenospere. All this is expressed by seismo-gravitational anomalies, not tidal variations of a gravity, of changes of a hydrogeochemical regime, of a level of underground waters, etc. During movement of a longitudinal tectonic wave the increases and reductions of mass under stations cause sign-variable changes of a gravitations accelerations. Movement of a cross tectonic wave causes alternate increase and reduction of mass on the one and the other sides from stations where sign-variable changes of a gravitational field in two mutually perpendicular horizontal directions are fixed. All this explains the precursors of gravitational character, modulations of a microseismic background, change of geochemical characteristics, of a level of underground waters, electric and magnetic properties of rocks. Their connection with the concrete focuses is declared a post factum – after earthquakes in the one or the other distant area. How much hopes on this are justified?

It is logical to believe, that sources of tectonic waves as precursors though with not very smaller intensity and long-range, are the potential seismic focuses not only of strong earthquakes, but also of forshocks. They themselves have some more weak forshocks with the focuses and tectonic waves starting out of them. All this corresponds to representations about fundamental self-similarity of structure and about automodel evolution of geomedium. The other its fundamental feature - rough discreteness, hence, vague recognizability of seismogenic volumes of different ranks. Thus the amplitude of the different sizes of the focuses inside of a rank can be significant. The forms, depths, density of allocation, "maturity", speeds and terms of "maturing" should be unequal both inside of rank and between different ranks. All this should complicate inevitably and significantly the general picture of radiation and distribution of tectonic waves and a problem of recognition and interpretation of conformable signals as precursores of the strong earthquakes unloading those or others concrete focuses at that or other certain terms.

All this is true also concerning those seismoactive zones, through which tectonic waves follow "by transit" on distances in thousands of kilometers and more to the recording stations. Such interstitial, complicately structured and functioning sources of excitation of tectonic waves should even more hamper recognition and interpretation those elements of a wave picture which could be considered as precursors of earthquakes of this or that force, in this or that area, at this or that time. Besides there are inevitable interference effects in displays of the waves moving in different

directions in complicated geomedium. High sensitivity of the apparatus, providing exact registration of signals, complicates the whole of assemble, simultaneously hampering their identification as results of the certain processes in any concrete area, and interpretation as precursors of those or other events. A picture is complicated by mechanical properties of rocks, by the character of geostructure, by fluidsaturation, depths, a thermal stream, which operate in common, changing in time and in space, influencing character and intensity of occurrence and distribution of tectonic waves not summatively, but by systemic mode. The integrated result should possess not previsible qualities which are not following from properties of each factor separately. Accordingly, in a recorded wave picture hardly it is possible to hope on reliability of revealing results of action of any concrete factor.

All this lead to questions about principles and methods of interpretation of data recorded at such greater distances from places of origin of tectonic waves, about validity of statements 90% reliability forecasts of the earthquakes received on the basis of long-range precursors. On the contrary, in a view of concepts of nonlinear dynamics [1] and the self-organized criticality [17] in nonlinear far-from-equilibrium systems the opinions about unpredictability earthquakes [26-31] may be considered as been proved.

6 CONCLUSIONS

In what to see attributes of forthcoming earthquake, a problem of its reliable prediction consists in character of a recorded signal itself. It, because of self-similarity and rough-discrete structure of geomedium, at any area and at any interval of time gives not one, distinctly isolated anomaly-precursor, but always – a few extremes of different-ranks, with low-contrast of differences on adjacent ranks, and fluctuating on amplitudes and duration in ranks.

Now even the authors reporting on successes, in the majority agree, that the reliable way to the steady forecast is still not founded. But what results should be received to declare rightfully about achievement of the satisfactory decision of the problem? In fact any empirical result shows what has already *occured*, and nothing tells about what *should happen*.

Only the theoretical substantiation may give confidence in the forecast. But it needs empirical control, which, however, will be completed not earlier, than the term of the next forecast will end, i.e. when it will not be needed. Only then it becomes clear, whether assumed tactics was justified. But this conclusion will define again what has already taken place, and nothing will tell about the future. If 12 or 13 events from 15 are successfully predicted, whether there is a certainty, that the forecast of the following 15, and then of 30 events will be better or insignificantly worse? There are neither theoretical nor empirical bases to expect occurrence of such certainty.

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SECTION 2
Earth Sciences

SUBSECTION - Geology and Geophysics

ELABORATION OF THE INTERDISCIPLINARY DATABASE FOR THE CONSTRUCTION OF THE GEODYNAMIC MODELS OF DEEP STRUCTURE OF THE NATURE DISASTER REGIONS (NEFTEGORSK EARTHQUAKE, SAKHALIN ISLAND)

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The Information interdisciplinary database was used for construction of the deep structure model in the region of the Neftegorsk Earthquake which has occurred on May 28, 1995 in the North Sakhalin. The location of the earthquake epicentre was 52.6°N, 142.8° E with magnitude Ms=7.2. The hypocentre of Neftegorsk earthquake was found on a depth of 18 km. As a result of this disastrous earthquake a seismic rupture of north-northeast strike of an overall length of 35 km appeared which caused right-lateral strike-slip fault displacement with amplitude of the horizontal shift component up to 8 m and vertical upthrust component up to 2 m. The constructed model shows that North Sakhalin consists of the North Sakhalin sedimentary basin, the Deryugin basin and the ophiolite complex located between them. The Deryugin basin was formed on site of an ancient deep trench after subducting the Okhotsk sea plate under the volcanic arc along Sakhalin in the Late Cretaceous-Paleogene.

The North Sakhalin sedimentary basin was formed on a place of back-arc basin at that time. The ophiolite complex combined by the ultrabasic rocks, fixes position of ancient subduction zone acting about 100-60 million years ago. On a surface the subduction zone manifests itself as deep faults running along Sakhalin.

The center of the Neftegorsk earthquake was directly formed by burst of activity of this ancient subduction zone. From a position of the ancient subduction zone under Sakhalin, which is a cause of strong earthquakes here, it follows that the region is one of seismic dangerous in Russia.

Proposition

We propose to create the International Information Interdisciplinary Database including geology-geophysical parameters of lithosphere under thenature disaster regions of the Earth which characterized by tectonic, seismic and volcanic activity and other natural hazards. It will give the chance to construct geodynamic models of a deep structure of the regions dangerous to people living here.

This database will provide a basis for the further possibilities of a prediction and prevention of grave consequences of disastrous events. Constructed on the basis of complex interpretation of the geologic-geophysical data the geodynamic models of active continental margins give the chance: to study a deep structure of the Earth under seismic dangerous zones, volcanic areas, mineralization regions and sedimentary basins; to investigate a role of the deep processes in mantle

which have an influence on formation of crust structuress; to relate the geological features, tectonomagmatic, hydrothermal activity with the processes in the upper mantle; to plot maps in detail with zones of increasing risks to prevent active building or other economic activities in such dangerous regions.

INCREASED SEISMIC DANGER: DUE TO EARTHQUAKES OR THE HUMAN ACTIVITIES?

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The time behavior of strongest world earthquakes announced in the USGS NEIC data base is investigated for the latest 120 years (invention of modern seismographs). At a magnitude more or equal to 6.5, unpersuasive (correlation coefficient up to 0.46) very slow increasing in the earthquake's amount (around 7% in 10 years, at a linear approximation) is established after the 70^{ies} of the 20th century. In data sets of greater lower cut-off magnitude any trend of quantity could not be noticed. Concerning to the energy radiated by earthquakes, two upper extremes of energy exist at the beginning of both, the 20th and 21st century. The data set of M >=7.5, treated by a linear approximation, shows (correlation coefficient 0.67) a slight trend of radiated seismic energy to increase with time (around 2.5 times in 10 years) during the latest 3 decades. A special attention is devoted to different kinds of seismic events in Bulgaria. Some recommendations are proposed.

Keywords: strongest world earthquakes, time distribution, seismic energy released, Bulgarian natural seismicity, man-made seismicity, natural – man-made earthquakes

1. INTRODUCTION

At present, during the first decades of the 21st century, the humanity is going through more and more difficulties. There are many reasons of this: the shortening of on-surface and sub-surface wealth of the Earth (mineral-water-oil deposits) is advancing; most citizens in the developed countries are motionless due to the hi-tech "boom" there; deep changes in the ecosystem at all, political stress and economic crisis, religious defiance, and terrorism are set in. In addition, devastating natural phenomena have recently badly disturbed the Earth. Some of them – tornado, hurricanes and floods were of local character. The earthquakes and the volcano eruptions represent distinct indicators of the no stopped Earth's life and evolution. The earthquakes create the biggest regional and global damages to the planet. Not long ago, volcanoes in the Northern Europe and South-Eastern Asia disturbed the local society life. They also caused difficulties in the regional and the global air traffic.

Recovering from disasters of wide spread scale, like the earthquakes, is rather expensive. Many lives are lost. The nations suffer heavy economical and financial losses. The normal activities of people are disturbed. The troubles happen due to surface faulting, landslides, liquefaction, tectonic deformation, tsunamis, seiches, and ground shaking itself. In the latest years numerous and intensive manifestations of earthquakes, except of volcanoes, attracted the attention of the society, mainly of the scientists.

The accent of this study is on earthquakes of whatever type they would have been.

2. WORLD SPREAD EARTHQUAKES

2.1. Earthquakes typology

The earthquakes and created by them seismic danger for population and the environment represent subject of our interest and investigation.

The seismic events are mainly of natural (geological) origin. The earthquakes occur because of sudden stress changes in the earth. They presumably originate from a sudden slip along a fault or a slab in a zone of subduction, obduction (tectonic earthquakes) or in cases of magmatic activity (volcanic shocks). Karsts or cave collapses create natural quakes of limited sizes. The tectonic earthquakes are the most dangerous. The radiated seismic energy results in ground shaking that causes consequences from unnoticeable changes on the earth's surface to damages beyond repair. This type of earthquakes may trigger seismic activity for years. Prior to the time of modern instrumental records of earthquakes, the earthquakes were described by people who experienced seismic shaken, i.e. in regions well inhabited at that with cultural traditions. The enormous advantage of present possibilities of earthquakes documentation is visually demonstrated by illustrations in Fig. 1.

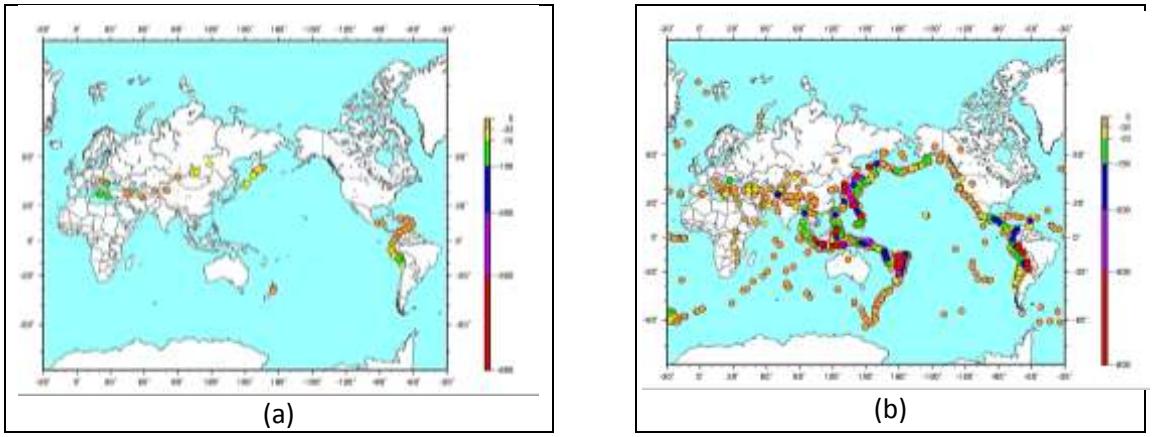

Fig. 1. Worldwide earthquakes of a magnitude M >= 6.5: (a) 1600-1880; (b) 1973-2010 [supplied by USGS NEIC]. In 280 year pre-instrumental period only 78 shocks were documented and the focal depths were slightly distinguished.

Along with the human evolution some other type of earthquakes appeared and attracts observation. These are earthquakes caused by human activities, so they are called man-made seismic manifestations. One of them is the blasting activity. It is conducted routinely in mines, quarries, road building, and other human endeavors and does not induce considerable post-earthquakes. The ground motion is produced by waves that are generated by sudden pressure at the explosive source. The explosions' energy characteristics cannot gain values corresponding to large natural earthquakes. Consequently, the explosions cause damages to limited territories and in relatively short time period.

In special cases the man-made factors in addition to the natural ones contribute intensively to the earthquake running. These earthquakes could be defined as natural-technological or natural - man-made ones. They happen to be a result of mine works, of creation and filling up with water of big dams, etc, when they occur in tectonic or volcanic active territories. The information about consequences provoked by natural-man-made earthquakes is insufficient for generalizations. However, a number of scientific investigations are devoted to one of the classic examples of "reservoir-induced seismicity" that is the 1967 Koyna earthquake in India. It is evidenced that the filling and changes in water level of the Koyna dam has contributed to the earthquake origination. All the dwellings in Koynanagar and several nearby villages were damaged by this seismic event with magnitude 6.3; the shock killed 177 people, injured over 2000, and left 50000 homeless.

The present day activities of the society over our planet are increasing very intensively. We have established that the number of the man-made as well as of the geological-man-made earthquakes is growing. In the course of time, it is not to be excluded certain increase of their negative consequences as well.

2.2. Recent world earthquakes

Many catastrophic earthquakes have occurred since the beginning of the 21st century. These were earthquakes in the Eastern Indian Ocean (the Great Indian Ocean Earthquake [EQ, here and afterwards] on 26 Dec 2004, magnitude M was 9; it triggered massive tsunamis and made millions homeless: 226 000 souls lost their lives in the hours that followed), in China (the Great Sichuan Earthquake on 12 May 2008, M 8, was a deadly earthquake – over 69 000 have been killed, around 374 000 injured, about 4.8 million people left homeless), Haiti earthquake (12 Jan 2010, M 7: over 180 000 homes were damaged or destroyed, 1.5 mln people became homeless - 86% of people in Port au Prince were living in slum conditions, 220 000 people died in result of the EQ impact plus over 4000 people were killed by cholera, over 300 000 people were injured and 216 000 were infected), this year Japanese earthquake (11 March 2011, M 9) that is the largest in Japan since modern instrumental recordings began 130 years ago - its unfavorable consequences (the Fukushima NPPs) concern the overall humanity of the world.

This sad list of catastrophic earthquakes could be expended to the seismogenic processes realized in the Central Asia (Pakistan: the Kashmir EQ on 8 October 2005, M 7.6 to 7.8: 3.5 million people homeless; 18 Jan 2011, M 7.2-7.4), South America (Chile EQ on 27 February 2010; it triggered a tsunami which devastated several coastal towns in south-central Chile and damaged the port at Talcahuano; the death toll is 562 victims), Kamtchatka earthquake series (20 April 2006, M max 7.6; 40 people injured), Indonesian EQs (the West Java earthquake on 2 Sept 2009, M 7.0, killing at least 79 people, injuring over 1 250; the southern Sumatra EQ of 30 September 2009, M 7.6; around 135 000 houses were severely damaged, 65 000 houses were moderately damaged; 1 115 dead, 1 214 severely injured and 1 688 slightly injured people), etc.

Facts and danger are real. The state must be received and get under control. An important question to be settled is the following: Is the earthquake power over the Earth increasing?

2.3. Time changes in world strong earthquakes behavior

2.3.1. Main tasks to be decided

To answer the very important question set above, two main tasks have to be treated:

(1) Is there some growth of the strong earthquakes' amount in the Earth?

(2) Is there some increase in the released seismic energy which acts on people, man-made constructions and the environment?

2.3.2. Earthquake database

We searched for changes of seismic activity using the USGS NEIC earthquake database. This earthquake database might be considered one of the most homogeneous along with the ISC and EMSC databases.

In the course of time variable reliability should be prescribed to the data. It is inferred from the facts that this is due to (i) the way of obtaining of each individual EQ record (from descriptions or instrumentally), (ii) the manner of data accumulation (density of points of observation), (iii) the approach of EQ parameterization (non-instrumental or instrumental).

Most important feature which characterizes the EQ data base's (the catalogue's) reliability is the manner of the joint catalogue compiling. To express all the EQ parameters uniformly it is important to know how each of them has been produced and to assess its reliability.

The central problem here, to what extent the USGS catalogue can be believed, is possible to be visually decided. In Fig. 2 earthquakes' amount since 1600 till now can be traced versus time.

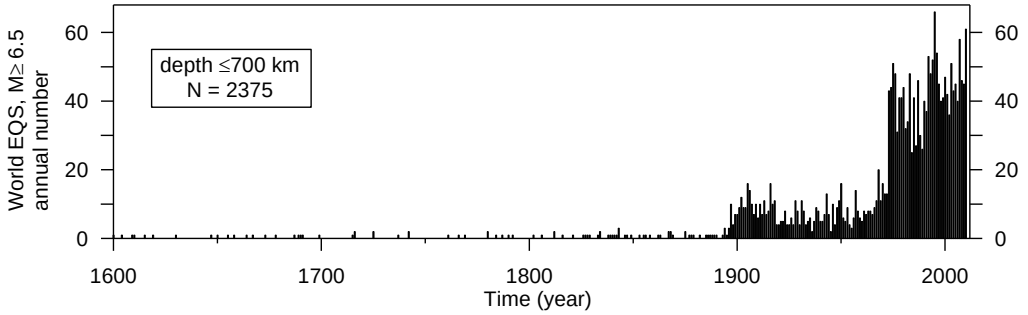

Fig. 2. Time behavior of quantity of world strong EQS, M≥6.5 since 1600.

Just about the last decade of the 19th century this plot shows acceptable pattern of annual earthquake number. Most probably, this is connected with the time when the first modern seismographs were invented, the period 1880-1900. After that time, the epoch of non-uniform parameterization of earthquakes came about to its end.

2.3.3. Time changes of the earthquake amount

In order to trace if there is any change of the earthquake amount in time, several excerpts of damaging earthquakes proceeding from the USGS catalogues and USGS searching software have been compiled. After the distribution pattern shown in Fig. 2, these samples cover the time backwards to 1891. The minimum magnitude of interest in our study is M 6.5 because such amount of radiated energy is capable to cause casualties or substantial damage on land regions.

The extracted earthquakes are divided in four groups according to the lower cut-off magnitude. The sample containing the greatest number of earthquakes N=2 291 is that one of a magnitude M 6.5 or more; the next samples are formed with a step of 0.5 M. Thus, Fig. 3 illustrates the time distribution of earthquakes under describing conditions; they occurred at any depth in the Earth down to 700 km.

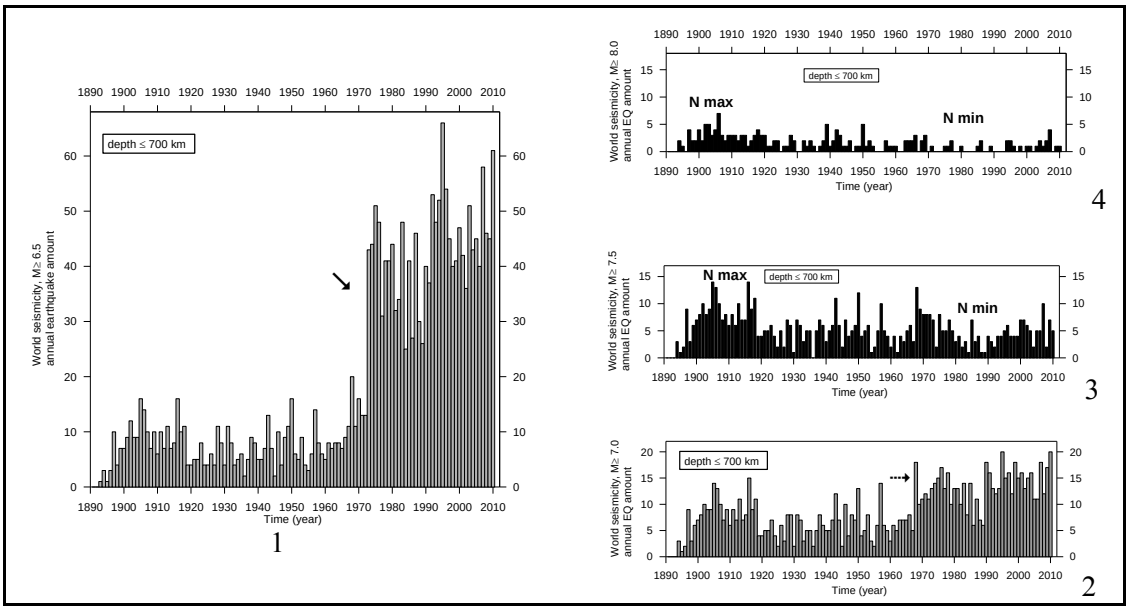

Fig. 3. Time behavior of quantity of world strong EQs, instrumentally recorded during 1891-2010.

In both cases, with a lower M value equal to 6.5 and 7.0 (plot 1 and 2 in Fig. 3), the annual amount of earthquakes shows two different patterns versus time. The two samples have analogous character; they show a crucial moment around the year 1970. Such behaviour can be explained by two reasons: (i) since 1973 the work conditions in NEIC have been changed for the M>=6.5

earthquakes, and, respectively, since about 1968 concerning the data set of M>=7.0 events; (ii) the specificity of the sample's content. This needs to be precised. The "work conditions" are going to better by drawing recording points closer to each other, so that they to cover well the seismogenic volumes of the Earth. What concerns the content of the cited samples, they consist of aftershocks presumably or represent durable seismogenic activation at a high energetic level in certain regions (clusters or sequences).

In case 1 (M>=6.5) 1973 is the crucial year; since that time the EQ amount seems to have been increased to 5-7 times. In case of plot 2 (M>=7.0) the EQ amount seemingly increases minimum twice since 1968. On the opposite, the greatest amount of most severe world EQs (M above 7.5 or 8.0) was in the first two decades of the 20th century. The minimum number of largest EQs is met about a half of a century later (plot 3 and 4 in Fig. 3); this effect started around 1970, after the crucial points of M>=6.5 and M>=7.0 sets. We consider the registration of largest world EQs completely reliable, especially in the latest decades.

In view of the fact that the routine computation of surface wave magnitude M_S in the NEIC activity began in 1968, we would have confidence in analysis based on data since that moment. In the working samples compiled in this study we are using M_S namely. After dividing the general set of earthquakes with M>=6.5 into subsets in respect of the focal depth of events, the resulting time behavior is as it is shown in Fig. 4.

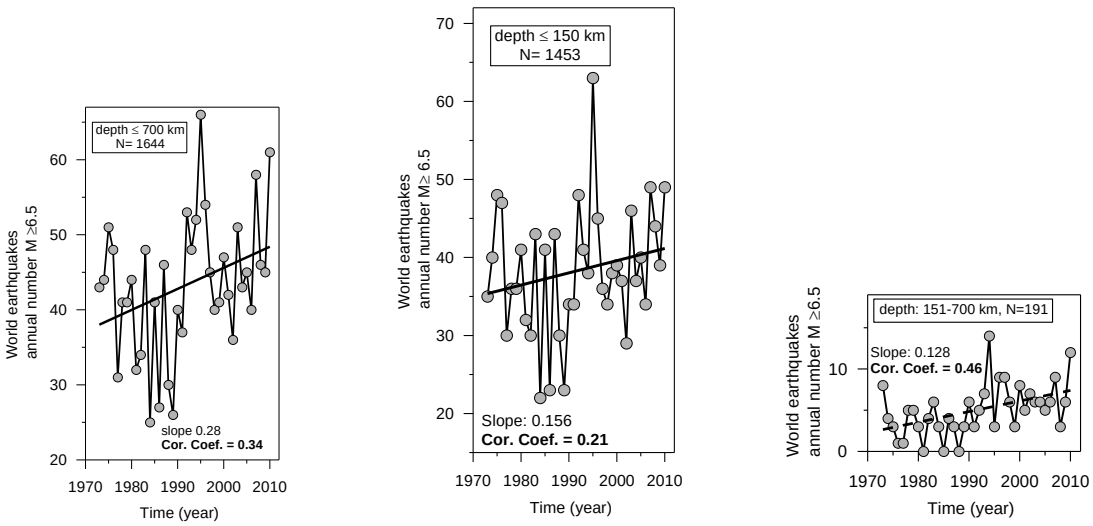

Fig. 4. Slight increase of annual world-spread EQ amount for M>=6.5 events since 1973.

Obviously, the annual EQ amount oscillates with quite great amplitude, up to 30% between neighbouring years. Since 1973 the data set of M>=6.5 shows a trend of very slow increase of EQ amount per annum. The correlation coefficients which describe time behavior of the earthquake quantity derived from a model of linear approximation are too low for catching a definitive trend of changes. More details can be found in Table 1.

Table 1.

Time behavior of world earthquakes amount in USGS NEIC data sets M>=6.5 and M>=7.0

World-spread earthquakes (EQs), M >=6.5						
Time Interval, ***t***	Focal depth ***h***, km	Number of EQs, ***N***	Time behavior of EQs amount Linear approximation ***N(t)***			Comments
			N	Slope coef.	Correl. coef., ***r***	
1891 – 2010	<= 700	2273				1973 is a crucial year – starting from that time, the average EQ amount is 5-7 times more
	<= 150	2019				Since 1973 – around 5-7 times more EQs than earlier
	151÷700	254				Slight increase since 1973
1891 – 1972	<= 700		629	0.046	0.275	Oscillations around the averaging line; Very slow increasing
	<= 150		566	0.044	0.29	
	151÷700		63	0.003	0.07	
1973 - 2010	<= 700		1644	0.28	0.338	Unpersuasive, slight trend of EQs increasing (around 7% in a 10-year period)
	<= 150		1453	0.156	0.21	Slow increasing
	151÷700		191	0.128	0.46	Slow increasing
World-spread earthquakes (EQs), M>=7.0						
1891 – 2010	<= 700	1055				Annual amount of EQs - about 2 times more after 1968; unpersuasively
	<= 150	934				This very great part of cases (90%) has imposed on the time behavior
	151÷700	121	121	0.013	0.36	Slight trend of increasing – too slow change
1891 – 1967	<= 700		486	0.03	0.02	No general trend; only oscillations around the averaging line
	<= 150		429	-0.02	0.16	Allusion to decreasing of EQs' amount in time
	151÷700		57	0.002	0.05	No trend for changes except from slight oscillations
1968 - 2010	<= 700		299	0.08	0.30	Oscillations around the averaging line; slight trend to increase of EQs (around 34% in 50 yrs)
	<= 150		235	0.008	0.03	Oscillations around the averaging line
	151÷700		64	0.07	(0.61)	Appearance of 2-3 EQs per annum since 1990, against lacking in realizations previously

Table 1 gives an idea about the results of the analytical analysis made. Some trend in changes of the earthquake number could be evidenced in the data set of M >=6.5. Any similar trend cannot be confirmed by very low values of the slope coefficients at M>=7.0. In the data sets of bigger lower magnitude threshold that contain the main shocks and have been extracted from the

USGS NEIC database, it is not possible to mention any word about increase in the world earthquake amount.

2.3.4. Energy-time behavior of world strong earthquakes

Damaging influence of the earthquakes is associated with two basic circumstances: (i) how powerful the earthquake is, and (ii) the vulnerability of the attacked objects. The earthquake's power concerning society is manifested by the radiated elastic seismic energy Es. The affectation degree is influenced by interaction between the frequency characteristics of the seismic oscillations and of each individual object.

This subsection is devoted to the first of these problems, especially whether there is a steady change of the energy radiated by earthquakes. On this purpose, the illustration in Fig. 5 has been drawn. Plots there show the time changes of radiated seismic energy, year after year, in the course of one century. Annual sums of energy, obtained through the Gutenberg-Richter's correlation between the earthquake magnitude (its surface wave value M_s) and elastic seismic energy, are presented in Fig. 5, ***a*** to ***d***, at different lower M-threshold (0.5M units between neighbouring levels).

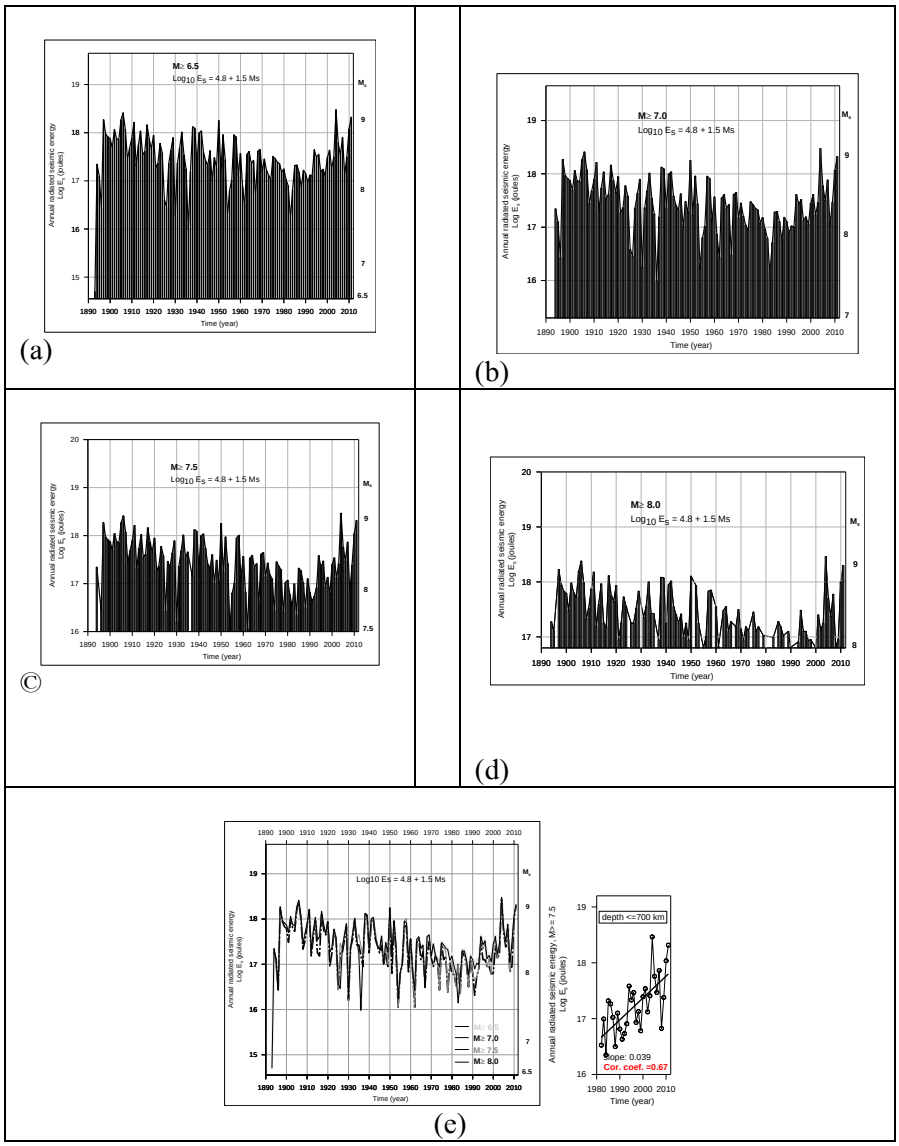

Fig. 5. Time behavior of seismic energy radiated by worldwide earthquakes, 1890-2010

It is obvious that two apparent maximums of radiated energy are caused by largest earthquakes on the Earth (M >=8.0). These two extremes of energy exist at the beginning of both, the 20th and 21st century. They are present in all the data sets independently of the lower cut-off magnitude value of the sample.

To end with the energy-time behaviour of world earthquakes, the envelopes of annual quantities of seismic energy for the four considered data sets are proposed (Fig. 5, plot *e*, on the left). Relying on the manner of compiling this plot, the lower extremes of energy are not to be taken into account. Interesting are the upper extremes. The cases of different lower cut-off M-value, that correspond to the same moment (year, in particular) show upper extreme values quite close together. This is convincing evidence that the smaller magnitude EQs have small contribution to total amount of radiated energy.

Is there any evidence of increased potential of the Earth to originate severe earthquakes? A few intervals of earthquake radiation could be visually distinguished in Fig. 5e (on the left). Two interpretations are possible:

Variant 1:

- Since the middle of the last decade of 19th century to about 1920: mean magnitude around 8.7-8.8;
- 1920 – 1960: average magnitude around 8.5;
- ca. 1963 – 2000: minimum radiated Es, average magnitude around 8 ¼;
- 2000 – 2011: M 8.7-8.8 again, i.e. second maximum of Es.

Variant 2:

- Up to 1963 – the behaviour is the same as above;
- 1963 – 1978: around 8 ¼;
- Since about 1981 (if the largest half-period would be broken) till now: increase of the Es radiation.

In order to clarify which of the variants would be more acceptable, let us go back to previos plots in Fig. 5. In the sample M >=8.0 any increase of radiated energy is not noticeable. However, in data sets of smaller lower M-threshold clear energy increase can be marked since 1982. The linear approximation applied to the events of the data set M >=7.5 shows a slight trend of radiated seismic energy to increase with time (Fig.5*e*, on the right); in a 10-year period Es increases only 2.465 times (for the sake of comparison, the magnitude increase of 1 unit corresponds to about 32 times more released seismic energy). This behaviour is evidenced by the correlation coefficient equal to 0.67.

SEISMIC PECULIARITIES IN BULGARIA

Losses at recent natural earthquakes

In the first half of 20th century several quite damaging tectonic earthquakes occurred in Bulgaria. They were kept in mind for long. Their origins were spread all over the territory of Bulgaria from the very NE territory in 1901 (M 7.2, Black Sea epicenter) to the SW state boundary in 1904 (two earthquakes with M 7.8 and 7.1), in the Upper Thracia - the 1909 local damaging earthquake (M 5.9) and the 1928 large earthquakes (M 6.8 and 7.0) which involved many subsequent shocks for almost four years.

Beyond damages of dwellings, these earthquakes brought significant disturbance to the environment. The offshore 1901 earthquake and its aftershocks caused wide-spread landslides and rockfalls along the Black Sea coast line. The 1904 earthquakes occurred in rarely populated mountainous area and were not popular with great damages in the relatively poor country buildings. However, they obstructed the great Strouma River and formed barrages. They influenced unfavorably the current of the river and provoked troubles in the local transport communications and life. Landslides, rockfalls and cracks threw into disorder the existing villages and small towns. The 1928 South Bulgarian seismic activity killed over 100 inhabitants and a great amount of livestock. The 18.04.1928 Popovitsa earthquake (M 7.0) caused considerable damages in Plovdiv

city, the second important city in Bulgaria (Fig. 6). In a great area, dwellings, hospitals, schools, infrastructure and the environment were destroyed.

Fig. 6. Destruction of representative buildings in Plovdiv City as a result of 1928 Popovitsa earthquake (M 7.0) [1]

In the same 20th century the Romanian Vrancea source hit seriously the northern part of Bulgaria in 1940, 1977, 1986 and 1990. It is well known that the strong Vrancea earthquakes are generated at depths about 100-150 km. In the Balkan region they provoke disasters of different degrees in almost all territory of the Peninsula. The damages in Bulgaria, especially in its Northern part are very serious. Financial losses are very important as well. The 1977 Vrancea (Romania) earthquake with its Mw 7.5, maximum among all cited events, caused human losses, considerable destructions and significant changes in the environment of Romania, and North Bulgaria (Fig. 7).

Fig. 7. Economic College in Svishtov (N Bulgaria) ruined by 1977 Vrancea earthquake (Mw 7.5) [2]

Man-made earthquakes

The man-made earthquakes are related to various kinds of human activities in the world. In the second half of the 20th century the scientists paid attention to important influence of the human activity over several geological processes including the earthquakes. So, the first studies appeared about influence of big barrages on the seismic activity. The mining and the drilling in the Earth crust also provoke appearance or increase in existing seismic activity [3]. There are numerous cultural monuments with interesting history and art heritage of great worth in the Sofia City surrounding. They are known under the name The Small Atos. One of them is the mediaeval Seslavtsi monastery (Fig. 8, SsM in Fig. 9).

At the end of the 16th and the beginning of the 17th century the monastery was renewed with the help of the rich Kremikovtsi monastery (KrM). Its decoration was very attractive. It included traditional themes, also new elements of the Sofia City history such as two heroes of the

national resistance against the Turkish domination. The decoration was made by the famous Bulgarian painter Pimen Zografsky. The monastery represents a fragment of the spiritual richness of Sofia and Bulgaria as a whole.

In the second half of the 20th century a short-term mining work took place in the monastery surrounding. The working territory was very close to the national cultural monument. The mining included a number of explosive works. The explosions destroyed a big part of the monastery buildings and fractured considerably the church (Fig. 8).

Fig. 8. The Seslavtsi monastery (W Bulgaria) that was damaged by a number of man-made earthquakes, and seemingly by natural quakes as well

Drilling works could provoke or increase the shallow seismic activity as well. The drilling related to the research of schist gas represents a new try for the decision of energetic problems of the world. In UK these drillings cause first manifestations of earthquakes in the investigated regions. Their magnitudes are of 1.6-2.3. The government decision has stopped very rapidly the works in the indicated direction. It is very significant decision of the appeared problems. It shows that changes in seismic security of the UK are not acceptable. The example of UK should be applied in other countries as well. In Bulgaria the scientific discussions about the beginning of the research of schist gas in the NE Bulgaria are very animated. We hope that the arising problem would be decided in most reasonable way.

Natural – man-made earthquakes

This kind of seismic events are in process of study. In Bulgaria, there is some evidence for periodical seismic activation of the region of the barrage Iskar and its elongated artificial lake. The barrage is situated to the South of Sofia, the capital of the country. The lake follows the direction of a recently active Iskar fault zone and it is a fragment of the Maritsa fault zone. The Maritsa fault zone is one of most often activated structures in Bulgaria. The tectonic situation creates possibilities of generation or intensification of the earthquakes. The barrage and its artificial lake are capable to initiate more active seismic events originating.

Some local impacts are known to have reached intensity up to VI or VII degree during 19th and 20th centuries. Their epicenters can be noticed within a square framed area in Fig 9, a. Nowadays instrumental National Network clarifies the picture of distribution of the earthquake sources in the region (Fig. 9, b). The periodically manifested seismic activity in the barrage surrounding could be product of the local tectonic instability and the changes in water level in the man-made hydrological construction (Fig. 9).

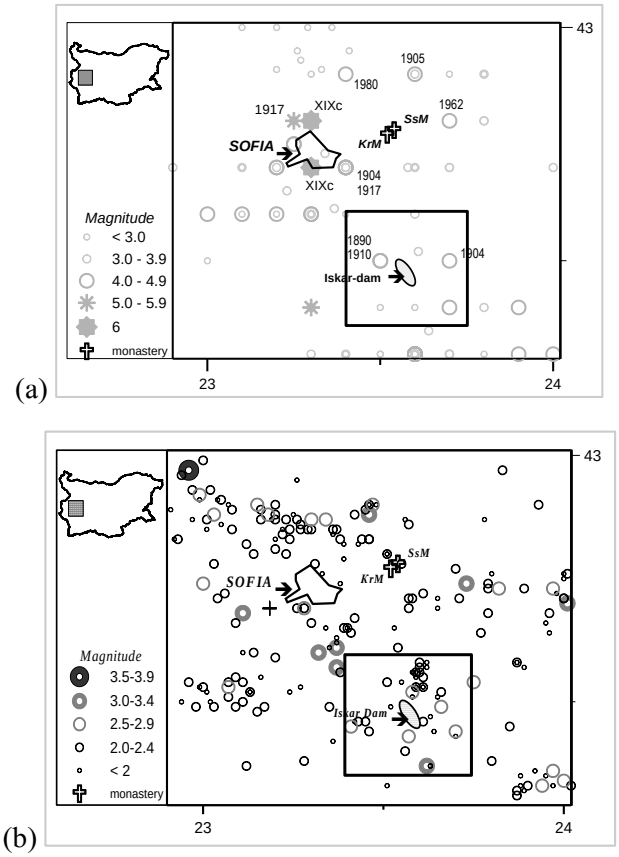

Fig. 9. Seismic activity in the surrounding of the barrage Iskar: (a) 19st & 20th c prior to 2000; (b) in first decade of 21st c. [4]

The seismic data at disposal propose interesting information about the manifestations of natural -man-made earthquakes. Till now the seismic intensity in the investigated region has been limited, but the further development depends on the tectonic capability and the regime of filling in the lake with water. The seismic manifestations in the region of the barrage Iskar have potential to create considerable danger for the well populated Sofia City and its surrounding. Another example of unfavorable influence of human intervention takes place in Provadia region (North-Eastern Bulgaria). It is a territory with a long-time salt mining. The works occurred with different intensity during its several thousand year exploration. The mining provokes manifestations of seismic activity. The town is developed on two slopes of Provadia River where there are active faults and landslides. The situation creates preconditions for tectonic movements. The local seismicity includes relatively often weak and moderate earthquakes (Fig. 10). Due to the shallow depth (down to 10 km) of the earthquake sources and predisposition to landslides, the seismic activity manifestation is related to serious problems for the population. Several destructions of buildings and considerable number of slightly fractured dwellings in the town of Provadia and its surrounding are the result of influence of the natural - man-made earthquakes on the badly built residential constructions.

Conclusions

Finally we underline that the seismic danger in Bulgaria and over our planet is increasing. This development is as a result from natural and man-made processes that cause the manifestations of natural, man-made and natural-man-made earthquakes. How does the portion of the natural earthquakes look during the latest 120 years?

- There is very slow increasing in the earthquake's amount; this process of changing is detected with great difficulty after the 20th century's 70ies.

- Some increase in the annually radiated seismic energy is noticeable since 1982 in all checked data sets with minimum M value lower than M 8; based on the USGS NEIC internet source they are compiled with a step of 0.5M down to M6.5. The most distinct effect, traced in the M>=7.5 set of data, is the 2.5-fold increasing in 10 years (correlation coefficient of 0.67 at linear approximation).

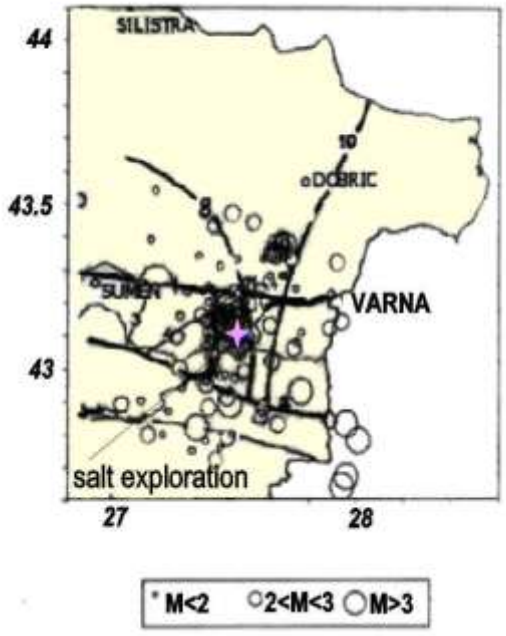

Fig. 10. Natural and natural-man- made earthquakes in the region of the town of Provadia during 1995-2004 [5]

In our days, when the rapid technological evolution in the 21st century is indisputable fact, the responsibility of the scientists and the engineers is growing non stop. Our society and our planet feel strong technological influence. Respectively, the present day situation provokes increasing in the quantity of man-made or of geological-man-made earthquakes. Such a tendency could be regulated or reduced by an active position and a good argumentation from the side of the representatives of the society. The investigation of man-made and natural-man-made earthquakes will be a task of recent 21st and the next centuries. Now it is time of responsible scientific and technological decisions with good care for the people and nature. The reasonable decisions will support the reduction of the negative seismic effects for the population and environment.

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SEISMIC INVESTIGATION OF THE EARTH'S CRUST OF A UNIQUE PROVINCE OF CENTRAL ASIA (ALTAI) WITH DEEP SEISMIC SOUNDING

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The Altai-Sayany region is a unique rare metallic-gold-complex metallic province of Central Asia. On the other hand it is characterized by rather high seismic activity.

Geodynamic situations within particular structural units do not only depend on regional and local geomechanical processes caused by the development of mineral deposits (the Altai, Baikal rift zone, etc.), construction of artificial water storages (the Novosibirsk, Krasnoyarsk, Bratsk ones), changes of water level in large intracontinental basins (Lake Baikal), etc., but also on global tectonic forces, such as the movement of Hindustan in a westward direction to the Eurasian plate, which define seismicity of Central Asia. It arouses considerable interest in studying the earth's crust structures and composition in the region. In recent years within the Altai-Sayan folded region geophysical monitoring of surroundings has been made in the context of federal and international programs aimed at studying geodynamic situation and forecasting seismic danger of the territory. Various organizations, namely, Siberian Branch of the RF Academy of Sciences, SNIIGGiMS and GEON company, have been carrying out systematic investigations of the Earth'crust of the Altai-Sayany region with deep seismic sounding.

SEISMIC DATA PROCESSING AND INTERPRETATION

As of now, more than 5 000 km regional seismic profiles have been measured on the territory of the Altai-Sayany region (Fig. 1). In terms of technique all the organizations conducted observations using similar systems: spread offset to a maximum of 300 km, receiver-to-receiver distance from 5-10 to 20 km at a shotpoint interval of 20 to 40 km. Powerful 100-tons stationary and 40-tons mobile vibrator sources (Fig. 2) measured five 300-km long DSS lines along which we obtained depth seismic sections of the earth's crust and upper mantle (Fig. 3). Using special procedure of areal interpretation of time-distance curves of direct Pg and Sg waves and Moho-refracted Pn and Sn waves caused by industrial explosions and earthquakes and recorded by the areal seismograph network (Fig. 1), we have established the distribution of P and S wave formation velocities in the upper earth's crust and P and S wave boundary velocities along the Moho discontinuity in the central Altai-Sayan region over the area of 250 000 km^2.

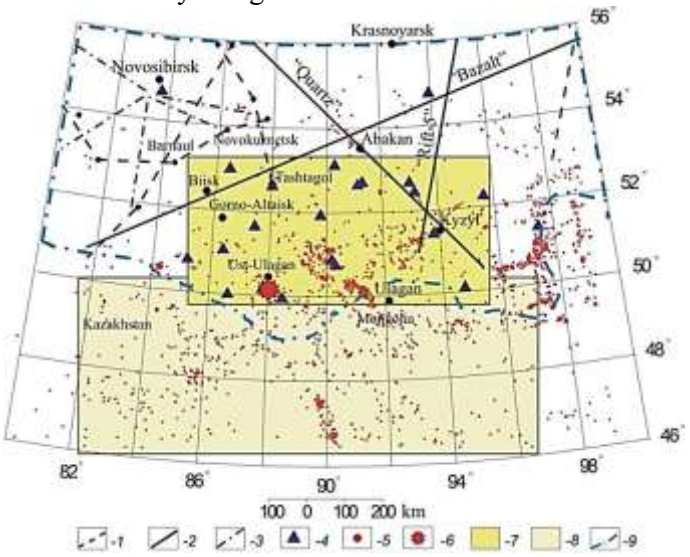

Fig. 1. The scheme of seismic research of the Altay-Sayan folded area
1 - DSS profiles, 2 - geotransects, 3 - vibroseismic profiles, 4 - seismic stations, 5 - earthquake epicenters (I> 2) for the period of 1984-1992 and 1998-2000, 6 - Chyskoe earthquake, 7 and 8 - the region of area seismological researches, 9 - boundary of the Altay-Sayan region

Seismic tomography was used to cover the inner structure of the Earth's crust. The tomographic transform of a time field followed the method of 2D seismic tomography at first-arrival time delays [1].

Fig. 2. 100-ton stationary and 40-ton mobile vibrator source

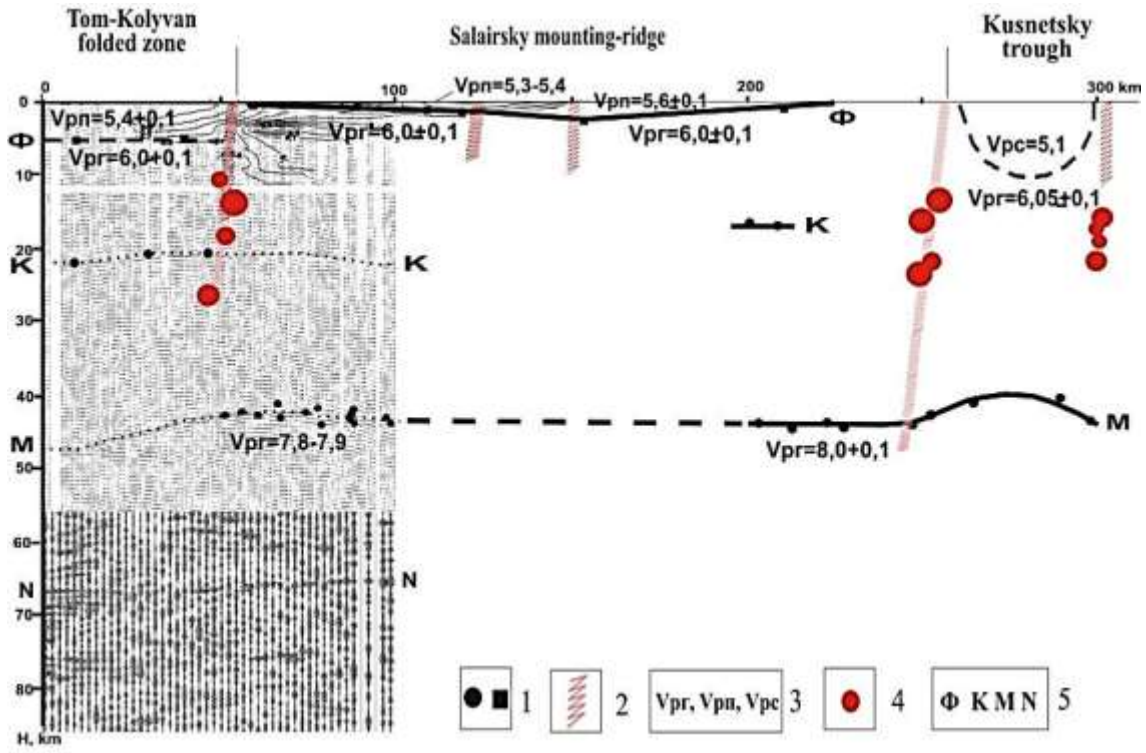

Fig. 3. Seismic section of the earth's crust in line Bystrovka – Novokyznetsk

1 - Depth obtained by reflected and refracted waves, 2 - Fracture zones obtained by geologic-goephysic data, 3 - Boundary, bedded and mean velocities of longitudinal and shear waves, correspondingly (km/sec), 4 - Epicentres of earthquakes of different energy classes, 5 - As this took place, one only used the most stable and reliably traced longitudinal waves recorded at first arrivals in the range between 0 to 300 km. The tomographic transform of a time field provided for constructing seismic-tomography sections in the form of velocity fields. Data of conventional and seismic-tomographic interpretations were used in combination with the resulting construction of geologic-geophysical sections.

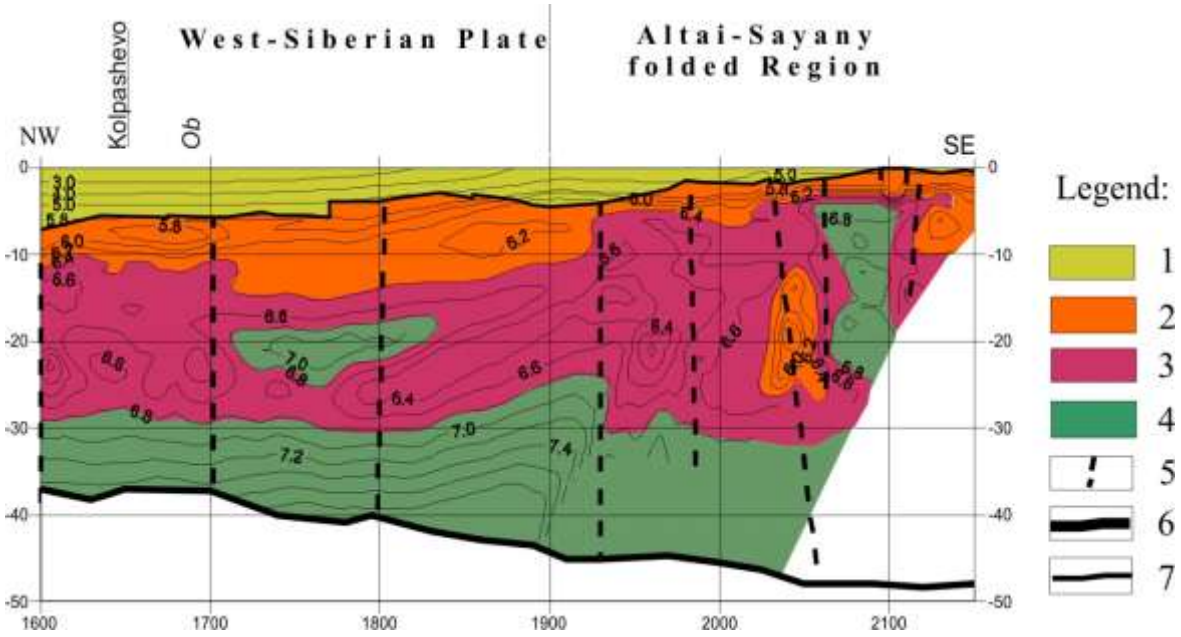

Fig. 4. Geologic-geophysical section of the Earth's crust along the "Kvarts" geotraverse
1 – volcanogenic-sedimentary complex; 2 – granite gneiss (granitomorphic) layer; 3 – granulitic layer; 4 – basic layer; 5– rupture dislocations; 6 – Moho discontinuity; 7 – Consolidated crust surface

An example of such a combined interpretation is a segment of the geologic-geophysical section over the "Kvarts" geotraverse (Fig. 4) crossing the Altai-Sayany Region in a north-westward direction. Here, at the boundary of junction of the Altai-Sayany folded region with the West-Siberian Plate there appears a sudden uplift of basic and granulitic rocks almost to the surface leaving no place to granite-gneissic formations. In the inner structure of the Earth's crust one can observe local waveguides showing lower seismic velocities and a pillar-like intrusion of high-velocity basic rocks. Many deep faults break the Earth's crust into blocks. The consolidated crust thickens from 30 km where the "Kvarts" profile crosses the Ob River to 49 km at its end portion.

RESULTS OF REGIONAL SEISMIC STUDIES

Geologic-geophysical sections were used to draw up schemes showing surface reliefs of crystalline formations, granulitic and basic layers, and Moho.

Figure 5 presents a relief map of the consolidated crust of the Altai-Sayany Region, which is highly varied. Against the background of average depths of 1 to 3 km one observes deep basins of submeridional trend with maximum values of depth contours from 5 to 10 km (Kuznetsk, Barnaul and Abakan ones). As a rule, the basins are broken apart by sizable uplifts of 0 to 2 km in depth and limited by deep faults. A dense network of deep faults as a whole is a peculiar feature of the structural surface of the territory under consideration.

Figure 6 displays a structure of the M-discontinuity. In the regional pattern the M-discontinuity subsides from north to south between 36 and 54 km. On the background of the regional subsidence three large submeridional uplifts of the M-discontinuity are apparent. In plan they coincide with the Barnaul, Kuznetsk and Abakan basins revealed over the consolidated crust surface.

Figure 7 is a scheme of the granulitic layer relief. In the center of the territory under consideration there is a vast raised zone within which depths vary from 3 to 5 km. The whole surface is broken with numerous faults.

Figure 8 shows a scheme of the basic layer surface. The relief of basites is rather generalized. In the center of the area under investigation there is a large subsided zone with 30-35 km depths to its surface. The basite surface is broken with deep faults, which more often than not, delineate rather wide linear uplifted zones of mainly submeridional trend.

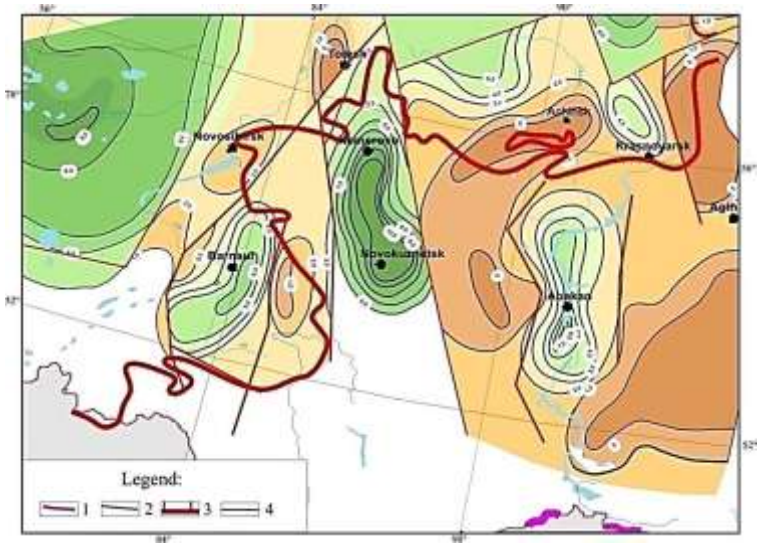

Fig. 5. Relief map of the ASR consolidated crust (on evidence derived from DSS)
1 – the border of the Russian Federation; 2 – rupture dislocations; 3 – limit of Mesozoic-Cenozoic deposits of the West-Siberian Plate; 4 – depth contours to the consolidated crust surface

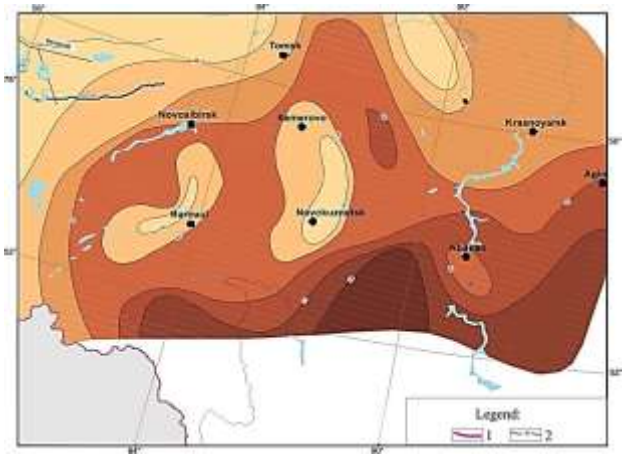

Fig. 6. Relief map of the ASR M-discontinuity (on evidence derived from DSS):
1 – the border of the Russian Federation; 2 – depth contours

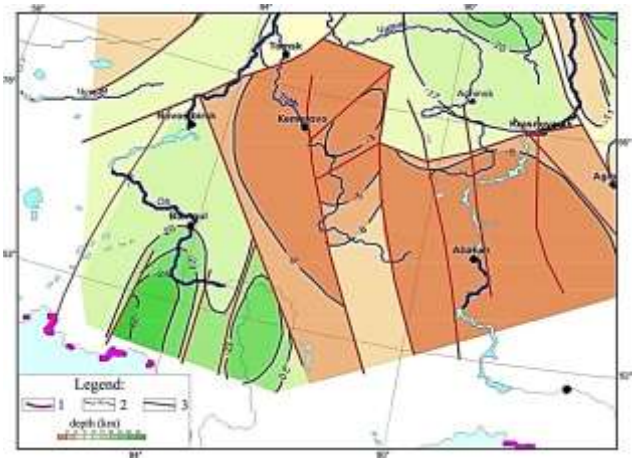

Fig. 7. Scheme of the ASR granulitic layer relief (on evidence derived from DSS)
1 – the border of the Russian Federation; 2 – depth contours to the conventional surface of the granulitic layer of 6.4 km/s; 3 – rupture dislocations

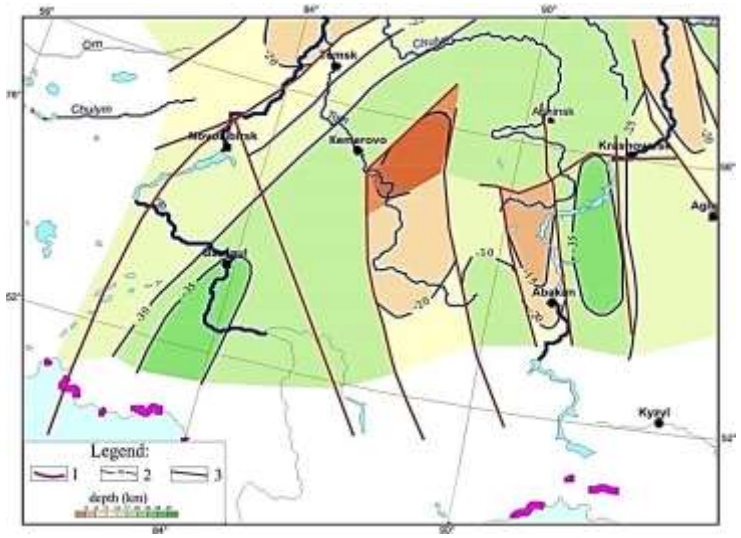

Fig. 8. Scheme of the ASR basic layer relief (on evidence derived from DSS)
1 – the border of the Russian Federation; 2 – depth contours to the conventional surface of the granulitic layer of 6.8 km/s; 3 – rupture dislocations

In the upper mantle of the region areas of lower (to 7.6–7.7 km/sec) and higher (to 8.3–8.4 km/sec) boundary velocities of P waves are apparent. Depths of the Moho discontinuity varying in this region from 40.0 to 55.0–60.0 km are determined (Fig. 9).

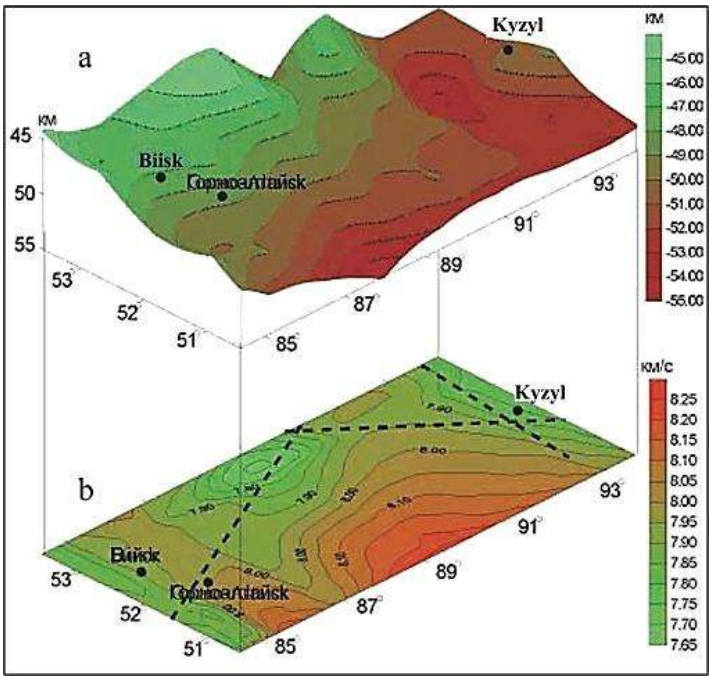

Fig. 9. Depths distribution (a) and velocities distribution (b) on Moho in the Altay-Sayan folded area

Practically isotropic areas with maximum anisotropy factors of 1–3% and zones of evident elastic anisotropy to 10–12% are identified in the upper mantle of the Altai-Sayan region in interpreting an anisotropic medium model (Fig. 10). We have also established changes in the preferred orientation of the highest values of boundary velocity ellipses in some areas of the upper mantle.

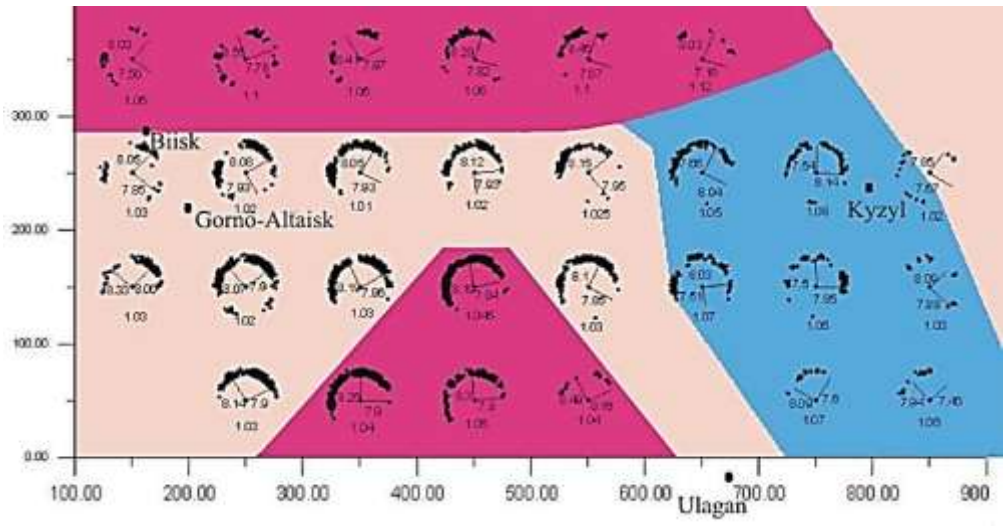

Fig. 10. Interpreted results of Moho refracted waves within the limits of the anisotropic model of medium

In the upper earth's crust areas of higher P (5.85–5.95 km/sec to 6.15–6.25 km/sec) and S (3.40–3.45 to 3.57–3.59 km/sec) velocities are identified (Fig. 11).

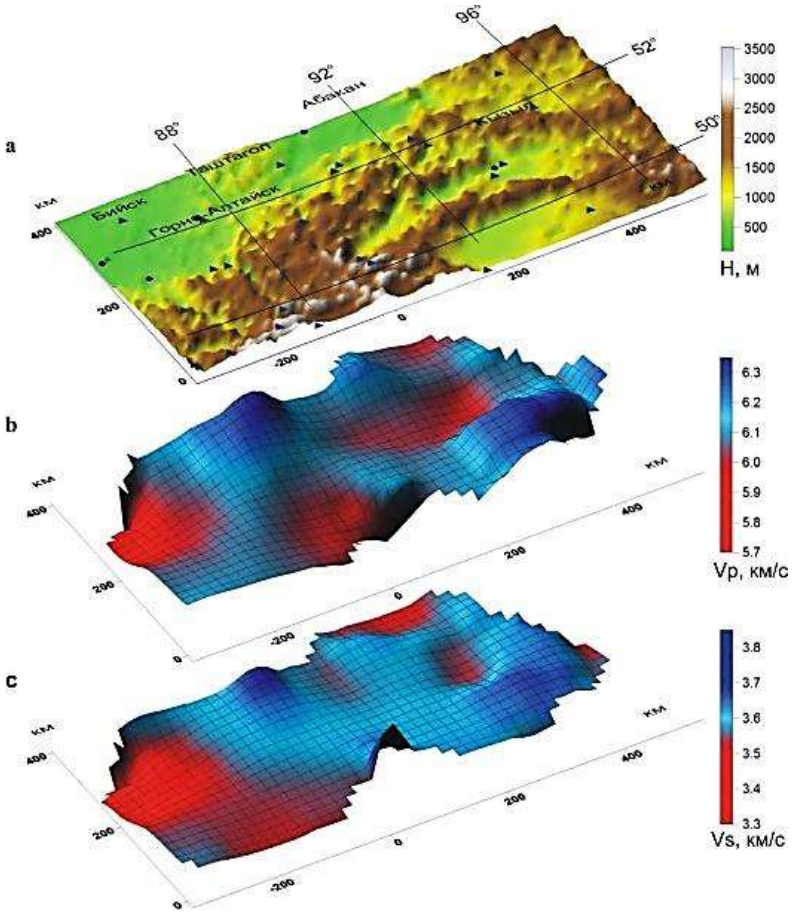

Fig. 11. The distribution of P and S wave formation velocities in the upper earth's crust (0-10 km)

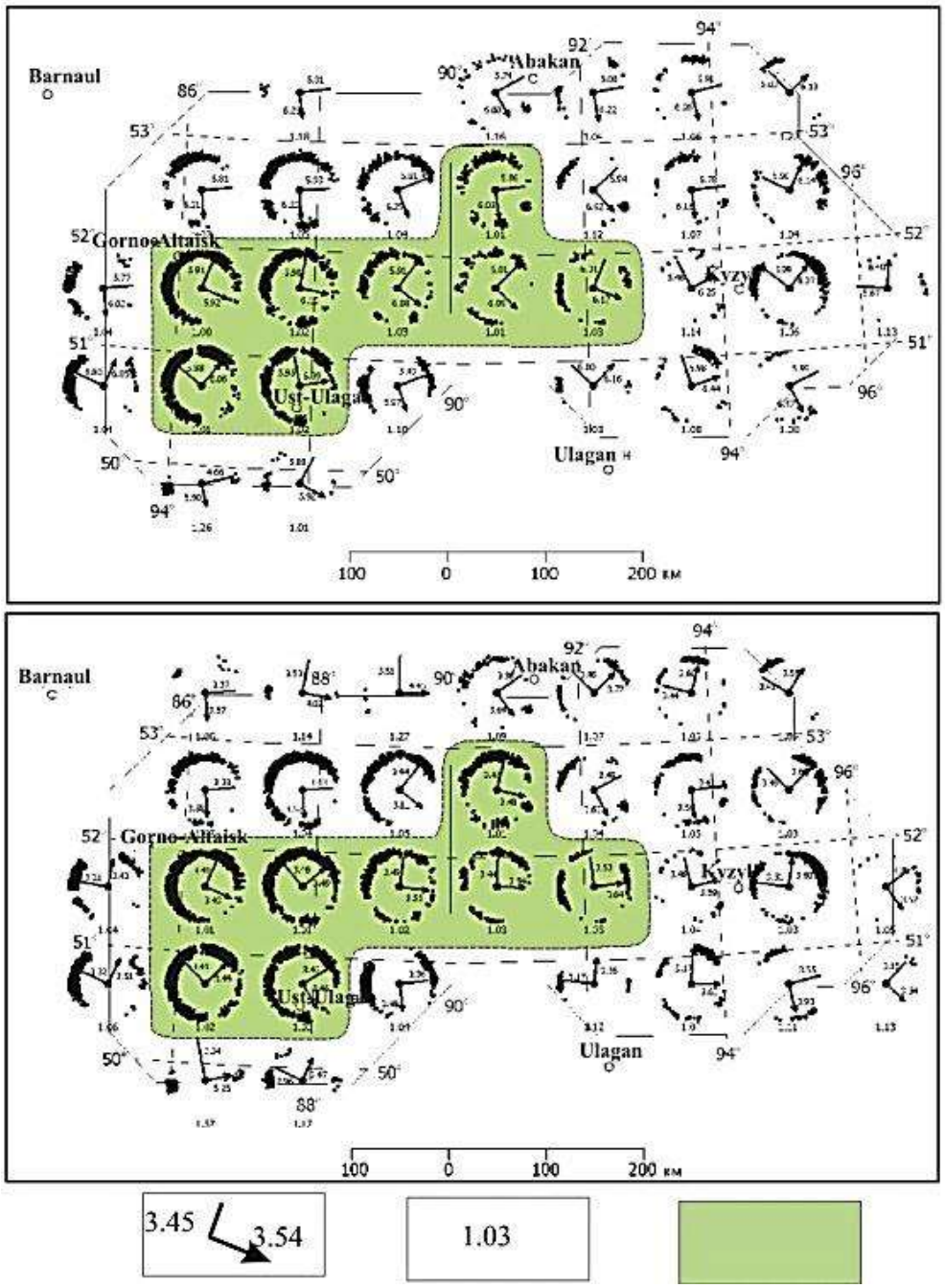

Fig. 12. Interpreted data of Pg (a) and Sg (b) waves for the anisotropic model of the upper earth's crust

In interpreting Pg and Sg waves within the limits of the anisotropic model, we have established anisotropy factors varying from 1 to (7-9) %. This may be testimony to the fact that in the earth's crust there are very strong stresses or systems of oriented jointing responsible for the effect of anisotropy of rather thick rock strata (Fig. 12). It is also found that the isotropic area detected in the southwestern part of the region under investigation and showing minimum anisotropy factors of (1–3) % correlates with the zone of maximum seismic activity in the Altai-Sayan region. According to the OCP-97A seismic zoning plan magnitude 9 earthquakes are possible there.

Analysis of structural imaging and its relation to minerals and earthquake focuses

The central part of the Altai-Sayan folded region is the most extensively studied area. Interpreted seismic data enable a solid model of the earth's crust and upper mantle of the region to be developed, and extensive blocks differing widely in elastic parameters to be identified, which may testify that the earth's crust has a considerably inhomogeneous composition. Figure 13 illustrates Vp/(γ-1) distribution, where γ is the P and S wave velocity ratio, whish is related to P and S wave velocities in the upper earth's crust at depths of 0 to 20 km.

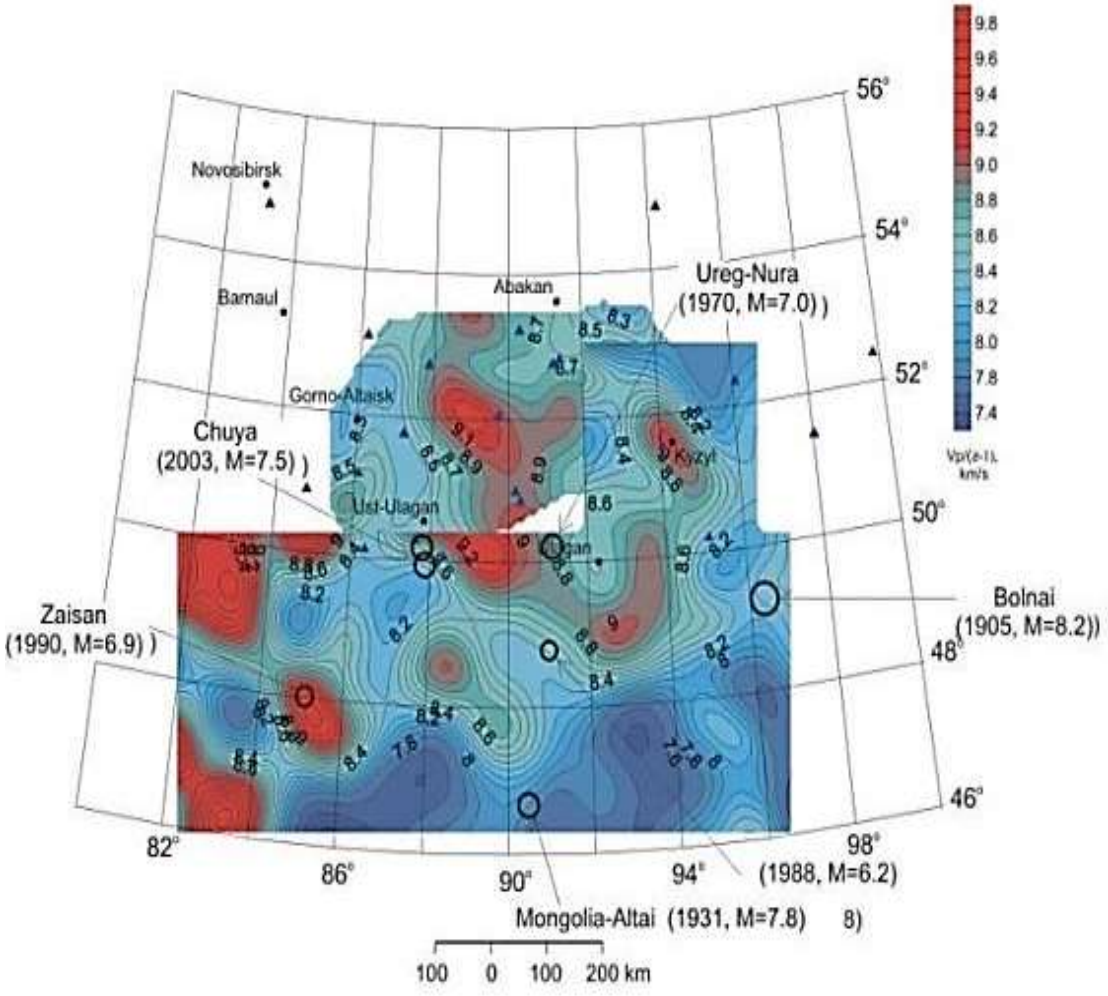

Fig. 13. The distribution of parameter Vp/(γ -1) in the upper earth's crust

Heterogeneities of mechanical-and-physical properties of the medium largely dictate where most of the known major earthquakes are confined to. The analyzed results lend essential support to this fact as the strongest earthquakes of the Altai-Sayan folded region are confined to block boundaries with different values of the parameter under consideration

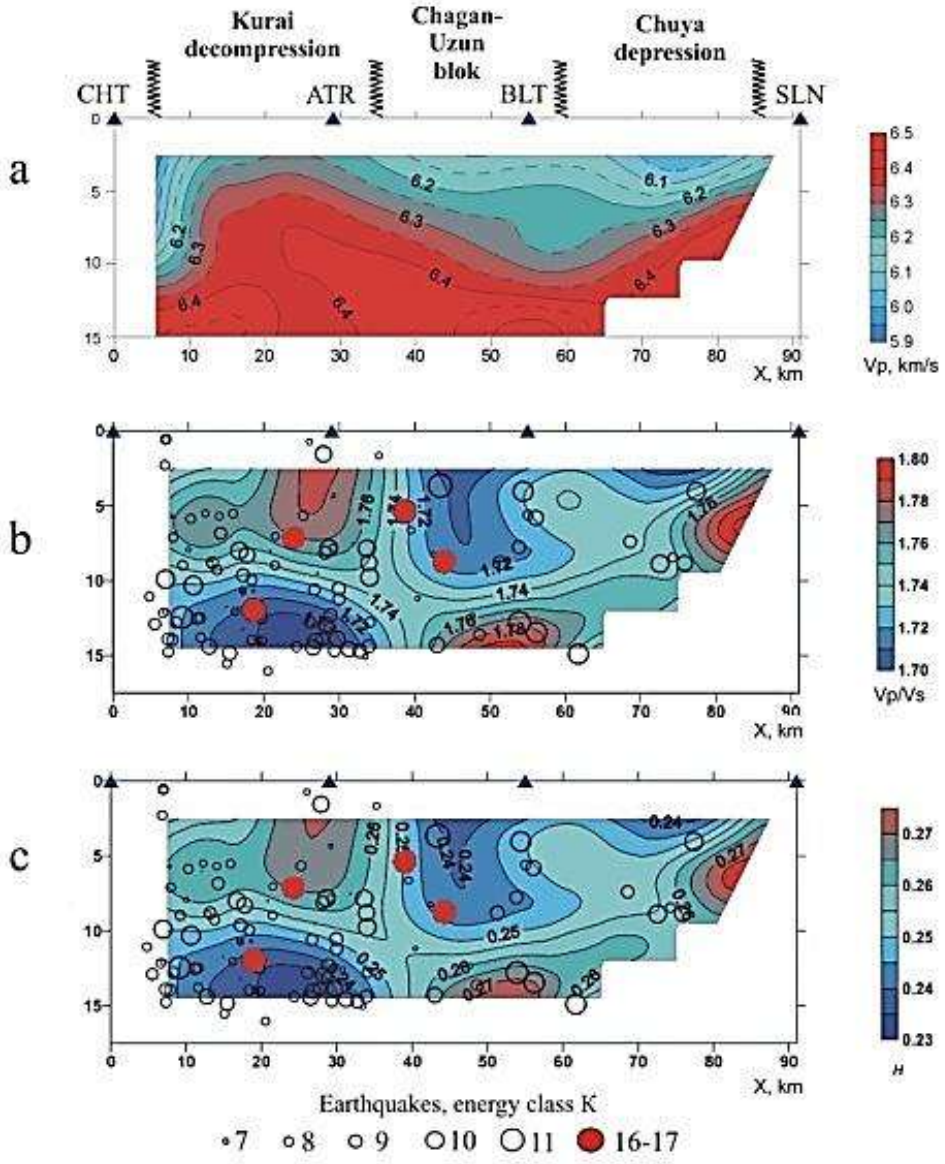

Fig. 14. Velocity of P wave (a), parameter Vp/Vs (b) and Poisson's ratio (c) of waves distributed along the line crossing the Chuya earthquake epicenter

As indicated by Figure 14, the 90-km long aftershock zone of the 2003 Chuya earthquake [2]correlates with the transition zone of high (to 9.2) to low (8.0–8.2) values of the above parameter. It should be particularly emphasized that the aftershock zone itself (a long axis of aftershock ellipse) is at a tangent to the boundaries of inhomogeneous blocks. The major Ureg-Nura earthquake in the southern Altai is the similar case. It seems likely that media occurring between homogeneous (in elastic properties) blocks are less firm (more dislocated by regional and local faults), which promotes the aftershock process accompanied by liberation of the energy accumulated in the Earth's crust.

In making a comparison between seismic structural imaging and distribution of hard minerals, mainly coal and complex deposits, the following features are noticeable. Coal deposits in pattern are coordinated with a deep fault revealed over the granulite surface (Fig. 15). This feature is testimony to the influence of hypogene energy factors on the formation and development of the Earth's crust structure and coal deposits. Judging from the pattern of iron ore and complex deposits and peculiarities of the Earth's crust inner structure (Fig. 15), they are also inclined to deep faults.

CONCLUSIONS

As of now, more than 5 000 km regional seismic profiles have been measured with DSS method on the territory of the Altai-Sayany Region. Conventional and seismic-tomography processing and interpretation of gathered data have resulted in geologic-geophysical sections of the Earth's crust and structure schemes over the surfaces of consolidated crust, granulitic and basic rocks as well as Moho discontinuity.

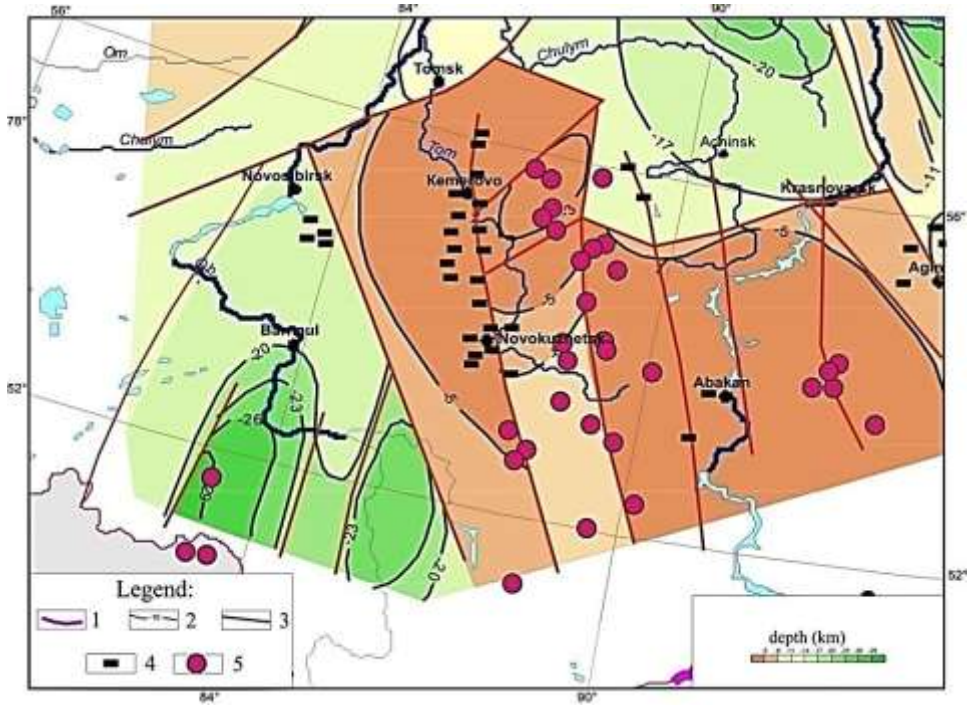

Fig. 15. Distribution of useful minerals over the ASR granulitic layer surface
1 – the border of the Russian Federation; 2 – depth contours to the conventional surface of the granulitic layer of 6.4 km/s; 3 – rupture dislocations; 4 – coal deposits; 5 – complex deposits

The Altai-Sayany folded region is clearly recognized in seismic-tomography sections and schemes by the pattern of the earth's crust thickening and extreme behavior of deposits of basic and granulitic compositions. The Earth's crust of the Altai-Sayany Region is intensively broken by deep faults into blocks. Heterogeneities of mechanical-and-physical properties of the medium largely dictate where most of the known major earthquakes are confined to. The analyzed results lend essential support to this fact as the strongest earthquakes of the Altai-Sayan folded region are confined to block boundaries with different values of the parameter under consideration. It seems likely that media occurring between homogeneous (in elastic properties) blocks are less firm (more dislocated by regional and local faults), which promotes the aftershock process accompanied by liberation of the energy accumulated in the Earth's crust. Complex and coal deposits are mainly linked with deep faults in the Earth's crust which may have played the role of channels for deep flows of energy and fluids forming hard mineral deposits.

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RUSSIAN NATIONAL SYSTEM OF MONITORING GEOPHYSICAL PROCESSES AND REAL TIME VARIATIONS THEREOF

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1. Description of the Project

NPP GT «Geofizika» LLC (Pyatigorsk) has designed high-output geophone-hydrophone sensors GH-3 protected by patents [1, 2] able to determine parameters of gravity and wave fields in boreholes, underground openings, seas, on surface, flying or moving objects. The sensors may be used for hydrodynamic testing of wells, gravity and seismic survey, in meteorology, seismology, navigation, medicine, for earth-quake prediction. They are capable of sensing slightest variations of hydrodynamic pressure field in wide range of frequencies from 0 to 4500 Hz with sensitivity higher than that of modern gravimeters, seismic detectors, seismographs.

Substantial Earth deformation resulting from gravity waves acting upon earth surface and water medium, appearance of low-frequency noise (less than 0.001 Hz) in rocks are signs of forthcoming earthquake. There are correlations between variations of gravity, geohydrodynamic pressure and Earth magnetic fields which are to be used for prediction of oncoming earthquakes and location thereof. At the Russian National Exhibition in Azerbaijan (2006) NPP GT «Geofizika» LLC reported on the expediency of creating "Russian National System of advance warning people about oncoming earth-quake" (RNS AWP) based on the Geophone-hydrophone sensor GH-3 and Real Time Space-Time System (RT STS). The whole system was called "Russian National System of Monitoring Geophysical Processes and Real Time Variations thereof" (RNS MGP).

During the Exhibition joint operation agreements were concluded with International Seismic Risk and Earthquake Resistant Construction Commission of International Academy of Sciences, the International EUTRASIA PACIFIC UNINET Organization (Austria) and Research Institute for Earthquake Prediction and Study of the International Academy of Sciences (Azerbaijan). For financing the problem it was proposed to involve not only state but also international funds.

based on the Geophone-Hydrophone GH-3 sensor".

Federal State Unitary Enterprise Moscow Energetic Institute Special Design Office (FGUP OKB MEI) of Roscosmos and NPP GT "Geofizika" LLC (Pyatigorsk) have developed the RNS MGP pilot project including RNS OWP and RT STS as addition to the GLONASS system.

RT STS pilot project is to be carried out by FGUP OKB MEI of Roscosmos (Moscow). Later on scientists and specialized organizations from foreign countries (Azerbaijan, Ukraine, Austria, Turkey, etc.) located in the zone of Alpic-Himalayan seismic belt will be involved into the work. To this end, "Geofizika" Research Centre ("Geofizika" RC) shall be established on the territory of Caucasian Mineral Waters (CMW). "Geofizika" RC tasks are: formation of RNS MGP regional sub-system, carrying out international researches and experimental development to supply the above countries with high-accuracy space-time measurements, development of the newest technologies for oil-and-gas industry, geophysics, seismology, earthquake prediction, navigation and medicine. Special attention is paid to realization of the RNS AWP project – the most actual problem for Nothern Caucasus and adjoining countries, especially for Turkey, Iran, Azerbaijan, Armenia, Georgia.

In 2006 NPP GT «Geofizika» LLC took part in talks on creating Regional RT STS on Turkey territory via Turkish company "TUSKON". The talks were conducted with the mayor of Kğzğkzekmece, the largest Istanbul district most suffered from earthquake in 1999.

Regional observation posts shall be created in Azerbaijan (Binagady), in Russia (CMW, Kracnodar territory), Ukraine (Crimea), Turkey (Istanbul).

The posts are to be interconnected in the RT STS Global telescope (fig. 1) system which is to be used for simultaneous any (including geological and logging) data acquisition and transmission for centralized real time processing.

Within the pilot project Research Centre "Geofizika" shall be designed and built in the health-resort zone of Pyatigorsk; regional RT STS shall be built with radio telescope at the top the Mashuk Mountain (fig. 2) and subsurface seismologic stations round it and the "House for Scientists and Specialists of Foreign Countries" shall be constructed. The "House" is expected to provide capabilities of training, conducting conferences, spa cure, rest and residence for scientists and specialists according to European standards.

Within the RNS MGP project NPP GT "Geofizika" LLC has already been accomplishing the following tasks for monitoring development of oil and gas deposits.

1. Determination of formation oil and gas saturation factor $K_{нг}$ (S), accurate location of water-oil contact (WOC) or of gas-oil contact (GOC) in producing and observation wells of oil and gas fields using Electric Logging through Steel Casing EKOS-31-7(7M) technology.

2. Basing on GH-3 Geophone-Hydrophone sensor:

a) Control of running wells production (differential production rate, behind-the-casing cross-flow) under Influx Profile Locator technology (IPL-31);

b) Control of hydrocarbon accumulation pattern efficiency, tracing of formation hydraulic breakdown and injection frontal advance in horizontal plane.

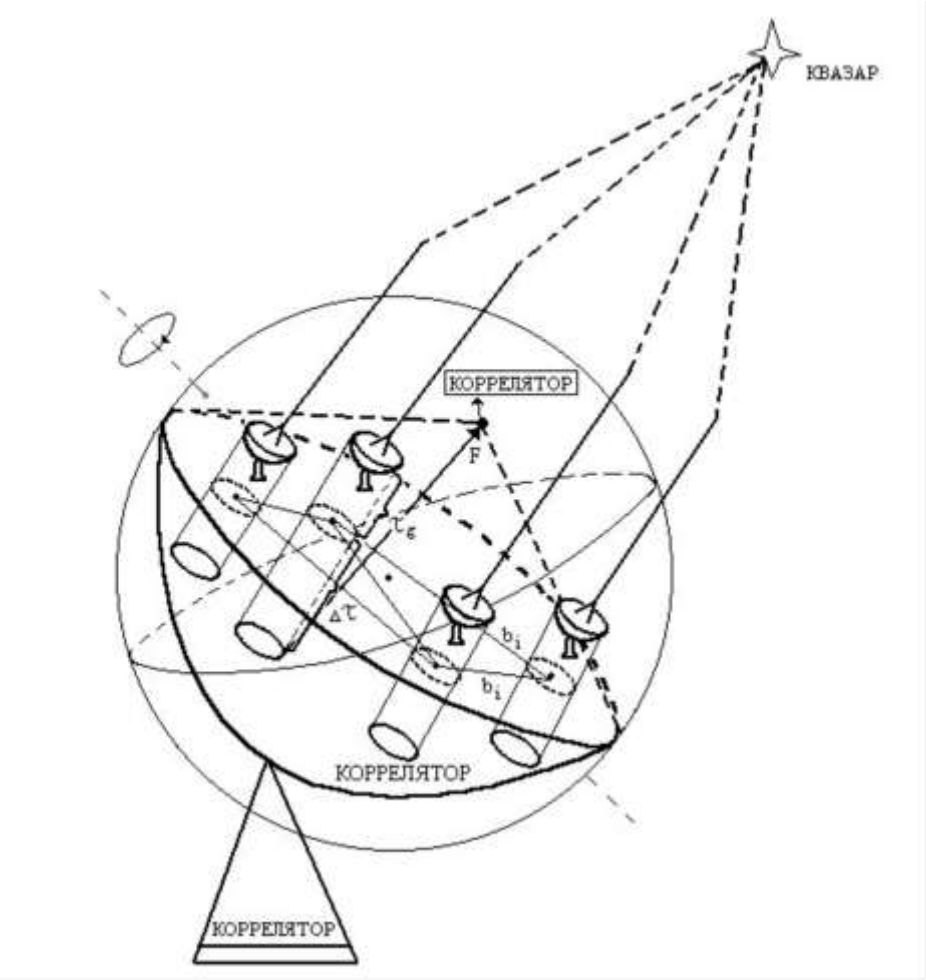

Fig. 1. Global Telescope

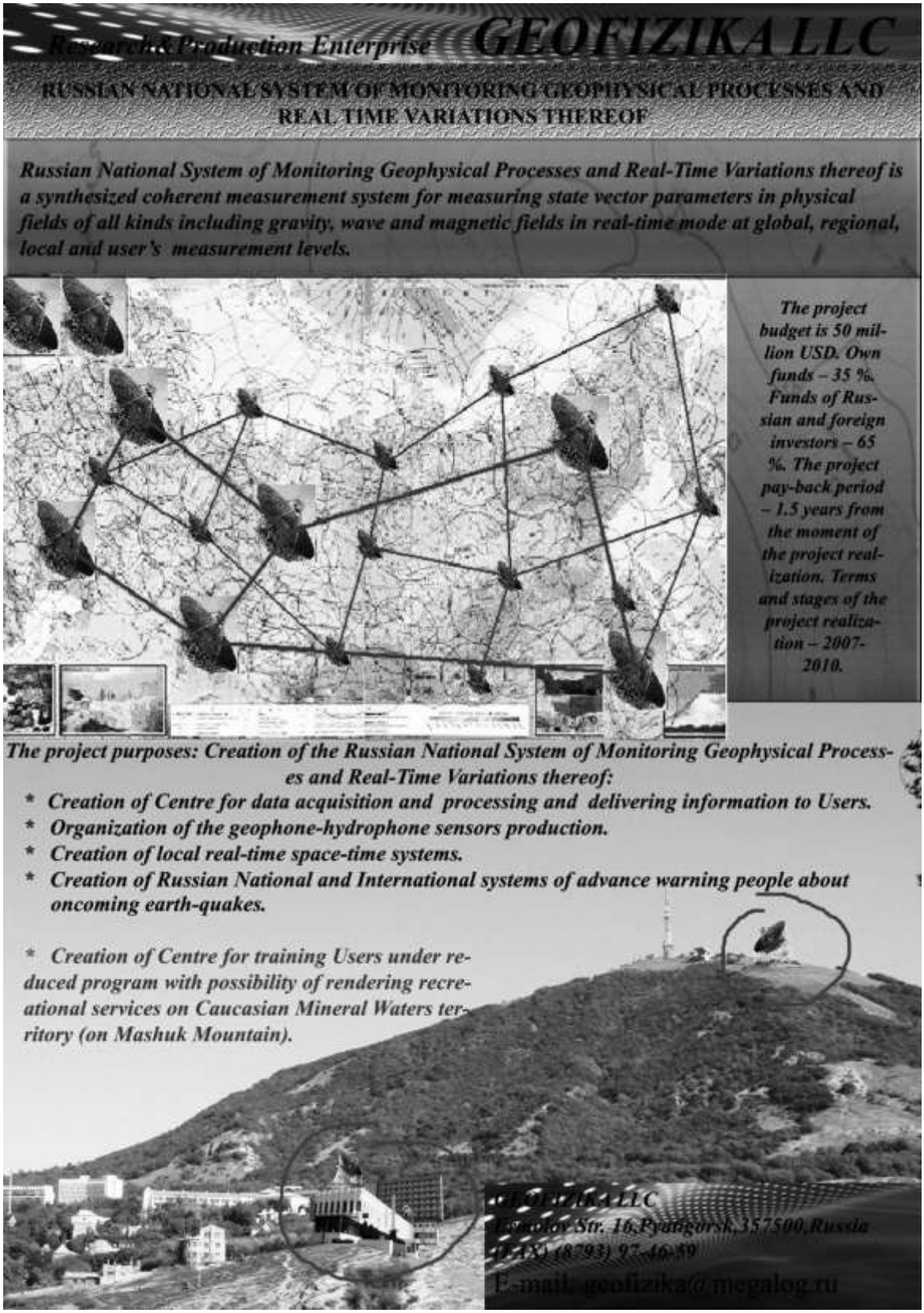

Fig. 2. Design Location of Global Telescope Antennas on Russia Territory at th top) and on Mashuk Mountain with Additional Cosmic Communication Radio Telescope on "Geofizika" RC Building

2. RUSSIAN FEDERATION REAL-TIME SPACE-TIME SYSTEM

Real-Time Space-Time System is a synthesized coherent measurement system for measuring state vector parameters in physical fields of all kinds including gravity, wave and magnetic fields in real-time mode at global, local and user measurement levels.

Space-Time Radio Metering System

- Global synthesized coherent space-time radio metering system is a global radio telescope (see fig. 1) with unfilled aperture equivalent to synthesized phased array antenna and a central synchronizer of RT STS.

Geophysical Subsystem

- It serves to determine parameters of gravity and wave fields on the Earth surface, in aero space, sea, boreholes, when set on stationary, flying or movable objects.
- At every functional level of RT STS the elements of the radio system and of the geophysical subsystem are interconnected at mechanical and electric interfaces level.
- Radio system is a geometric frame and a synchronized time and space atomic scale for geophysical subsystem.
- Collocation is realized at measurement data level in unified space-time basis.
-

RT STS Functionality

1. Creation, maintenance and distribution:
   - of the reference global network for real-time measuring parameters of physical and wave fields and determining sources thereof including gravity, magnetic and electric fields;
   - of the reference ground-space high-accuracy time-and-frequency synchronization network based on associated universal-time scales (UT1), coordinated atomic-time scale (UTC) and global atomic-time scale RT STS of highest-accuracy.
2. Calibration and metrological control to provide uniformity of global, regional and local space-time and physical measurements.

SPACE-TIME REFERENCE SYSTEM

1. Reference STS as the base of global radio telescope with unfilled aperture (Stratum 0) comprising: full-circle radio telescopes 12 – 70 meters in diameter equipped with atomic time-and-F1-75 frequency scale keepers connected via data transmission optical channels with a central synchronizer.
2. STS application subsystem (Stratum 1) with full-circle radio telescopes 6 – 12 m in diameter; atomic time- and-F1-75 frequency scale keepers connected via optical channels of data transmission with a central synchronizer and with a Centre for control, acquisition, processing and analysis of space-time measurements in real time.
   The reference and application STS subsystems are plug-compatible and can be functionally combined.
3. The STS subsystem of the second accuracy level (Stratum 2) consisting of minimum 96 mobile 3-m full-circle antennas with F1-76 class frequency hydrogen standards, synchronizers for stand-alone processing of the measurements and connected via optical and other channels with STS stations of the highest accuracy subsystems (Stratum 0) or with Centre for control, acquisition, processing and analysis of space-time measurements in control-calibration mode.
4. The second accuracy level STS subsystem (Stratum 2) with small diameter (3 m) mobile radio telescopes equipped with satellite communication and functionally connected to STS stations of Stratum 0 and Stratum 1 subsystems in compound-interferometer mode.

Subsystem for geophysical measurements built into all instruments of all RT STS subsystems (gravimeters, accelerometers and magnetometers).

Reference Real-Time Space-Time System

In OKB MEI antennas were developed designed to be used in Pyatigorsk and South-West regions of Russia.

Fig. 3. Full-circle antenna THA-57, 12 meters in diameter. It will be placed on Mashuk mountain

Geophysical Subsystem Contribution and Fields of Application:

- Geophysical investigations
- Seismic prospecting (ground, sea)
- Gravity prospecting (ground, sea, aerial)
- Seismology (registration of earthquakes, landslides, avalanches)
- Meteorology
- Navigation motor, aeronautical and missile equipment
- Devices for determination of flying vehicle orientation in the Earth gravity field, devices for guidance to moving surface, subsurface, underwater and flying objects, in guided underwater and ground mines and shells, devices for recognition by oscillation spectrum of moving objects (a man, a dog, a motor car, a tank, a submarine, etc.) when protecting military and civil units (buildings, airports, frontiers), oil-and-gas pipe lines, atomic electro stations.
- Civil defense, ESM: earthquake alerting devices (including those of individual type), intrusion protection devices, thermal location of fires, etc.
- Medicine. For early detection of slowly progressing diseases (cancer, diabetes, etc.)

RT STS Geophysical Subsystem Configuration

RT STS geophysical subsystem is formed of the Geophone-hydrophone sensors and "Ferrosonde" sensor (of 0.1 nT sensitivity) whose design and technical characteristics are to be appreciated as a break through in the field of borehole and ground seismic prospecting, gravimetry, monitoring of oil, gas and other minerals field development, dynamics control of the Earth geophysical fields.

3. Main Directions of Global Positioning Means Employment in Civil Sphere:

- Higher geodesy and geodynamics: determination of the Earth shape and sizes, surface deformation thereof, tectonic movement of continental platforms, earthquake prediction and so on;
- Mapping, geodetic and air photography, cadastral survey, design of engineering structures; geoinformation systems (GIS) comprising electronic versions of various locality information;
- Monitoring of engineering structure and other natural objects deformation to prevent man-caused catastrophes;
- High-accuracy time standard verification of all world laboratories; synchronization of communication and energetic systems providing reliable functioning thereof and minimizing energy loss;
- Air navigation: en-route flight (route tracking and imaging, determination of distances to a destination station and estimation of arrival time to a destination airport); approach landing (here first of all validity of navigation information and failure detection are demanded by means of the system integrity control);
- Navigation of sea and river crafts, prevention of accident sailing in narrow water zones; monitoring of fishing fleets, quoting and control of sea fishery; evaluation of bottom contour and water way clearing; following port functioning capacity, cargo passage costal control service;
- Navigation in surface conditions and dispatching services of motor tracking; optimal routing, locating of a truck, control of cargo integrity and due-time arrival, etc.
- On railway transport – to improve safety, dispatching service effectiveness, optimization of train driving.
- Hydrographic applications: building marine structures, pipelining, construction of offshore oil production platforms, seismologic survey of sea bottom;
- Popular applications of residential use RT STS.

4. Practical Proposals and Variants of Gaining Profit

1. Standardization of apparatus, devices and means to provide navigation on land, sea and space; to insure radio communication; to provide space movement control of all material and nonmaterial resources, as well as movement control of animate forces and technical equipment on monitored territory with accuracy of about 1 cm on land and 50 cm in water.
   Approximate need in the aforesaid means and equipment will be about 50 million items for two years and then about 5 million items per year in Russia only.
2. Licensing of plants manufacturing means of radio communication, navigation, telecommunication, synchronization, communication and diffusion of high-accuracy time and frequency scales on Russia territory using new standard.
3. Protection of information in synchronous data transmission nets based on use of high-accuracy time marker, delay of diffusion control instead of electronic signature and cryptographic protection system.

Radio region is strictly divided into sub-regions for different applications according to decision of international radio communication union.

Working-frequency ranges are the subject of trading and concession at interstate level and at regional communication operator level. Time-frequency radio channelizing due to improving synchronous systems performance is to bring in unpredictable return.

Improvement of current optical main channel and communication centers performance by improving synchronization and channelizing has no restrictions. It is also unpredictable profit.

Today financial yearly demand of cosmic sector to ensure normal systematic operation, but with accuracy an order worse than the proposed variant, is 350 – 500 million dollars a year.

When Russia turns to its own time and frequency standard, anti-missile defense (AMD) tasks would be solved in more efficient and effective way which is to bring unrestricted return depending on tasks and requirements of the state.

In case of complete STS construction it is possible to set up mode of regional and central control of all moving in space vital activity and life support elements during peace and war (all produced weapon including tabled one, missiles, shells, etc.).

It may be of great use in lowering terrorism and other negative society occurrences.

Similar to GPS sales volume of RT STS signals receivers may reach 4.7 milliard dollars in motor, 3.8 milliard dollars in tourist businesses and more than 6 milliard dollars in cartography and cargo transportation spheres.

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THE GEOECOLOGICAL PROBLEMS OF NATURAL ARSENIC POISONING OF DRINKING WATER IN DAGHESTAN REPUBLIC

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Worldwide chronic arsenic toxity has become a human health threat. Evidence for elevated arsenic concentrations in groundwater of geologic origin in aquifers of fluvial and deltaic river delta formations has been increasing over the past 20-30 years in different parts of the world (1). Although the calamity of arsenic exposure in Bangladesh may have been the most well-known endemic because of the magnitude of the exposure (2, 3), many other regions in the world have well-documented high level arsenic concentration in drinking water. This documentation has been possible thanks to geological and geochemical researches that had been made in these countries.

The problem of arsenic poisoning of drinking water is also actual in Daghestan republic. The Daghestan Republic is one of the water resources rich regions of the Russian Federation. The water resources are presented by surface water and groundwater.

The ground hydrosphere consists of hidrogeological basins and massives: aqueous massives of Shale Daghestan, karsted fracturing massives of Limestone Daghestan, basins of thermomineral waters of Foreland Daghestan, the North Daghestan Artesian Basin (NDAB).

In several regions of Daghestan republic, there is high arsenic contamination in groundwater. In north districts drinking water contain arsenic as a result of geochemical characteristics of the land, as well as in south districts causing a non-occupational exposure. The populations in this region use groundwater as drinking water and obtain it from the naturally contaminated sources. This region is known as having elevated arsenic levels of water dating back from the 1970's. And as a result, more than 300 thousands of people are exposed to arsenic via drinking water.

Vchese poisoning districts are within NDAB, which is the part of huge East-Ciscaucasian synclinal depression. It consists of Pliocene-Pleistocenesediments with magnitude 300–1200 meters. The climate of this territory is arid, the lowland soils are normal light chestnut. In hydromorphic landscapes there are meadow and meadow-chestnut soils. In the sea sediments (in the east part of the lowland) there are saline soils. The scientists have different opinions about arsenic genesis in groundwater. But there is the most evident hypothesis about possible regional arsenic coming with infiltration water after its contact with arseniccontained rocks (4). As we know, arsenic minerals exist in the environment principally as sulfides, oxides, and phosphates. Arsenic occurs as a constituent in more than 200 minerals, although it primarily exists as

arsenopyrite and as a constituent in several other sulfide minerals. Mechanisms by which arsenic is released from minerals are varied and accounted for by many (bio) geochemical processes: oxidation of arsenic-bearing sulfides, desorption from oxides and hydroxides, reductive dissolution, evaporative concentration, leaching from sulfides by carbonate, and microbial mobilization. The introduction of arsenic into drinking water can occur as a result of its natural geological presence in local bedrock. Significant natural contamination of surface waters and soil can arise when arsenic – rich geothermal fluids come into contact with surface waters. Arsenic enrichment also takes place in geothermally active areas. Globally, millions of people are at risk for the adverse effects of arsenic exposure. The majority of harmful arsenic exposure comes from drinking water from wells drilled through arsenic-bearing sediments. This drinking water contains primarily inorganic arsenic, which is more acutely toxic than the organic form. Inorganic arsenic is an established human carcinogen. Chronic arsenic exposure places people at risk for a host of adverse health effects, from skin and internal cancers (of the bladder, kidney, liver, lung, colon, uterus, prostate and stomach) to diabetes mellitus and vascular, reproductive, developmental, and neurological effects. Studies have shown arsenic to be a potent endocrine disruptor, altering hormone-mediated cell signaling at extremely low concentrations. Skin lesions, notably hyperkeratosis, or thickening of the skin, and both hypo- and hyperpigmentation are the most common outward sign of chronic arsenic exposure, though many dermatologic symptoms are thought to be mediated by nutritional factors. So, the populationin northern Daghestan is arsenic – exposed because poisoning groundwater is an important and often the only source of drinking water here they have to use. For our research we took water samples from artesian wells in the biggest villages of the northern Daghestan (Fig.1).

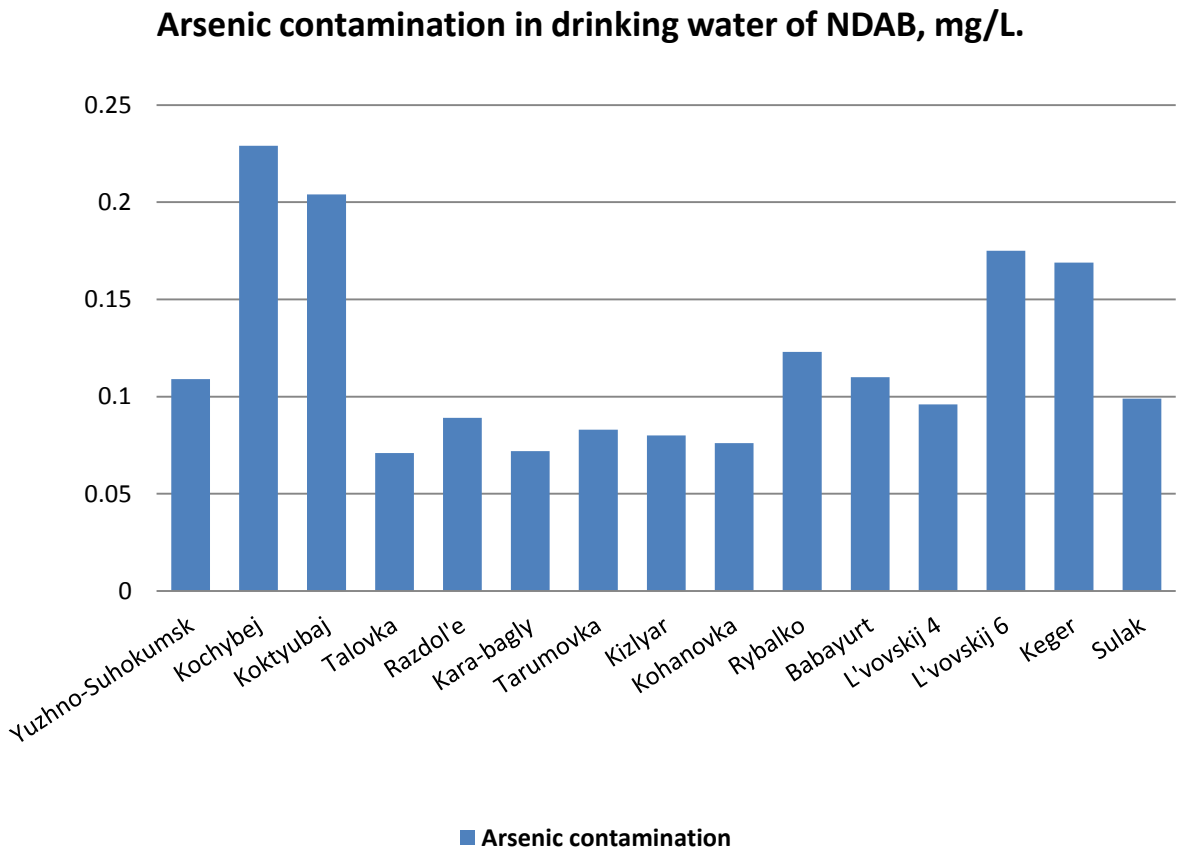

Table 1. Districts with tube-wells contained high levels of arsenic in drinking water

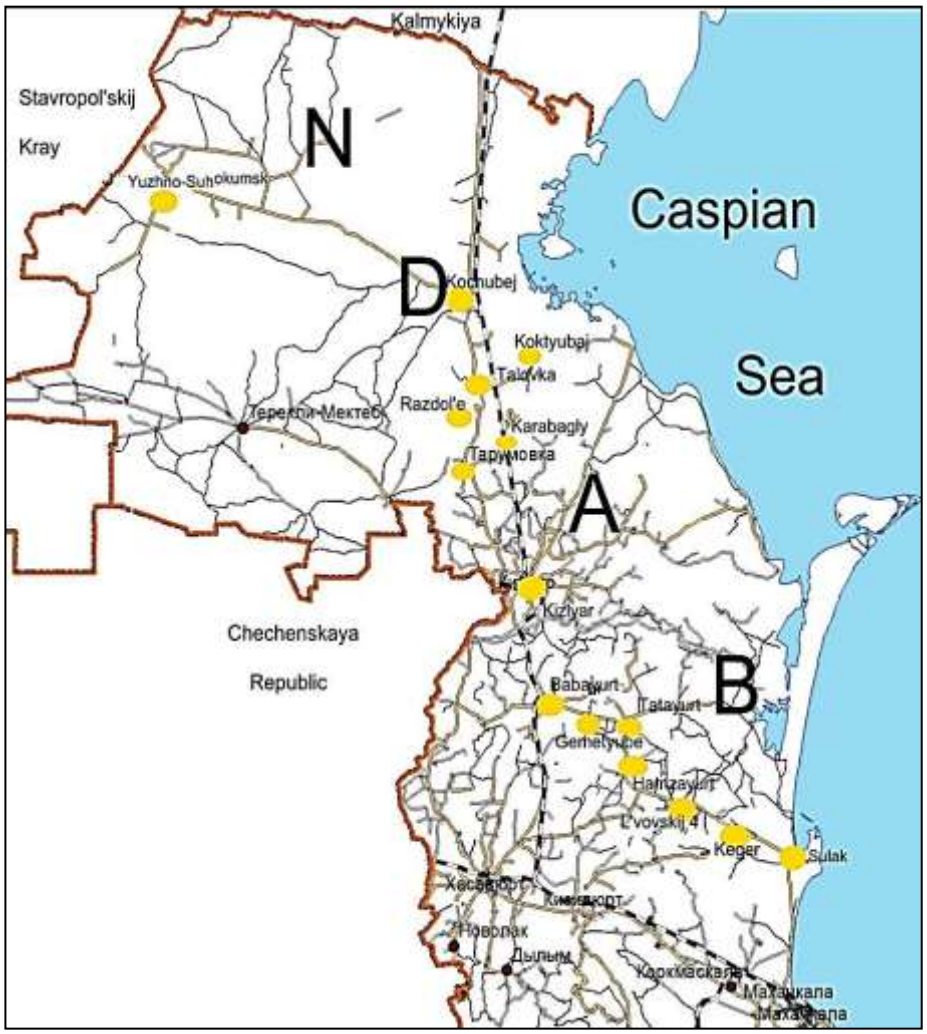

Fig.1.

Methods

The arsenic levels were measured by the method of atomic absorption spectrometry in 43 water samples, collected from 2 towns and 19 settlements. Samples of drinking water were collected in acid-washed 50-mL plastic bottles from the study subjects' districts and 1mL of concentrated nitric acid was added for preservation and then transported to laboratory for analysis according to the international standard ISO-5666/1.

Results

The range of arsenic concentrations were from 0,011-0,229 mg/l. The minimum of arsenic concentration (0,011 mg/l) was in L'vovskij 1 and the maximum (0,229 mg/l) is in **Kochubej.** More than 90% of the water samples had levels above the current national standard of 0,05 mg/l and 100% - above WHO standard of 0,01 mg/l (Tab.1).

Exposure to arsenic can cause many health problems. Inhalation of arsenic causes scin cancer, in addition to other characteristic skin alterations such as keratosis and hyperpigmentation (5). Arsenic exposure can also increase the risk of developing lung, bladder, kidney and liver cancers (6, 7).

In general, research need to be continued and pursued to confirm or reject some of the more hypotheses of possible regional arsenic poisoning of drinking water.

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PRE-ALPINE GEODYNAMICS OF THE CAUCASUS, MULTISTAGE REGIONAL METAMORPHISM AND GRANITOID MAGMATISM

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The Caucasus represents a complicated polycyclic geological structure involving mountain foldsystems of the Greater and Lesser Caucasus and adjacent foredeeps and intermountain troughs. Paleomagnetic and paleokinematic, as well as traditional geological data (character of sedimentation and magmatism, geology and age of ophiolites, paleoclimatic and paleogeographic data) indicate that within the oceanic area of Tethys (with a typical oceanic crust), which separates the Afro-Arabian and Eurasian continental plates, in geological past relatively small continental or subcontinental plates (terranes) were situated, having various geodynamic nature and characterized by specific lithologic-stratigraphic section and magmatic, metamorphic and structural features. During the Late Precambrian, Paleozoic and Early Mesozoic these terranes underwent horizontal displacement in different directions within the oceanic area of Proto-Paleo-and Mesotethys (Neotethys) and as a result of Variscan, Early Kimmerian, Bathonian and Austrian orogeny they underwent mutual accretion and ultimately joined the Eurasian continent. The Greater Caucasian, Black Sea-Central Transcaucasian, Baiburt-Sevanian and Iran-Afghanian terranes are identified in the Caucasian segment of the Mediterranean mobile belt, which in geological past represented island arcs or microcontinents "Fig. 1" [1]. In terms of modern structure, they represent accretionary terranes of the first order separated by trustworthy or supposed ophiolite sutures of different age. Terranes of the first order, in their turn, consist of great number of subterranes delimited as a rule by deep faults or regional thrusts.

They were considered earlier as separate tectonic units (zones) of the Caucasus. Besides, in many places of the Caucasian region there are ophiolite terranes - relicts of the oceanic crust of small or large oceanic basins overthrust (obducted) from the above-mentioned ophiolite sutures. It should be especially noted that the Earth's crust of the Caucasus is tectonically layered. [2-5]. Similar tectonic layering has recently been reported from many regions of the world. It has also been traced throughout the whole central segment of the Mediterranean mobile belt. One of the authors of this paper (I. Gamkrelidze) had for a long time (1976-1990) been in a position to

investigate the nappe structures of the Mediterranean belt and to prove the existence of deep-seated nappes in the basement of the Alps, Western and Central East Carpathians, northern Apusenides, Bohemian massif, Rhodopian crystallinicum, Pannonian basin, Transcaucasian massif and crystalline core of the Greater Caucasus [1, 6]. "Fig.2". At the same time, this layering was not given due regard in the solution of some geological problems, including petrogenetic modelling, in particular, that of the genesis of Caucasian metamorphites and granitoids.

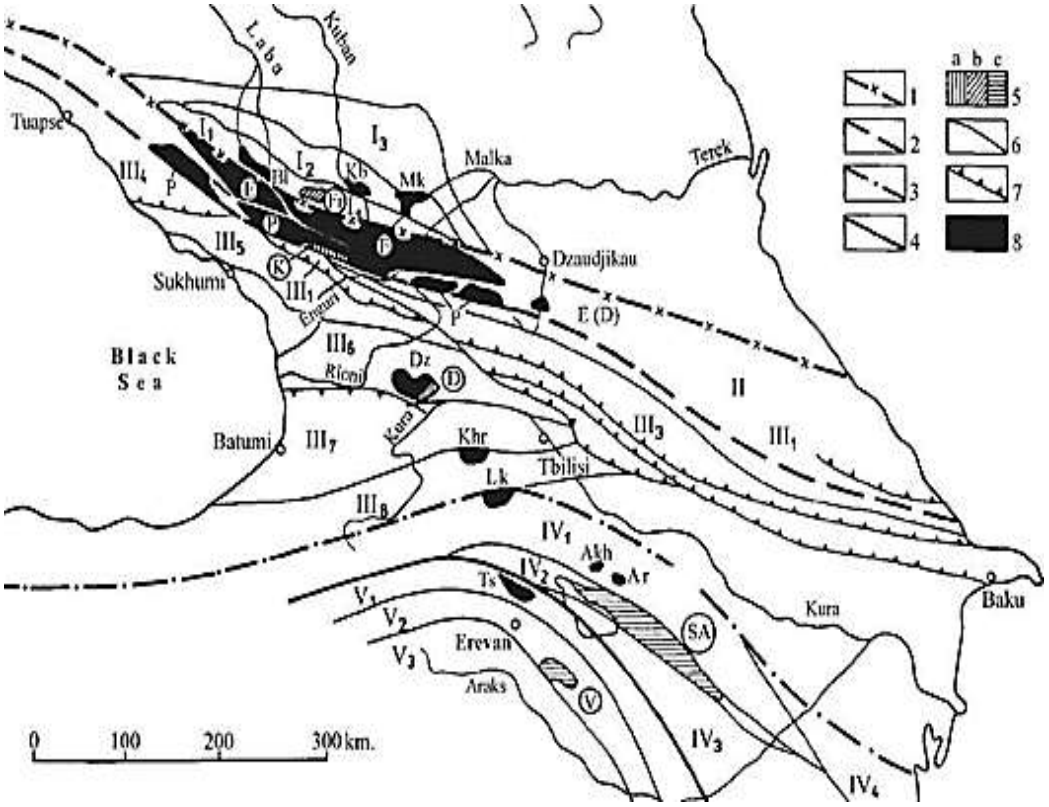

Fig.1. Tectonic zoning of the Caucasus on the basis of the terrane analysis [1] with additions

I. Part of Scythian platform involved in Neogene time into rising of the Greater Caucasus: I_1 - Forerange zone, I_2 - Bechasyn zone, I_3 - zone of North Caucasian monocline; Accretionary terranes of the first order and subterranes: II - Greater Caucasian terrane (island arc); III - Black Sea-Central Transcaucasian terrane (microcontinent). Subterranes: III1 - Chkhalta-Laila, III_2 - Kazbegi-Tphan, III_3 - Mestia-Dibrar, III_4 - Novorosiisk-Lazarevskoe, III_5 - Gagra-Java, III_6 - Dzirula, III_7 - Adjara-Trialeti, III_8 - Artvin-Bolnisi, III_9 - Middle and lower Kura; IV - Baiburt-Sevanian terrane (island arc). Subterranes: IV 1 - Somkhit-Karabakh, IV_2 - Sevan-Akera, IV_3 - Kafan, IV_4 -Talysh; V - Iran-Afghanian terrane (microcontinent). Subterranes: V1 - Miskhan-Zangezur, V_2-Erevan-Ordubad, V_3 - Araks. 1-4 - ophiolite sutures, marking the location of small and large oceanic basins: 1 - of Early? - Middle Paleozoic age, 2 - of Late Precambrian - Paleozoic age, 3 - of Late Precambrian-Early Mesozoic age, 4 - Mesozoic age; 5 - ophiolite terranes (obduction plates): 5_a - Late Precambrian age, 5_b - Paleozoic age, 5_c - Mesozoic age; 6 - borders of subterranes (deep faults or regional thrusts); 7 - detached cover nappes; 8 - exposures of pre-Alpine crystalline basement. Lettered separate exposures: Kb - Kuban, Mk - Malka, Bl - Blib, P - Pass subzone of the Main range zone of the Greater Caucasus, E - Elbrus subzone of the Main range zone, E(D) - Dariali exposure of the Elbrus subzone, Dz - Dzirula, Khr -Khrami, Lk - Loki, Akh - Akhum, Ar - Asrikchai, Ts - Tsakhkunyats.Letters in circles - Ophiolite terranes (obduction plates): - Fr - Forerange zone, K - Klich, D - Dzirula, SA - Sevan-Akera, V - Vedi.

Just in such an aspect, on the basis of plate tectonic theory and the conception of tectonic layering of the lithosphere, regional metamorphism and granite formation processes are considered in the paper. Suitable natural laboratory, accessible in the Caucasus, provides a basis for the investigation of likely problems.

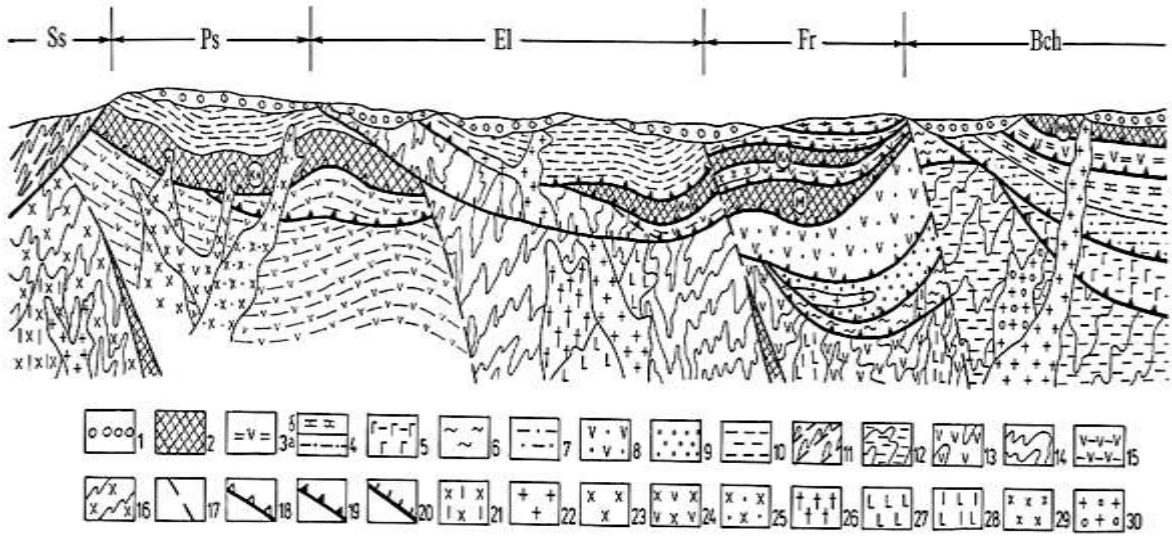

Fig. 2. Principle scheme of pre-Alpine structure of the contemporary Greater Caucasus

1 – Upper Paleozoic molassic deposits (neo-autochthon); 2 – fragments of oceanic crust in supposed suture zones and ophiolite allochthons (figures in circles – ophiolite nappes: Kl-Klichi and also Kassar, Damkhruts plates and their analogies in the Elbrus subzone and the Forerange zones, M-Marukha, Mk-Malka,); 3-11 – tectonic nappes of Precambrian and Paleozoic crystalline rocks and Paleozoic volcanogenic – sedimentary deposits : 3 – Lakhran nappe; 4 - Urlesh nappe; 5 – Khasaut nappe; 6 – Shaukol nappe; 7 – Lashtrak overthrust plate (part of the Atsgara nappe); 8 – Kisilkol nappe; 9 – Tokhan nappe; 10 – Macera nappe and its analogs in the Forerange zone, as a member of Atsgara nappe, and in the Pass subzone of the Greater Caucasus (part of the Buulgen complex; 11 – Dizi nappe; 12-16 – autochthonous and parautochthonous crystalline complexes: 12 – bechasin, chegem and verkhnekuban suites of the Bechasin zone; 13 – Blib complex of the Forerange zone (balkan and armov suites) (Precamrian); 14 – infrastructure of the Elbrus subzone of the Main Range zone (Precambrian); 15 – gvandra suite of the Buulgen complex and its analogs in the Forerange zone in Atsgara nappe in the Elbrus subzone and in the Macera nappe (Upper Proterozoic); 16 – gneiss-migmatite complex of the Black-sea-Central Transcaucasian terrane (Precambrian); 17 – faults; 18-20 – sole of tectonic nappes: 18 – of Late Baikalian, 19 – of Variscan (Saurian), 20 – of Early cimmerian; 21-30 – granitoid complexes: 21 – Precambrian quartz-diorite orthogneisses of the Dzirula massif, 22 – Late Variscan microcline granites in all zones of the Greater Caucasus, 23 – Late Baikalian plagiogranites of the pass subsone of the Greater Caucasus, 24 – Bretonian or pre-Variscan gabbro-diorite-quartz-diorites of the Pass subzone, 25 – Late Variscan (Sudetic) quartz-diorites and plagiogranites of the Pass subzone, 26 – Late Baikalian granodiorite orthogneisses of the Elbrus subzone of the Greater Caucasus, 27 – Bretonian plagiogranites and granodiorites of the Elbrus subzone, 28 – Late Caledonian plagiogranites and plagiogneisses of the Forerange zone, 29 – Bretonian quartz-diorite-tonalite-trondhjemites, 30 – Early Caledonian plagiogranite-granodiorite orthogneisses of the Bechasyn zone. Ss – Southern slope zone, Ps – Pass subzone of the Greater Caucasus, El – Elbrus subzone of the Greater Caucasus, Fr – Forerange subzone, Bch – Bechasyn zone.

Paleotectonic Reconstructions and Geodynamic Settings of Metamorphic and Granitoid Complexes Formation

Magmatism and metamorphism of different type, being a reflection of thermobaric field variation in the external shells of the Earth, represent direct consequence of geodynamic settings in various structural units of the Earth's crust and lithosphere. A model revealing tectonic settings of realization of magmatism and metamorphism and their connection with other endogenic processes participating in the formation of the Earth's crust can be constructed exactly on the geodynamic basis [4]. The most important for reconstruction of geodynamic settings is to establish the nature and location of paleooceanic basins. The existence of oceanic realm in the area of the Mediterranian belt in Neoproterozoic is shown by a number of various global reconstructions. The birth of the Prototethys at that time is also confirmed by the existence of ophiolites of Late

Precambrian age not only in its southern periphery (the Anti-Atlas, the Arabian-Nubian shield, the Loki, Murguz and Tsakhkunyats massifs), but also in the northern periphery of the belt (the Alps, Bohemian and Dzirula massifs).

The newest plate tectonic reconstructions are made at the global scale [7], as well as for Variscan-Alpine orogeny [8].

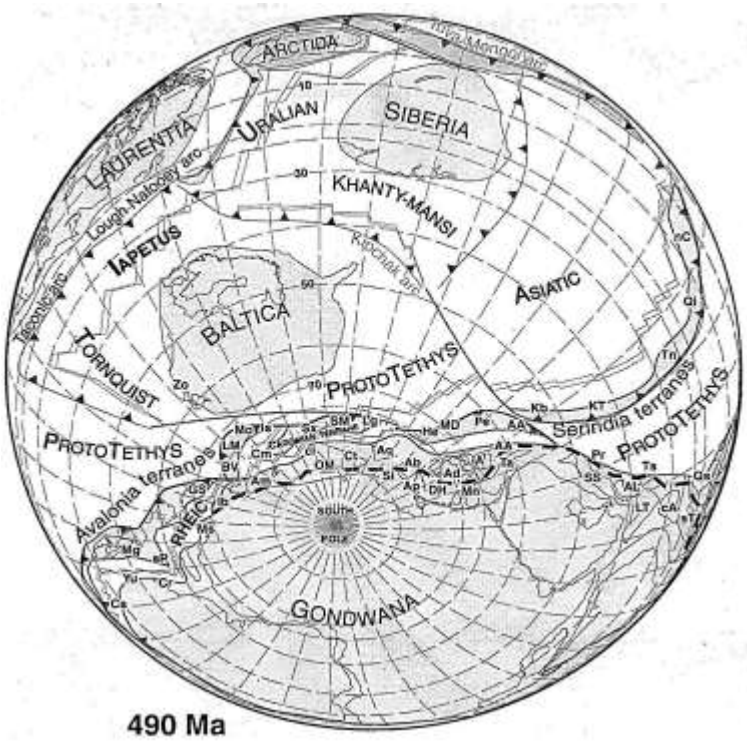

Fig. 3. Early Ordovician reconstruction after G. Stampfli and G. Borel (2002).
Broken line - place of the opening of the future Paleotethys. A-Apula, DH-Dinarides, He-Elinides, Mn-Menderes, Ta-Tavrian Ridge, SS-Samandjan-Sirdjan, Al-Elbrus, LT-Lut-Tabas, cA-Central Afghanistan

For global plate tectonic reconstructions [7] integrated data on dynamic plate boundaries, ocean spreading rates, restored synthetic oceanic isochrones and major tectonic and magmatic events were used [7]. According to these reconstructions at the beginning of Ordovician (~ 490 Ma. ago), the Prototethys was located in the West between Baltica and Gondwana land and in the East between Gondwana and the so-called Serindia terrane. Later, in Silurian time, on the periphery of the Gondwana land, detachment of the Han superterrane and generation of a narrow rift zone of the Paleotethys ocean took place. Paleotethys location coincides with our supposition about its location in the Caucasian region. In particular, southern terranes of the Caucasian segment of the Mediterranian belt (Iran-Afghanian and Baiburt-Sevanian) are located on the northern periphery of the Gondwana land, but northern ones (Black Sea-Central Transcaucasian and Greater Caucasian) are located in the southern periphery of Laurussia "Fig. 4".

This ocean reached the maximum width at the end of Carboniferous and began shortening in Permian (-280-250 Ma. ago). At the rear of the Paleotethys, in the northern periphery of the Gondwana land, Cimmerian superterrane detachment resulted in the generation of the main axis of Neotethys. The Lesser Caucasian bay of this ocean arose later within the Eurasian continent "see Fig. 4", which also completely corresponds to our conception [2, 3, 6].

Geological information and paleomagnetic data referring to separate regions are not completely applied in these global reconstructions. This has been indicated by the following in the Caucasian region: disregarding the existence of some exposures of Late Precambrian - Paleozoic ophiolites and paleomagnetic data indicated seemingly inheriting the development of the Paleotethys from Prototethys and preserving the relict oceanic basin up to the Middle Jurassic. For

this reason the opening line of the future Paleotethys is unnaturally drawn on the northernmost edge of Gondwana "see Fig. 3". Therefore, in making the palinspastic sections of the Caucasus from the above-mentioned global paleoreconstructions we have used the following data: approximate size of oceans at separate stages of their development, location of big continental masses in the space and absorption age of middle oceanic ridge of the Paleotethys in the subduction zone. Principal attention was paid to specific geological (nature of magmatism, peculiarities of lithologic-stratigraphical section, geology and age of ophiolites), as well as to available paleomagnetic data for the Caucasian region. The location of the suture line of the Paleotethys Ocean in the Caucasus has been debated for a long time. According to I. Gamkrelidze [4], this line sits between the Black Sea-Central Transcaucasian and Baiburt-Sevanian terranes, i.e. along the northern periphery of the contemporary Somkhit-Karabakh subterrane "see Fig. 1,4". This is proved by geological and paleomagnetic data, which correspond to criteria of paleomagnetic reliability. The paleomagnetic data obtained for Carboniferous volcanites of the Dzirula and Khrami massifs of Black Sea – Central Transcaucasian terrane with paleolatitude - 12°-13° n.l. is close to the paleolatitude of the southern periphery of the Eastern-European continent in the Late Paleozoic (8-9° n.l.), whereas the paleolatitude of rocks of the same age from Daralagez (South Armenia) and Elburs is 22° s.l. [9]. Hence, there is quite a large gap taken up by the ocean. This gap, inherited from the Paleozoic, is also preserved here in Triassic and Early-Middle Jurassic. In particular, on the one hand, paleolatitudes of Early-Middle Jurassic rocks of the Loki massif region of the Somkhit-Karabakh zone are 22° n.l., and on the other hand, paleolatitudes of rocks of the same age of the Dzirula massif are 27-29° n.l. [9]. This fact shows that these two regions in Early-Middle Jurassic were separated from each other by 6-7° "see Fig. 4". At the same time these two regions, according to their geological structure, have very different geological history in Paleozoic and Mesozoic. In particular, the Somkhit-Karabakh zone basement age by all data is purely Variscan, in contrast to the northern part of the Transcaucasian massif and the Greater Caucasus with Grenville-Baikalian core. In the Early-Middle Jurassic, contemporary Artvin-Bolnisi and Adjara-Trialeti zones (subterranes) were represented by high-eroded land, but in the south within the Somkhit-Karabakh zone in the Middle-Late Jurassic, calc-alkaline volcanic series accumulated rather intensively. If these reasonings are correct, it can be supposed that Proto-Paleotethys was developing during the Early Mesozoic, as well, and was closed only in Middle Jurassic (Bathonian) orogeny. In favor of such assumption we refer to: the existence of serpentinite melange in the eastern periphery of the Loki massif (very close to the supposed ophiolite suture), transgressively overlain by Late Jurasic turbidite-olisostrome suite and data about ophiolites of Northern Anatolia that directly follows the supposed ophiolite suture, where the number of geologic, paleobiogeographic and paleofloristical data also indicate the existence of the oceanic basin of the Paleotethys developing in Early Mesozoic, as well. The existence of Paleozoic or older oceanic basins is supposed as being in the area of the contemporary Greater Caucasus. It is confirmed by the Paleozoic ophiolites in the Fore Range zone and the Klich, Kassar and Damkhurts ophiolitic sheets and their analogues in the Greater Caucasus Main Range zone "see Fig. 2,4". The location of this oceanic basin (or basins?) is debatable. Data on magnetic anomalies indicating spreading of the ophiolite belt of the Northern Caucasus show that side by side with oceanic basin, located to the south from the contemporary Main Range zone, in Early and Middle Paleozoic between the contemporary Fore Range and Main Range zones another, the so-called Arkhiz oceanic basin was located representing the "motherland" of ophiolite nappes of the Fore Range zone. With the consideration of zircon age of the Buulgen complex amphibo-lites (600±20 Ma), the existence of N-MORB type rocks in composition of Klich, Kassar and Damkhurts ophiolitic sheets, as well as paleomagnetic data, can be assumed, that the Southern Slope oceanic basin of the Greater Caucasus was laid in Late Precambrian as relatively small spreading basin. As a relict of this basin, most part of which was "absorbed" in the subduction zone along the southern edge of the Greater Caucasian island arc, Paleozoic-Triassic deposits of dizi series can be considered to be formed on the southern passive margin of this ocean under conditions of continental slope [4].

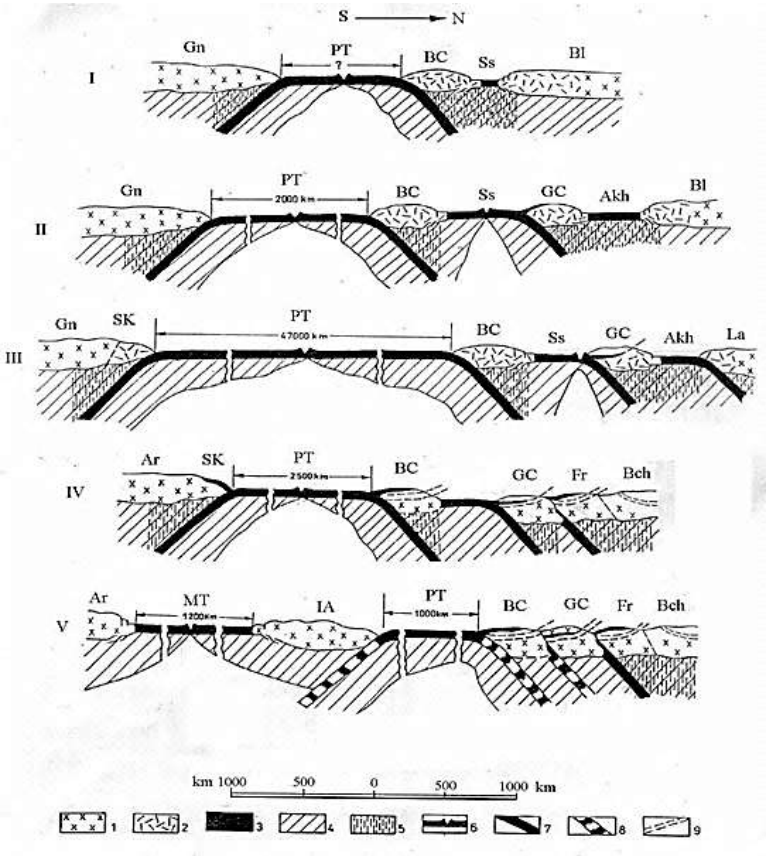

Fig. 4. Schematic palinspastic profiles of the Caucasian segment of the Mediterranean mobile belt for: I. Late Precambrian (Neoproterozoic), II. Late Cambrian, III. Devonian, IV. Early and Middle Carbon, V.Late Triassic (vertical scale is exaggerated approximately for the five times)

1-continental crust, 2-subcontinental crust, 3-oceanic crust and obducted ophiolites, 4-upper mantle, 5-streams of heat, fluids and magmatic melts in mantle, 6-Middle oceanic ridge, 7-subduction zones, 8- inactive subduction zones, 9-surfaces of tectonic layering of the Earth's crust. Paleooceanic basins: PT – Proto-Paleotethys, Ss – of the Southern slope of the Greater Caucasus, Akh – Arkhis, MT – Mesotethys. Continental plates: Gn – Gondvana, Bl – Baltica, La – Laurussia, Ar – Arabia. Terranes: BC – Black sea-Central Transcaucasian microcontinent, GC – Greater Caucasian island arc, IA – Iran-Afghanian microcontinent. contemporary tectonic zones: SK – Somkhito-Karabakh, Fr – Forerange, Bch – Bechasin.

Later (apparently in Early-Middle Paleozoic) the Arkhiz basin began to develop. Judging from the nature of the volcanic complex of the Fore Range zone ophiolite association, this basin belonged to the marginal sea type. In Neoproterozoic and Paleozoic under suprasubduction conditions on the peripheries of the above-mentioned large and small oceanic basins regional metamorphism and granite formation took place. Consequently main source of thermal energy represented frictional heat of subduction zones. But, side by side with this, certain part play also radiogenic heat of continental crust, fluids, first of all a water, and dissipative heat being generated at the sole of large allochthonous plates, which create temperature barriers (so called "thermal screen") hindering a transference of heat to the surface and stipulating rise of geothermal gradient at the depth [5].

The evidence of the oldest regional metamorphism in the Caucasus can be observed in Tsakhunyats massif of the Iran-Afghanian terrane, the lower structural stage of which is part of Middle Proterozoic and older craton. However, within the Caucasian segment of the Alpine belt, signs of the oldest regional metamorphism (Grenville) we can observe in the gneiss-migmatite complex of the Dzirula massif, of the Greater Caucasus Main Range zone and, apparently, of the Khrami massif [4]. The main stages of regional metamorphism and granite formation are bound up with Grenville, Baikalian (Panafrican), Late Baikalian (Salairian), Early and Late Caledonian and Variscan orogeny. They were stipulated by the functioning of subduction zones by both sides of

Proto-Paleotethys and along the northern peripheries of comparatively small oceanic basins of the Arkhiz and Southern Slope of the Greater Caucasus [4].

Regional metamorphism, mainly of low and moderate pressure and correspondingly high and moderate temperature, and formation of pre- and synmetamorphic granitoidic complexes of sodium series took place in pre-Variscan time, in the northern and southern continental margins of the Paleotethys. It should be noted that according to new data here in places heightened and high-pressure metamorphism are observed. In the Late Baikalian orogenic phase, the same events took place also in the northern periphery of the oceanic basin of the Southern Slope of the Greater Caucasus. Since the Middle Paleozoic subduction began to appear also along the northern periphery of the Arkhiz marginal sea "see Fig. 4". However, the existence of the spreading zone in the basin seems to be doubtful. Consequently, it is more accurate to use the term pseudosubduction, which, as is generally known, means that subduction is not in direct connection with spreading [10]. Processes of regional metamorphism with P-T conditions analogous to pre-Variscan metamorphism are connected with Variscan orogeny. Although in the deepest, subsided parts of metamorphic complex (the Blib autochthonous complex of the Fore Range zone) and in the sole of the Shaukol nappe in the Bechasyn zone "see Fig. 2" high baric type of metamorphism is established. At the same time, intensive tectonic layering of the Earth's crust and formation of granitoids, mainly of potassic series, took place. This orogeny covers a range of geological time from the latest Devonian (Famennian) to Late Visean (about 17-18 Ma.). Due to the existence of appointed succession of vital geological events in clearly limited time intervals, manifestation of several orogenic phases can be assumed in the Caucasus. Specifically, with the Early Variscan (Bretonian) orogeny (at the end of Devonian and beginning of Early Carboniferous), regional metamorphism of the most Lower-Middle Paleozoic rocks of the Caucasus and formation of synmetamorphic granitoids is connected. Also we assume the evidence of Saurian orogeny (seemingly in Turneasian), which corresponds to the most important pre-Alpine time of nappe formation in the Caucasus. And here, at last, Late Variscan orogeny with processes of intensive granite formation is established. During the Saurian orogeny, dynamic events were the most important, provoking, in the first place processes of tectonic layering of the Earth's crust and its shortening, which in their turn provoked the origin of additional dissipative heat at the sole of large allochthonous plates and melting of potassic granites in Late Variscan time. With Saurian phase there coincides overthrusting of ocean crust fragments of Proto-Paleotethys on the Black Sea-Central Transcaucasian microcontinent together with sedimentary rocks formed within its continental slope (the Chorchana-Utslevi complex). In the Saurian phase, overthrusting of metamorphic scales of the Loki massif, including Precambrian ophiolites, and ophiolites of the Akhum and Asrikchai salients on the other, southern continental periphery of the Paleotethys took place.

The formation of the system of N-vergent nappes of the Fore Range zone (including ophiolite nappes), S-vergent nappes of the Khasaut synform of the Bechasyn zone, and also overthrusting of large Macera nappe from the Pass sub-zone to the Elbrus sub-zone of the contemporary Main Range zone of the Greater Caucasus were connected with the same orogeny "see Fig. 2". The next, Late Variscan (Sudetic) orogeny was the time of the formation of all the potassic granites (except the Pass sub-zone poor in K granitoids) in the Caucasian region, of regressive metamorphism of constituent rocks, and of the origin of true continental crust in it. These processes were connected with activities of all subduction zones. At the very end of the Variscan orogeny, extraordinary fast (instantaneous in a geological sense) exhumation of deeply subsided parts of the Earth's crust took place. The first pebbles of microcline granites of the Main Range zone, forming in the depth of 4-5 km, in Upper Paleozoic neoautochthonous complex of the Fore Range zone, already appear in Middle Carboniferous (in Westphalian). The same situation can be observed in the Dzirula crystalline massif, where the clastic material with fragments of Late Variscan microcline granites are observed in the upper part of the neoautochthonous complex including the period - Upper Visean - Upper Carboniferous – Permian. All these show that within the Black Sea-Central Transcaucasian and Greater Caucasian terranes exhumation of Late Variscan granites took place mainly at the end of the same orogeny. Such instant raising of the crust and exposure of abyssal rocks can be attributed to the summary manifestation of isostasy processes, conditioned by high buoyancy of the consolidated crust lightened by that time, its shortenning and intensive

erosion. An Andian type large volcanic belt existed in Late Paleozoic on the southern periphery of Eurasian plate developing during Late Permian-Triassic. Hence, it could be assumed that at that time the activity of the northernmost subduction (pseudosubduction) zone was preserved "see Fig. 4". Later, in the Early, Middle and Late Jurassic subduction zones functioned along the northern and southern peripheries of the relict basin of the Paleotethys, where the formation of very thick volcanic series of calc-alkaline composition took place. Considerable tectonic movements in the Caucasus were manifested during Early Cimmerian (Indosinian) orogeny. In the Greater Caucasus, this phase featured overthrusting of Paleozoic dizi series to the north, as well as overthrusting of the Elbrus sub-zone infrastructure to the south - into the Pass sub-zone. Early Cimmerian orogeny took place in the Dzirula, Loki, Akhum and Asrikchai massifs, where it causes a folding of Early-Middle Paleozoic metamorphites and intensive milonitization of the Dzirula massif microcline granites. Thus, Early Cimmerian orogeny, which occurred almost in all terranes of the Caucasus, completes the formation of the structure of its metamorphic basement. The specific of some of regional metamorphism and granite formation processes in separate terranes of the Caucasus is worth mentioning. In particular, all terranes of the first order (superterranes), as well as the southern edge of the Scythian platform are characterized by manifestation of polymetamorphism processes, though in various terranes, which differ from each other by geological structure and history, separate stages of regional metamorphism became unequally apparent. For instance, Grenvilian regional metamorphism is observed only in the Greater Caucasian, Black Sea-Central Transcaucasian and Iran-Afghanian terranes, whereas the Baikalian metamorphism can be observed only in the Scythian platform and Iran-Afghanian terranes. Late Baikalian metamorphism took place only in the Greater Caucasian and Black Sea-Central Transcaucasian terranes. Caledonian regional metamorphism strictly characterizes the Scythian platform and the Greater Caucasian terrane. Early Variscan (Bretonian) metamorphism is observed almost in all terranes of the Caucasus, excluding the Iran-Afghanian terrane, and southern edge of the Scythian platform. Late Variscan metamorphism also comprises almost the whole Caucasus excluding the Fore-Range zone (Scythian platform) and Iran-Afghanian terrane.

Within separate terranes, as well as in the Scythian platform, synchronously or almost synchronously with principal stages of metamorphism (connected with the main phases of tectogenesis), formation of pre-syn- and postmetamorphic granitoids of different type took place. Observed occurrence at different times and diversity of endogenic activity in various terranes of the Caucasus show the asynchronism of episodic activity of subduction zones on different sides of the oceanic basins separating these terranes. In conclusion it should be noted that cited above data about interrelation and the age of pre-Alpine basement constituting rocks, stages of regional metamorphism and granite formation are recently fully corroborated by new U-Pb LA ICP MS dating [11,12]. In particular as a result of isotope dating of zonal zircon crystals from plagiogneisses of gneiss-migmatite complex of the Elbrus subzone of the Greater Caucasus Main Range zone in the core of zircon crystals Neoproterozoic age 1200±16 Ma was fixed; it most likely corresponds to the first stage of RM (T=700-750°C, P=2.8-3.1 kbar). In intermediate zone of crystal received Late Baikalian figures – 515±6 Ma answering the second stage of RM (with T=500-620°C, P=2.3-2.8 kbar) but in the external envelope of crystal – Late Variscan- 311±3 Ma corresponding to regional microclinization of granitoids. In the cores of 3 zonal zircon crystals from Late Variscan granitoid 622±11, 630±11 and 690±12 Ma are established answering the Baikalian endogenic processes. The concordant age of 25 local measuring in 24 zircon crystals in the same rocks makes up 309±2.5 Ma corresponding to true age of crystallization of magmatic granite intrusions of the Elbrus subzone. Local isotope U-Pb LA-ICP-MS dating of zircons from Late Variscan granitoids of the Greater Caucasus Pass zone in most cases (in 21 crystals) shows Late Variscan concordant age – 325±2.5 Ma. In 7 crystals is received inherited age within the limits of 658-603±11 Ma, which corresponds to Baikalian age of endogenic process of mineral formation most likely in the Lower part of Precambrian-Paleozoic Buulgen metamorphic complex and deeper horizons. 2 determinations – 514.0±10 and 526±9 Ma possibly answer the Late Baikalian age of retrograde RM of the Buulgen complex. Early, inherited groups of zircon with the age 2129.0±13 Ma, 2160.0±32 Ma, 1814±28 Ma, 1836.0±16 Ma, 1009.0±17 Ma and 1023.0±18 Ma are fixed as well, which probably correspond to the age of detrital zircons. In the Dzirula massif five age and genetic types of zircons are distinguished: 1 - detrital zircon – >1200 Ma; 2 –

zircon formed presumably at the Grenville stage of metamorphism - 1000-800 Ma; 3 - zircon developed during the crystallization of quartz-diorite orthogneisses - 650-540 Ma (Baikalian stage); zircon 4 - formed presumably during the crystallization of tonalite-granitic series - 530-500 Ma (Late Baikalian stage of metamorphism) and 5 - zircon formed during the crystallization of Late Variscan granitoids and also under the impact of high-temperature fluids over pre-Late Variscan rocks - 330-310 Ma. The age of regional metamorphism of gneiss-migmatite complex of the Khrami crystalline massif is determined as 930Ma (Neoproterozoic). The Late Variscan granitoids are dated within the interval - 319-332Ma. The studies conducted substantially fill up the gaps existing in the isotope-geochronological data of the pre-Alpine crystalline basement of the Black Sea-Central Transcaucasian terrane and specify to a considerable extent the age of pre-Alpine endogenic processes.

Conclusions

Paleomagnetic, paleokinematic and geological data, as well as global plate tectonic reconstructions indicate that within the oceanic area of Tethys, with a typical oceanic crust, in geological past relatively small continental or subcontinental plates (terranes) were situated. During the Late Precambrian, Paleozoic and Early Mesozoic these terranes underwent horizontal displacement in different directions and ultimately they joined the Eurasian continent. In many places of the Caucasus there are ophiolite sutures and ophiolite terranes (obducted plates), which represent the oceanic crust of small or large oceanic basins. At the same time geological (structural) and geophysical data indicate that the Earth's crust of the Caucasus is tectonically layered. this layering, side by side with other sources of heat (subduction, stream of fluids, radiogenic heat), owing to dissipative warming up of rocks, creates "thermal screen" and stipulates the generation of supplementary deep energy for metamorphism and granite formation processes. In Neoproterozoic and Paleozoic on the peripheries of the oceanic basins regional metamorphism and granite formation took place, which were conditioned by the functioning of subduction zones by both sides of Paleotethys and along the northern peripheries of comparatively small oceanic basins of the Arkhiz and Southern slope of the Greater Caucasus.

Processes of multi-stage regional metamorphism, granite formation and tectonic deformations were timed to Grenville, Baikalian (Panafrican), Late Baikalian (Salairian), Caledonian, Variscan and Early Cimmerian (Indosinian) orogenies. Observed occurrence at different times and diversity of endogenic activity in various terranes of the Caucasus show the asynchronism of episodic activity of subduction zones on different sides of the oceanic basins separating these terranes.

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GEOLOGICAL CATASTROPHES AND EVENT DEPOSITS

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Geological catastrophic events (unlike the cosmic and technological ones) in the nature are manifested in the form of earthquakes, volcanic eruptions, mudflows and turbidity currents, floods, landslide processes, etc. The sediments formed as a result of these processes are event deposits characterized by specific structural-textural and lithological features. For the first time presence of event deposits was noted in cyclic (rhythmic) formations, treated in a number of interesting researches [1]. In chaotic formations the existence of event deposits first was noted by F. Maisadze in the Upper Eocene formations of the Southern Slope of the Greater Caucasus [2, 3].

Cyclically built rocks are built of the layered rhythms that are identical or fairly close by composition; they repeat regularly in a section. In terms of structural and textural features the cyclically built formations have been unified under the name of "cyclites" or "elementary cyclites". They included turbidites, storm deposits, calcareous-marly rhythms, flood deposits, etc. When their classification was endowed with a genetic notion, they were subdivided into three groups: periodites, tempestites and turbidites. Periodites are attributed to normally-sedimentary formations, while tempestites and turbidites - to "event deposits" [1]. The last ones (coquina beds, condensed layers, storm sandstones, flat-pebble conglomerates, turbidites, etc.) are geological bodies of sedimentary origin [4], formed as a result of rapid, single catastrophic events. Cyclites belong to periodites; they are deposited in deep-water parts of the basin (below the wave base level) and are characterized by a certain periodicity of sedimentation caused by facial changes. They represent non-turbiditic pelagic and hemipelagic calcareous-marly rhythms [5]. Their sedimentation in time can last some tens and hundred thousand years. Tempestites settle between the storm and normal baselines of waves, and turbidites - mainly on continental slopes. Unlike periodites, sedimentation of tempestites and turbidites occurs instantly, as a result of catastrophic events, the latter being one of the main factors of their formation. The given examples show well the extent of diversity of sedimentation of structurally similar, but genetically different cyclically built deposits. However, in nature there is also another group of rocks, which analogously to cyclic deposits, has an identical structure, but the involved rocks considerably differ from each other genetically. This refers to chaotically built formations to which belong sedimentary conglomerates and breccias, olistostromes (block breccias), wild flysch, horizons with inclusions, volcanic breccias, tectonic breccias (mylange), glacial and mud breccias, etc. Among these genetically different chaotic formations, the object of our attention is their exclusively sedimentary varieties, formed in marine basins. Such are breccias, conglomerates, olistostromes, wild flysch, horizons with the inclusions and reef breccias. All of them are made up of fragments and pebbles of rocks of different composition and age; their size varies from several centimeters (conglomerates, breccias) to several hundreds and thousands cubic meters (olistostromes, wild flysch).

As is known, reef breccias, owing to their specific conditions of formation, differ from other sedimentary breccias. In particular, they are formed as a result of the action of sea waves on the slopes of reef structures, and representing a product of destruction of coral islands. Usually, reef breccias closely merge with the reef body composed of massive or obscurely lamellar limestones. In case of surf processing of boulders, they pass into a well-rounded pebble, forming conglomerate

seams. Their characteristic feature is that, as well as breccias, they contain limy pebbles and cement. As for the horizons with inclusions, the laminated norm-sedimentary rocks in them are base components, and the clastic material has a subordinate role; by their lithological nature, they most likely belong to intermediate (transitive) deposits between norm-sedimentary and chaotic formations. As to conglomerates and breccias, by origin they are identical, with the only difference, that in conglomerates the degree of roundness of the fragments composing them is higher. Genetically olistostromes and wild flysch are alike as well. The basic distinction between them lies in the conditions of their formation. In particular, the olistostromes settled in the basins with epicontinental mode of sedimentation, and wild flysch - in flysch basin. As is known, in the formation of sedimentary deposits, along with many factors (climatic changes, activity of organisms, fluxes and refluxes, facies realm, etc.), tectonic movements play quite an important and often defining role. The sedimentary chaotically built formations under consideration are not an exception.

Transgressive and regressive deposits, mostly composed of conglomerates and breccias, are formed as a result of the lowering and rise of sedimentary basins. During these processes, the tectonic movements proceed rather evenly without any cataclysms; thus, as the normal process of sedimentation is uninterrupted, the conglomerates and breccias are norm-sedimentary formations. However, in cases when tectonic movements were activated, catastrophic events were occurring. These events together with appropriate paleogeographic and facies conditions provoke deposition of olistostromes and wild flysch, representing event deposits.

Thus, proceeding from the genetic principles, the chaotic formations under consideration, can be subdivided into two groups: normally-sedimentary (conglomerates, breccias) and event (oilstostromes, wild flysch) deposits. One of the vivid examples of chaotically built event deposits are the Upper Eocene olistostromes and wild flysch of the Alpine folded area - a subject of interest of many researchers [6-14]. They contain valuable information for paleogeographic reconstructions and about the tectonic movements at the Eocene-Oligocene boundary, being one of the important periods in the history of the region. The increased interest in studying the Upper Eocene olistostromes and wild flysch is accounted for by the fact that they are widespread in the entire Alpine fold belt; besides, they are peculiar marker formations, allowing to establish the time and duration of the manifestation of the Pyrenean orogeny, thereby enabling correlating of the tectonic movements including catastrophic events, both in the Alpine fold system and beyond its limits. In the greater part of the Alpine fold system olistostromes are part of flysch formations allowing F.Kaufman [15] to identify them as "wild flysch," though according to a number of researchers, by their nature and structure they differ from typical flysch [9] or are not at all flysch [16]. However, as correctly noted by M.G.Leonov [17] wild flysch is a component of flysch formations of the Alpine area, in a greater part of which flysch formation was complated in Late Eocene. As to the term "olistostrome" (landslide bed) it was introduced much later by G.Flores [18] for any chaotically built sedimentary rocks and from the beginning implying their formation as landslide-induced events only. However, as it often happens, initial meaning of the term loses its sense and it begins to be applied to structurally and lithologically similar formations as well. The term olistostrome is not exception either. Subsequently, it turned out that in the formation of olistostromes, besides landslide events, an important role is played by tectonics and that is especially important, for their formation in time mostly corresponds to the peaks of Alpine tectogenesis [19].

Before passing to the issues concerning the paleogeography and nature of formation of the Upper Eocene olistostromes and wild flysch, let us consider the geological position of these formations in some folded structures of the Alpine system. There are only a few examples below, where, in our opinion, deposits of our interest are most well studied.

The Swiss Alps. In the segment of the Alpine folded system under consideration wild flysch is developed in the Ultragelvet nappe, which is situated above the Helvetide nappes. The Ultragelvetian cover is built up of intensively deformed flysch deposits in which thin covers are developed. Wild flysch composes the lowermost of them - the Plen-Mort nappe [20]. It is developed in the form of a narrow strip between the Alpine molasse (in the north) and the deposits forming the Helvetian and Pre-Alpine nappe from Lake of Geneva in the south-west to the Austrian Alps in the north-east. The most interesting exposures of wild flysch are observed in the Habkern zone, situated in the northern part of Central Switzerland, between the lakes Tun and Firvaldshtet.

Here the flysch formations form a syncline trough and are represented by Habkern flysch, outliers of Klippe nappe and Schlieren flysch. The object of our interest is Habkern flysch, which, by structural-lithological features, is subdivided into three parts, each representing an independent tectonic sheet [21]. The lowermost part is represented by a flysch of basal sheet followed by a flysch with the packages of Limern beds and wild flysch. The sediments, composing the latter two sheets are interesting to that they, to a different extent are a result of event sedimentation and are formed synchronously. Marls among which there are sandstones, conglomerates and breccias, also lenses and interlayers with fragments of foraminifer shells form the tectonic slab of the basal sheet. By the fauna in the deposits of basal sheet, these rocks are dated as Late Eocene (Priabonian) [21]. The sheet is tectonically over thrusts by the more ancient deposits of the Helvetian nappe and the Upper Eocene formations inclusive. In its turn, the slab of basal sheet from south is also overthrust by another sheet, built up by flysch with packages of Limern beds and a wild flysch. Flysch formations composing the given sheet are lithologically similar to the rocks of the basal sheet and are represented by alternation of marls, aleurolites, sandstones and breccias. The only difference between them is that in the sheet under consideration, in the groundmass of flysch there are fragments of thick marls and limestone blocks of the Upper Cretaceous and Paleocene age; in some places, their size reaches several tens of meters. By faunistic data and that of the nummulites inclusive the groundmass of flysch, which contains these inclusions, is dated as the Late Eocene (Priabonian) [21]. The next tectonic sheet represented actually by wild flysch, was identified by Gigon [21] as an independent facies; it consist mainly of dark marls and marl slates with intercalations and lenses of sandstones, limestones, conglomerates and breccias. This groundmass contains inclusions of crystalline and sedimentary rocks with a stratigraphic range from the Triassic to Eocene inclusive. Among the crystalline rocks, the Habkern granites prevail in volume and quantity and Limern limestones among the sedimentary rocks. Overall, the dimensions of clastic material vary from several centimeters to several thousand cubic meters. In particular, separate blocks of Habkern granites reach 13000 $м^3$, and the Limern limestones - 100m in length [22, 23]. In intercalations and lenses of conglomerates and breccias the same rocks, as the olistholites of wild flysch, are mainly presented by clastic material. Separate partings of breccias contain a considerable amount of fragments of oyster shells. Along with them condensed beds (tempestites), consisting of elements of re-deposited fauna of different age are also present; along with wild flysch they represent event deposits of two generations.The age of wild flysch is reliably defined by faunistic data as the Late Eocene (Priabonian) [22, 21] etc.). If the assumption is accepted that wild flysch was formed as a result of overthrusting, which began at the end of Late Eocene [12], the age of wild flysch can be specified as the upper part of Upper Eocene. Lithological similarity and synchronism of flysch formations forming separate tectonic sheets of the Habkern zone, allow one to assume that they settled in a single flysch basin. In Late Eocene, in the process of flysch formation, as a result of the catastrophic events of different scale and intensity sedimentation of event deposits of different categories took place. During powerful catastrophic processes a wild flysch was formed with packages of Limern and Habkern granites, and at their weaker manifestation tempestites (coquina breccias, the condensed layers) and turbidites were deposited. The location of the parent rocks of those exotic blocks and fragments, whose bedrock outcrops are not exposed nowadays, today are debatable among the researchers. This primarily refers to Habkern granites, to crystalline schists and Limern beds. Inclusions of the last, as was already marked, are distinguished in the large sizes. The researchers connect the presence of exotic blocks in wild flysch, as well as origin of the latter, with destruction of the frontal parts of the Pennine and Austrian-Alpine nappes, thrusting from the south [24, 7, and 21]. In order to explain the presence of fragments of Habkern granites the existence of hypothetical granite boundary between the Ultragelvet and Pennine areas [7] has been assumed. An analogous assumption, as it will be shown below, also has been made for exotic inclusions (Upper Jurassic reef limestones, Bajocian volcanogens, Pre-Jurassic crystalline rocks), contained in the Upper Eocene olistostromes of the Southern Slope of the Greater Caucasus.

The French Alps (Western Alps). Here chaotic event deposits are presented by olistostromes which have developed within the Tertiary basin of Valensol, a part of the sub-Alpine chain and forming the external sedimentary cover of the Dauphine zone. Olistostromes here are developed in two places, where they extend for tens of kilometers in the form of narrow strips. The

first outcrop of olistostromes is confined to the Dign-Barle nappe; its northern part passes within the sub-Alpine chains and the southern - between the deposits of sub-Alpine chains and Provence. In the northern part the mentioned nappe has more or less meridional, and in the southern - an arcwise orientation. Due to this thrust, the allochthonous deposits of the Mesozoic (Trias-Liassic) age from the east to west thrust over the autochthonous molasse formations. The thrust zone suffered heavy tectonic impact and is built up of several tectonic sheets, consisting of rocks of diverse age. One of such sheets contains olistostromes with red bed matrix. In them, unlike the western outcrops of olistostromes, besides Cretaceous rocks olistoliths of Upper Jurassic limestones are present as well, their size varying within 20-80m [25]. To the west of Dign-Barle thrust the second outcrop of olistostromes is located. Here they take part in the structure of red molasses, occupying its bottom horizons. The red molasse itself is a lower part of the autochthonous molasse. In the ascending section, it is replased by continental deposits. The latter, in their turn, are overlapped by Miocene marine molasse and the Mio-Pliocene Valensol conglomerates. The red molasse olistostromes consist of separate horizons of chaotically built breccias and olistoliths of Cretaceous rocks that reach several hundred meters in diameter. The maximum thickness of olistostromes is up to 1 km [25]. Study of the structure, tectonic setting and composition of the olistostromes of the Valensol basin, led the majority of researchers to the conclusion that olistostromes were formed in similar paleogeographic conditions and that the main factor of their formation was tectonics that caused disintegration of rocks and formation of the tectonic cover made up of olistostromes [25, 26]. According to brachiopods and algae, also, by its stratigraphic position beneath the Miocene marine molasses, the age of the red molasse turned out to be the Lower Oligocene. The olistostromes that occupy the lower part of the red molasse are conventionally dated to the Upper Eocene.

Outer Dinarides. In the particular fold system, wild flysch is developed in the Ionic zone, within Albania and in the north-west of Greece. Here these formations are located between the Oligocene and Upper Eocene flysch deposits. They are most widespread along the eastern margin of the Ionic zone, in the area from the Greek border to middle Albania (zone Gavrovo). It is remarkable, that in the clastic parts of wild flysch, besides dense sandstones and limestone blocks, there is a considerable amount of fragments of Mesozoic ophiolites (serpentinites, periodites, gabbro, diabases, etc.) [27]. In this part of the Dinarides in flysch formations (as well as in molasses and other terrigenous deposits) there occur buried, rootless detached (exotic) blocks up to tens of millions of cubic meters in volume, mainly represented by limestones.It is considered that they got into the sedimentary basin due to strong co-sedimentary tectonic movements that took place at the end of Late Eocene [27]. Formation of wild flysch occurred in a short time interval, as testified by the complex of foraminifers; they are observed in the layers underlying and overlying the wild flysch, represented by practically the same complex of microfauna [28], most likely dating these formations to the upper part of the Upper Eocene.

The Greater Caucasus. In the given folded area, the Upper Eocene event deposits in the form of olistostromes are developed on the Southern Slope of the Greater Caucasus. Their greatest part is located within Georgia and only their separate outcrops are observed in the Azerbaijan part of the Southern Slope of the Greater Caucasus (Dashbulag and Talistan outcrops, Talistan and Shabian "cliffs").

The olistostromes under consideration - despite their strong tectonic processing and displacement over great distances (20-50 km) - give valuable information about the paleogeography and tectonic events, including catastrophic ones, going on in the second half of Late Eocene. Olistostromes formed to the south of the flysch basin, within the northern part of Gagra-Java zone with epicontinental mode of sedimentation, at present overlapped with overthrust nappes. They are distributed irregularly and observed in two localities "Fig.1".

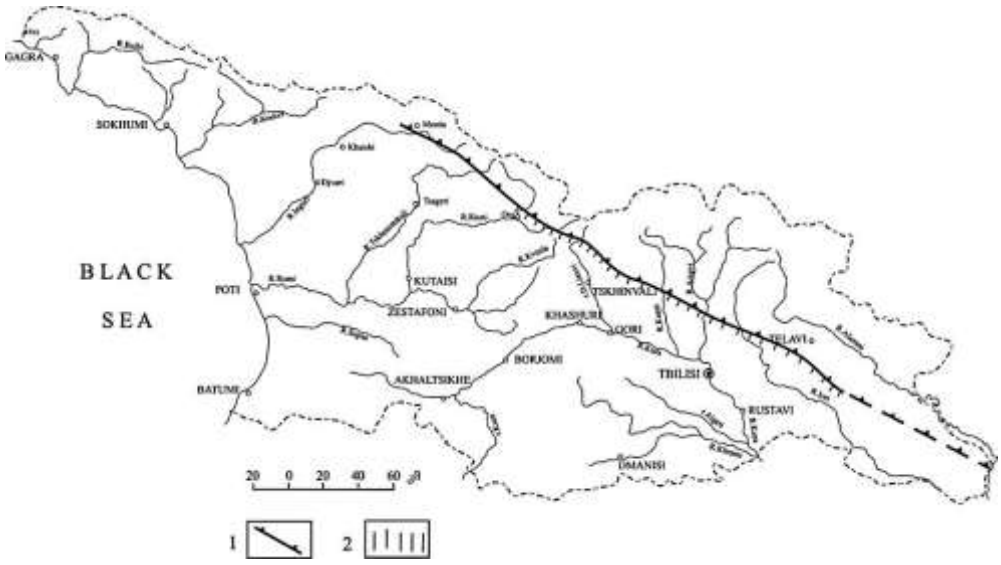

Fig.1. Scheme of distribution of Upper Eocene olistostromes on the territory of Georgia
1 - Frontal of thrust of flysch deposits; 2 – Zone of olistostromes propagation

Their minor part, developed in the western segment of the fold system (Adler depression) is part of the regressive Matsesta suite represented as a "horizon with inclusions" [29]. The completeness of the section of the Matsesta suite, contained the nummulitic fauna in it and distinct borders between the underlying and overlapping suites (Argveti and Khosta suites), allows to establish the beginning and duration of the New-Pyrenean orogeny. This orogeny has caused accumulation of the suite as a whole, and in its maximum display - formation of the "horizon with the inclusions". By its nature, the latter represents typical olistostromes of tectonic-gravitation origin [30, 31]. The main part of Upper Eocene olistostromes is developed in the eastern segment of the Southern Slope of the Greater Caucasus. Here, from the river Rioni they stretch as a narrow strip to the east, along the frontal line of the thrust of allochthonous flysch deposits of the Mestia-Tianeti zone. Due to this thrust the deposits under consideration partially, and at places probably entirely, are tectonically overlapped by the Cretaceous-Paleogene flysch deposits. In their turn, from the north, the olistostromes thrust over the autochthonous normally-sedimentary rocks of the Gagra-Java zone, including the Upper Eocene ones.

Researchers disagree on the issue of olistostrome age. They were attributed to different stratigraphic levels of the Eocene. According to nummulitic fauna they have been dated to the Upper Eocene [32]. Initially it was believed that the olistostromes cover all the Upper Eocene or its base. Then on the basis of new faunistic findings [17] and correlations with the coeval formations of the adjacent areas [30, 33] it proved feasible to specify the age of the olistostromes and to refer them to the uppermost Upper Eocene. Our studies show that the olistostromes are synchronous formations of the "horizon with the inclusions" of the Matsesta suite [30]. Olistostromes are built up mainly of olistoliths of the Mesozoic and, partially, Paleogene deposits of the Gagra-Java zone. Among them the Upper Jurassic reef limestones and Bajocian volcanites are widesprea. Moreover, these olistoliths are characterized by huge size. Especially it concerns to limestones, which in separate exposures correspond to olistoplacs; in volume they reach several hundreds and thousand cubic meters (mountains Orbodzala and Alevis-klde, the Georgian Military road, etc.). Because of huge sizes of these rocks, some of them had earlier been considered as the Upper Jurassic bedrocks. The inner structure of the Upper Eocene olistostrome complex is very complicated. Separate parts of this section of the strata thrust over each other, stratified varieties of rocks are intensively kneaded, competent strata are fractured, boudinaged, brecciated, broken up. If taken into account the irregular placement of debris (olistoliths) and slabs (olistoplacs) in the matrix, in general chaotic character and tectonic processing, the presence of tectonized fragments and, as noted, great volume and immense spread, these olistostromes should be attributed mainly to tectono-gravitational olistostromes. Nevertheless M.G.Leonov [34] notes the presence of lenslike bodies of peculiar breccias of small thickness (1-2m)

and extent (20-30m), coarse-grained part of which is composed of absolutely unrounded, curved, oddly deformed fragments of sandstone beds, but the matrix is composed mainly of pelitic material. These breccias are characterized by the presence of clayey pellets and absence of allothigenic material. The composition of breccia fragments and matrix corresponds to that of the enclosing sediments. Proceeding from these features, these locally spread bodies of breccias are attributed to gravitational mixtites.

When dealing with the formation mechanism of olistostromes of the Southern Slope of the Greater Caucasus, it should be noted that many researchers consider tectonics to have a key role in their formation. The process of olistostrome formation is attributed to the periods of folding and nappe formation [17, 34, 35, 36, 30, and 33]. V.P.Rengarten [37] was the first to specify linkage of olistostrome formation (block breccias) with the destruction of frontal parts of tectonic nappes.

The presence in olistostromes of exotic inclusions of the Upper Jurassic limestones (the Georgian Military road, Kakheti) and crystalline rocks of the basement (to the east of the river Aragvi) gave rise to the question of the location and structure of the land that supplied the Late Eocene basin with clastic material. Such a hypothetical land was most likely the Racha-Vandam land; it was a chain of separate cordilleras, located in the northern peripheral part of the Gagra-Java zone, extending from the Utsera meridian in the west along the southern boundary of the flysch basin [36, 30].

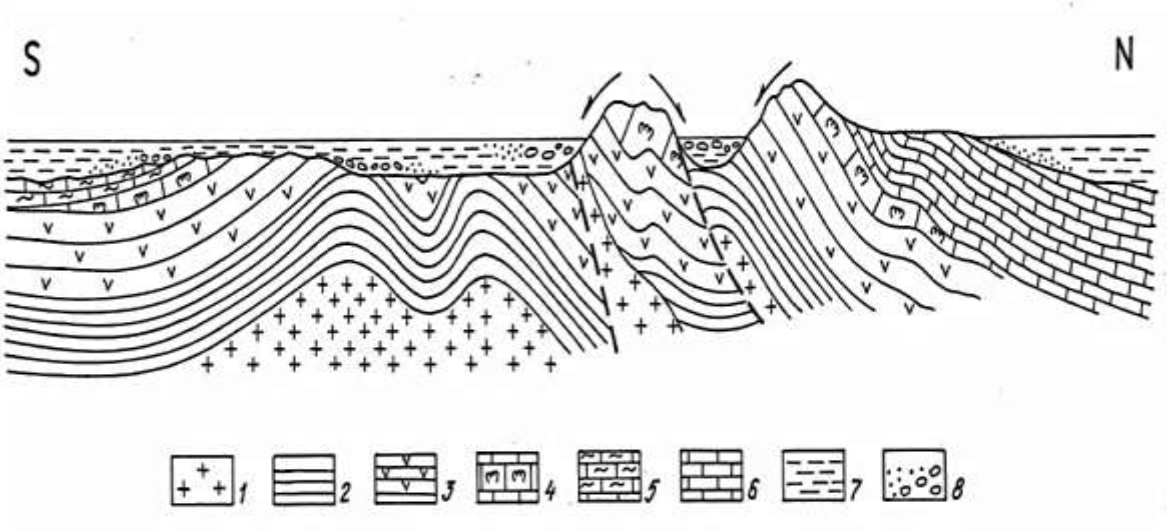

Fig. 2. Paleogeographic profile of the end of the Late Eocene
1 – Pre-Alpine crystalline basement, 2 – Lower Jurassic-Aalenian sandstones and shales, 3 – Bajocian porphyritic series, 4 – Upper Jurassic reef limestones, 5 – Cretaceous limestones (Gagra-Java zone facies), 6 – Aptian-Paleogene flysch sediments, 7 – Upper Eocene norm- sedimentary suite, 8 – Upper Eocene olistostromes.

The composition of the clastic material of olistostromes shows that this cordillera zone had been built up mainly of Mesozoic and partially of Lower Paleogene rocks of the Gagra-Java zone; beginning from the river Aragvi and more easterly, it consists of the rocks of the pre-Jurassic crystalline basement "Fig.2". It was the main source of terrigene material not only in Paleogene, but most likely in the Cretaceous period as well [33, 38]. In the second half of Late Eocene, during the Pyrenean orogeny, along the thrust front of flysch formations, due to nappe formation [17, 34, 36, 30, 2] there took place an intensive destruction of Racha-Vandam cordillera zone and dislocation of the disintegrated material in the southward direction, towards the epicontinental basin; here there began deposition of olistostromes around the cordilleras.

Delivery of rudaceous material did not occur gradually over a long time, but it was connected with oft-recurring short-term catastrophic processes (instant in geological sense). This is indicated by sharp contacts of breccias with the surrounding sandy-argillaceous sediments, and it can be seen as the blocks press in underlying, probably not consolidated sediments.

The cordillera zone – at present completely overlapped with flysch thrust – was apparently formed due to the Bathonianorogeny, existing up to the Late Eocene inclusive [36].

Conclusions

As to the issues of general paleogeography and genesis of both the olistostromes and the wild flysch of the Alpine fold system, it should be noted that, along with catastrophic events, their formation necessitated the presence of a dissected relief in the form of cliffs and cordilleras - the basic suppliers of clastic material. Movements of disintegrated material in the areas of sedimentation, as illustrated by the examples, mostly occurred due to the tectonic movements and the attendant downfall-landslide processes, being indicative of their tectonic-gravitational origin. These geological events occurred especially frequently in the zones of deep faults and in the process of nappe-formation as well. Whereas olistostromes and a wild flysch of tectonic-gravity origin are, as a rule, characterized by regional spreading, great thickness, and polygenic content of rocks of different age and by the presence of exotic blocks, analogous formations of purely landslide genesis are spatially restricted and have a rather uniform composition of inclusions. Gravity-induced olistostromes are indicators of intensification of vertical movements, mainly along high-angle faults, while tectonic-gravity olistostromes point to horizontal dislocations connected with the formation of tectonic nappes [34, 39].

When considering the process of wild flysch formation from the point of view of catastrophic events, one should note the following sequence in its formation. During flysch formation when the background deposits settled, in definite time intervals, due to relatively weak catastrophic events turbidities were deposited. However, when tectonic movements reached their peak, intensive catastrophic processes took place, thus delivering into the basin fragments (blocks) of huge size, causing the formation of olistostrome strata building a wild flysch. Comparing event deposits of cyclically (tempestites, turbidites) and chaotically (olistostromes, wild flysch) built formations, it may be stated that they sharply differ from each other by structure and lithology; though they are similar by genesis, being products of catastrophic events of varying scale andintensity. While tempestites and turbidites are products of single and very short-term catastrophes, olistostromes and wild flysch were often formed due to recurring catastrophic events; thus, their formation in time lasted longer, though according to geological criteria it too is a short-term event. Even at great thicknesses, the stratigraphic range of their accumulation is excessively short [34]. The considered event deposits of the Alpine fold system, being synchronous formations, clearly pointing to their timing to the same geological event. In particular, as V.E.Khain [40] assumes, such could have been a collision leading to the formation of the fold-nappe structure of the Greater Caucasus. It began at the end of Late Eocene, reaching its maximum in Late Miocene when the Arabian plate separated from the African plate and began movement to the north. In addition, it should be noted that, in our opinion, classification of event sediments, should be made with account of the extent of intensity and scale of manifestation of those catastrophic events, which form these sediments. From this point of view, event-induced chaotic sediments (olistostromes, wild flysch) are formations of higher order, than analogous sediments of the rhythmically built formations (tempestites, turbidites).

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SUBSECTION
Atmosphere and Climate Change

THE HYDROLOGICAL CYCLE AND NATURAL CATACLYSMS IN THE MODERN CIVILIZATION

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Water, the most important natural resource in the world, plays a major role in the development of communities. Without water life cannot exist and industry cannot operate. Unlike many other raw materials water cannot be substituted by any other resource. Therefore it can be stated that water is an essential prerequisite for the establishment of human communities.

However, water as a natural resource for human wellbeing is only one aspect. Water in its different physical phases, like liquid, solid and gaseous, may pose risks to life, residences, and industrial plants. Heavy precipitation, floods, storm surges, and ice are only some examples for the occurrence of risks and the related problems. Therefore the knowledge about the movement of water on the land surface and the interactions with oceans and the atmosphere is a key issue. This movement is known as the 'Hydrological Cycle'.The hydrological cycle is a closed system in the sense that water circulating in the system always remains within the system. The whole cycle is driven by the excess of incoming solar radiation over outgoing radiation. The cycle consists of several subsystems, namely: the atmosphere, surface runoff, subsurface water (or unsaturated zone), groundwater (or saturated zone), river networks, and the oceanic subsystem. It is obvious that the occurrence of water on the land plays a major role within this cycle, because it is mainly there where man and the hydrological cycle interact. This part is called surface hydrology and it follows the atmospheric hydrology, which deals with the atmospheric motion of water usually in the form of vapour and water fluxes, and finally subsurface hydrology, which deals with the water in porous underground. The subdivision of the hydrological cycle into subsystems above and below the land surface is somewhat arbitrary, because continuous, but spatially and temporally varying, interchanges between them take place in the dynamic processes of the water movement.Within these highly dynamic processes of the water movement, the main activities of the mankind take place with all the cities, industrial plants and harbours on lakes, rivers, estuaries, or coastal waters. Even if all these facilities did not release any kind of substance which is not harmful, they would have influence on the dynamic water motion. Change in vegetation, e.g. from forest to arable land, has influence on the movement of water and its variation in time. There will be changes in water storage, precipitation, and even loss of soil into the rivers. The soil in the river can also cause reactions like erosion and sedimentation in other parts of the river system. Urbanization and the creation of impervious areas affect both the hydrology and hydraulics of drainage systems. They change the runoff characteristics and have adverse effects on the designed drainage structures, such as bridges, culverts, and sewers. These are only a few examples of anthropogenic impacts on the hydrological cycle. There are many other processes, which take place on local, regional, and global scales. When evaluating the influence of man's activity, the natural variation of the system has always to be taken into account. This variation can be tremendous. Nowadays, nearly all large rivers are trained for navigation. The natural behaviour of a river is not static, it is dynamic, e.g. meandering. Storms that hit unprotected coastlines can carry off large amounts of valuable land. Nowadays many coastlines are improved by shore protection structure and dikes. Therefore the risk of land loss by storm surge will be small, but there is always a remaining risk. However, tidal rivers, which were deepened for navigation, will have a much bigger tidal range than before. Deeper water serves the incoming ships by providing a fairway and improves the transport by large

ships. The reverse effect is the change of the incoming tide, which introduces more energy and carries more sediment into the tidal river. As a consequence, more dredging is needed in the fairway. Unfortunately, the liquid and solid wastes from communities have a considerable potential for environmental pollution. This pollution also affects the hydrological cycle. Therefore it is necessary to address this problem in more detail. The various interconnected subsystems and parts of the Earth, like atmosphere, water, soil sediments, and biota, contain material that is characterized by high area-to-volume ratios. Adsorption influences the distribution of pollutants between the aqueous phase and particulate matter and, in turn, affects their transport through the various parts of the hydrological cycle. The geochemical fate, the residence times, and the residual concentrations of reactive elements such as heavy metals and organic pollutants are to a large extent controlled by their affinity to solid surfaces. Colloids are ubiquitous in sea water, in freshwater, in soil, and in groundwater. The chemical, physical, and biological processes that occur in the different subsystems and at the interfaces between them influence the major geochemical cycles.Hydrological knowledge is also needed in the assessment of the interaction of the hydrological cycle with the biochemical cycles. Understanding how chemical cycles inter-depend and are coupled with particles and organisms may aid our understanding of global ecosystems and teach as how interacting systems may become disturbed by human activity.Water, a natural resource for a growing population and industrial development, has to be managed very carefully.

THE STUDY OF SINKHOLES IN THE MOSCOW TERRITORY

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About ten new sinkholes are registered every year in Moscow during the last 10 years. The lateral dimensions of sinkholes formed at the surface reach 10--15 m. These sinkholes cause noticeable damage to the urban economy and may threaten human lives and health. They may occur on roadways, under which the subsurface pipelines are laid, near construction pits and sewage wells. However, most of sinkholes are not evidently confined to any underground structures. To forecast possible collapses, it is necessary to be aware of their formation mechanism and to identify geological criteria for subdividing urban territory in areas of different stability. In Moscow, sinkholes and surface subsidence have been investigated by many researchers; most of them treat these phenomena as karst and suffusion manifestation. Karst-suffusion development is favored by specific geological structure: easily soluble calcareous deposits are overlain by sand and clay of varying thickness. Suffosion processes are induced by the presence of water-saturated sandy deposits of different age and heterogenous composition in the upper part of geological massif.Proceeding from annual information reports published during 1935-1995, mass media data, and our own observations, 183 sinkholes and subsidence cases were registered on the Moscow territory since 1930 till 2010. The MS Excel database was compiled, which included information about time, place, and the data source on each case; sinkholes and subsidence cases were classified depending on the data availability on the possible technogenic reasons of an incident (water pipelines break, new construction, etc.) The obtained data on sinkholes were represented in the form of point objects in a computer map of Moscow using MapInfo Professional GIS. Next, for each case of collapse or subsidence, the neighbor boreholes records were analyzed and the geological structure information was added to the database (surface elevation a.s.l., technogenic layer thickness, thickness of moraine deposits, depth of karstified limestone occurrence, the total thickness of overlaying clay, etc.)The statistical processing of the data obtained permitted us to classify sinkhole cases by seasons, allocation at different geomorphological areas, and types of geological structure.

THE IMPACTS OF GLOBAL CLIMATE CHANGES ON THE HYDRO METEOROLOGICAL CONDITIONS OF AZERBAIJAN REPUBLIC

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As the result of global climate changes the number of natural disasters related to dangerous hydro meteorological processes, such as mudflows, floods, forest fires, droughts and etc. has been increased recently. According to the information provided by World Meteorological Organization (WMO) 80-85% of natural disasters all over the world were caused by dangerous hydro meteorological processes. It's clear that such increase in the dynamics of natural disasters of different origins is the result of global warming impacts on atmosphere connected to the global climate changes.

In general, during whole observation period, XX century was declared as the most warm century, the last 10 years of the XX century were declared as the most warm decade, 1995, 1998, 2000, 2003, 2006 years – the most warm years in history. As the result, humanity has been faced with climate changes and dangerous natural disasters created by certain geophysical processes. One of the key challenges for scientists worldwide is the increasing of World Ocean's level, decreasing of ice cover on the Arctic Ocean, Antarctica and in Greenland follows from global temperature increasing.

In comparison with the basis period 1961-1990, established by WMO, at the territory of Azerbaijan Republic increasing of long-term annual (perennial) temperature up on 0.7^0C and little increasing in precipitations were observed. It's particularly interesting that, if we will make confrontation between basis period and last 15 years period the increasing in winter seasonal temperature and decreasing in spring seasonal temperature could be observed. For other seasons, such as summer and autumn, seasonal temperature increasing could be observed. In 2006, 2007, 2008 and 2009 years at the altitudes of the territory of Azerbaijan Republic significant changes in dynamics of precipitation and temperature in comparison with the norm were observed.

The table shows that at the territory of republic the maximum increase of temperature was observed at the altitude more than 1000 m.As the result of disasters, about 20000 houses were flooded, more than 300 were destroyed, 2000 were in emergency condition, about 50 hectare of cropped land were flooded.

The total amount of material looses were estimated at 500 million AZM.

Table 1.

Distribution of the middle-term annual and long-term annual (1961-1990) temperature on different altitudes of the Azerbaijan Republic territory in 2007, 2008 and 2009

Heights м	**≤ 0**	**0 - 200**	**201-500**	**501-1000**	**>1000**	**According to the Republic territory**
Norm 1961- 1990	14.6	14.3	13.3	11.9	7.8	12.3
Middle annual 2007	15.3	14.9	13.7	12.4	8.5	12.9
Difference, °C	*+0.7*	*+0.6*	*+0.4*	*+0.5*	*+.0.7*	*+0.6*
Middle annual 2008	*15.4*	*15.1*	*14.2*	*12.5*	*8.9*	*13.0*
Difference, °C	*0.8*	*+0.8*	*+0.9*	*+0.6*	*+1.1*	*+0.7*
Middle annual 2009	*15.2*	*14.9*	*14.1*	*12.3*	*8.8*	*12.9*
Difference, °C	*+0.6*	*+0.6*	*+0.8*	*+0.4*	*+1.0*	*+0.7*

SECTION 3
Cosmic-Terrestrial Relations, Chronobiology, BIOCOS Program

INFRADIAN CYCLES IN AGING HUMAN PSYCHOPHYSIOLOGY GAUGED BY THE CIRCADIAN MESOR AND AMPLITUDE

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Aim. By odds ratios based on the criterion of shared frequencies in the infradecadal, notably para-annual range of the spectrum, the association of environmental functions with solar activity more than matches the association of helio- to geomagnetics (1, 2). Therefore, we seek to continue the cartography of aging with the aim of replacing the misconceptions of aging trends by more complete time structures, including cycles.

Method. Multiple psychophysiological variables – oral temperature (Temp), vigor (VIG), mood, 1-minute time estimation (TE1m) and eye-hand coordination (EyeH) – were self-assessed about (~) 5-6 times/day for 43.5 years by a clinically healthy man, RBS. Some of the output of cosinor analyses of consecutive 48-hour spans (intermediate computations) was used to constitute two separate time series for each variable, one of the 24h MESORs (M, a better average than the arithmetic mean) and the other of the 24h amplitudes (A, measure of predictable within-day change). Linear-nonlinear extended cosinor analysis (3-5) of the circadian Ms and As reveal separate sets of periods during aging from ~20.5 to >64 years of age, Table 1 and Figures 1-5. The MESOR of Temp and TE1m are each characterized by an ~22-year cycle; Temp also has ~10.6-year and ~5.2-year cycles, perhaps in harmonic relation. TE1m also has ~6.6-year and ~3.7-year components, perhaps also in harmonic relation. Periods for 2A (the double circadian amplitude) are ~15.7 and ~10.2 years for Temp and ~16.6 and ~9.7 years for TE1m. It seems noteworthy, however, that the MESOR of mood has a CI (95% confidence interval) reaching 30.7 years and that of VIG a CI reaching 28.5 years. For 3 of the 2As, the CI enters the 30-40-year range (VIG, TE1m and EyeH), and for mood a CI reaches 41.2 years. We thus realize that, as Brǧckner noted, given a very wide variability of what we called the transtridecadal Brǧckner-Egeson-Lockyer (BEL) cycle, we might rather deal with a paratridecadal cycle in 2 variables' MESORs and double circadian amplitudes in 4 variables. Accordingly, para-tridecadal periods (τ) have been redefined, in the light of analyses of double amplitudes here tabulated, as having a CI of τ reaching into the range of τs from 28-42 years. Some of these τs, congruent with solar activity cycles, may be evolutionary built-in signatures of the ~22-year Hale cycle of sunspot bipolarity (4 of the Ms) and of the ~11-year Schwabe cycle and/or of their harmonics. A selective assortment of the organism's and the environment's congruent τs (6) may change somewhat with the lengthening of the time series, Figure 5, and/or as a function of age (1). Such findings are not apparent by inspection of a plot of the variables investigated here (7), Figure 6, and elsewhere by others (8-13) and us (14-17).

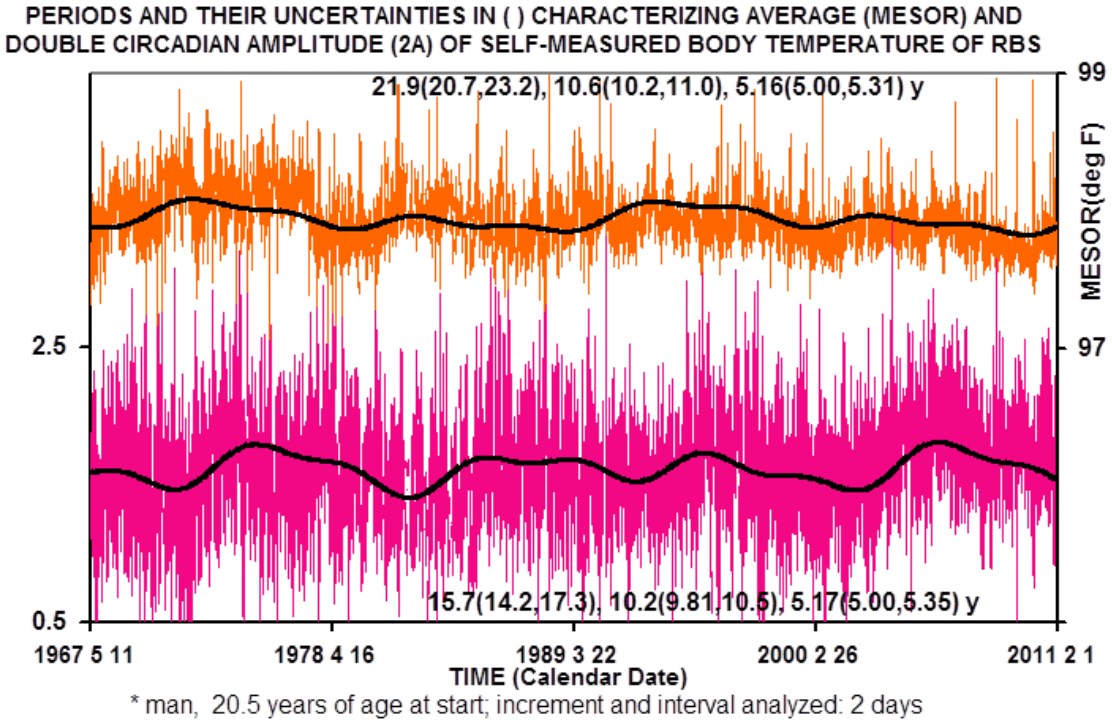

PERIODS AND THEIR UNCERTAINTIES IN ( ) CHARACTERIZING AVERAGE (MESOR) AND DOUBLE CIRCADIAN AMPLITUDE (2A) OF SELF-MEASURED BODY TEMPERATURE OF RBS
21.9(20.7,23.2), 10.6(10.2,11.0), 5.16(5.00,5.31) y
15.7(14.2,17.3), 10.2(9.81,10.5), 5.17(5.00,5.35) y
99
97
MESOR(deg F)
2.5
0.5
1967 5 11
1978 4 16
1989 3 22
2000 2 26
2011 2 1
TIME (Calendar Date)
* man, 20.5 years of age at start; increment and interval analyzed: 2 days

Fig.1.

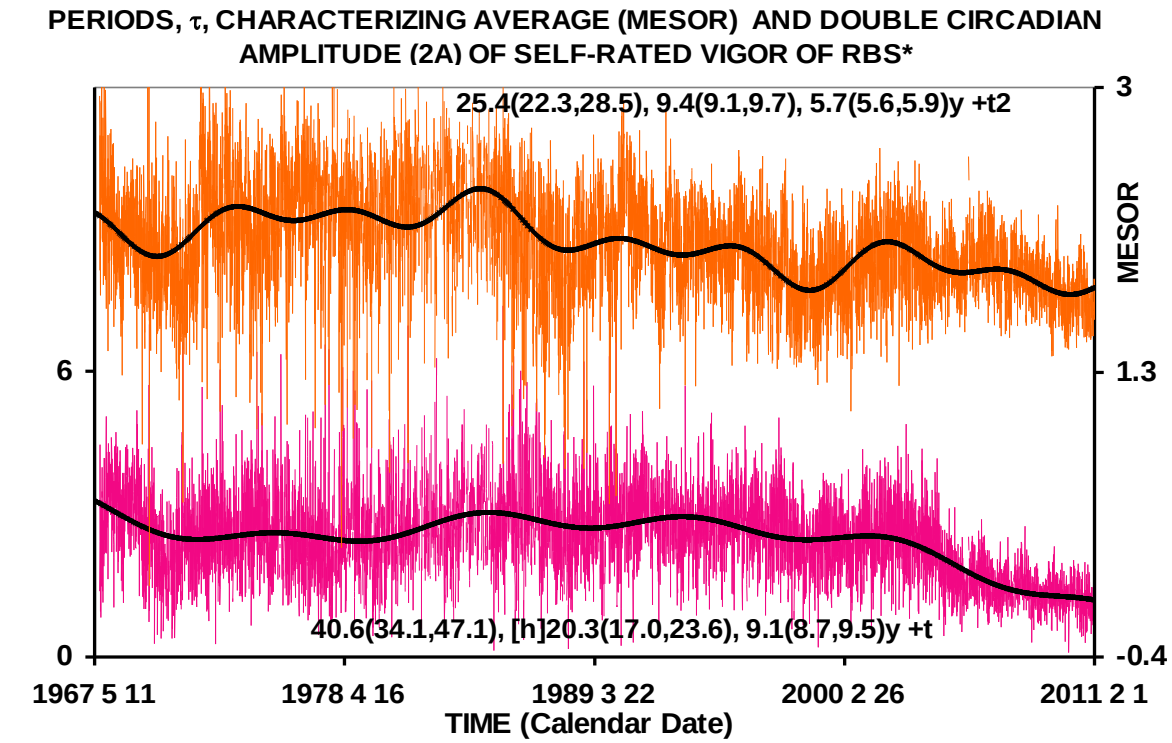
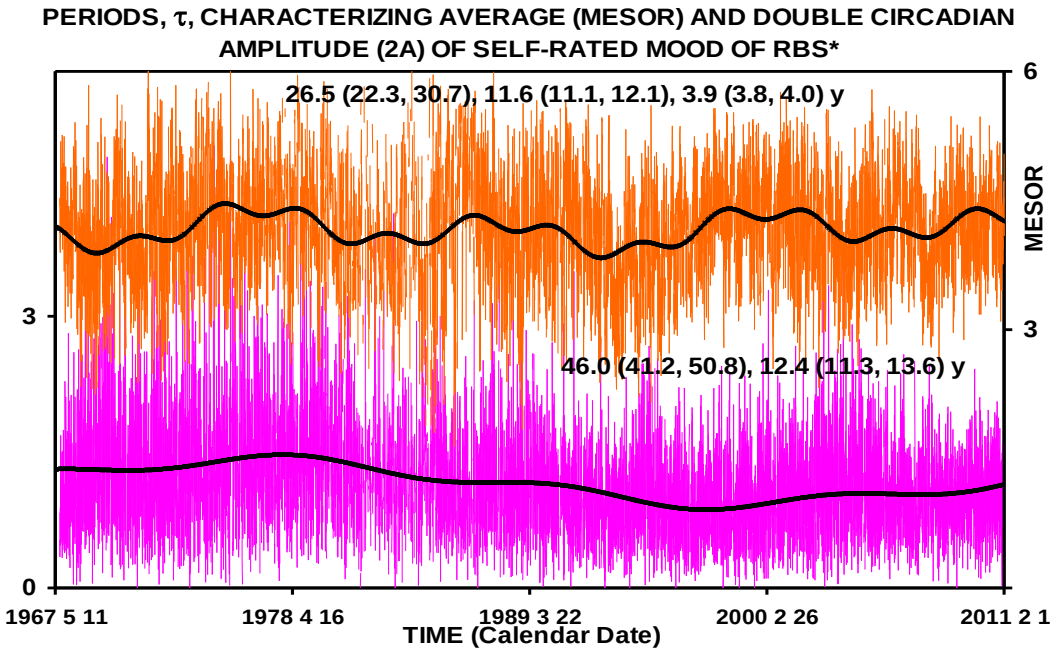
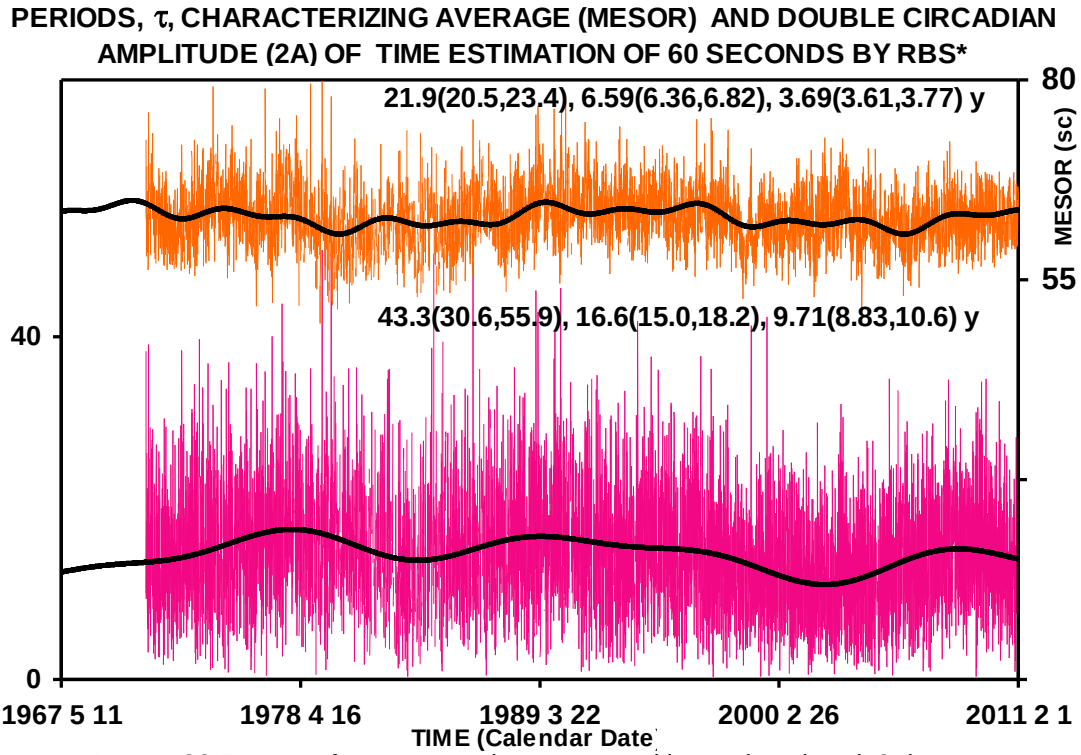

PERIODS, τ, CHARACTERIZING AVERAGE (MESOR) AND DOUBLE CIRCADIAN AMPLITUDE (2A) OF SELF-RATED VIGOR OF RBS*
25.4(22.3,28.5), 9.4(9.1,9.7), 5.7(5.6,5.9)y +t2
40.6(34.1,47.1), [h]20.3(17.0,23.6), 9.1(8.7,9.5)y +t
3
1.3
-0.4
MESOR
6
0
1967 5 11
1978 4 16
1989 3 22
2000 2 26
2011 2 1
TIME (Calendar Date)
* man, 20.5 years of age at start; increment and interval analyzed: 2 days

Fig. 2.



* man, 20.5 years of age at start; increment and interval analyzed: 2 days

Fig. 3.



* man, 20.5 years of age at start; increment and interval analyzed: 2 days

Fig.4.

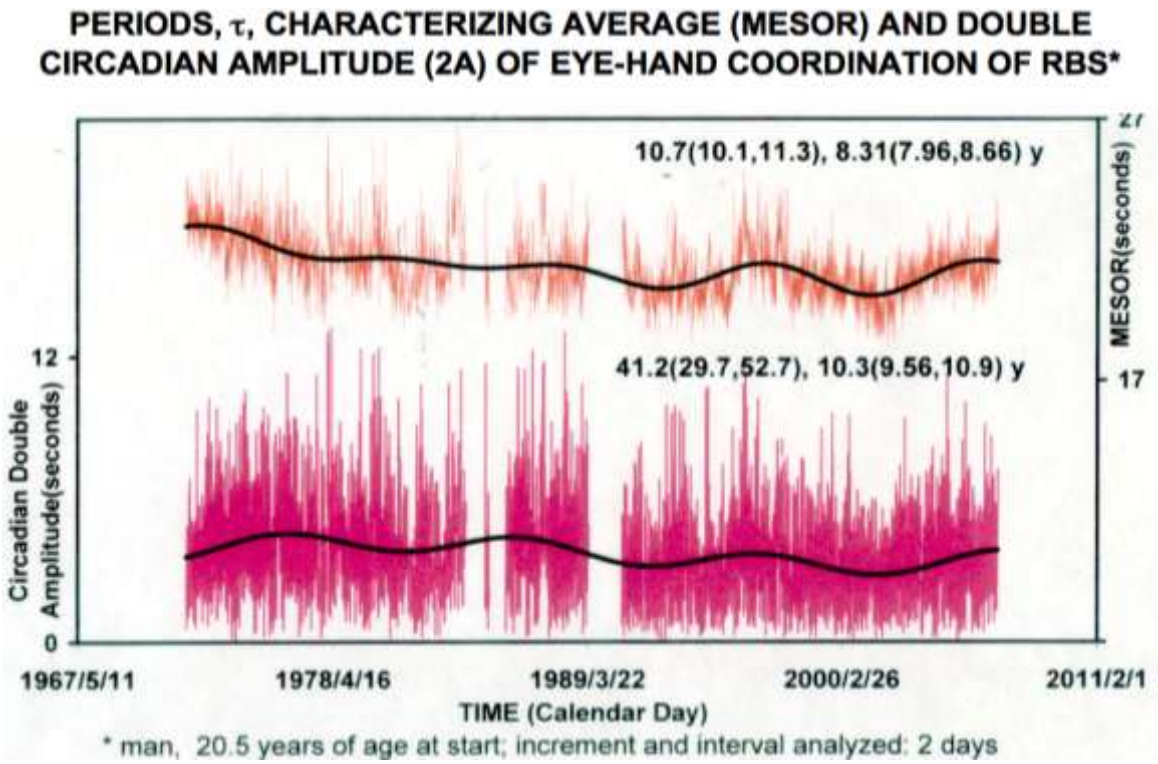

PERIODS, τ, CHARACTERIZING AVERAGE (MESOR) AND DOUBLE CIRCADIAN AMPLITUDE (2A) OF EYE-HAND COORDINATION OF RBS*
10.7(10.1,11.3), 8.31(7.96,8.66) y
41.2(29.7,52.7), 10.3(9.56,10.9) y
MESOR(seconds)
Circadian Double Amplitude(seconds)
12
0
17
1967/5/11
1978/4/16
1989/3/22
2000/2/26
2011/2/1
TIME (Calendar Day)
* man, 20.5 years of age at start; increment and interval analyzed: 2 days

Fig. 5.

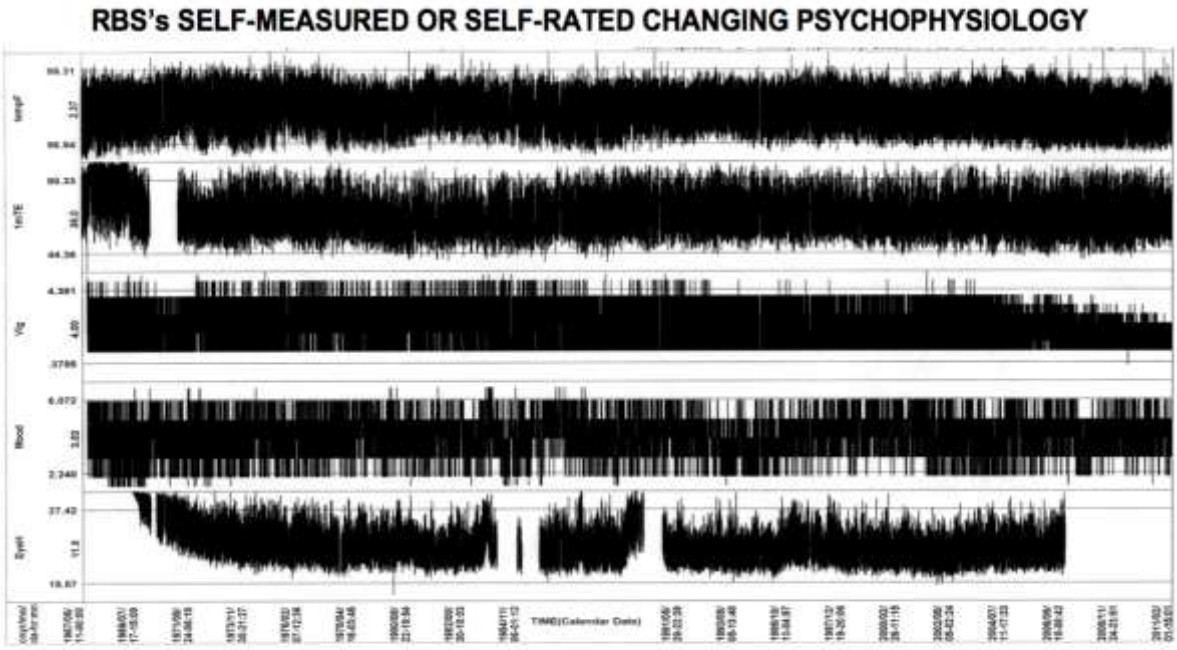

RBS's SELF-MEASURED OR SELF-RATED CHANGING PSYCHOPHYSIOLOGY
*Data between negative and positive 2 standard deviations (SD) from the mean are plotted hourly within the proximal horizontal lines. Beyond these lined, in the strips out to the distal upper and lower borders, data are compressed for an exponential approach to the upper and lower extremes representing + or - infinity, respectively. Location: 3 SD at ~5/8, and 4 SD at ~7/8 of strip width.

Fig. 6.

Table 1

Statistically significant periods (τ) from nonlinearly extended cosinor in 5 variables of RBS, a clinically healthy man self-measuring and self-rating 6 times a day for 43.5 years*

		Period (95% CI) (years)				Trend	Overall SE
MESOR							
Temp	τ	21.9 (20.7, 23.2)	10.6 (10.2, 11.0)	5.16 (5.00, 5.31)	-	-	0.20
	2A	0.14 (0.11, 0.17)	0.12 (0.09, 0.15)	0.06 (0.03, 0.09)	-	-	
VIG	τ	25.4 (22.3, 28.5)	9.38 (9.06, 9.70)	5.74 (5.61, 5.87)	-	t^2	0.29
	2A	0.17 (0.12, 0.22)	0.16 (0.11, 0.21)	0.15 (0.10, 0.19)	-	-	
Mood	τ	26.5 (22.3, 30.7)	11.6 (11.1, 12.1)	3.87 (3.78, 3.96)	-	-	0.65
	2A	0.20 (0.10, 0.30)	0.35 (0.25, 0.44)	0.19 (0.10, 0.29)	-	-	
TE1m	τ	21.9 (20.5, 23.4)	6.59 (6.36, 6.82)	3.69 (3.61, 3.77)	-	-	3.38
	2A	2.27 (1.74, 2.80)	1.32 (0.80, 1.83)	1.10 (0.58, 1.61)	-	-	
EyeH	τ	9.80 (8.98, 10.6)	8.05 (7.66, 8.44)	5.76 (5.49, 6.04)	3.45 (3.39, 3.50)	t^2	0.91
	2A	0.63 (0.36, 0.90)	0.90 (0.62, 1.18)	0.39 (0.18, 0.61)	0.59 (0.40, 0.78)	-	
Double amplitude							
Temp	τ	15.7 (14.2, 17.3)	10.2 (9.81, 10.5)	5.17 (5.00, 5.35)	-	-	0.40
	2A	0.13 (0.07, 0.19)	0.21 (0.15, 0.27)	0.11 (0.05, 0.16)	-	-	
VIG	τ	40.1 (35.3, 44.9)	[h] 20.0 (17.6, 22.4)	5.74 (5.59, 5.89)	-	t	0.78
	2A	1.08 (0.82, 1.34)	[h] 0.26 (0.13, 0.39)	0.33 (0.21, 0.44)	-	-	
Mood	τ	46.0 (41.2, 50.8)	12.4 (11.3, 13.6)	-	-	-	0.60
	2A	0.48 (0.41, 0.56)	0.14 (0.06, 0.22)	-	-	-	
TE1m	τ	43.3 (30.6, 55.9)	16.6 (15.0, 18.2)	9.71 (8.83, 10.6)	-	-	6.68
	2A	3.10 (2.07, 4.13)	2.93 (1.83, 4.03)	1.70 (0.63, 2.78)	-	-	
EyeH	τ	42.5 (27.2, 57.8)	10.2 (9.40, 11.0)	1.01 (1.00, 1.02)	-	-	1.88
	2A	1.00 (0.69, 1.31)	0.80 (0.48, 1.13)	0.70 (0.38, 1.02)	-	-	

Temp: core temperature; VIG: vigor; TE1m: time estimation, 1 minute; EyeH: eye-hand coordination; SE: standard error. 95% CI: 95% confidence intervals. SE: overall standard error. [h]: fixed harmonic; t: linear trend; t^2: quadratic linear trend.

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INFRADIAN CYCLES GAUGE AGING OF THE HUMAN CIRCULATION AND RESPIRATION AROUND THE CLOCK FOR OVER FOUR DECADES

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Aim. To map the cycles that characterize human adulthood and to substitute such cartography for the misconception of trends in aging that constitute misconceptions based in part on the lack of the kind of longitudinal data on individuals such as those investigated herein.

Method. Multiple physiological variables – systolic (S) and diastolic (D) blood pressure (BP) (mean of 3 readings), heart rate (HR), pulse pressure (PP), respiratory rate, assessed in 2 minutes (BR2m) and peak expiratory flow (PF, mean of 3 readings), Figure 1 – were self-measured about 5-6 times a day, for 43.5 years (y), by a clinically healthy man, RBS, aging from ~20.5 to >64 y. Cosinor analyses of consecutive 48-hour spans of these data yield, as intermediate computations (imputations), time series for two of the circadian (24-hour) rhythm characteristics, the **m**idline-**e**stimating **s**tatistic **o**f **r**hythm, MESOR (M) (usually a better average than the arithmetic mean), and the double circadian amplitude, 2A (a measure of predictable within-day change).

Results. When analyzed by the extended cosinor (1-4), these two new sets of time series of Ms and As for each variable reveal separate sets of periods during the span investigated (Fig. 2-7).

Table 1 summarizes the results. Some of the periods found correspond roughly in length to periods of solar variability or to their harmonics and may or may not differ for Ms vs. As. A paratridecadal period, τ, characterizing the environment (5-9), was anticipated for HR (10), and indeed one model fitted herein to HR has a 32.9y cycle with a CI (95% confidence interval) extending from 31.4 to 34.4y, but it has a larger residual error, as compared to that of a 48.8y period with a CI of τ that somewhat overlaps the 30-40y range when a trend (t) function is included (Table 1). The 48.8y period could result from possible changes (in period) with age and/or with the length of the series, as documented earlier for another subject as a change from the calendar year to a transyear component (11). It thus seems possible that a previously reported paratridecadal component has changed into an about 50y component, previously reported as a population rhythm for the incidence of strokes in Minnesota, USA, and in the Czech Republic (12), and well-known in economics as the Kondratiev period (13).

Only additional data can decide which period(s) apply. The same two models show that more than one τ or set of τs can fit the data. In the case of doubt the smaller residual error can be used as the criterion for the superiority of a model, unless another result was anticipated on the basis of prior evidence (10). This is the case in view of documentation of a near-32.9y τ for the previously analyzed HR data, found earlier when the series was shorter, a result that should approximate that currently obtained for the M of HR in RBS. A paratridecadal cycle is also reported for the BR2m-M (τ = 29.1y) and for SBP-M (τ = 29.1y with a CI reaching 29.0y). In view of these findings, "para" was added to "tridecadal" and the still-tentative definition of the BEL – Brǧckner (6), Egeson (5) and Lockyer (7) – cycle extended to τs whose CI reaches the region between 28 and 42y.

Conclusion. A selective assortment of the organism's and the environment's periods that probably reflect solar activity (14), at least in part (not shown), has changed somewhat with the lengthening of the time series and/or as a function of age. The naked eye can consider the original data plot in Figure 1 to guess that there are indeed changes with time in kind and extent of oscillation in HR and a trend in PF in the bottom row. Not only such macroscopy, but also a global analysis (of a series as a whole) in Figures 2-7, remains to be complemented by serial sections and/or gliding spectra, spectrograms and/or wavelets, to assess changes with time in the periods involved and thus to start placing aging on a chronobiologic basis.

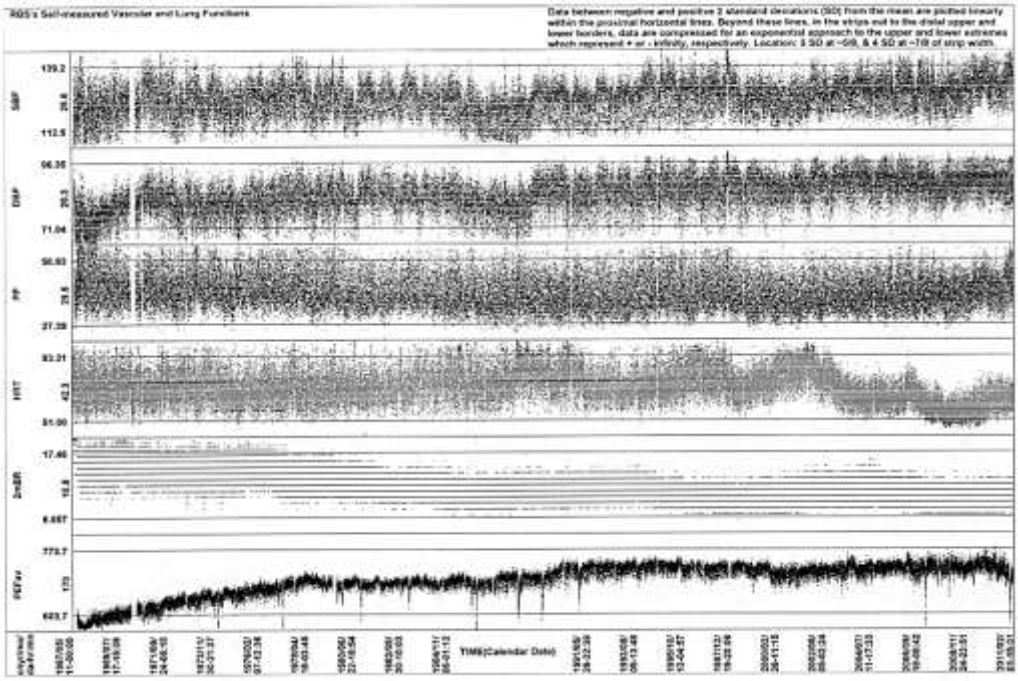


Fig. 1.

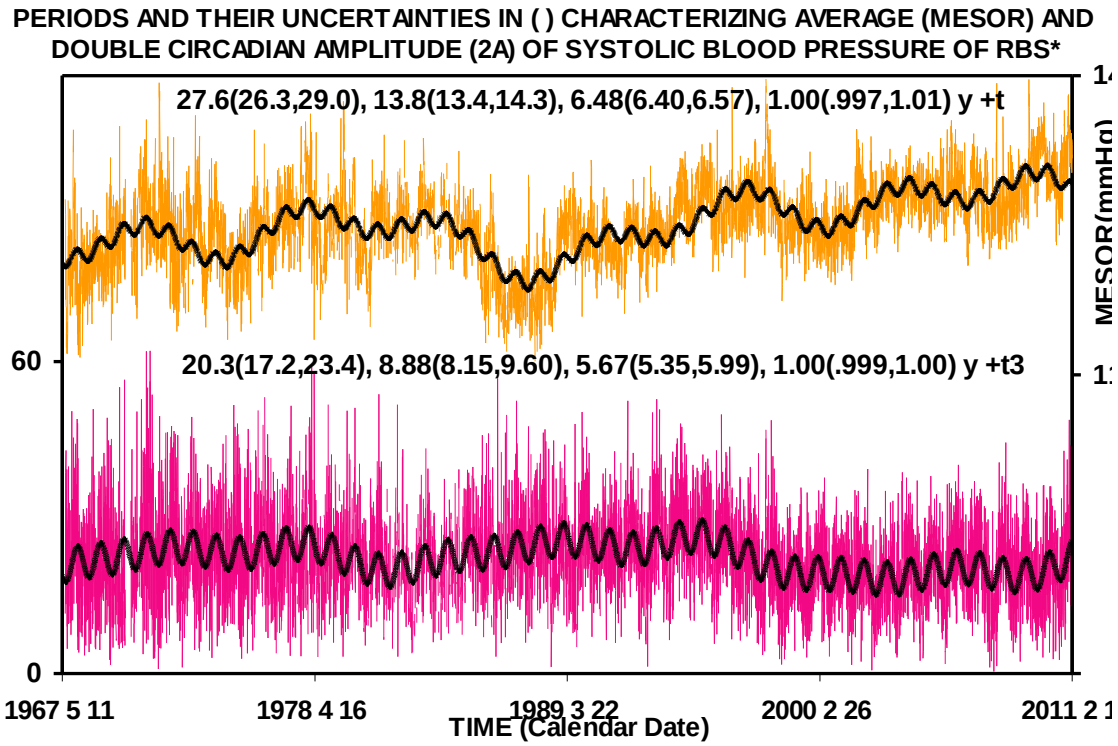
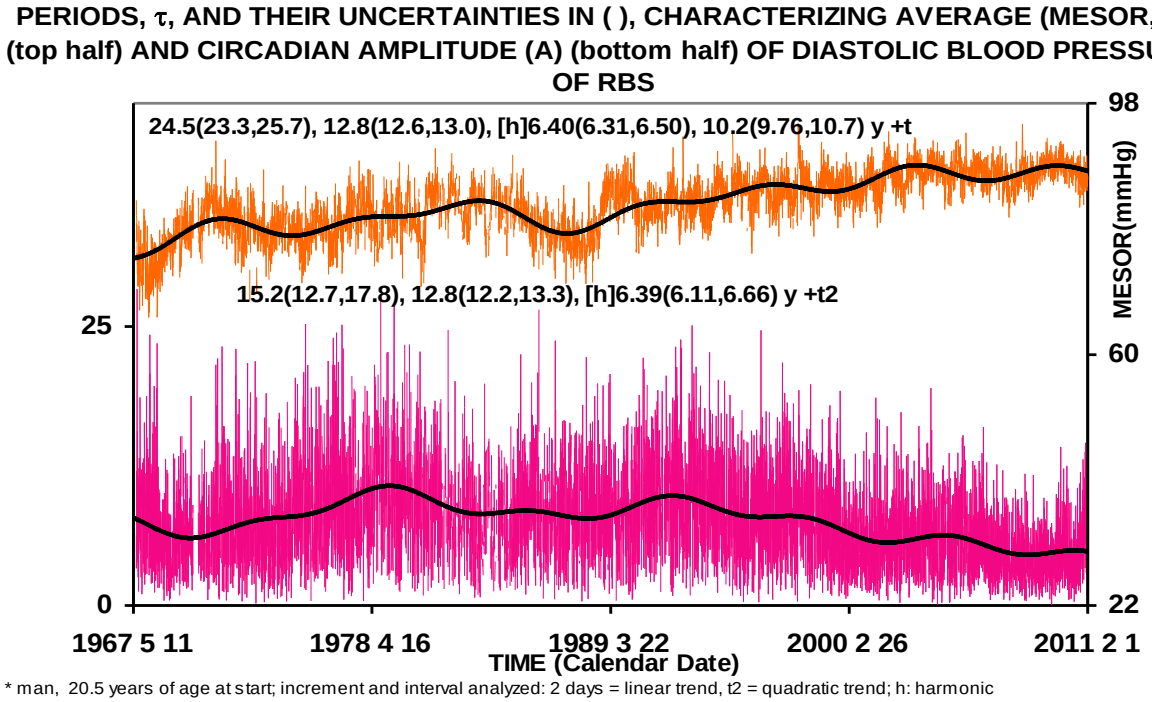
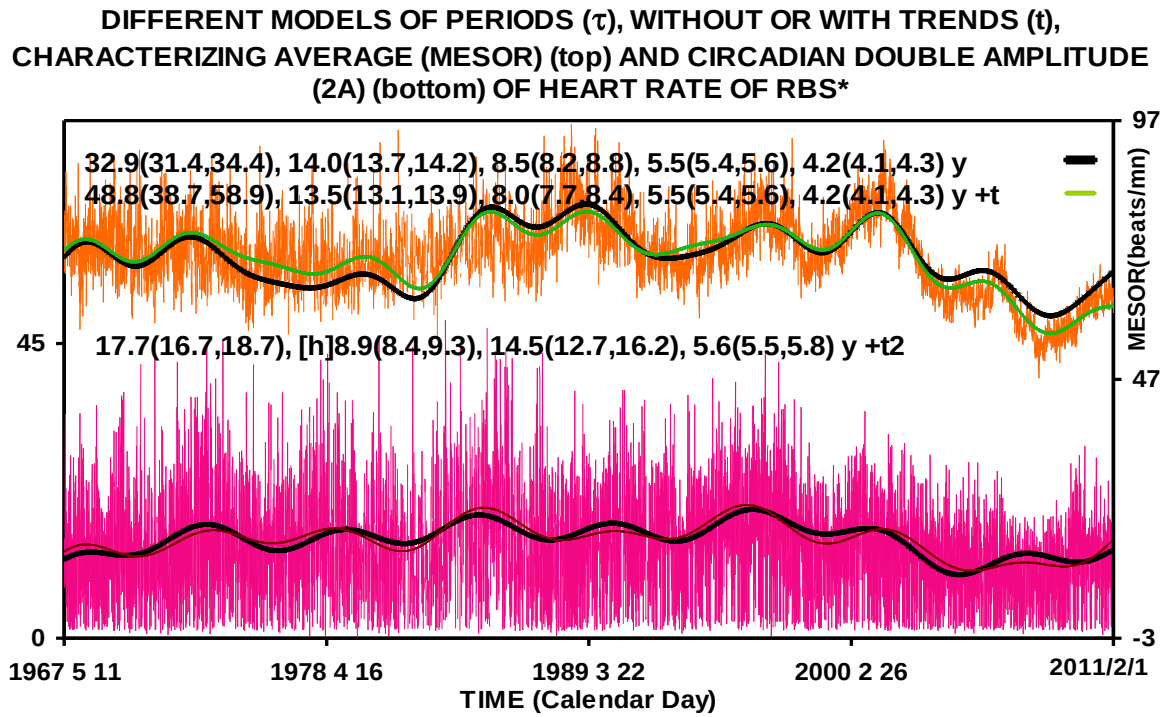


Fig. 2.



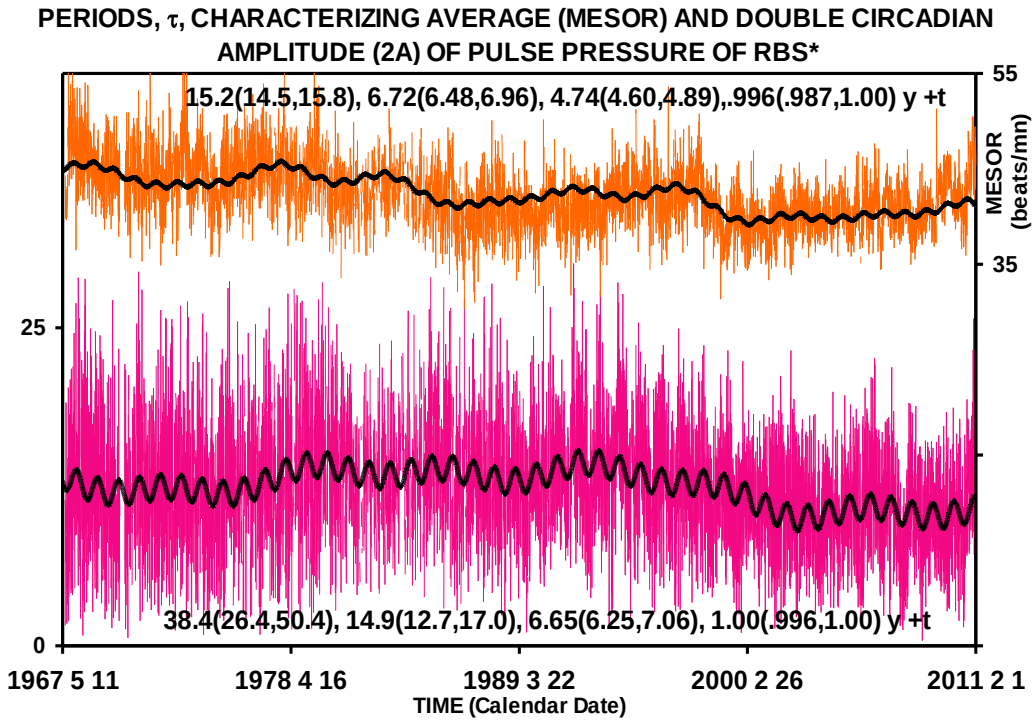
* man, 20.5 years of age at start; increment and interval analyzed: 2 days = linear trend, t2 = quadratic trend; h: harmonic

Fig. 3.



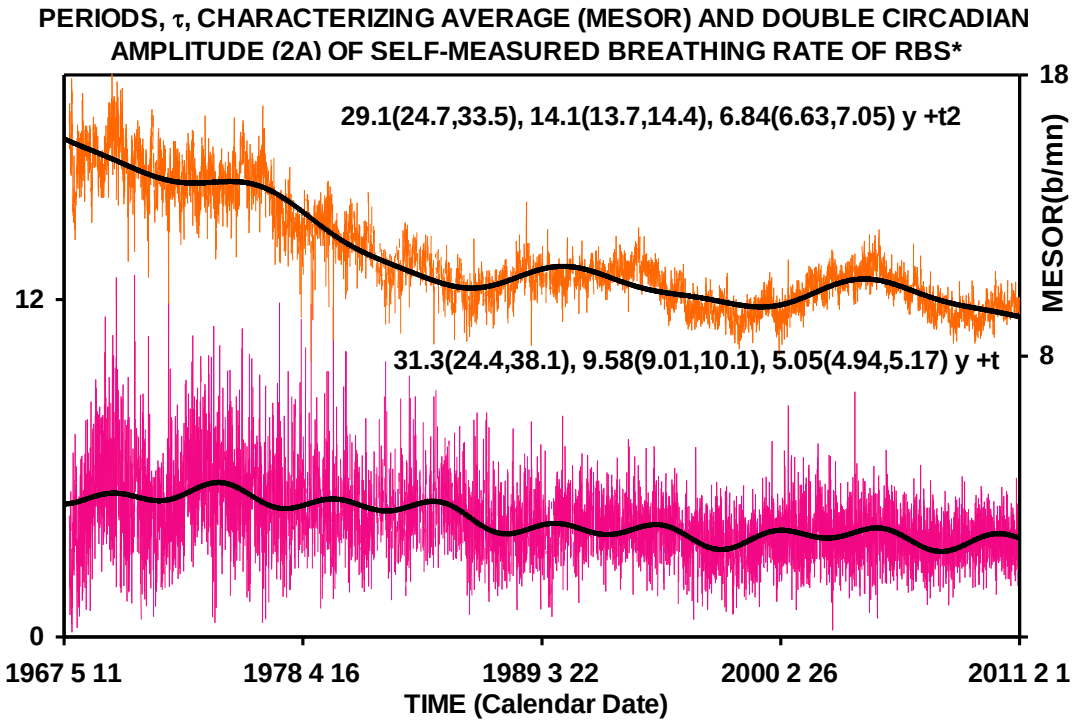
* man, 20.5 years of age at start; increment and interval analyzed: 2 days; t: linear trend; t2: quadratic trend; h: fixed harmonic.

Fig. 4.



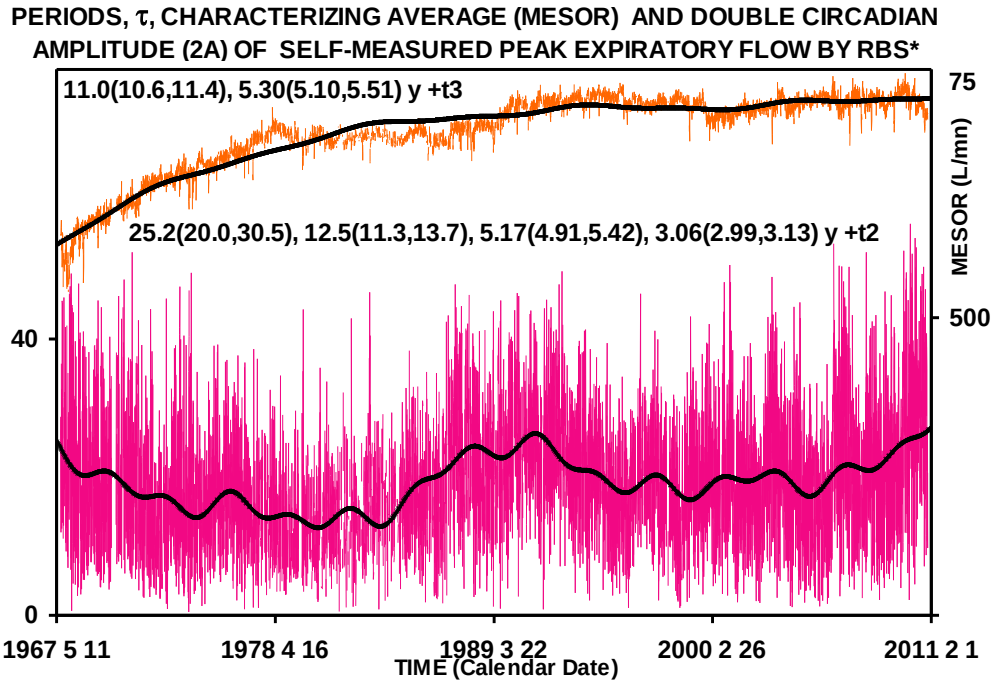
* man, 20.5 years of age at start; increment and interval analyzed: 2 days; t=linear trend

Fig. 5.



* man, 20.5 years of age at start; increment and interval analyzed: 2 days

Fig. 6.



* man, 20.5 years of age at start; increment and interval analyzed: 2 days

Fig. 7.

Table 1

Statistically significant periods (τ) from nonlinearly extended cosinor in 6 variables of RBS, a clinically healthy man self-measuring 5-6 times a day for 43.5 years*

		Period (95% CI) (years)					Trend	Overall SE
MESOR								
SBP	τ	27.6 (26.3, 29.0)	13.8 (13.4, 14.3)	6.48 (6.40, 6.57)	1.00 (0.997, 1.01)	-	t	3.08
	2A	4.06 (3.51, 4.61)	3.35 (2.82, 3.88)	3.32 (2.81, 3.82)	1.61 (1.11, 2.12)	-	-	-
DBP	τ	24.5 (23.3, 25.7)	12.8 (12.6, 13.0)	[h] 6.40 (6.31, 6.50)	10.2 (9.76, 10.7)	-	t	2.65
	2A	2.61 (2.13, 3.08)	1.70 (1.20, 2.21)	[h] 2.14 (1.71, 2.56)	1.83 (1.36, 2.31)	-	-	-
HR	τ	32.9 (31.4, 34.4)	14.0 (13.7, 14.2)	8.49 (8.19, 8.79)	5.52 (5.46, 5.59)	4.18 (4.12, 4.24)	-	5.27
	τ	48.8 (38.7, 58.9)	13.5 (13.1, 13.9)	8.03 (7.68, 8.38)	5.46 (5.39, 5.53)	4.21 (4.16, 4.26)	t	4.85
	2A	9.75 (8.82, 10.68)	9.32 (8.35, 10.29)	2.84 (1.85, 3.82)	5.62 (4.68, 6.56)	3.38 (2.46, 4.30)	-	-
	2A	16.52 (10.34, 22.71)	[h] 6.85 (5.87, 7.83)	2.48 (1.58, 3.58)	4.95 (4.06, 5.83)	3.68 (2.81, 4.55)	-	-
PP	τ	15.2 (14.5, 15.8)	6.72 (6.48, 6.96)	4.74 (4.60, 4.89)	0.996 (0.987, 1.00)	-	t	2.82
	2A	2.24 (1.76, 2.71)	1.15 (0.68, 1.62)	0.93 (0.46, 1.40)	0.62 (0.16, 1.08)	-	-	-
BR2m	τ	29.1 (24.7, 33.5)	14.1 (13.7, 14.4)	6.84 (6.63, 7.05)	-	-	t^2	0.68
	2A	0.76 (0.57, 0.94)	1.14 (1.03, 1.26)	0.31 (0.19, 0.42)	-	-	-	-
PF	τ	11.0 (10.6, 11.4)	5.30 (5.10, 5.51)	-	-	-	t^3	11.03
	2A	6.09 (4.45, 7.73)	2.80 (1.16, 4.44)	-	-	-	-	-
Double amplitude								
SBP	τ	20.3 (17.2, 23.4)	8.88 (8.15, 9.60)	5.67 (5.35, 5.99)	1.00 (.999, 1.00)	-	t^3	8.16
	2A	5.05 (3.46, 6.65)	2.25 (0.74, 3.76)	1.86 (0.41, 3.31)	6.48 (5.07, 7.90)	-	-	-
DBP	τ	15.2 (12.7, 17.8)	12.8 (12.2, 13.3)	[h] 6.39 (6.11, 6.66)	-	-	t^2	3.94
	2A	1.90 (0.58, 3.22)	0.98 (0.01, 1.94)	[h] 1.16 (0.56, 1.76)	-	-	-	
HR	τ	17.7 (16.8, 18.7)	14.4 (12.7, 16.2)	[h] 8.86 (8.38, 9.33)	5.64 (5.50, 5.79)	-	t^2	7.01
	2A	3.53 (0, 7.08)	4.38 (1.83, 7.93)	[h] 2.62 (1.39, 3.85)	3.31 (2.13, 4.49)	-	-	-
PP	τ	38.4 (26.4, 50.4)	14.9 (12.7, 17.0)	6.65 (6.25, 7.06)	1.00 (0.996, 1.00)	-	t	4.42
	2A	2.50 (1.75, 3.26)	1.21 (0.43, 1.99)	1.03 (0.29, 1.78)	2.02 (1.29, 2.75)	-	-	-
BR2m	τ	31.3 (24.4, 38.1)	9.58 (9.01, 10.1)	5.05 (4.94, 5.17)	-	-	t	1.29
	2A	0.52 (0.32, 0.71)	0.41 (0.22, 0.61)	0.53 (0.33, 0.72)	-	-	-	-
PF	τ	25.2 (20.0, 30.5)	12.5 (11.3, 13.7)	5.17 (4.91, 5.42)	3.06 (2.99, 3.13)	-	t^2	8.57
	2A	9.36 (6.51, 12.21)	4.17 (2.50, 5.85)	2.02 (0.51, 3.53)	3.33 (0.85, 3.81)	-	-	-

*Age 20.5y at start. SBP: systolic blood pressure (average of 3); DBP: diastolic blood pressure (average of 3); HR: heart rate/min; PP: pulse pressure; BR2m: breathing rate/2 minutes; PF: peak flow (average of 3). 95% CI: 95% confidence intervals; SE: standard error; SqRt: square root; QuadRt: quadratic root; [h]: fixed harmonic; t: linear trend; t^2: quadratic linear trend; t^3: cubic trend.

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NEONATAL ANTHROPOMETRY IN MOSCOW BY THE LATE BORIS NIKITYUK REVISITED GLOCALLY REVEALS A PARA-TRIDECADAL COMPONENT

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Aim. We here complement part of an earlier report of the time structure of neonatal variables in data covering 112 years by a glocal analysis, involving both global analyses of time series as a whole, and local analyses of sections of the data. We add the finding of a para-tridecadal Brğckner-Egeson-Lockyer (BEL) cycle in body length of newborn boys and girls and document its time course by chronomic serial sections.

Materials. Body weight and length and head circumference at birth were recorded from random samples of 25-150 babies in Moscow, Russia, over 112 years. The major component published in a first (global) analysis of the time series as a whole for body weight was of 63.02 years for boys with a CI (95% confidence interval) extending from 50.33 to 75.71 years, Figure 1 (1). In girls, body weight underwent a cycle of 64.35 years (CI: 40.91-87.67). Both boys and girls showed an added circadecadal (Horrebow-Schwabe) component of much smaller amplitude which was statistically significant only in girls (10.29 years; CI: 9.70-11.01). In birth weight, a major component common to boys and girls is an about 63- to 64-year cycle, validated nonlinearly. Figure 1 (1) also displays an about 10.2-year cycle (P=0.010). As to head circumference, the about 60-year component was dominant in boys and a longer cycle dominated in girls. Other components found in the least squares spectra were circadidecadal signatures of the Hale cycle of sunspot bipolarity (of about 20 years), present in body length and head circumference at birth.

The major component in neonatal body length in both genders was of about 50 years, a Kondratiev cycle reported in economics (14) and found in the incidence of stroke in several geographic locations (15).

Method. We applied the extended linear-nonlinear cosinor for global examination complemented by chronobiologic serial sections (4-6).

Results. Table 1 summarizes the periods found in a more recent nonlinearly extended cosinor analysis, prompted by results from wavelets on body length by one of us (SS). The table includes a BEL, the period of 32.4 and 33.5 years in boys and girls, respectively.

Table 1

Period(s) (τ) in body length (cm) at birth in Russia (1874-1985): data of Boris Nikityuk*

	Boys (overall standard error: 0.44)	**Girls (overall standard error: 0.47)**
MESOR	52.224 (51.962, 52.687)	51.564 (51.288, 51.840)
Slope	-0.017 (-0.027, -0.008)	-0.015 (-0.025, -0.005)
τ 1 (years)	53.671 (46.12, 61.23)	53.666 (42.00, 65.33)
Double amplitude	1.52 (0.74, 2.28)	1.32 (0.42, 2.22)
Acrophase	-276˚ (-247, -305)	-274˚ (-237, -311)
τ 2 (years)	32.404 (29.35, 35.13)	33.487 (25.88, 41.09)
Double amplitude	0.76 (-0.00, 1.50) [0.42, 1.08]	0.86 (0.00, 1.74) [0.48, 1.24]
Acrophase	-243˚ (-187, -300)	-207 (-151, -263)
τ 3 (years)	20.441 (18.31, 22.57)	21.217 (19.18, 23.25)
Double amplitude	0.84 (0.56, 1.10)	0.94 (0.62, 1.24)
Acrophase	-184˚ (-129, -240)	-158˚ (-109, -208)

* 95% confidence limits in are conservative; in the case of a very slight overlap of zero beyond the second decimal, 1-parameter limits are given in.

The time course of the characteristics of three components characterizing body length at birth is shown in Figures 2A and 2B. In these figures, the time course of acrophases shows greatest stability for the about 50-year periods. Several of these periods show variations in amplitude. The acrophase drifts may reflect drifts in periods.

Discussion. With respect to the recovery from the Little Ice Age, a prominent geophysicist indicates the need to assess multidecadal periodicities, adding that they are "natural" (Syun-ichi Akasofu's emphasis) phenomena and that they have to be taken into account "in order to determine the contribution of the manmade greenhouse effect" (7). By contrast, "Identifying [multidecadals] correctly and accurately", also Akasofu's plea, is hardly the explicit concern of others focusing on the length of the solar cycle as an indicator of solar activity associated with climate (8) that reveals a para-tridecadal

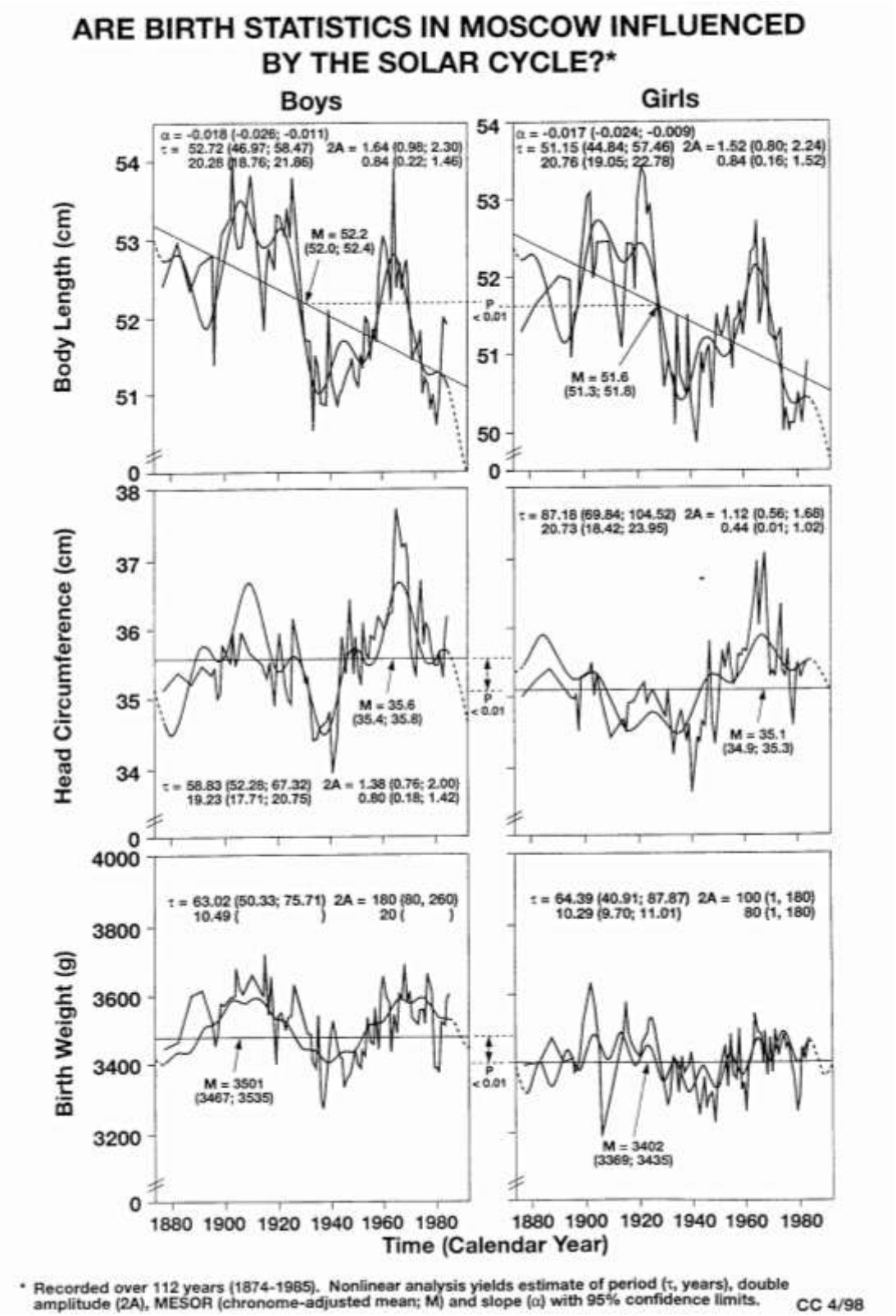
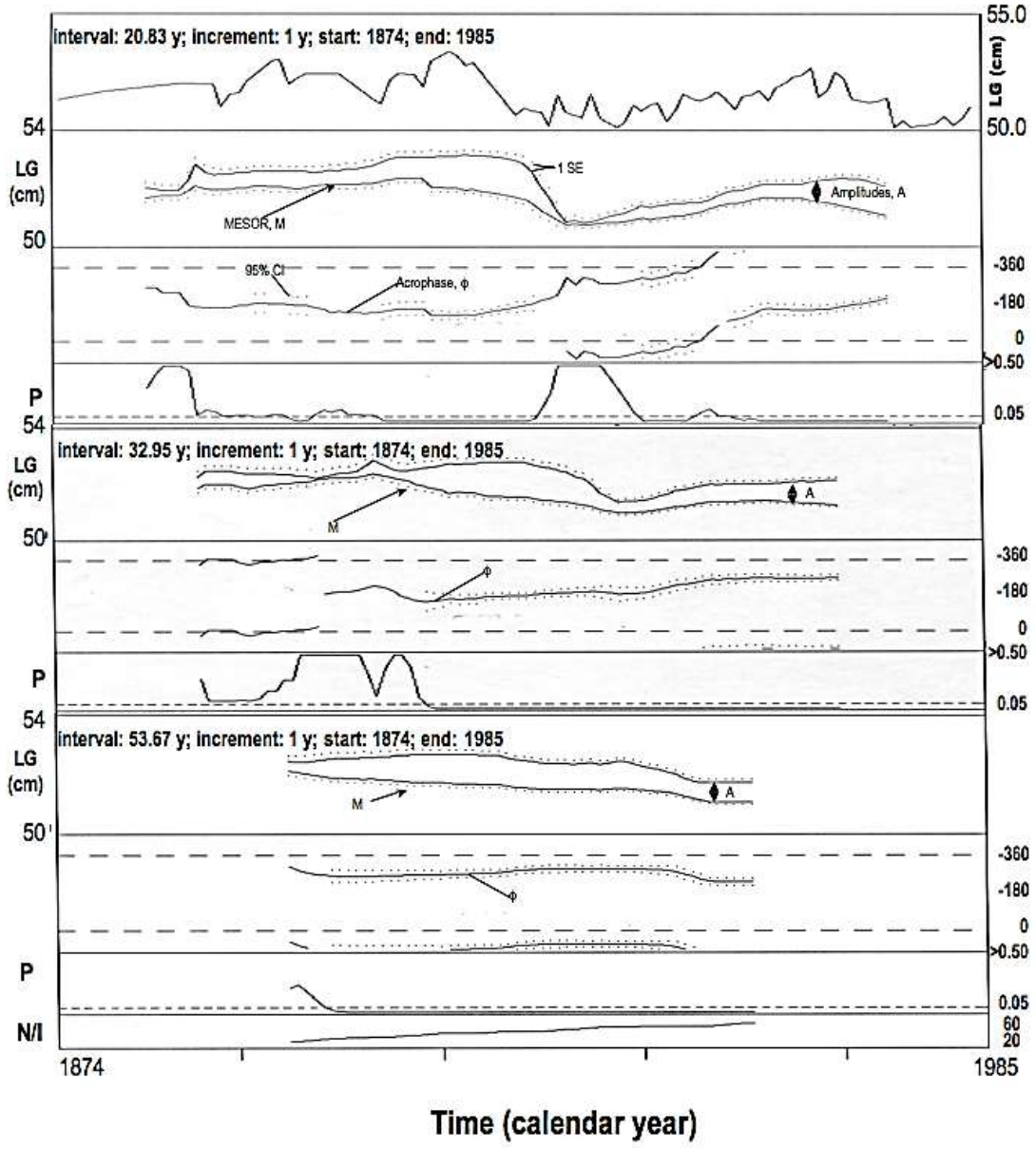


Fig. 1. Solar cycles' signatures in a biospheric magnetometer: the human neonate (4). See Figures 2A and 2B for the about 33-year BEL, that was missed until it appeared prominently after 1930 in wavelets, computed by one of us (SS). © Halberg.

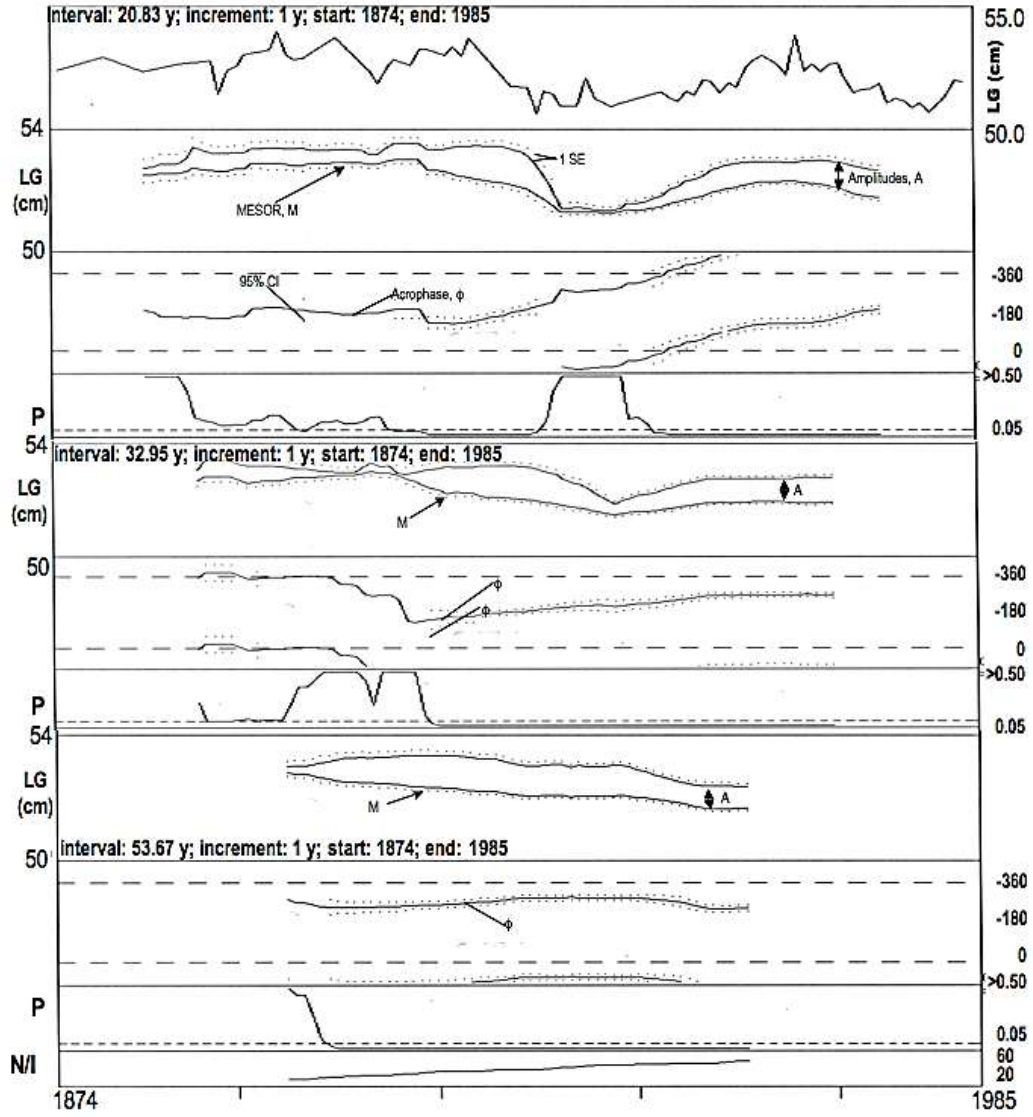
Components with periods of 20.83 (top), 32.95 (middle) and 53.67 (bottom) years characterizing length at birth (LG) of girls in Moscow, Russia, are more or less consistently detected with stable phases, as shown by chronobiological sections*



*MESOR: midline-estimating statistic of rhythm, rhythm-adjusted mean; Amplitude: half of the extent of predictable change from fit of cosine curve with given period; Acrophase: measure of timing of overall high values recurring in each cycle, expressed in negative degrees with 360° ≡ period length; N/I: number of data per interval (total N=79).

Fig. 2A. Body length at birth in boys is characterized by 3 main spectral components, some with intermittent reductions in amplitude (distance between the 2 curves in sections 2, 5 and 8). Didecadal (top section) and tridecadal (middle section) but not (except for the first few intervals analyzed with limited data) quindecadal (bottom section) cycles show relatively short spans of aeolian loss of statistical significance in rows 4 and 7 and some drifting acrophases, the latter in keeping with changes in period. Interval: 20 years; increment: 1.00 year. © Halberg.

Components with periods of 20.83 (top), 32.95 (middle) and 53.67 (bottom) years characterizing length at birth (LG) of boys in Moscow, Russia, are more or less consistently detected with stable phases, as shown by chronobiological sections*



*MESOR: midline-estimating statistic of rhythm, rhythm-adjusted mean; Amplitude: half of the extent of predictable change from fit of cosine curve with given period; Acrophase: measure of timing of overall high values recurring in each cycle, expressed in negative degrees with 360° ≡ period length; N/I: number of data per interval (total N=79).

Fig. 2B. Body length at birth in girls is characterized by 3 main spectral components, some with intermittent reductions in amplitude (distance between the 2 curves in sections 2, 5 and 8). Didecadal (top section) and tridecadal (middle section) but not (except for the first few intervals with limited data) quindecadal (bottom section) cycles show relatively short spans of aeolian loss of statistical significance in sections 4 and 7 and some drifting acrophases, the latter in keeping with changes in period. Interval: 20 years; increment: 1.00 year. © Halberg.

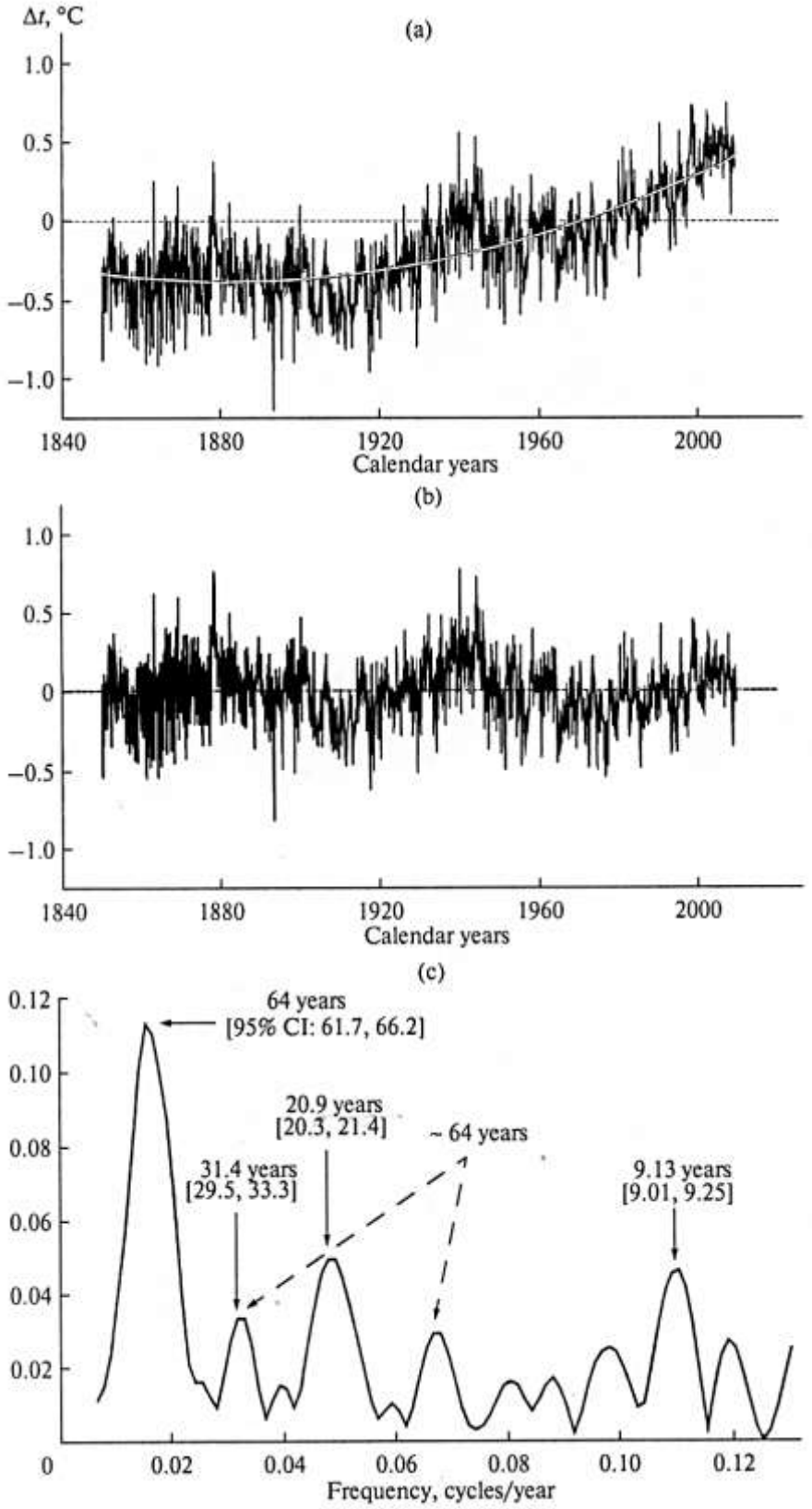


Fig. 3. BEL cycle in variations of air temperature for 1850-2008: (a) original data, (b) time series without the trend, and (c) spectrum of time series obtained after trend removal. The dashed arrows in (c) indicate modulation-induced beats of around 64-year oscillations (9). © Halberg.

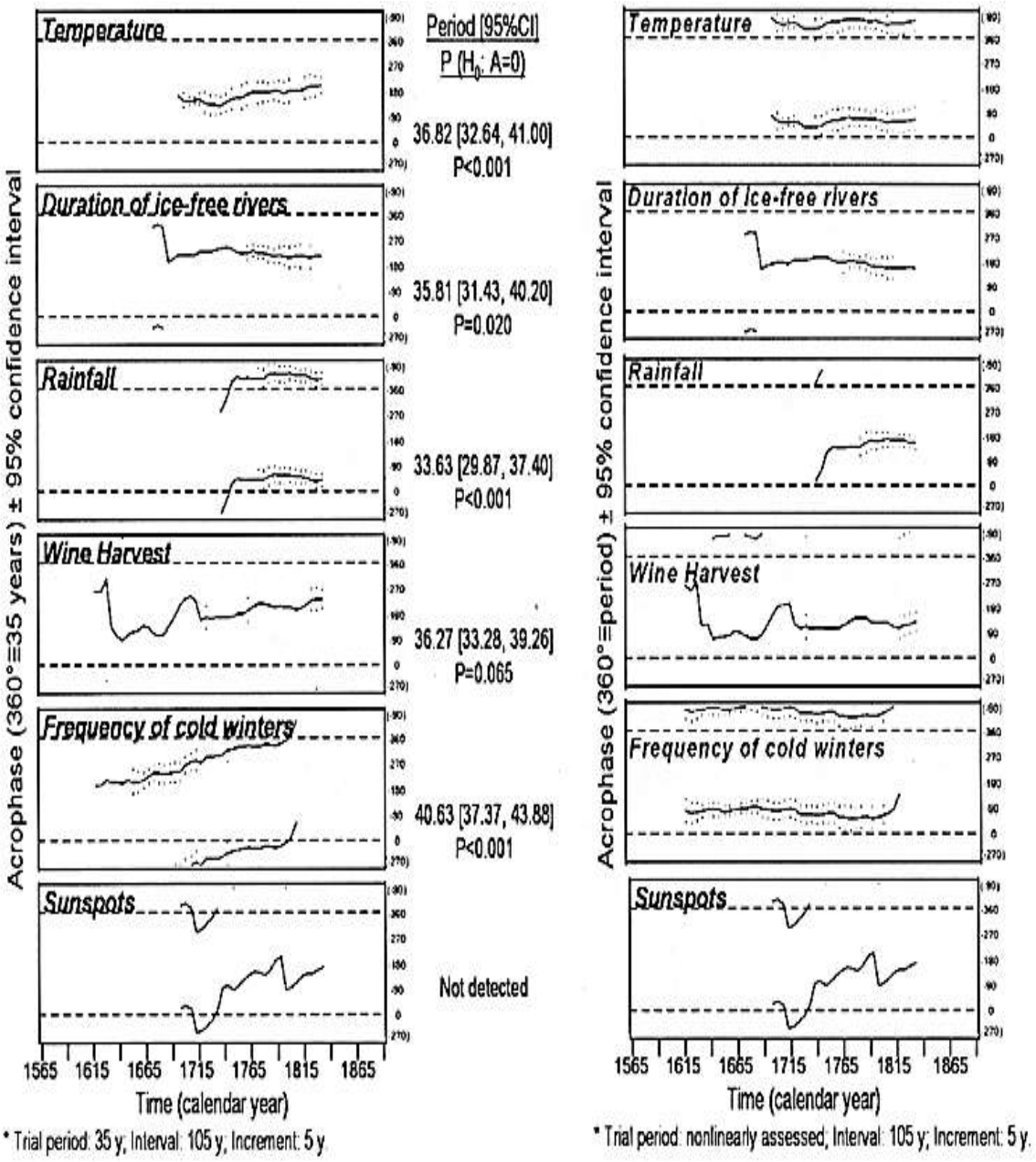


Fig. 4. Variations in acrophases of time series from Brückner [1890] calculated with the help of the cosinor method for 35-year (left) and near 35-year (right) periods of different parameters: (a) air temperature, (b) length of the ice-free period in rivers, (c) rains, (d) wine harvest, (e) frequency of cold winters, and (f) sunspots. The acrophases were estimated in a sliding window of 105 years with a step of 5 years. The central part indicates the values of periods, confidence intervals, and level of statistical significance (see text). © Halberg.

Brǧckner-Egeson-Lockyer (BEL) cycle in environmental temperature, human affairs and global warming, Figure 3 (9; cf. 10-18).

Readers may be interested to know that nonphotic recurrent changes, such as the BEL, are aeolian, coming and going in terms of detectability and, when present, waxing and waning in amplitude and drifting in phase and frequency, bifurcating or splitting into more parts and reuniting, a nonstationary behavior that earned them the title of quasi-periodicity (19; cf. 20), to which Julius Bartels added an explicit reference to quasi-persistence (21). Scholarly exceptions notwithstanding (16, 17, 22), the BEL is today mostly forgotten and indeed it is difficult to define it

in terms of a point estimate of its period, which is spread over more than 30-40 years, already in a meta-analysis of Brǧckner's original extensive data (9, 23), Figure 4 (cf. also 12). Hence the BEL was defined as a cycle with a 95% confidence interval of the period that falls between 30 and 40 years and called a para- (= near, beside) tridecadal cycle. Most recently, we became even more liberal when, with the addition of 5 years of longitudinal data (of WRB), a BEL had a 95% confidence interval of the period extending with its upper limit not quite to 30 years, while it was a clear BEL with only about 30 years of data (24). We submit for consideration the term "para-tridecadal", with exact limits for the "para" to be specified by further experience. The BEL is found not only in environmental temperature records, Figure 3, that are to be considered by scholars in global warming, but further in human military-political, economic and other affairs (9; cf. 10-18).

Conclusion. Meta-analyses by the nonlinearly extended cosinor which we owe to the late Donald Marquardt (25), which is complemented by a chronomic serial section (4-6), revealed a para-tridecadal component with its uncertainty by the extended cosinor. Moreover, when the time course of this trans-tridecadal is followed by chronobiologic serial sections, it is also revealed to be statistically significant before 1930 with one interruption, in keeping with its intermittent nonstationary aeolian behavior. The serial section complements the wavelet by focus upon a specific frequency. Before conclusions concerning causality can be considered, a glocal analysis will have to seek opportunities for a subtraction and addition approach, which depends upon cooperation by the environment (20, 26).

Footnote

Part of the general discussion was submitted on February 27, 2011, to the journal Natural Science by GC and FH under the title "Para-tridecadal cycles in environmental temperature, human affairs and global warming". The new analyses were prompted by results from wavelet analysis by one of us (SS, 27).

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DIFFERENT APPROACHES REVEAL DIFFERENT BLOOD PRESSURE BEHAVIOR IN DEPRESSION

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Aim. To determine whether changes in blood pressure (BP) are observed in association with depression and whether around-the-clock measurements interpreted chronobiologically can lead to conclusions different from those derived from spotchecks under special conditions.

Background. Hecht et al. (1) recently reported that in 425 patients with a resting systolic BP of <110 mmHg and not treated for high BP, they verified the triad of low BP, cervical spine

syndrome, and depressive disorders. BP was measured in a state of relaxation for 10 minutes at 1-minute intervals, using the lowest value among the last 5. No circadian stage of measurement was indicated. Fixing the time of day is not necessarily a sufficient precaution since opposite results such as changes with age over 4 decades have been observed with measurements taken at different circadian stages by the same subject (2).

Subjects and Methods. As part of the project on the BIOsphere and the COSmos (BIOCOS), 182 week-long profiles of around-the-clock measurements at 30-minute intervals by day and 60-minute intervals by night have been obtained from residents of Uruasu, Japan (3). Depression scores were obtained according to the GDS scale (4) from 170 subjects once (GDS1), 141 of them also providing a second score (GDS2) about a year later. Each BP record was analyzed by the extended cosinor (5). A two-component model consisting of cosine curves with periods of 24 and 12 hours was fitted by least squares, yielding estimates of the MESOR (M, Midline Estimating Statistic Of Rhythm, a rhythm-adjusted mean), as well as double amplitudes (2A, a measure of the predictable extent of change within a cycle) and acrophases (ϕ, a measure of the timing of overall high values recurring in each cycle) of each component. The M and 24h-A of systolic (S) and diastolic (D) BP and heart rate (HR) were compared by Student t test between subjects with a GDS score ≥ 5 (depressed) or a GDS score <5. These parameters were also linearly regressed with respect to the GDS score. Student t tests were also applied to the predicted low and high daily values computed as M-A and M+A, respectively, for the pool of all subjects and separately for men and women.

Results. Depressed subjects had a higher SBP-M (132.1 vs. 125.2 mmHg; P=0.002) and tended to have a higher DBP-M (79.8 vs. 77.4 mmHg, P=0.054), Figure 1. The increase in SBP-M with GDS1 is confirmed (r=0.171, P=0.025), Figure 2. SBP-M is also positively correlated with the $GDS1^2$ (r=0.176, P=0.022). The higher SBP-M in depressed subjects is observed numerically in both genders but only reaches borderline statistical significance in women. Numerically, both the nadir and the peak BP values are invariably higher in depressed subjects, but the differences are not statistically significant.

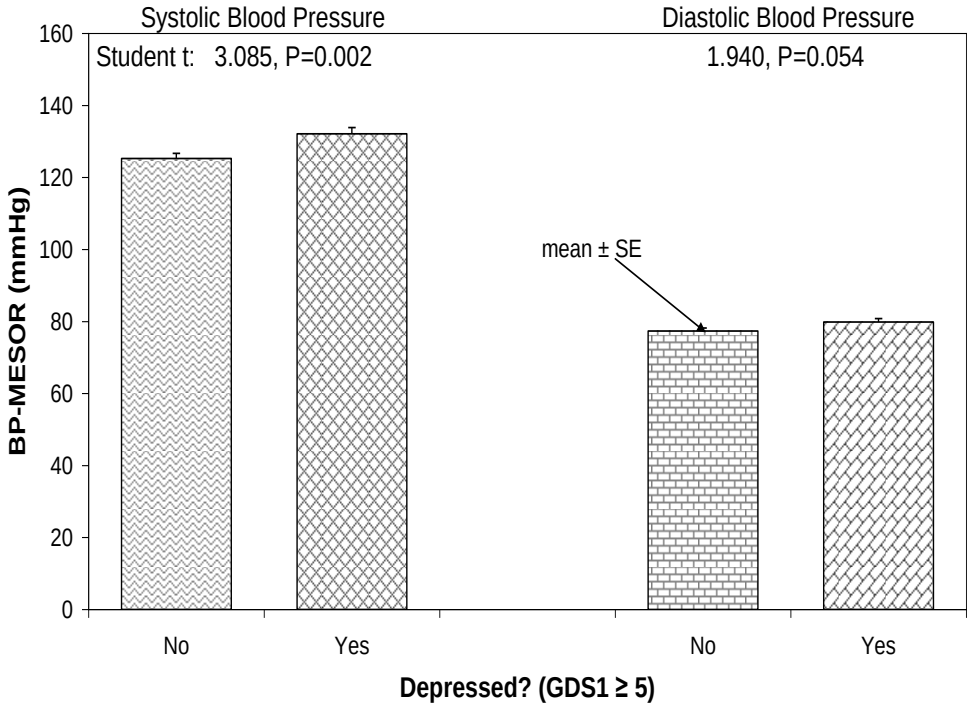

Fig. 1. Patients with a higher depression score have, on average, a higher blood pressure (measured around-the-clock for 7 days).

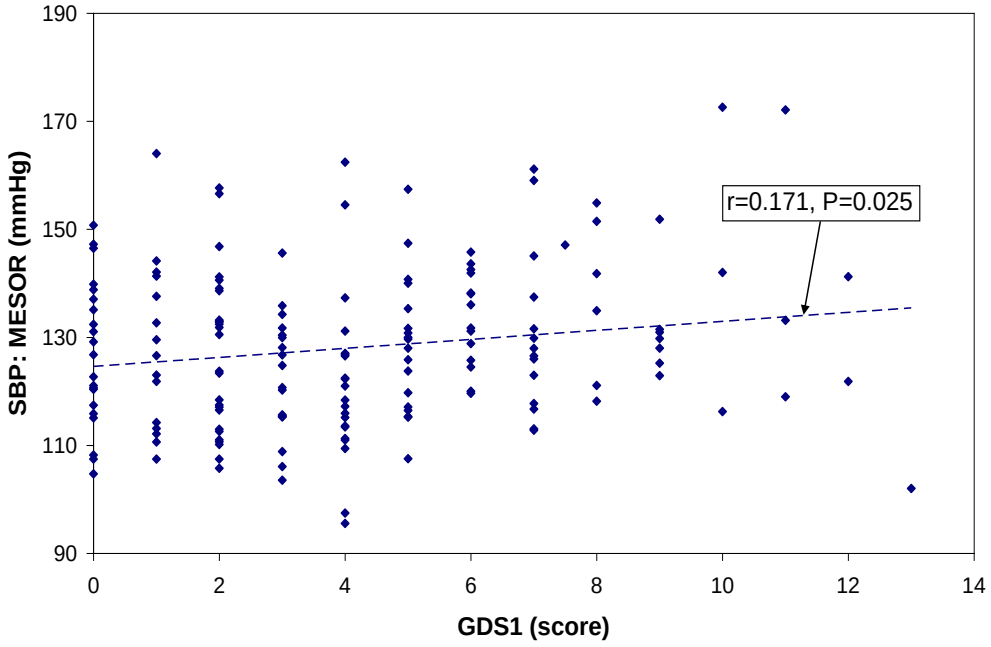

Fig. 2. Systolic Blood Pressure tends to be elevated in patients with a higher depression score.

Discussion and Conclusion. Depressed subjects were also found to have a smaller 24-hour HR-A (6.9 vs. 7.7 beats/min, P=0.084). The HR-A was negatively correlated with GDS1 (r=-0.215, P=0.005), Figure 3. HR-A is also negatively correlated with GDS2 (r=-0.179, P=0.034). The smaller HR-A is found only in men but not in women.

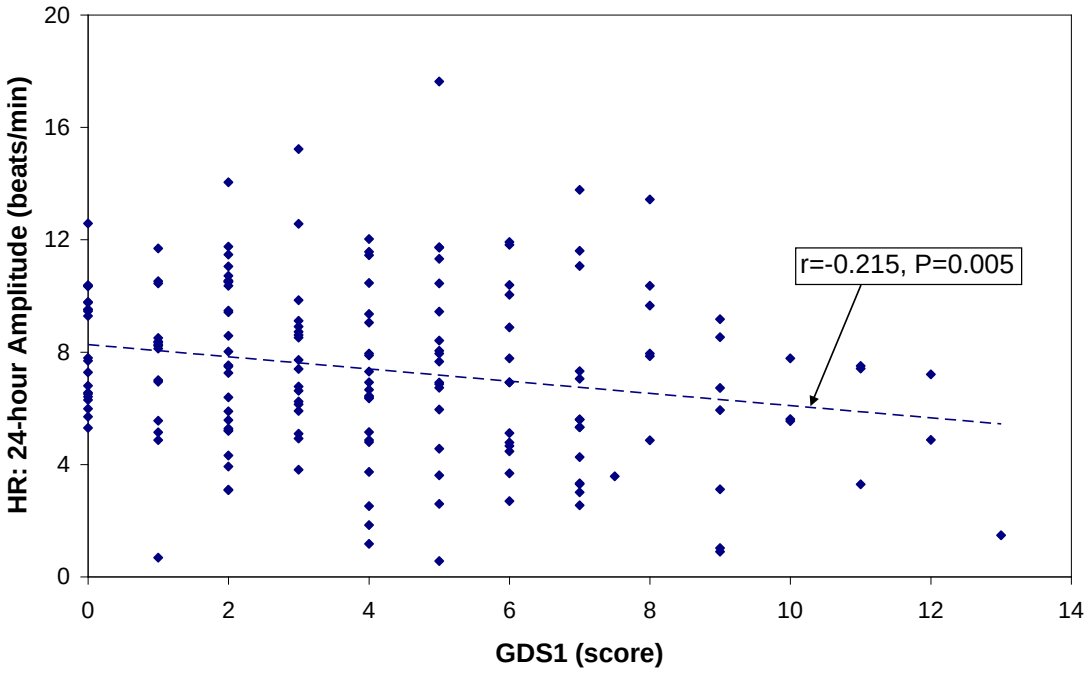

Fig.3. The circadian amplitude of HR is decreased in patients with a higher depression score.

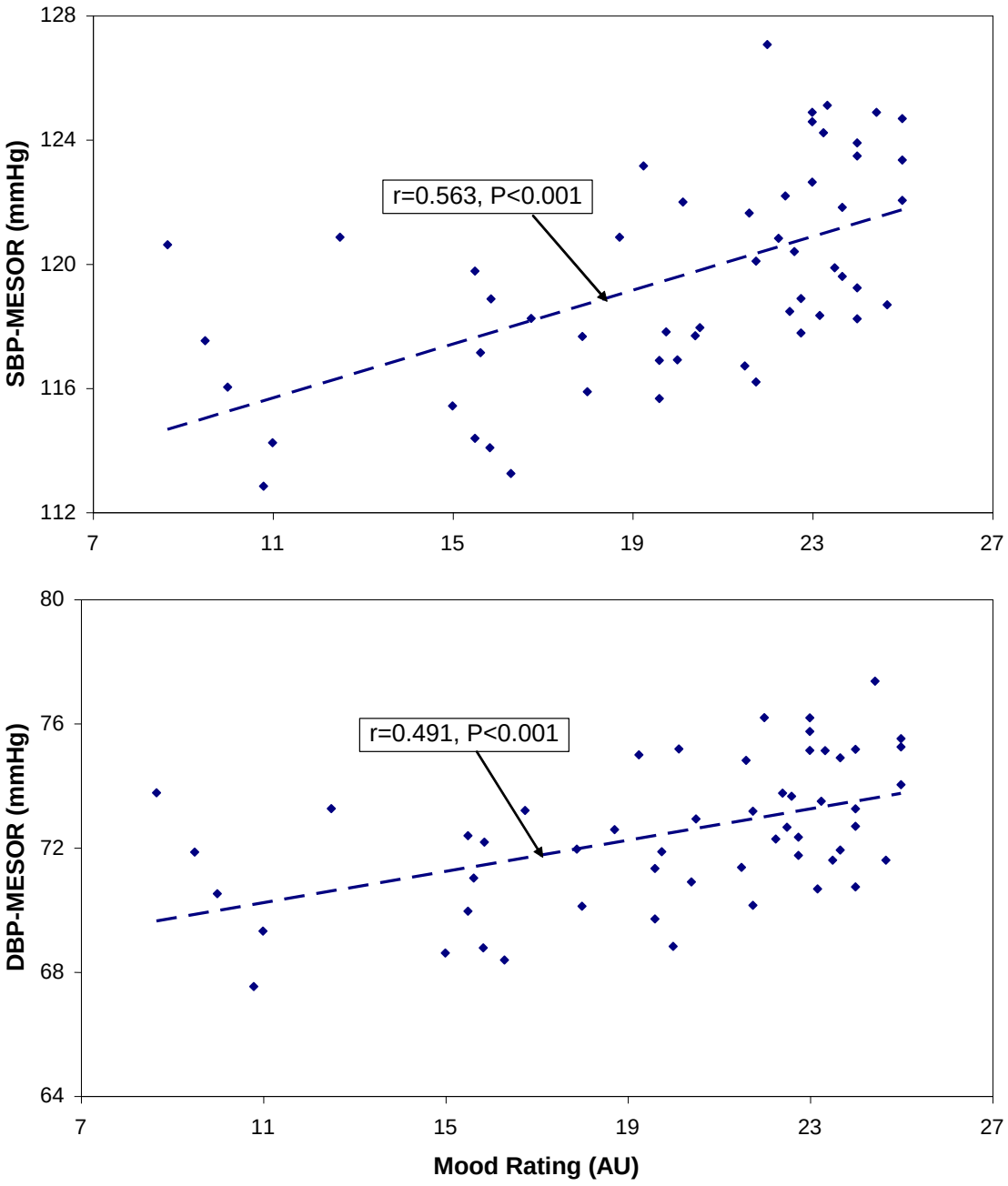

Figure 4. Lower BP with lower mood ratings in a 41-year old woman with bipoal disorder, monitored longitudinally. BP MESOR is rhythm-adjusted mean value of around-the-clock measurements at 30-minute intervals over consecutive days.

Whether ethnic differences, the fact that the Urausu database includes many elderly people, and/or the fact that 7-day ABPM instead of a few resting measurements were used in Urausu account for the discrepancy between the two studies remains to be investigated.

Reasons underlying a higher depression score may also play a role and may differ in the elderly versus younger people. In the case of a 41-year old woman diagnosed with bipolar II disorder who monitored her BP longitudinally around-the-clock for several months (6), the BP-M tended to be lower when mood ratings were lower (SBP: r=0.563, P<0.001; DBP: r=0.491, P<0.001) (Figure 4), in keeping with findings by Hecht et al. (1). Also worth of further

investigation is the finding both in this case and in the Urausu database of an amplified about 7-day component associated with a higher depression score (3).

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FROM JANEWAY TO C-ABPM: AN AUTOMATIC INTERNATIONAL MULTILINGUAL CHRONOMIC WEBSITE

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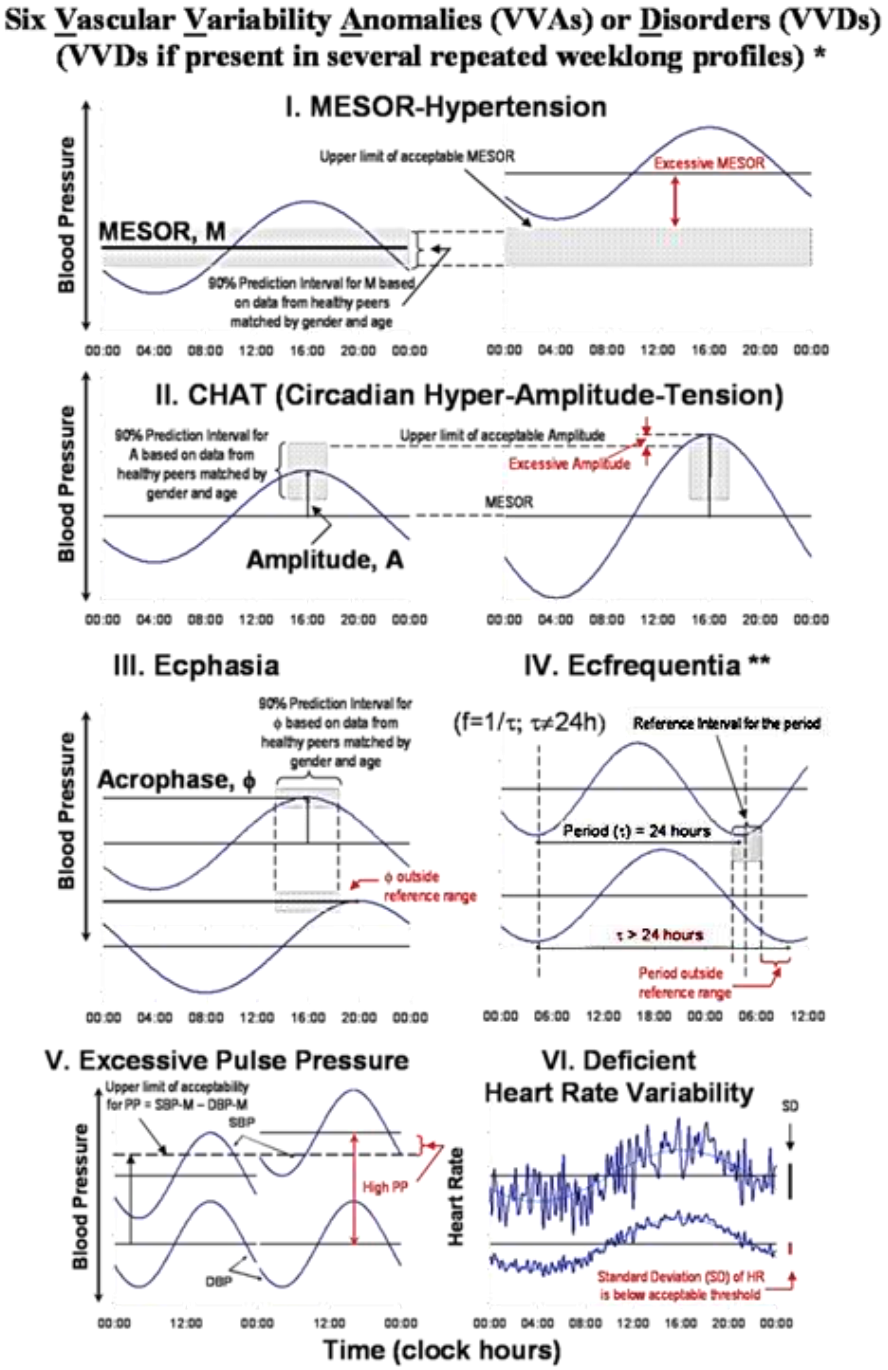
A broad spectrum of photic and non-photic environmental cycles is mirrored in sociological, epidemiological and psychophysiological variables like blood pressure (BP) and heart rate (HR), examined in decades-long around-the-clock still-accumulating time series. Cycles in spirituality (1), crime (2), war (3, 4), revolution (5), and terrorism (6) are currently mapped by a project on The BIOsphere and the COSmos, BIOCOS, which also provides worldwide, on a small scale, cost-free analyses of 7-day around-the-clock BP and HR data for detecting Vascular Variability Anomalies (VVAs) or if replicated for weeks Disorders (VVDs) that can coexist to bring about Vascular Variability Syndromes (VVSs), Figure 1 (7).

Chronomics implemented by BIOCOS aligns and examines associations among the time structures in and around us. Each structure, environmental or matchingly organismic and, in the sense of similar cycle length, reciprocal, consists of deterministic and other chaos, cycles and trends (the trends often parts of cycles longer than the length of an available time series). Chronomic analyses by BIOCOS assess strain (as a quantifiable response to stress, e.g., as a deviant circadian and/or other rhythm characteristics) and cardiovascular disease risk based on a chronobiologic diagnosis and the timed treatment of the individual's VVAs, or if they persist, VVDs and VVSs if they persist coexisting (8). The same data pool for the individual's self-surveillance in chronobiologically-interpreted ABPM and other variables also was used for exploring associations of abnormality with human-made as well as natural environmental cataclysms, including terrorism (6) and earthquakes (9).



* Validated by chronobiologic analysis of around-the-clock 7-day/24-hour records of measurements at 1-hour or shorter intervals, interpreted in the light of time-specified reference standards qualified by gender and age. ** Ecfrequentia: short for frequency (f) alteration (e.g., desynchronization) that can be Dysfrequentia when associated with symptoms and/or persisting in repeated consecutive 7-day records.

Fig. 1. Abstract definition of Vascular Variability Anomalies (VVAs) or Disorders (VVDs) when confirmed in repeated 7-day records.

This transdisciplinary line of research, beyond seismology is a challenge for a website's (Figure 2) eventual human team which is also to manage any problems relating to the individual's health arising in the automatic analyses. The same multilingual website should further serve educational tasks related to the routine health care services and further for examining biospheric associations with space weather, monitored for the benefit of the greater public. This combined

personalized clinical service and space weather analysis could be done on a large scale by an automatic website receiving data from self-surveilling individuals for the detection of VVAs as measures of strain, of VVDs and VVSs, and also from governmental sources (such as state health departments) on natality, morbidities, mortalities and crime, for carrying out research on harbingers of VVAs. VVDs, and VVSs for individuals and the possible use of the same data as warning signals for populations. Scholars of geochange to whom this website proposal is to be submitted for a consensus along with inferential statisticians can play a pivotal role in optimizing the individual's health care: current exclusive reliance on spotcheck-based intermittent professional consultations, sometimes at long intervals, even of a year or longer, using experience and intuition to bridge the gap of data, can be complemented by care based on added continuous computer-aided sequentially (e.g., weekly CUSUM) examined as-one-goes self- and population-surveillance, the latter by the data flow from government sources, such as health and police departments. Further details, see (10, 11).

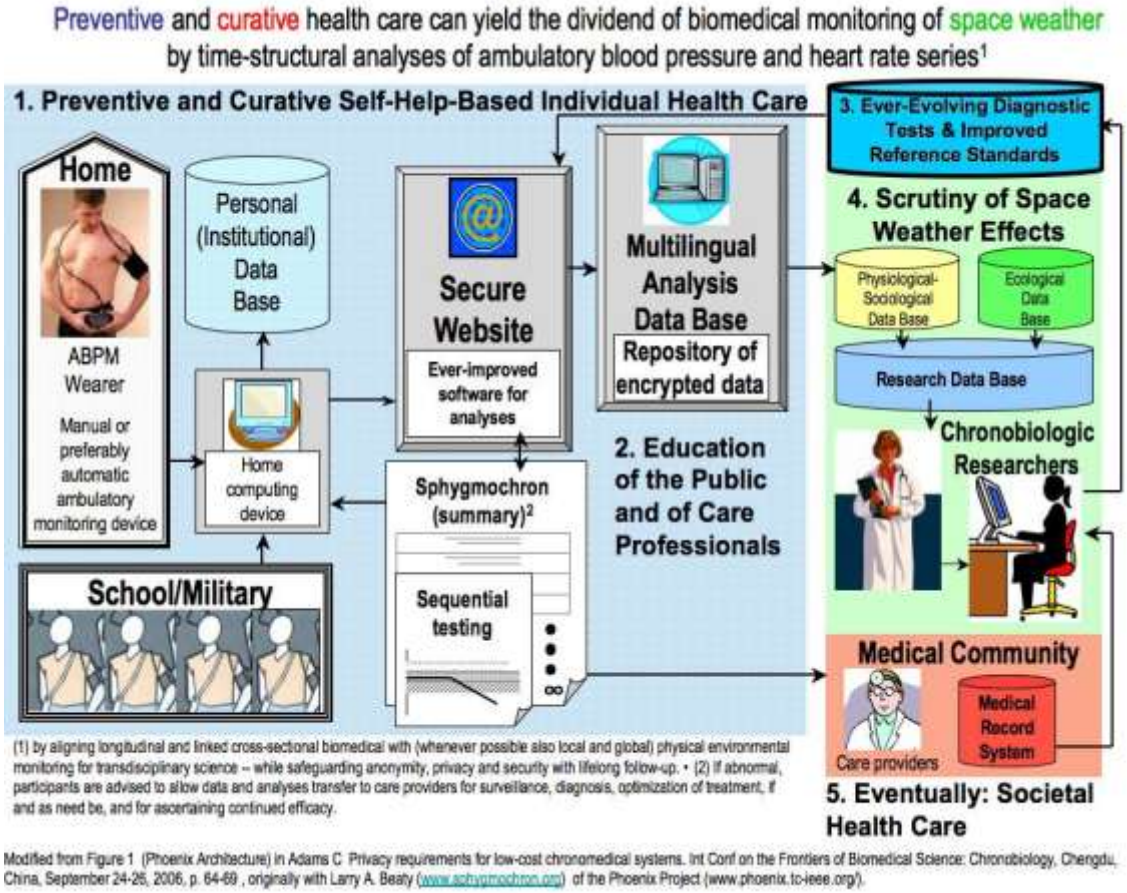


Fig. 2. Website for health self-surveillance and for monitoring the environment.

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THE NEONATE, A PARTICULARLY SENSITIVE MAGNETORECEPTOR? POPULATION RHYTHMS REVEAL CYCLES

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To determine already in the newborn the risk of developing cardiovascular disease (CVD) later in life, we monitored the blood pressure (BP) and heart rate (HR) of babies around the clock at hourly or shorter intervals in Minneapolis, Moscow, Brno, Milan and Tokyo (1-6). A list of findings in 85 published titles from the cooperation of Muscovites and Minnesotans is available, among others, from corne001@umn.edu. During 1985-1986, on 161 babies, the circadian amplitude of blood pressure (BP), albeit small, was larger in babies with a positive than in those with a negative family history of high BP and/or other CVD, in keeping with a similar finding in children. In 1987-89 we could not find this difference, Figure 1 (7).

We assumed that the newborn's circadian BP rhythm may be modulated by one or several infradian cycles with long period(s) and that this modulation affected newborns' CVD risk differently as a function of family CVD-history. In the following years we found a cycle with a 95% confidence interval of the period overlapping 10 years in the MESOR (Midline-Estimating Statistic Of Rhythm) of 527 babies studied over only 8 years (8).

From 1988 to 1995, systolic (S) and diastolic (D) BP of 527 babies were measured automatically around the clock for spans ranging from one day to several weeks. Each series was analyzed by chronobiologic serial section over several consecutive non-overlapping 2-day spans to minimize any under-estimation of the circadian amplitude due to possible phase changes, e.g., desynchronization of the 24-hour free-running period observed in early extra-uterine life. Estimations of the MESOR (M) and circadian double amplitude (2A) (total N = 1016) were processed in a transverse approach to explore any solar modulation.

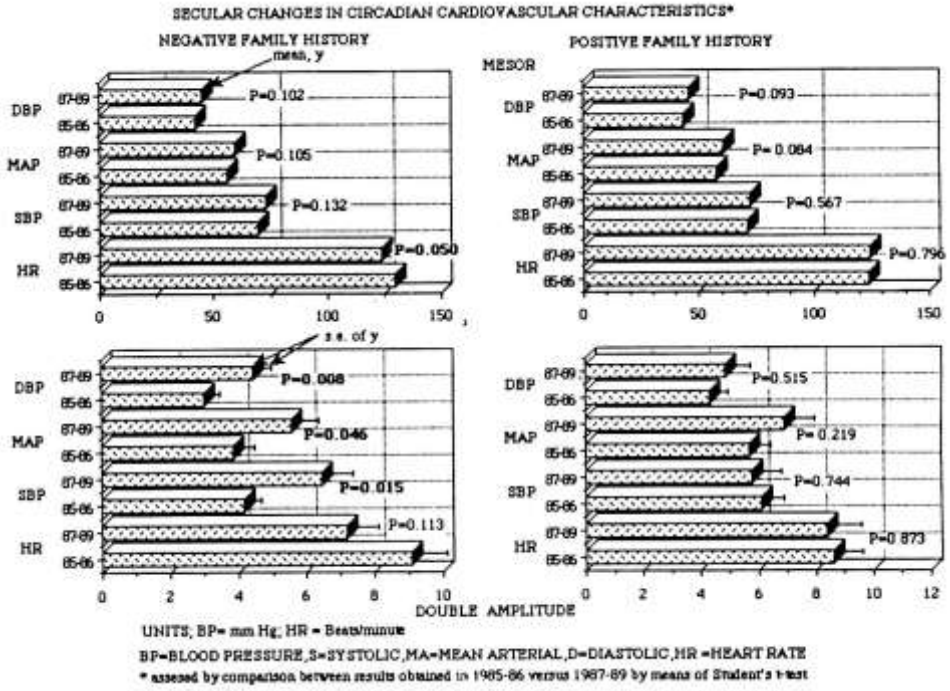

Fig. 1. Statistically significant secular changes in the circadian amplitude (bottom) but not in the MESOR (top) of BP of newborns with a negative family history of high BP may account for the failure in 1987-89 to confirm the difference in the circadian amplitude of BP between babies with a positive or negative family history of high BP observed in 1985-86.

Subgroups were analyzed separately according to 1. gestational ages longer (G1) or shorter (G2) than 33 weeks, a separation not prompted by prematurity, but rather by sample size, since there were many more prematures than babies born at term, 2. the presence (R1) or absence (R0) of a family history of high BP and related vascular complications, and 3. whether the MESOR and amplitude estimates were obtained during the first (wk1), second (wk2) or third or later (wk3+) week of life. For each category, the MESORs and circadian amplitudes of SBP and DBP were averaged on a yearly basis and the yearly means analyzed by single cosinor with a 9.5-year trial period matching the duration of solar cycle 22 (minima in 1986 and 1995-1996, maximum in 1989).

Results were further summarized by population-mean cosinor, considering family history and post-natal age subgroups as replicates for G1 and G2 babies, and after pooling results from G1 and G2 babies. An about 9.5-year component was found to modulate the MESOR of SBP and DBP of both G1 and G2 babies, Table 1.

Table 1

Group	N	P	MESOR ± SE	2A (95%CI)	ϕ (95%CI)
	SBP-MESOR				
G1	6	0.029	72.1 ± 0.6	5.1 (1.8, 8.3)	-348 (-334, -22)
G2	6	0.013	69.3 ± 0.8	9.9 (4.8, 14.9)	-2 (-325, -22)
G1+G2	12	<0.001	70.7 ± 0.6	7.4 (4.6, 10.3)	-357 (-337, -12)
	DBP-MESOR				
G1	6	0.008	42.4 ± 0.4	3.9 (2.4, 5.4)	-341 (-327, -359)
G2	6	0.099	41.0 ± 1.2	4.3	-12
G1+G2	12	<0.001	41.7 ± 0.6	4.1 (2.3, 5.9)	-358 (-310, -32)

MESOR and 2A in mmHg; ϕ (acrophase) in (negative) degrees, with 360°≡9.5 years, 0°=previous solar minimum in 1986 (8).

Follow-up studies on 154 newborns from 1995 to 2005 revealed a circadecadal cycle in the 24-hour amplitude, as well as in the MESOR of BP and HR, Figures 2-4.

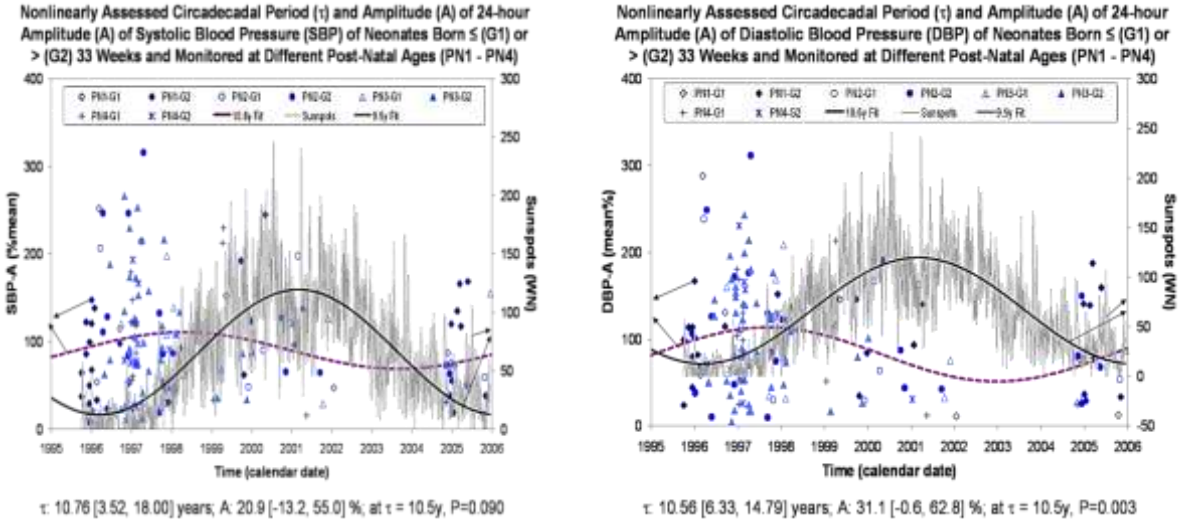

Fig. 2. A circadecadal component characterizes the circadian amplitude of systolic (left) and diastolic (right) BP of neonates monitored in early extra-uterine life. For comparison, the data are shown together with Wolf numbers gauging solar activity during the study span.

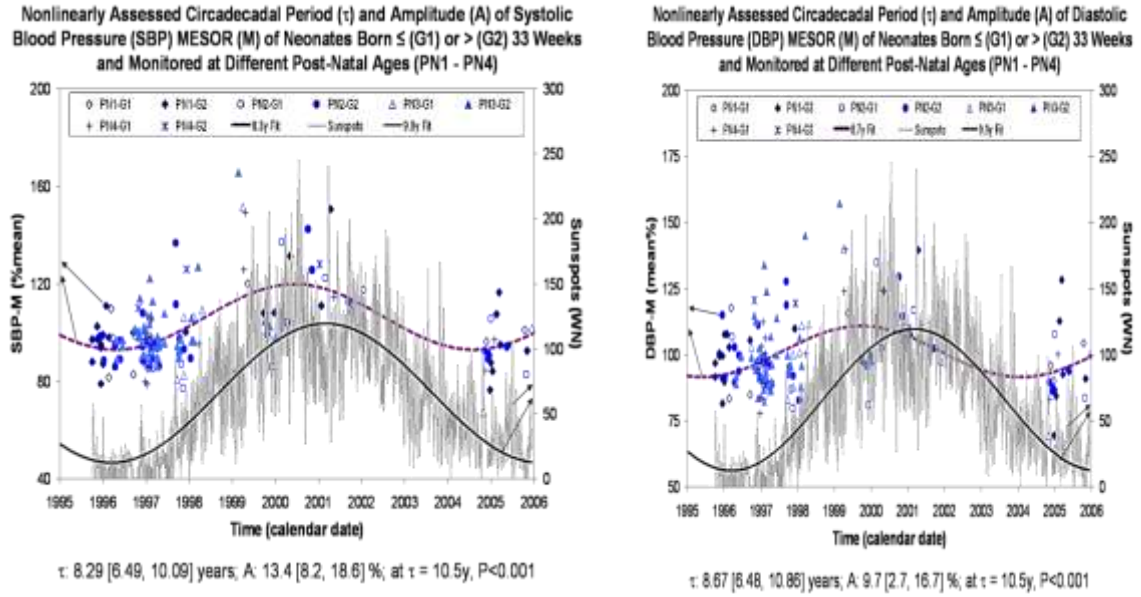

Fig. 3. A circadecadal component characterizes the MESOR of systolic (left) and diastolic (right) BP of neonates monitored in early extra-uterine life. For comparison, the data are shown together with Wolf numbers gauging solar activity during the study span.

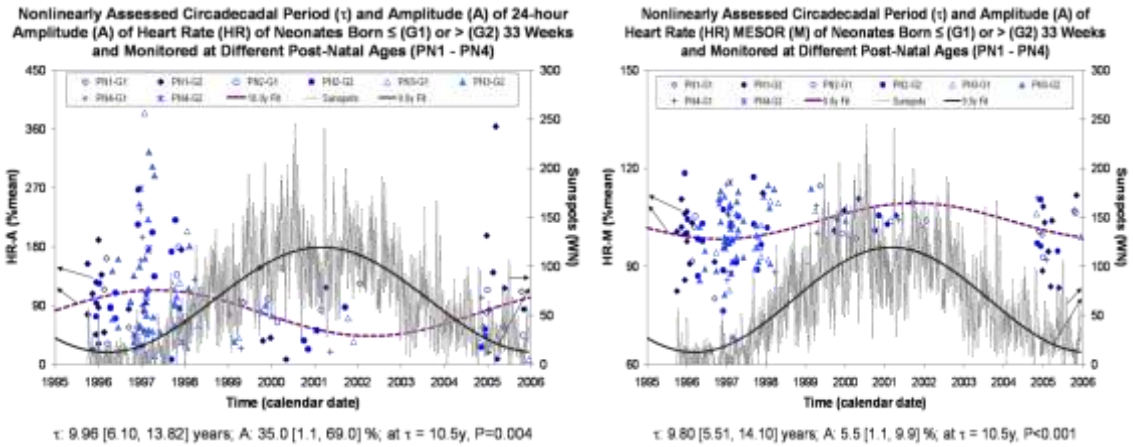

Fig. 4. A circadecadal component characterizes the circadian amplitude (left) and MESOR (right) of HR of neonates monitored in early extra-uterine life. For comparison, the data are shown together with Wolf numbers gauging solar activity during the study span.

Differences in decadal characteristics between babies with a negative or positive family history of high BP seen for the MESOR of SBP and DBP (Figure 5) illustrate how interactions among rhythms of several frequencies (e.g., one cycle per day and one cycle per decade) may lead to differences in opposite directions at different stages of the lower-frequency component. These findings extend the scope of the differences in the circadian acrophase of eosinophil counts in relation to two competing external synchronizers that led to Minnesotan Chronobiology (9).

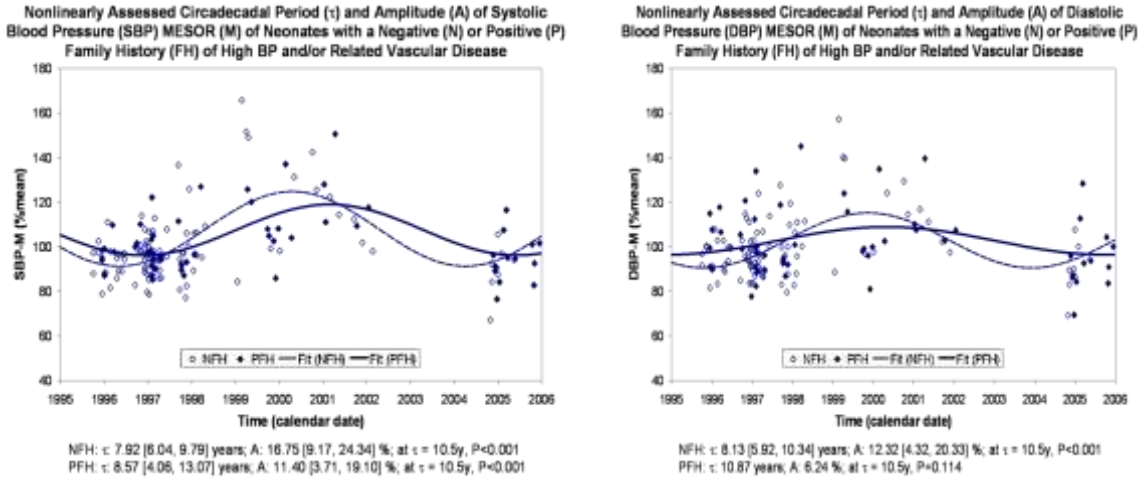

Fig. 5. Differences in circadecadal characteristics of the MESOR of SBP (left) and DBP (right) between neonates with a positive or negative family history of high BP illustrate how differences in circadian endpoints between the two groups may change as a function of a time.

Our inability to confirm an earlier finding on a difference in circadian BP-A between newborns with a positive vs. negative family CVD-history led to finding infradian components. Controls mapped in the decadal range of periods are essential for avoiding blunders. Mapping such infradians revealed a vast new set of complementary neonatal population rhythms that were also found in longitudinal monitoring of adults (10). These aeolian non-stationary non-photic components include circaseptans (2, 11), quinmensals (12, 13), semiannuals (14), transyears (15-17), decadals (18, 19), didecadals (19), para-tridecadals (20) and multi-decadals (21), probably related to magnetism, complementing the body's counterparts of the photic day and year.

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CIRCADIAN STAGE-DEPENDENT EFFECT OF LISTENING TO MUSIC ON SYSTOLIC BLOOD PRESSURE

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Aim. To assess any effect of music therapy on human blood pressure (BP) and heart rate (HR) along the 24-hour scale.

Subject and methods. A 60-year old woman (GC) automatically measures her systolic (S) and diastolic (D) BP and HR around-the-clock, mostly at about 30-minute intervals, with interruptions, with the TM-2430 ambulatory monitor from A&D (Tokyo, Japan). Within a 9-day span, she performed 21 sessions of listening to preprogrammed music designed to lower BP (1). The program (1D, Sanoson) was the same in all sessions that took place at different times during waking (from 07:00 to 02:00). During the 33 minutes of the musical program and for about 30 minutes before and after each session, her BP and HR were measured every 5 minutes according to the protocol of Figure 1, while she continued her professional activities. This point is noteworthy at the outset since music therapy is often recommended along with a cessation of routine activities (1-5). Effects of special kinds of music have also been documented in the laboratory (6-8).

Linear and quadratic regression models were fitted to data pooled from the 90-minute sessions carried out on different days to assess any trend as a function of time. All data during the 9-day study span were averaged over consecutive 90-minute intervals (the duration of one session). The 90-minute averages during each day as well as over the entire 9-day span were analyzed by cosinor (9-11) to obtain estimates of the circadian rhythm characteristics: the MESOR (Midline Estimating Statistic Of Rhythm, M, a rhythm-adjusted mean), the double 24-hour amplitude (2A, a measure of the extent of predictable change within a day), and the 24-hour acrophase (phi, a measure of the timing of overall high values recurring each day), Figure 2. Means and standard deviations (SDs) before, during and after each music session were calculated and assigned to the start time of listening to music to determine their respective circadian rhythm characteristics as well as those of differences between spans spent listening to music and the immediately preceding 30 minutes. Parameter tests (12) were also performed to compare the circadian characteristics of BP and HR before, during and after listening to music.

Results. Regression analyses indicate a decrease in HR overall ($P<0.001$), brought about primarily by a decrease before the music session itself, likely related to the decrease in activity associated with a 90-minute session. A robust and stable circadian rhythm characterizes BP and HR when it is assessed on the basis of all data collected around the clock. The 2A of SBP and DBP averages 28.8 and 17.5 mmHg, respectively, and that of HR 16.5 beats/min over the 9-day study span, Figure 3.

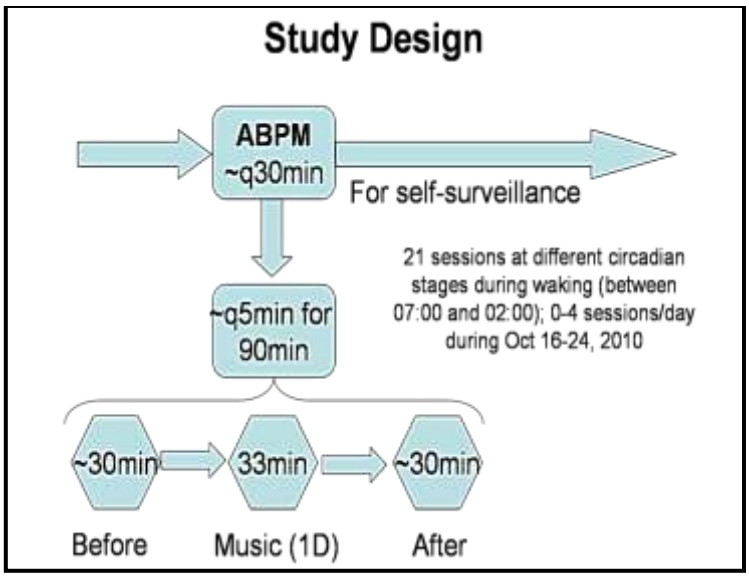

Fig.1. Protocol of the study.

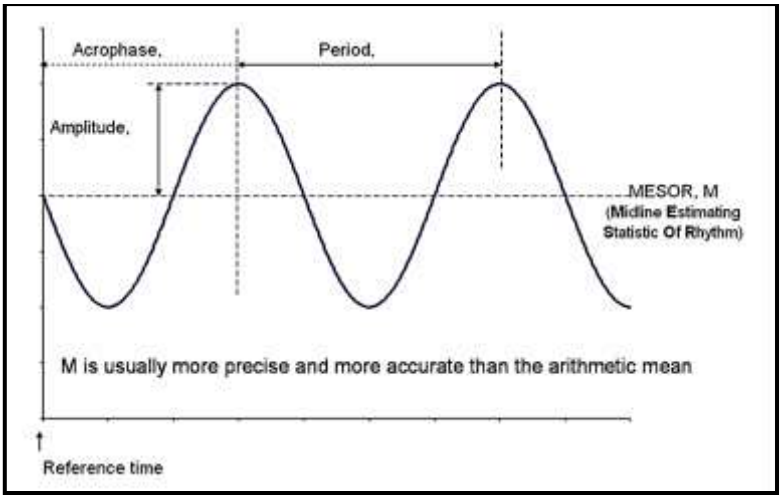

Fig. 2. Definition of circadian rhythm characteristics.

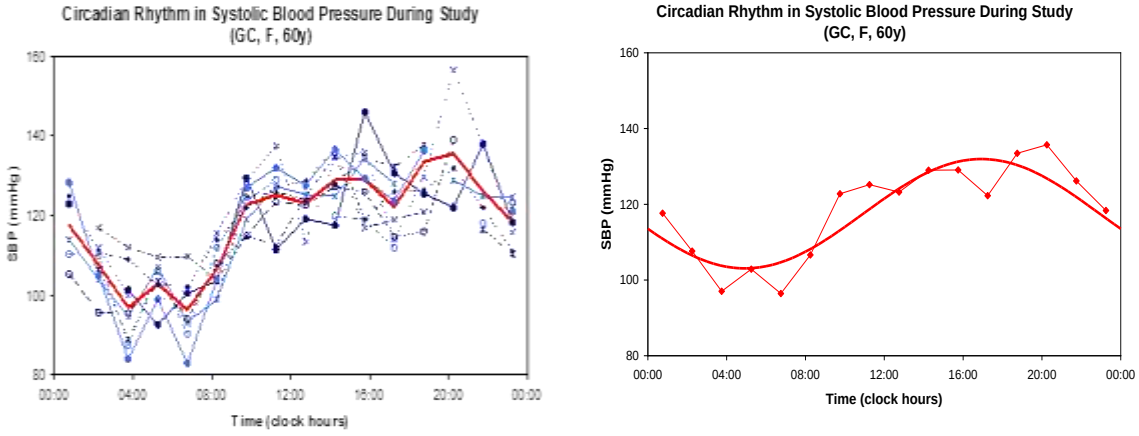

Fig. 3. Left: Systolic blood pressure data (90-min means) collected around-the-clock for 9 days. Right: 24-hour cosine curve fitted to the averaged systolic blood pressure data.

A circadian rhythm in BP cannot be detected with statistical significance, however, for the average values from the 30-minute spans preceding the 21 music sessions, their 2A being estimated at only 4.4 and 5.0 mmHg for SBP and DBP, respectively, Figure 4.

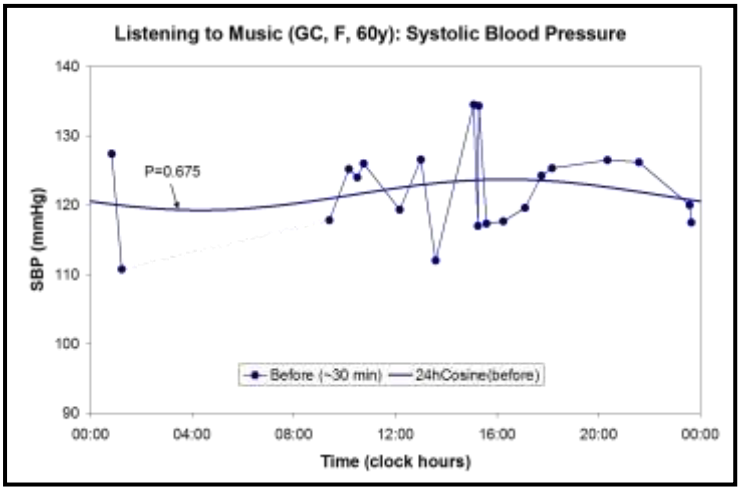

Fig. 4. Failure to detect a circadian rhythm in systolic blood pressure data collected before each of the 21 sessions of music exposure.

By contrast, a circadian rhythm can be demonstrated for both BP and HR when the data collected while listening to music are analyzed ($P<0.05$), Figure 5. Music was associated with a numerical increase in the 2A of SBP and DBP, estimated at 12.1 and 8.6 mmHg, respectively. The amplification of the circadian rhythm in BP ($P<0.05$) persists during the 30-minute spans following the listening to music, the 2A of SBP and DBP being estimated at 16.8 and 8.8 mmHg, respectively, Figure 6.

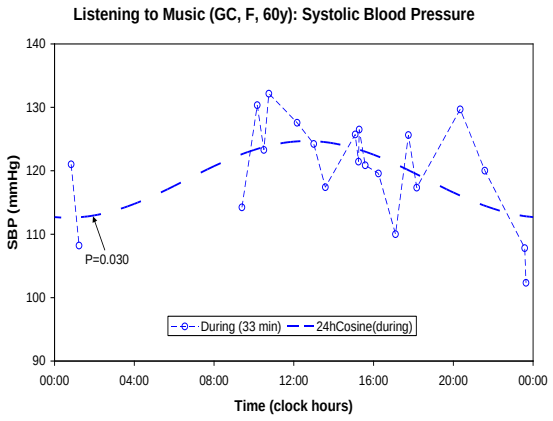

Fig. 5. Demonstration of a statistically significant circadian rhythm in systolic blood pressure measured during music sessions.

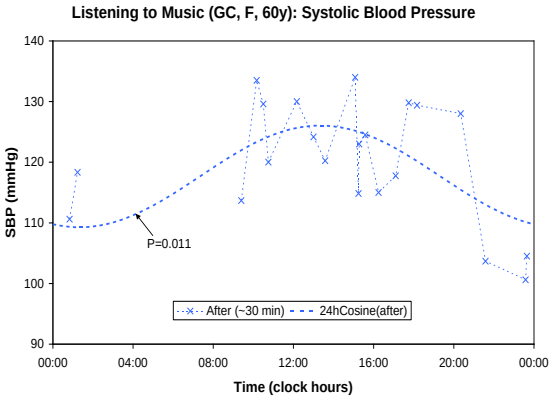

Fig. 6. Demonstration of a statistically significant circadian rhythm in systolic blood pressure measured during the 30-min spans immediately following the music sessions.

The difference in (A, phi) pair of SBP after versus before listening to music reaches borderline statistical significance ($P=0.066$), suggesting that music may indeed induce or reinforce the circadian variation in BP, Figure 7. A response rhythm for SBP is also detected ($P=0.025$) by fitting a 24-hour cosine curve to the "during-before" differences computed for the 21 sessions and assigned to the start times of music listening, Figure 8.

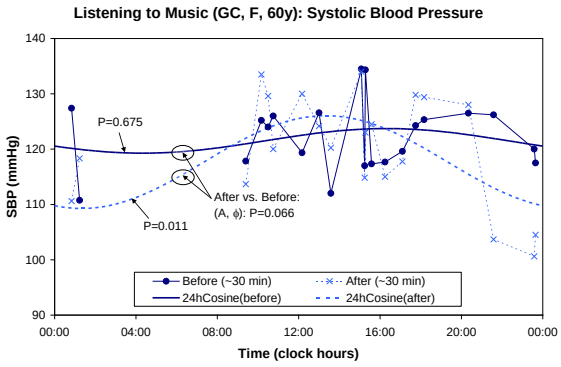

Fig. 7. Listening to music amplifies the circadian variation in systolic blood pressure.

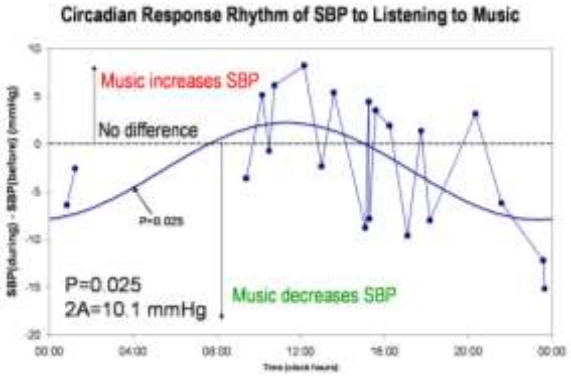

Fig. 8. Whereas systolic blood pressure is lowered by listening to music early in the morning or in the evening, it is increased during the middle of the day.

Discussion and Conclusion. The response rhythm observed for SBP indicates that, on the average, listening to the music program examined herein is associated with a decrease in SBP of about 2.8 mmHg. With a 2A of 10.2 mmHg and an acrophase occurring between 11:00 and 12:00, it means that listening to music in the morning can be associated with an increase of about 2.2 mmHg, contrasted with an expected decrease of about 7.9 mmHg during evening sessions. Extrapolation beyond a single case and the special kind of music program tested is not warranted. It can be assumed that the continuation of professional activities during the exposure to music may have blunted rather than amplified the effect. Furthermore, the differing response of SBP to a 33-minute session of preprogrammed music as a function of circadian stage was anticipated since earlier a circadian-stage dependence was demonstrated for a variety of stimuli such as noise (13), X-irradiation (14, 15), various drugs (15-20) and nutriceuticals (20), food (21-24), periodontal surgery (25), and the milder stimulus of immersing one's hand into cold water (26, 27), findings in keeping with generalization, albeit not with numerical extrapolation of the results in the case here examined.

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WEEK-LONG ABPM RECORDS ARE A PREREQUISITE FOR A RELIABLE DIAGNOSIS OF VASCULAR VARIABILITY DISORDERS (VVDS)

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Automatic around-the-clock measurements of blood pressure (BP) and heart rate (HR) by ambulatory monitoring (ABPM) in clinical health served to derive time-specified reference limits computed as 90% prediction limits specified by gender and age (1). Data are analyzed by sphygmochron (2-4), consisting of parametric and non-parametric assessments. Parametrically, by least squares (Figure 1), a two-component model, consisting of cosine curves with anticipated periods of 24 and 12 hours, is fitted to the data (Figure 2) yielding estimates of the MESOR (M),

24-hour and 12-hour double amplitudes (2A) and acrophases (ϕ) (5-7). Definitions of rhythm characteristics are provided in Figure 3 for the case of a single component.

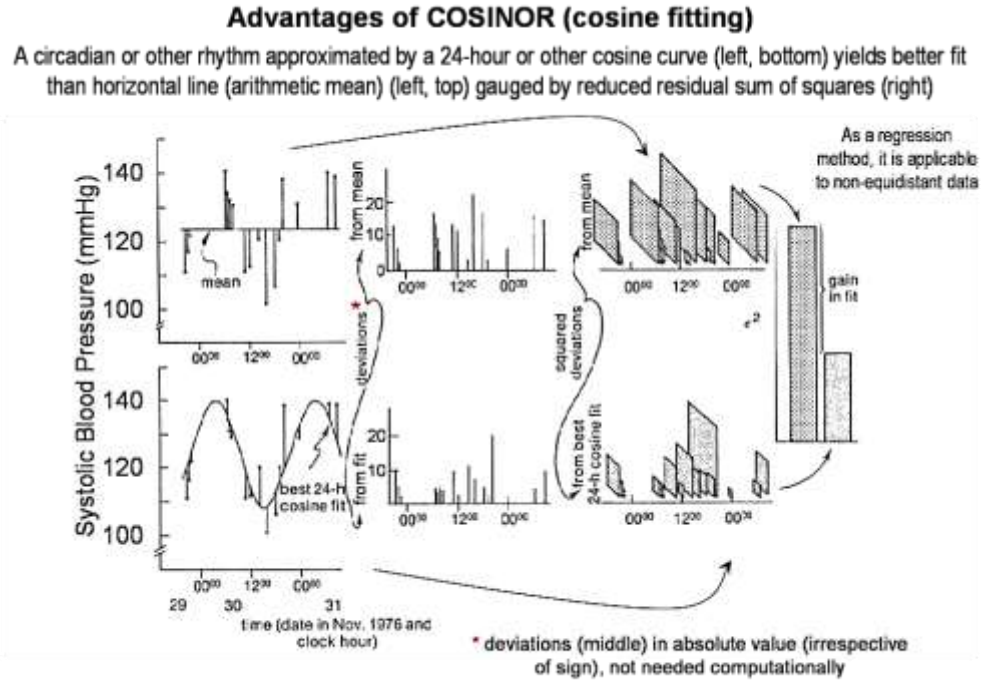

Fig. 1. Illustration of the principle of least squares underlying the extended cosinor method.

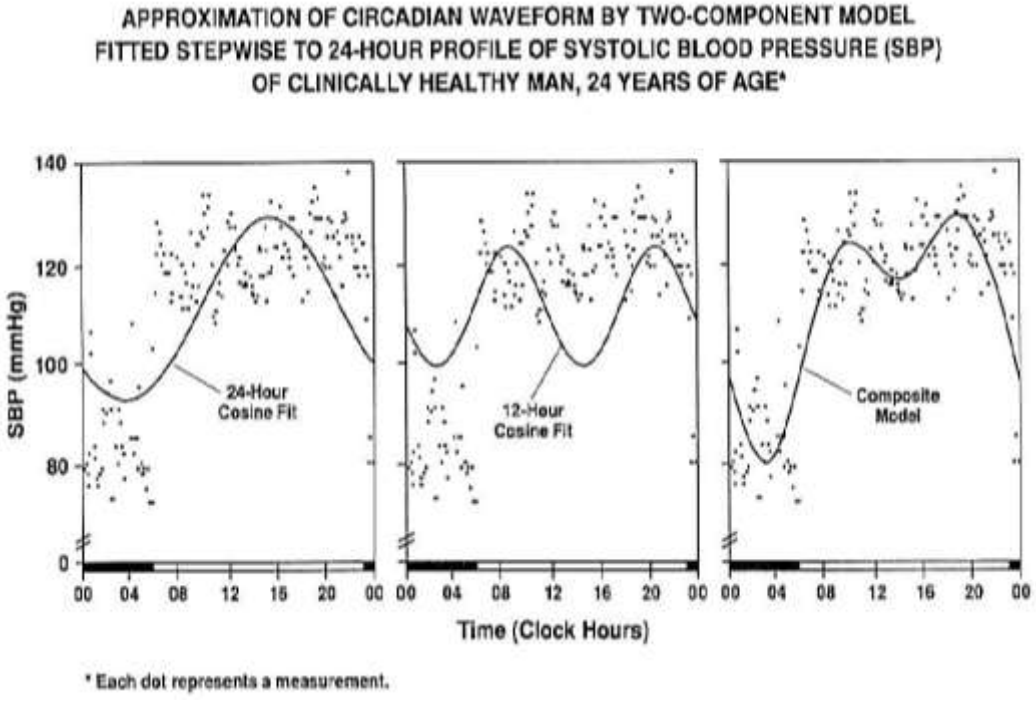

Fig. 2. Fit of 2-component model to systolic blood pressure (SBP) data.

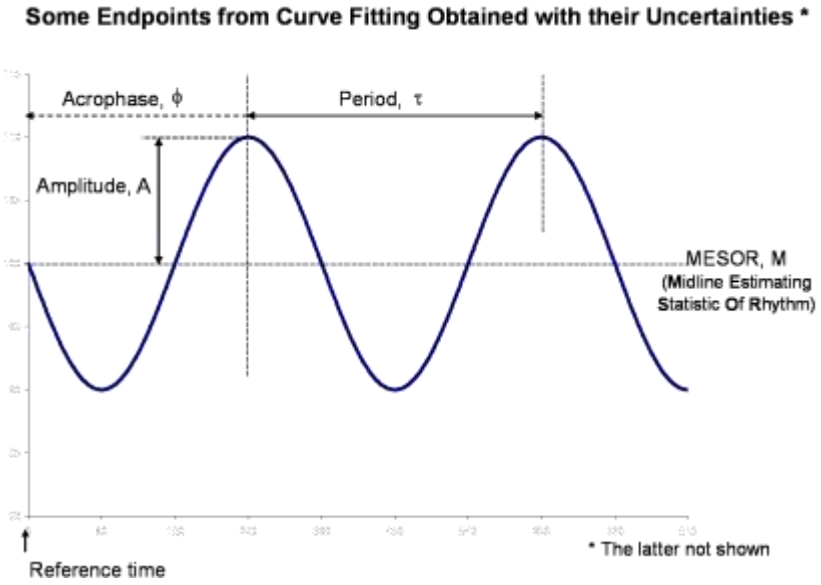

Fig. 3. Definition of parameters from curve fitting: MESOR (M), amplitude (A) and acrophase (ϕ). Non-sinusoidal waveforms can be approximated by the (A, ϕ) pairs of harmonic terms (see Figure 2). Uncertainties are usually provided as 95% confidence intervals for M, and (A, ϕ) pairs.

Reference limits, also computed as 90% prediction limits separately for men and women of different age groups are derived for M, 2A and ϕ from records in clinical health. This model usually provides a good approximation of the decrease during rest, the small increase around mid-sleep followed by a more rapid increase around awakening, a post-prandial dip that is more accentuated with increasing age, and the evening slower decrease, Figure 4 (8).

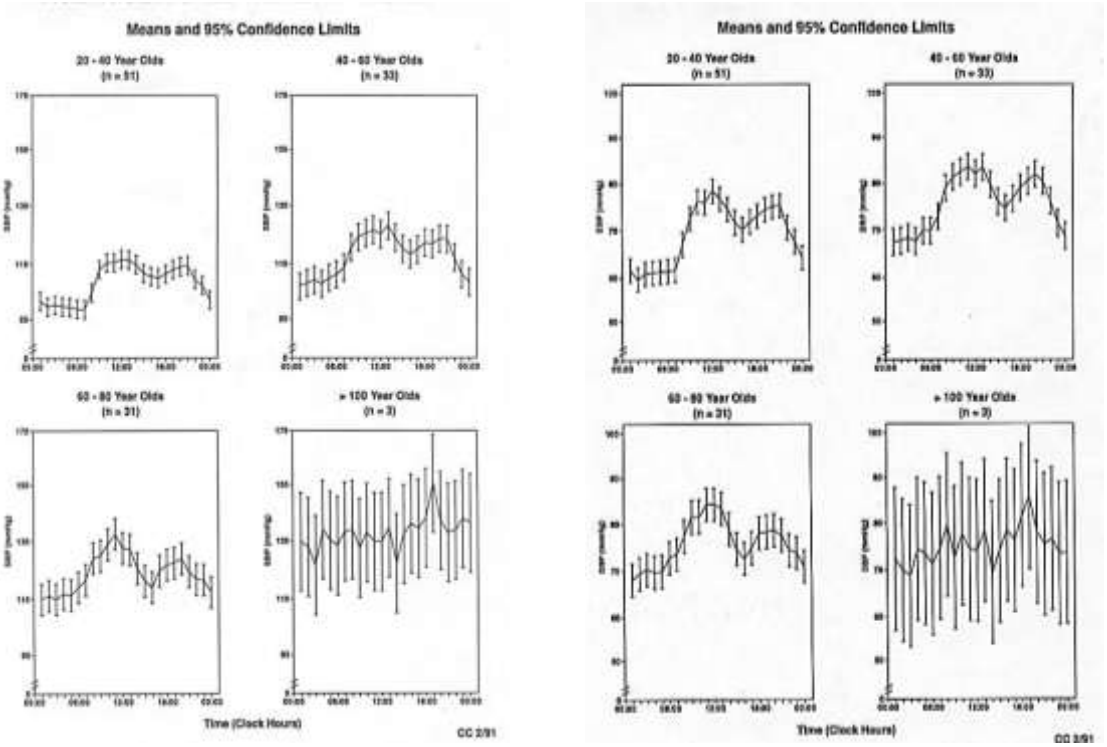

Fig. 4. Circadian waveform of systolic (left) and diastolic (right) blood pressure in four age groups.

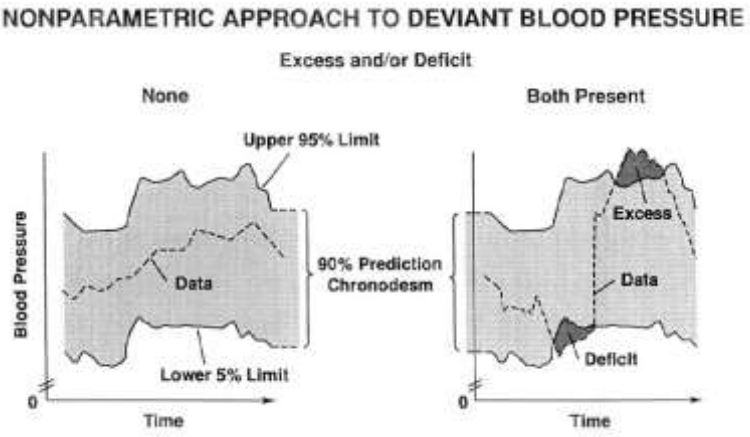

Fig. 5. Nonparametric approach to blood pressure assessment.

Non-parametrically, percentage time elevation, area of excess and timing of largest excess are determined by numerical integration, Figure 5. In addition to MESOR-hypertension, deviations from these chronobiological norms lead to diagnoses of CHAT and/or ecphasia when the 24-hour BP-2A is excessive and/or the 24-hour BP-ϕ is outside acceptable limits but the 24-hour HR-ϕ is acceptable. These conditions along with an excessive pulse pressure (above 60 mmHg) and a deficient HR variability (standard deviation of HR <7.5 beats/min) constitute Vascular Variability Anomalies (VVAs) when present during one or a few days, or Vascular Variability Disorders (VVDs) when the abnormalities are confirmed over repeated week-long records in the absence of a persisting load (4). Any two or more coexisting VVDs are referred to as Vascular Variability Syndromes (VVSs).

Table 1

Number of days with at least one VVA will have to be complemented by the extent of severity of VVA(s) each day and overall *

		VVA in weeklong record?		Comments
N of days with a VVA	N of subjects	No	Yes	
0	0			
1	3	3	0	
2	7	7	0	
3	2	2	0	
4	6	4	2	1 VVA each (S-CHAT)
5	4	2	2	1 D-MH; 1 S-&D-CHAT
6	1	1	0	
7	3	0	3	1 S-CHAT; 2 with 3 VVAs**

* One can have 6 days with a VVA and no abnormality in the overall record (row 7), a finding suggesting that the duration of a VVA is an incomplete measure, the extent of abnormality also in need of being assessed. Continuous recording with automatic analyses carried out both day-to-day and week-to-week is recommended in any event once a validated, unobtrusive monitor is miniaturized and rendered affordable in a chronobiologic system subservient to health monitoring, including mental and other strain assessment, with dividends for medical research and for monitoring effects of natural environmental factors, including solar activity.
** 1 with S-MH, EPP and S-CHAT and 1 with S-MH, EPP and DHRV.
VVA: Vascular Variability Anomaly; S- (Systolic); D- (Diastolic); MH: MESOR-Hypertension; CHAT: Circadian Hyper-Amplitude-Tension; EPP: Excessive Pulse Pressure (>60mmHg); DHRV: Deficient Heart Rate Variability (standard deviation of HR <7.5 beats/minute.

ABPM records from 26 residents (4 men and 22 women 39-74 years of age) of Tosa City, Japan over 6 or 7 days (2 and 24 profiles, respectively) were analyzed overall and day-by-day in order to determine the frequency of occurrence of abnormalities and the extent of reproducibility of the results from one day to another. Among all 26 records, at least one VVA is found on at least

one day in all residents. Twelve subjects with no overall abnormality had a VVA in 1 to 3 days. Of the remaining 14 subjects, only one had no overall abnormality but at least one VVA in 6 of 7 days. Her data are plotted as a function of time in Figure 6, with an indication of VVAs detected on a daily basis. Her overall sphygmochron and circadian profiles of systolic and diastolic BP are shown in Figure 7. The other 13 had at least one VVA in 4 or more days as well as an overall abnormal record, Table 1. The 3 individuals with abnormality on all 7 days also have an abnormal 7-day record, one with only systolic CHAT, the other two with 3 VVDs, including systolic MESOR-Hypertension and an excessive pulse pressure together with either systolic CHAT or deficient HR variability, Table 1.

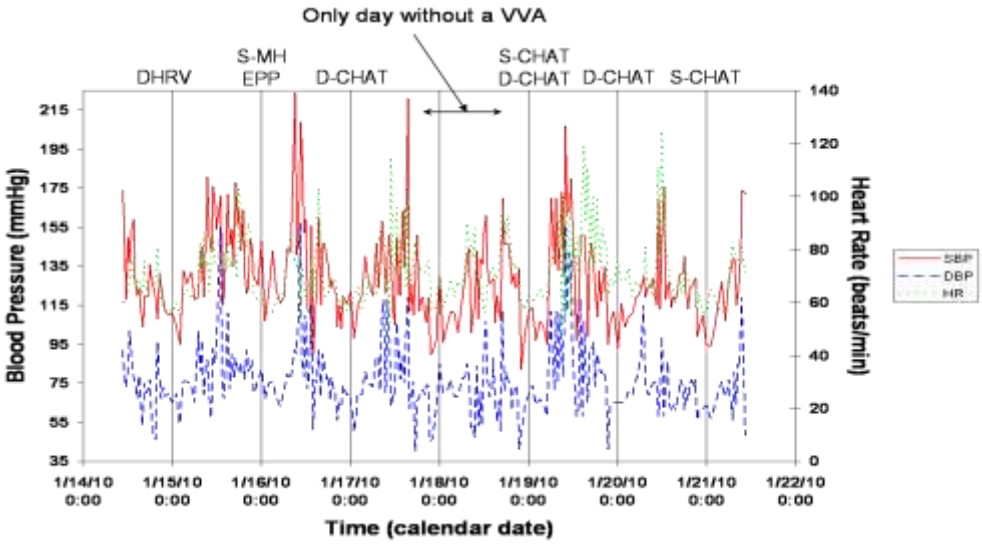

Fig. 6. Day-to-day variability in BP and HR behavior. In this record, there is at least one VVA on 6 of 7 days. The overall summary shows all endpoints to be within acceptable limits (see Fig. 7).

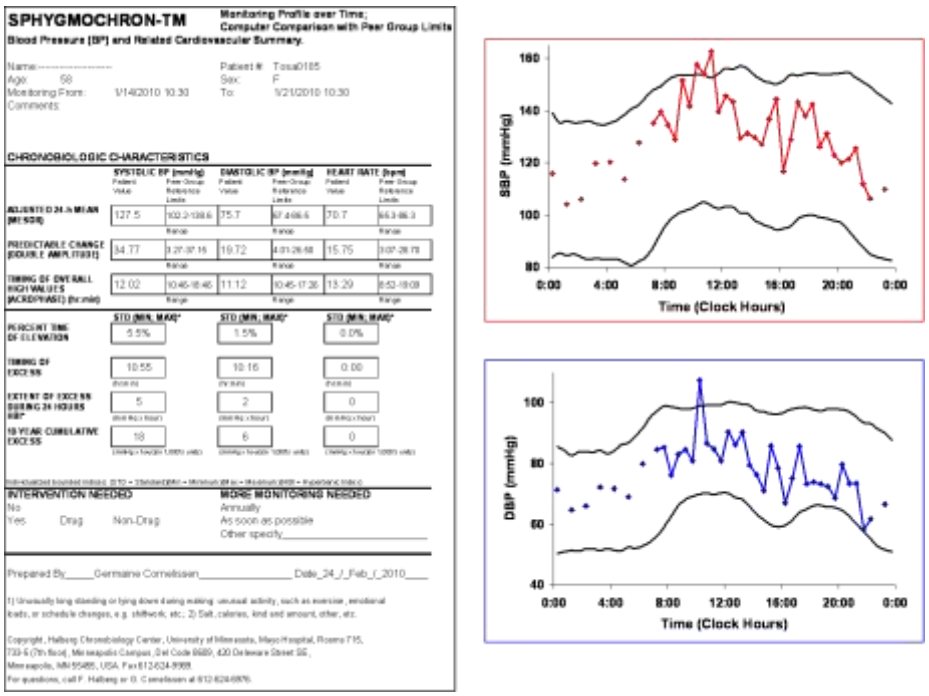

Fig. 7. Overall sphygmochron of subject whose data are shown in Figure 6. Stacking of the systolic and diastolic BP data in the light of reference limits reveals only minor BP excess.

The number of abnormal days in a weeklong record as such does not tell whether the 7-day record is also abnormal, a finding suggesting that the duration of a VVA is an incomplete measure, to be complemented by information on the extent of abnormality. Weeklong records were found to be abnormal in over 25% of the residents, a reason for recommending a follow-up 7-day profile once abnormality is detected in the first 7-day record, yet week-to-week variability underscores the need for unobtrusive, affordable instrumentation for continued monitoring of mental strain, gauged by VVAs (9).

For the limited purpose of cardiovascular disease risk monitoring, a one-day VVA can be neglected, but a VVA or several VVAs in a 7-day record analyzed by the fit of a model consisting of cosine curves with periods of 24 and 12 hours to the whole profile is an indication for continued monitoring.

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PERSONALIZED BLOOD PRESSURE CHRONOTHERAPY

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Aims. To determine whether the timing of administration of Losartan potassium/ Hydrochlorothiazide (L/H) can be optimized along the circadian scale and to assess the extent to the optimal circadian stage differs from one patient to another.

Background. Large studies on rodents amply documented that treatment timing can make a great difference in outcomes, sometimes between life and death (1). Small pilot studies in humans have also demonstrated the gain that can be obtained from optimizing the circadian stage of treatment administration (2, 3). In the case of low-dose aspirin, we also learned that the best treatment time to reduce toxicity differs from that to lower blood pressure (BP) or to prevent blood coagulation (4).

Subjects and methods. Fifteen patients automatically measured their systolic (S) and diastolic (D) blood pressure (BP) and heart rate (HR) around-the-clock at 30-minute intervals for 7 days first without L/H and thereafter after at least one month on L/H administered at a given circadian stage, at awakening and 3, 6, 9, 12 and 15 hours after awakening, with monitoring during the last week on a given timed treatment. Each record was analyzed by sphygmochron overall and separately for each day of the 7-day profiles. Estimates of the MESOR (M) and 24-hour amplitude (A) corresponding to the 6 treatment times were compared by one-way ANOVA and by cosinor (parameters being assigned to the time of treatment in relation to awakening) separately for each patient as well as for all 15 patients.

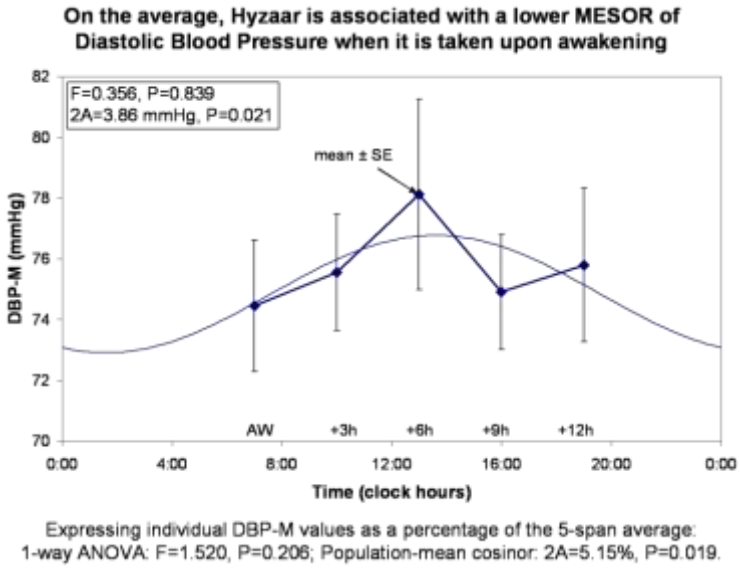
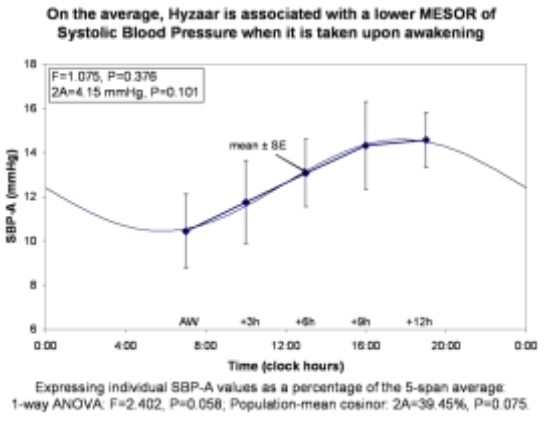


Fig. 1. © Halberg

Results. On the average, the MESOR of DBP is lower (Fig. 1) and the circadian amplitudes of SBP and DBP are smaller (Figures 2 and 3) when L/H is administered upon awakening.



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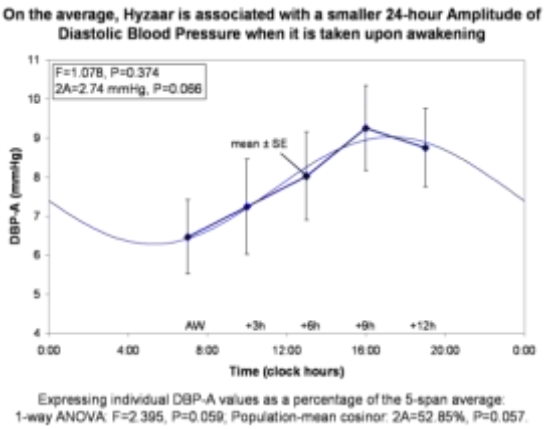

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An effect of L/H on the circadian amplitude (A) of BP is not trivial since several outcome studies have shown that when the BP-A is excessive (above the upper 95% prediction limit of BP-As of clinically healthy peers matched by gender and age), a condition known as CHAT (Circadian Hyper-Amplitude-Tension), there is a large increase in cardiovascular disease risk (5). An effect of circadian stage of L/H administration on the circadian BP-A (as well as on the MESOR) can also be demonstrated on an individual basis for some patients. For Su (M, 67y), the presence of CHAT

in the absence of treatment is exacerbated when L/H is taken 6 hours after awakening, but it is alleviated when the same dose of L/H is taken in the evening, 12 hours after awakening, Fig. 4.

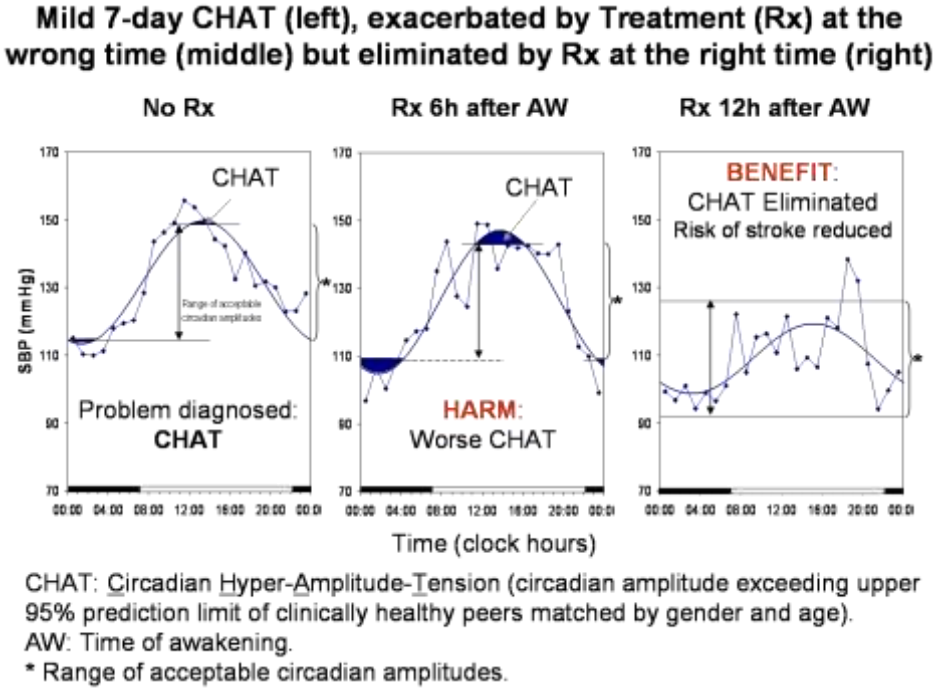
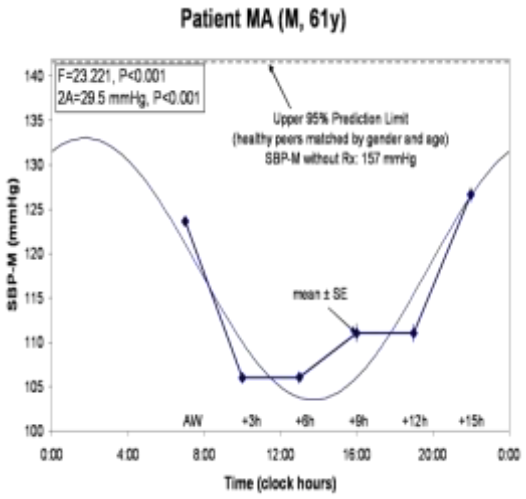


Fig. 4. © Halberg

For MA (M, 61y), SBP-M, DBP-M and pulse pressure (PP) are lowest around 6 hours after awakening (P<0.001), while his SBP-A and DBP-A reach the upper level of acceptability when L/H is taken 3 hours before bedtime (SBP: P<0.001; DBP: P=0.003), Fig. 5-9.



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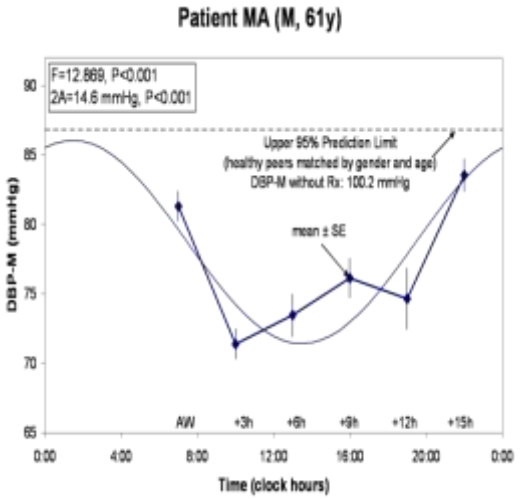
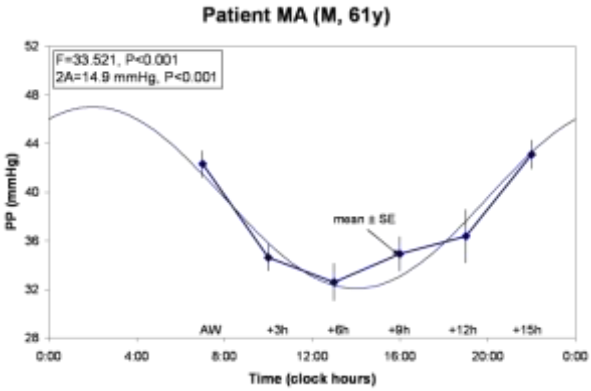


Fig. 6. © Halberg



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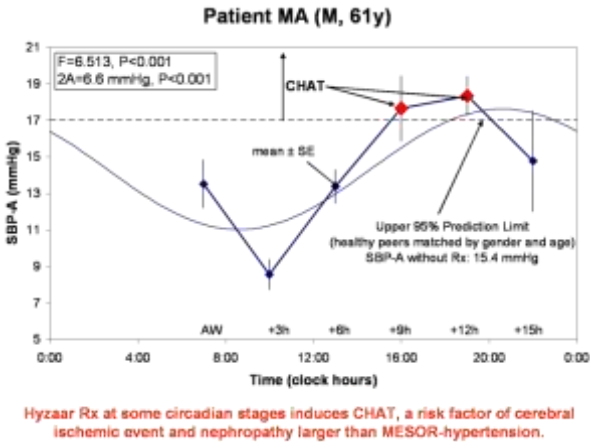

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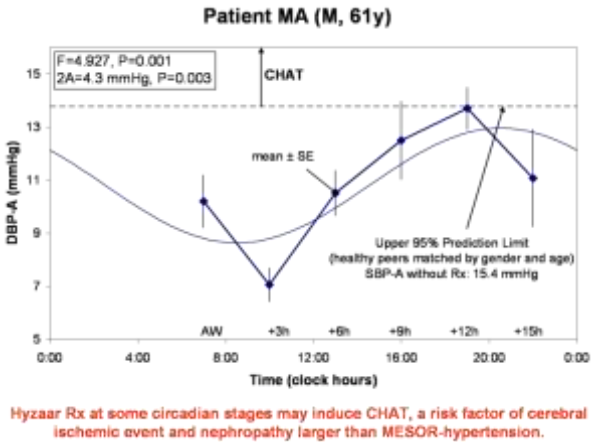
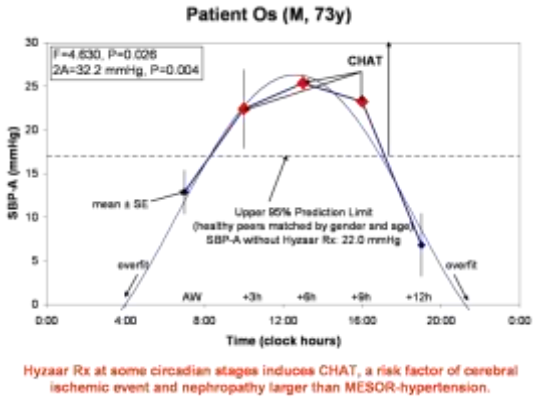


Fig. 9. © Halberg

For patient Os (M, 73y), SBP-A and DBP-A are excessive (corresponding to CHAT) when L/H is taken around mid-day (SBP: P=0.004; DBP: P=0.013), Fig. 10 and 11.



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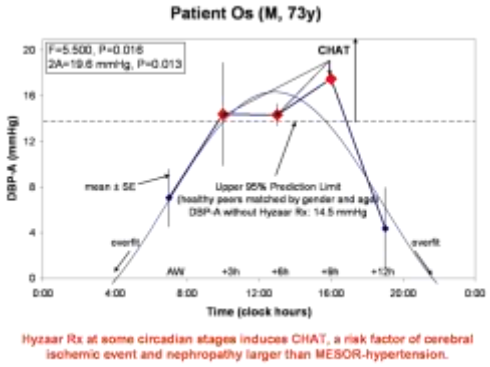

Fig. 11. © Halberg

Discussion and Conclusion. Patient Su discussed earlier (6, 7) is no exception. There are other patients for whom L/H can help or hurt depending on when it is taken by decreasing or increasing the circadian BP-A. Individual differences in terms of optimal timing on the BP-M as well as on the BP-A are sufficiently large to advocate optimization for each patient separately,

Figure 12. With inter-individual differences, an overall time effect is demonstrated for DBP-M (P<0.05).

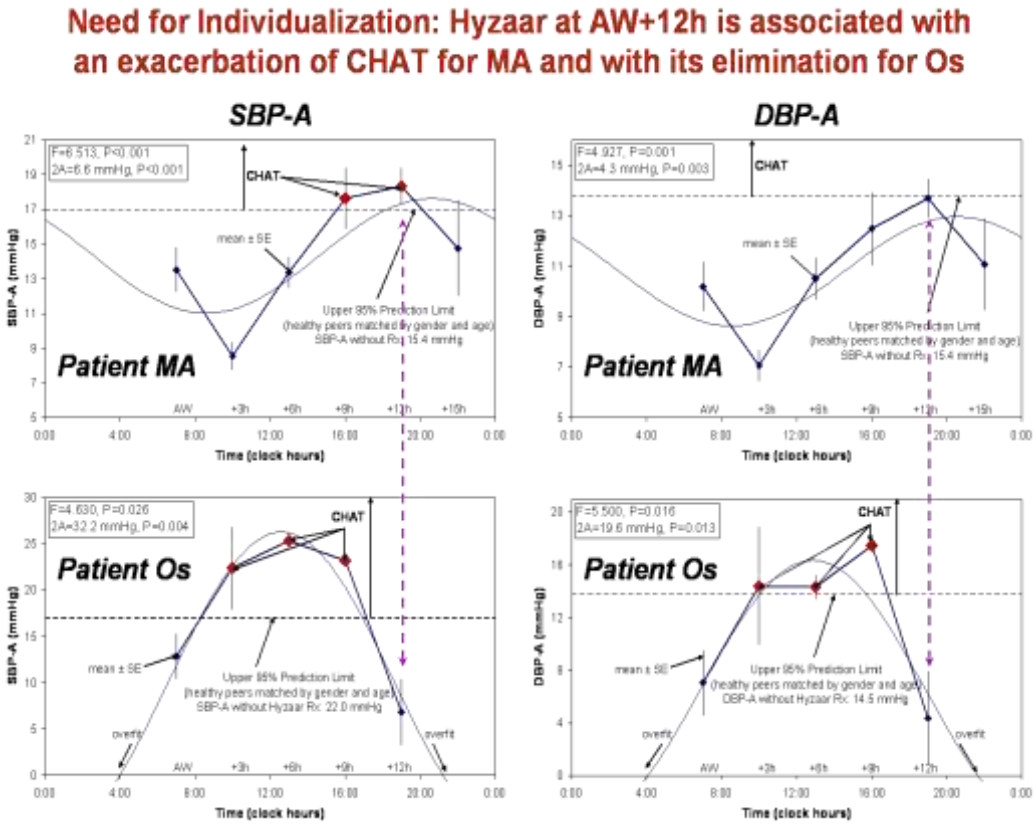

Fig. 12. © Halberg

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PHYSIOLOGY AND EARTHQUAKES, FOCUSING ON THAT IN 2011 IN EAST JAPAN

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Aim. To determine whether there were any changes in systolic (S) and/or diastolic (D) blood pressure (BP) and/or heart rate (HR) in relation to the 2011 Tohoku megathrust earthquake and tsunami.

Background. Bracketing the 12 May 2008 Wenchuan magnitude 8.0 earthquake in China, locomotor activity of mice monitored automatically around-the-clock was found to be dramatically decreased in 6 of the 8 animals on day 3 before the earthquake, the behavioral change lasting 6 days (1). Analyses of concurrent geomagnetic data showed a higher total intensity during the span when the circadian rhythm in activity was dampened (1). Unusual murine behavior has also been reported prior to the Kobe earthquake on 17 January 1995 (2), consisting of drastic increases in locomotor activity both during the rest and active spans. Abnormal behavior in fish, snakes, dogs, frogs and mice before an earthquake has been reported (3-5). Changes in groundwater chemistry prior to seismic events have been considered to account for their possible effects on animals (5, 6). Most accounts of changes in animal behavior remain primarily anecdotal, however, with only few exceptions (1, 2). In humans, the literature has primarily focused on consequences from cataclysms such as earthquakes on health risks. For instance, earthquake-induced potentiation of acute risk factors has been reported in hypertensive elderly patients and the question has been raised whether cardiovascular events may be triggered after a major earthquake (7). By 1948, the incidence of hypertension has been reported to increase following events such as the Texas City disaster, a deadly industrial accident that took place on 16 April 1947 and began with a mid-morning fire on board a vessel docked in that city's port (8). Reportedly, the majority of these victims showed definite although not prolonged diastolic hypertension (8). In a case-control study, somatization (hysteria) and anxiety were positively correlated with hypertension in flood victims of hurricane Agnes (9). BP elevation associated with mental loads following a natural disaster could, in turn, increase mortality from cardiovascular disease (10, 11). This investigation draws on the ongoing self-surveillance of BP and HR for health monitoring by several individuals to seek any changes that may have either followed or perhaps preceded the onset of an earthquake.

Subjects and methods. Thirteen Japanese residing in Tokyo were measuring their BP and HR around-the-clock at 30-minute intervals for 7 days bracketing the magnitude 9.0 Eastern Japan Great Earthquake Disaster (EQ) that occurred at 14:46 on March 11, 2011, striking the northern part of Japan from Iwate to Ibaraki Prefectures. Strong tremors in Tokyo measured upper 5 on the Japanese seismic intensity scale of 7. A model consisting of cosine curves with periods of 24 and 12 hours was fitted to the data, separately for each calendar day and also for each day relative to the time of occurrence of the earthquake. The daily standard deviations (SD) of HR and estimates of MESOR (Midline Estimating Statistic Of Rhythm, a rhythm-adjusted mean) and amplitudes of the 24-hour and 12-hour components were normalized for each profile and the relative values analyzed by one-way analysis of variance across the 13 subjects testing for any day-to-day differences. Similar analyses were conducted on two sets of data serving as controls. One set consisted of data from 11 similar patients monitored during previous years at about the same calendar date (mid-March). Another set stemmed from data from one of the study participants (YW) who has been monitoring himself for over 20 years. Week-long profiles in mid-March from 11 prior years were used as an additional control from the same individual. The two sets of data hence provided both a transverse and a longitudinal control. As the 2011 earthquake occurred on a Friday, Friday was chosen as the reference "event" day to account for any weekly pattern known to characterize BP and HR (12-14) as well as the incidence patterns of adverse cardiovascular events (15).

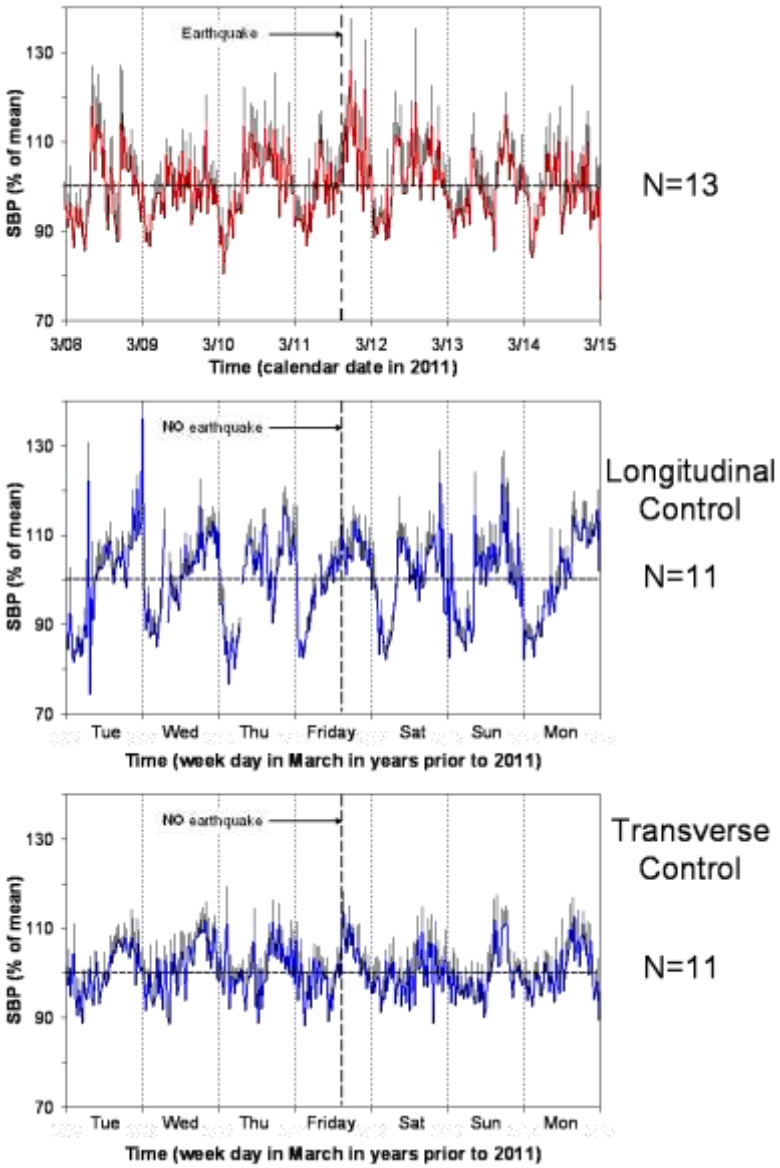
Results. The SBP data, expressed as a percentage of the 7-day mean, and averaged across subjects are shown in Figure 1 for the 13 subjects monitored in March 2011 and for the transverse and longitudinal controls. Based on analyses of 7 calendar days, day 4 being the day when the earthquake occurred, the 12-hour amplitude of SBP was decreased 2 days prior to EQ ($F=3.903$, $P=0.002$), a feature not observed in the controls. The 12-hour amplitude of HR was increased 3

days prior to the earthquake and decreased the day after it struck (F=2.724, P=0.020). Albeit not statistically significant, a somewhat similar pattern was found for the two sets of controls. When considering 3 days prior to the time of the earthquake and 3 days thereafter, ANOVAs confirmed an increased 12-hour amplitude of HR on day 2 prior to the event and a decrease on day 2 after it occurred (F=2.797, P=0.024). Again, a similar pattern was observed for the two sets of controls, albeit results on controls only reached borderline statistical significance. A progressive increase in the MESOR of HR peaking 1 day after the earthquake was of borderline statistical significance (F=2.103, P=0.076), Figure 2. The corresponding pattern of controls was also found to be non-random, similar for the transverse (F=2.279, P=0.059) and longitudinal (F=2.978, P=0.020) controls, but different from that seen in relation to the earthquake. Instead of a steady increase in HR-M, a peak on day -2 was followed by a trough on day -1, in keeping with a Wednesday peak associated with the circaseptan component.

As seen from Figure 3, the HR-SD was larger before the earthquake and started decreasing on day 2 after the earthquake (F=2.486, P=0.040). As for HR-M, a statistically significant non-random pattern was observed for the transverse controls but this pattern, similar to that seen in the longitudinal control, differed from the pattern in March 11 associated with the earthquake. Again, the controls showed a Wednesday peak likely associated with the expected circaseptan variation.

Particularly noteworthy is the steady increase in the MESOR of SBP, reaching a peak on the first day after the earthquake (F=3.157, P=0.013), Figure 4. Patterns in the controls were not statistically significant and showed primarily no noticeable change over the 6 (Figure 4, right) of 7 (Figure 4, left) days.

Discussion and conclusion. Comparing patterns of the different endpoints among the three datasets, characteristic features associated with the 2011 earthquake, not seen in the controls, include a steady increase in the MESOR of both SBP and HR preceding the earthquake and peaking one day after the disaster and a drop in the SD of HR starting on the second day after the earthquake. Whereas the latter effect may be a response to the disaster and may contribute to an increase in cardiovascular disease risk, in keeping with earlier reports (7, 10, 11), a decreased HR variability being a risk factor (16), the increase in both SBP and HR preceding the earthquake is a novel finding in humans, akin to earlier observations of precursor signs made in animals (1-3). The question has been raised whether the 12-hour component may represent a rhythm in its own right rather than being merely a harmonic of the circadian rhythm (17). Whereas this is a valid question, convincing evidence is hard to find. The different patterns of resynchronization of the 24-hour and 12-hour components of BP and HR after crossing several time zones do not necessarily prove that the 12-hour component is independent from the 24-hour component. An advance versus delay observed for the two components can be expected when the transmeridian flight involves more than 6 time zones as was the case between Minnesota, USA and St Petersburg, Russia (9 time zones) (17). The higher sensitivity of the 12-hour over the 24-hour phase change following a change over only 3 time zones, as observed in a study involving travel from Minnesota to the Artic Circle, is also expected as it involves a larger phase angle (18), but this greater sensivity of the 12-hour versus the 24-hour component may deserve scrutiny in any other data sets, retrospectively and prospectively. Continuous physiological surveillance could serve not only for primary prevention in healthcare but also as a way to monitor the antecedents of cataclysms in the environment. Monitoring on a broader scale in different geographic locations can yield signals that may eventually serve as a warning. If found to be amenable to generalization in different populations at different times, the data may be particularly welcome to those seismologists who hold the view that earthquakes are unpredictable. The biosphere needs to be tested for use as a very sensitive frequency-dependent magnetometer.



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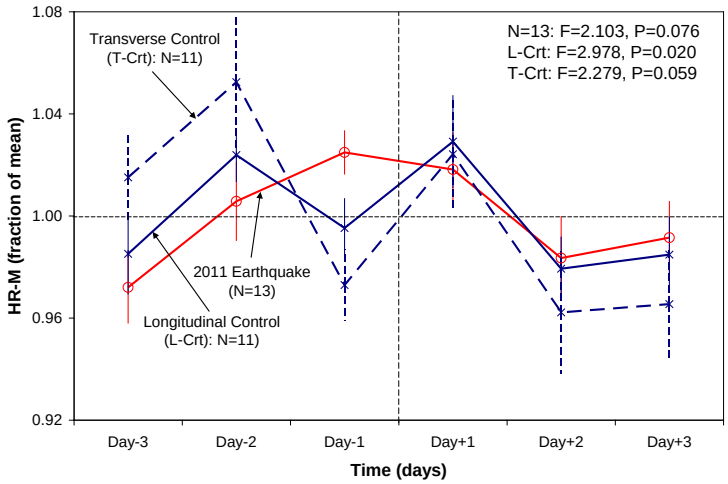

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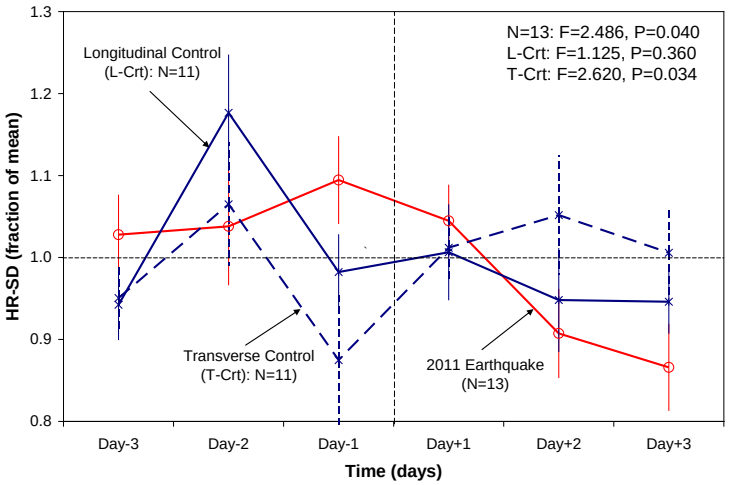

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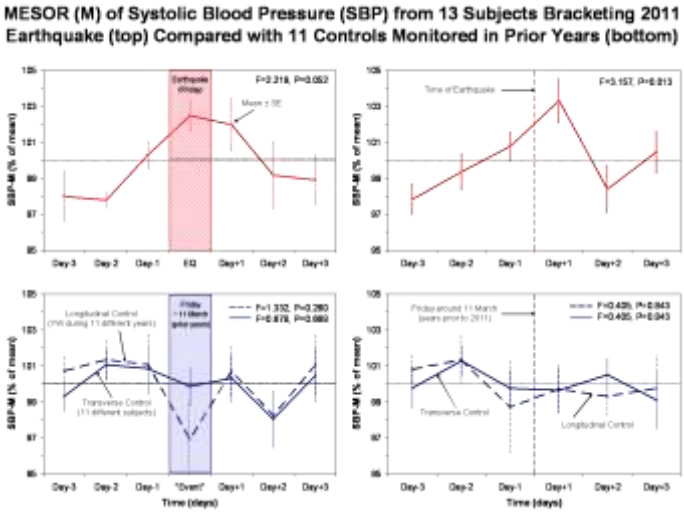

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ENDOCRINES' DESYNCHRONIZATION DURING ADYNAMIC DEPRESSION

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Aim. To document the outcome of most of a total of 11,700 salivary cortisol determinations, that echo what was found for cortisol (1), namely the detection of synchronization and desynchronization from the societal routine characterizing cortisol (1) as well as aldosterone, testosterone, estradiol and melatonin.

A 62-year-old woman (JF) at start of study collected saliva every 4 hours for 13 months, including parts of 2 winter and 1 summer downtimes of adynamia and depression lasting about (~) 2 months and recurring half-yearly for 20 years, with desynchronization from the societal 24-hour routine of her sleeping and waking and, i.a., of her partly monitored wrist activity and vigor self-rating. Vigor/wellness showed the double tidal period of 24.8 hours in the first months of 2 out of 3 self-rated episodes of unwellness and loss of vigor. Cortisol (1), aldosterone, DHEA, testosterone,

estradiol and melatonin were determined in 11,700 assays of saliva collected from 2009010100 to 2010111804, with only few gaps for few hormones. Chronobiologic serial sections of the data with intervals of 72 or 168 hours were in keeping for each hormone with desynchronization from the 24-hour societal routine during the ~2-month-long adynamic depressed downtimes, Figures 1-5. Figure 6 compares the acrophases of cortisol in the first 6 cycles with those of the other hormones. Scrutiny of the results in 1-month sections allowed the demonstration of two coexisting circadian components, one synchronized by the 24.0-hour society or near that length, the other longer and conceivably pulled by a double tidal period, perhaps via gravity (earth and ionospheric tides resulting in magnetic cycles?). A 24.83-hour period (95% confidence interval: 24.59-25.02) characterized salivary aldosterone in a first investigated downtime. The amplitude (A) of the longer-than-24.0-hour period exceeds the 24.0-hour A during unwellness and vice versa during wellness (2). A precise 24.8-hour period during the (long-term, up to 265-day) isolation of clinically healthy individuals suggests that the lunar pull is also present in health when the societal 24.0-hour schedule is eliminated by social isolation (2, 3). During Wever's shorter isolation studies, usually for weeks rather than months in a bunker (2), the circadian period was very close to the double tidal period (4, 5). It was 24.8 hours in our nonlinear meta-analysis of data from the bunker kindly offered by Dr. Robert B. Sothern. The fact that hormones like testosterone and estradiol desynchronize, as does DHEA, suggests that the sites of sex hormone production and certainly all three zones of the adrenal cortex are subject to the pull of the moon during isolation from society and in JF during life in society with behavioral, including sleep pathology. The desynchronization of melatonin, produced by the pineal and the gut, suggests an even more pervasive lunar effect than its action upon steroids involved in survival and reproduction. On the technical side, the length of the time series exceeding one year provides information relating to duration requirements of sampling for chronomic stress (or rather strain) tests and sex hormone panels, among others, while biospheric periods reflecting cosmic periods may also be found (3).

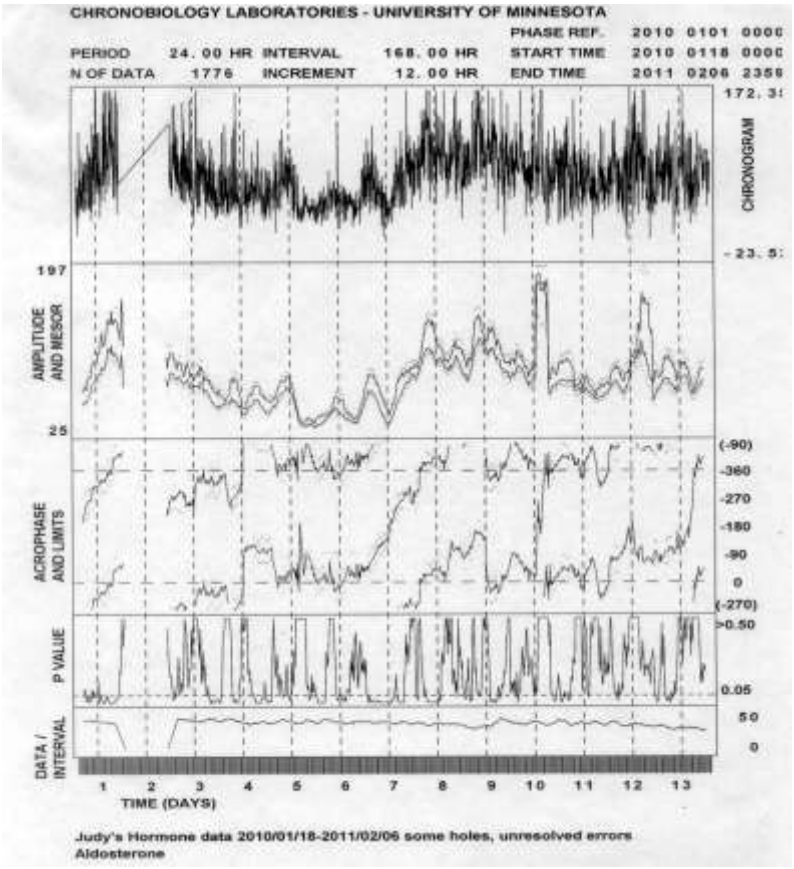
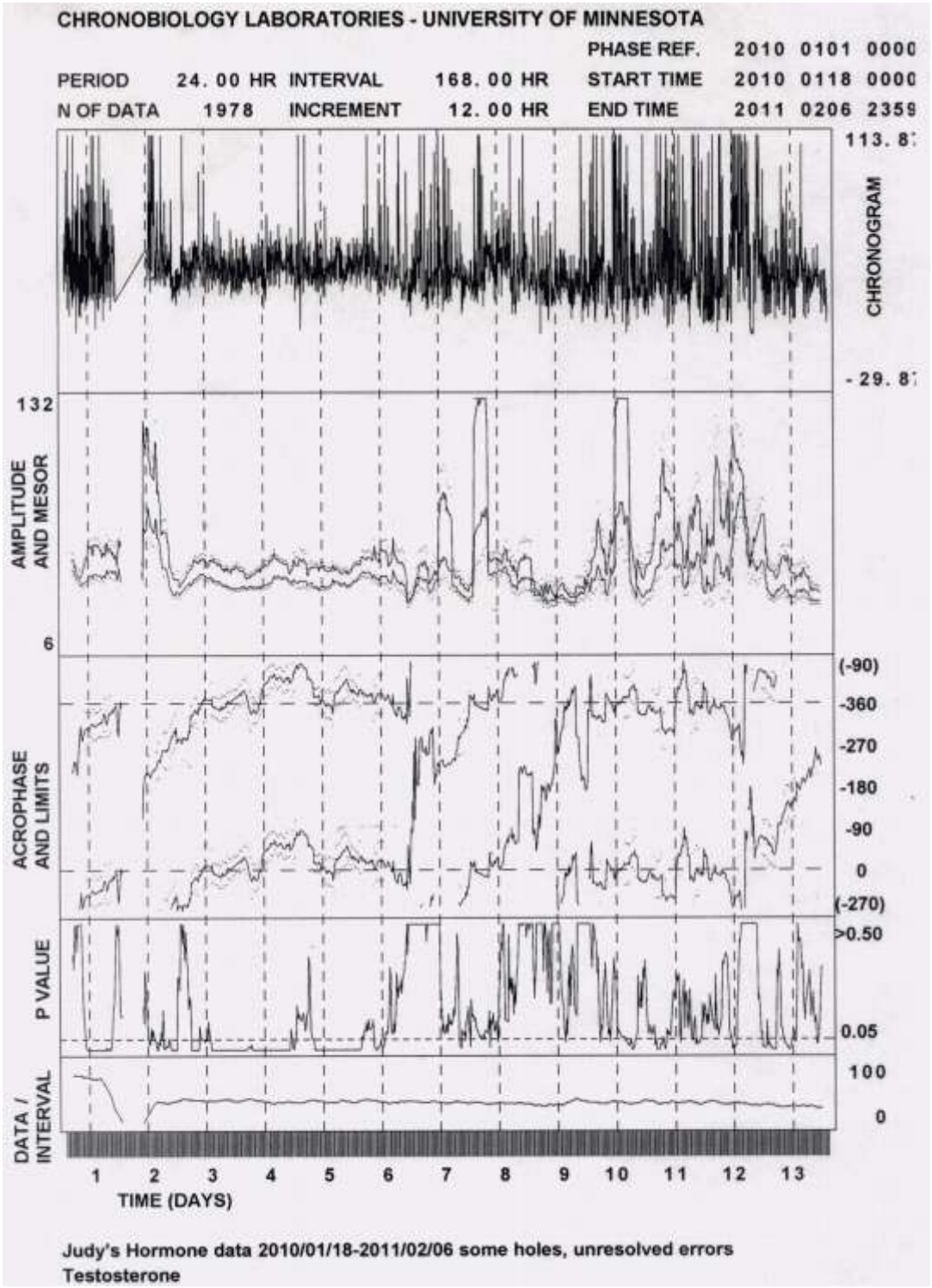


Fig. 1. Vertical dashed lines indicate dates of full moons. © Halberg



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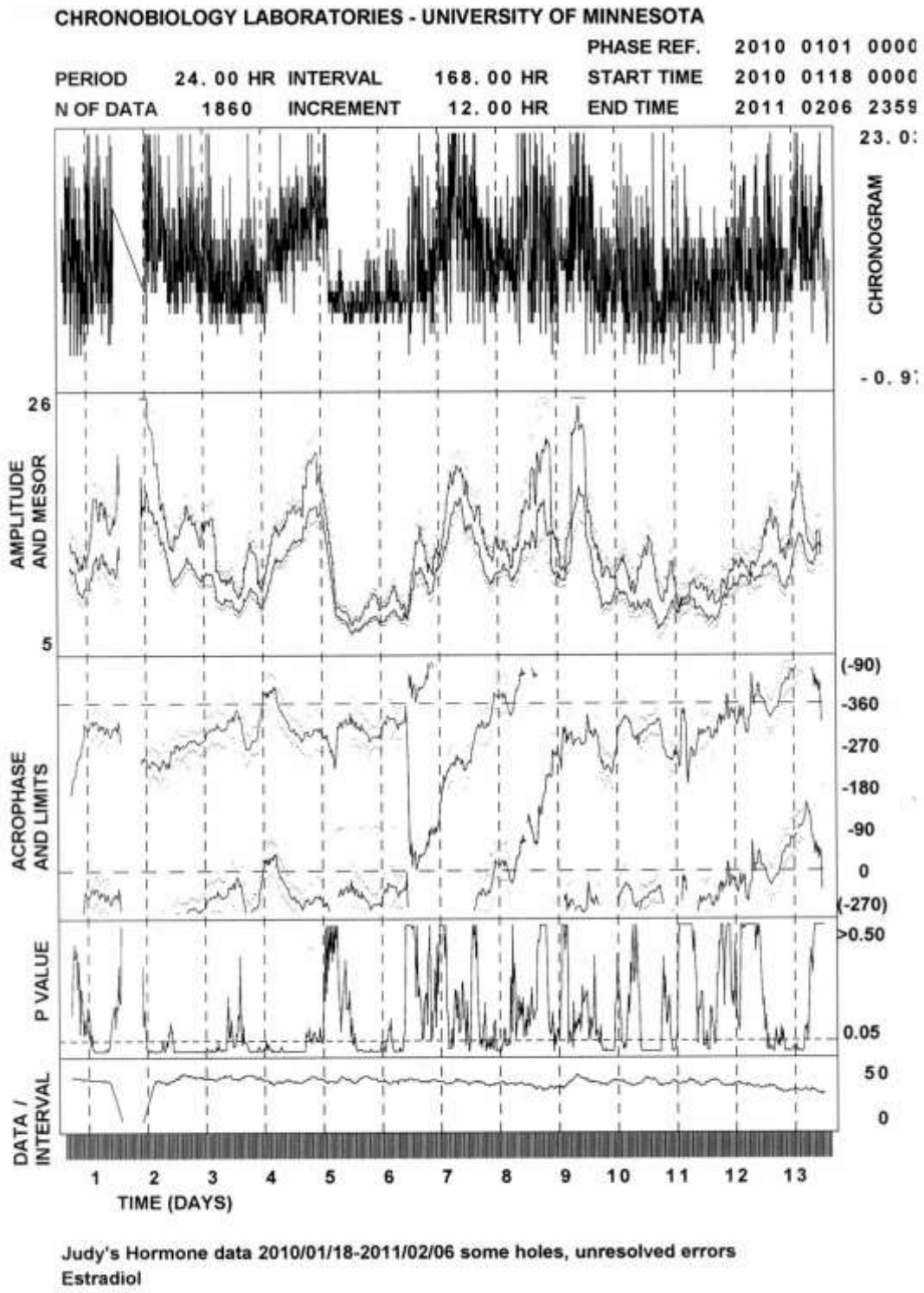

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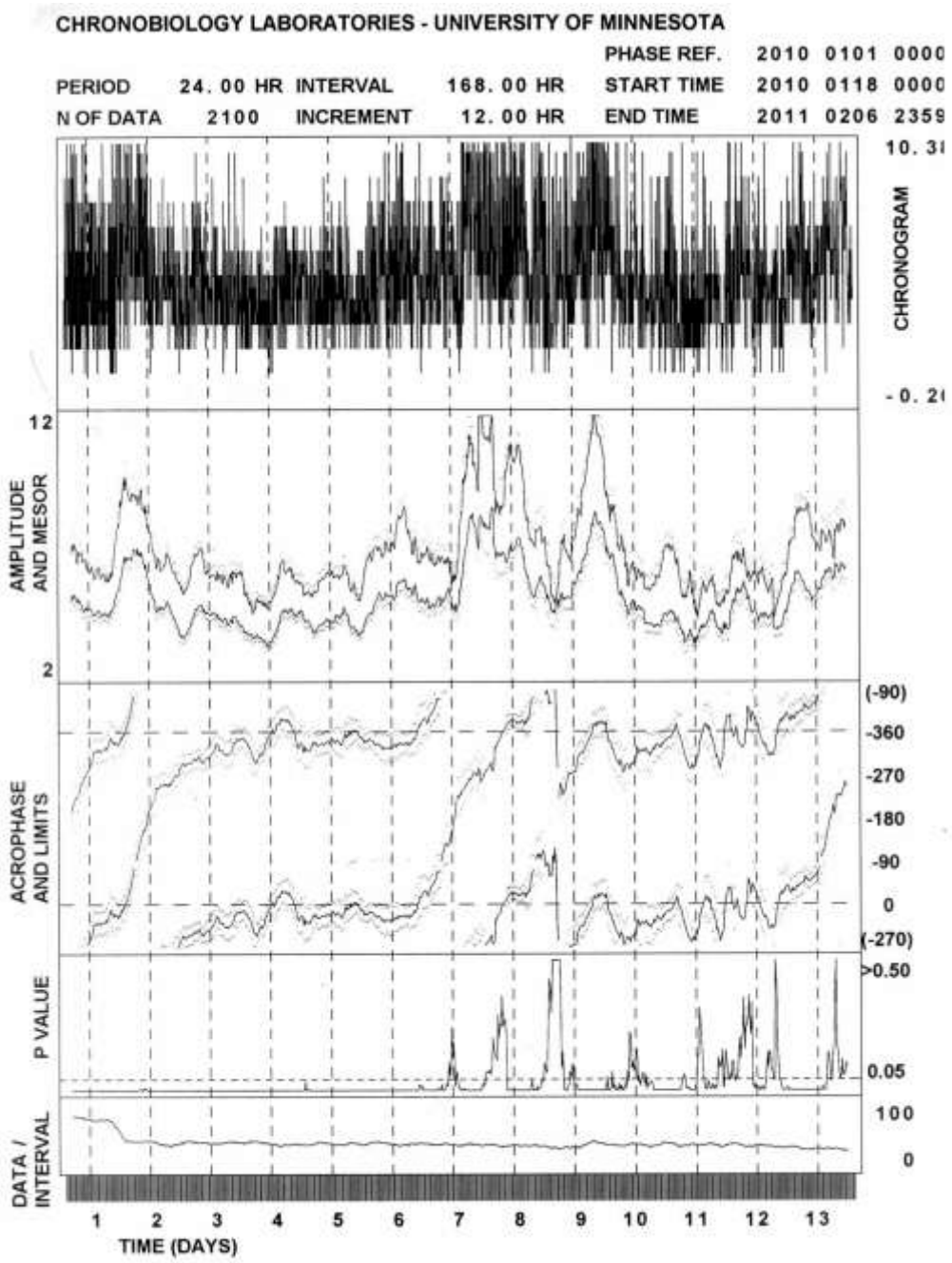

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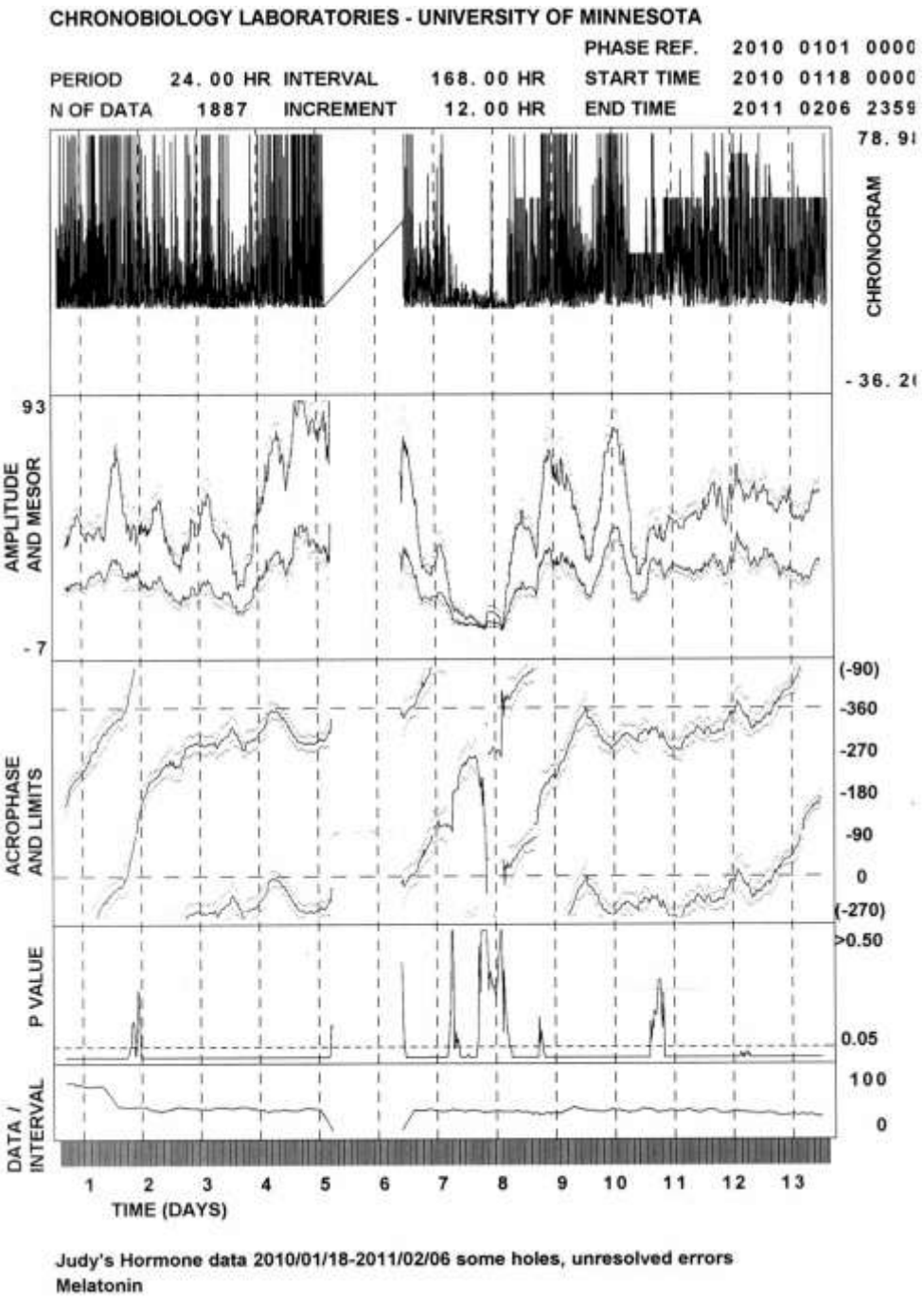

Fig.5. Vertical dashed lines indicate dates of full moons. © Halberg

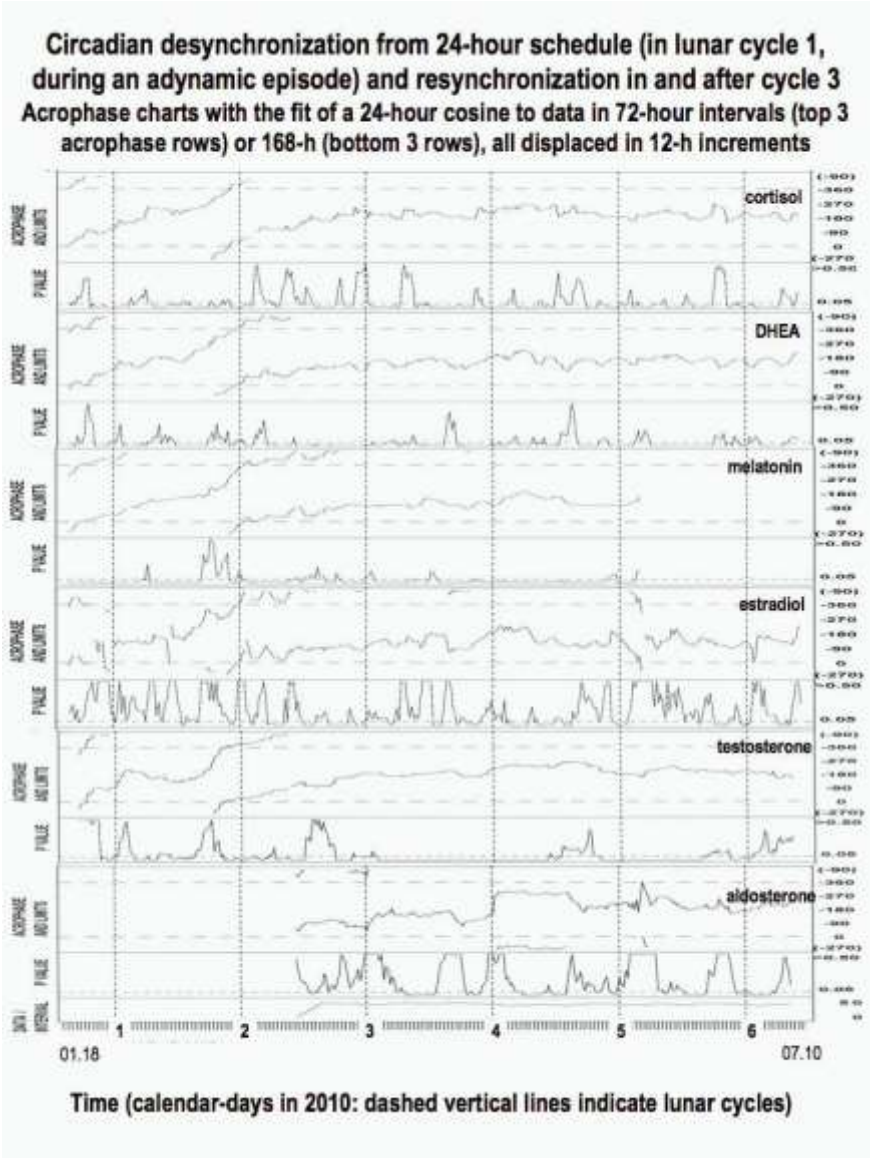

Fig. 6. © Halberg

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SERIAL SECTIONS REVEAL THREE CONSECUTIVE SOCIETAL DESYNCHRONIZATIONS OF SALIVARY CORTISOL DURING HALF-YEARLY RECURRING ADYNAMIC DEPRESSION

Maroun el-Khoury[1], Ning Cegielska[1], Germaine Cornelissen[2], Jerzy Czaplicki[3], Dewayne Hillman[2], Judy Finley[2], Faithe Thomas[2], Tomoshige Kino[4], George Chrousos[5], Rollin McCraty[6], Elias Ilyia[1], Franz Halberg[2]

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Aim. To qualify the use of a chronobiologic serial section while also showing its merit in detecting an endocrine desynchronization from the 24-hour routine and thus recommending this method for the analysis of serial salivary determination, notably for a check of societal synchronization.

Background. Earlier, we noted that salivary cortisol reflects solar flares' cis-half-year about (~) 5-month-long) quinmensal cycle complementing circadians and the solar wind's far-transyear. An ~154-day cycle, an ~5-month component, a quinmensal, is characteristic of solar flares (1), Table 1 and Figure 1, and is found in a 15-year series of 17-ketosteroid excretion (17KS) (2) and in blood pressure (BP) and heart rate (HR) monitored around-the-clock for decades. It is here demonstrated for the salivary cortisol of a 62-year old woman (JF) who collected saliva every ~4 hours around the clock for over 13 months while suffering from twice-yearly recurring adynamic depression.

Table 1.

Point estimates of a cis-half-year (~154-day) periodicity, sometimes given with estimates of uncertainty and hypothesis testing

Period (days)	***Reference***
154.3	Wolff CL. The rotational spectrum of g-modes in the sun. Astrophys J 1983; 264: 667-676.
154	Rieger A, Share GH, Forrest DJ, Kanbach G, Reppin C, Chupp EL. A 154-day periodicity in the occurrence of hard solar flares? Nature 1984; 312: 623-625.
158	Kiplinger AL, Dennis BR, Orwig LE. Detection of a 158-day periodicity in the solar hard X-ray flare rate. Bull Am Astronom Soc 1984; 16: 891.
152	Bogart RS, Bai T. Confirmation of a 152-day periodicity in the occurrence of solar flares inferred from microwave data. Astrophys J 1985; 299: L51-L55.
152-158	Dennis BR. Solar hard X-ray bursts. Solar Physics 1985; 100: 465-490.
152	Bai T, Sturrock PA. The 152-day periodicity of the solar flare occurrence rate. Nature 1987; 327: 601-604.
near 155	Lean JL, Brueckner GE. Intermediate-term solar periodicities –100-500 days. Astrophys J 1989; 337: 568-578.
152	Üzgğz A, Ataz T. Periodic behavior of solar flare index in solar cycles 20 and 21. Solar Physics 1989; 123: 357-365.
154 (± 0.6)	Bai T, Cliver EW. A 154 day periodicity in the occurrence rate of proton flares. Astrophys J 1990; 363: 299-309.
near 155	Carbonell M, Ballester JL. A short-term periodicity near 155 day in sunspot areas. Astron Astrophys 1990; 238: 377-381.
153	Drüge W, Gibbs K, Grunsfeld JM, Meyer P, Newport BJ, Evenson P, Moses D. A 153 day periodicity in the occurrence of solar flares producing energetic interplanetary

Point estimates of a cis-half-year (~154-day) periodicity, sometimes given with estimates of uncertainty and hypothesis testing

Period (days)	***Reference***
	electrons. Astrophys J Suppl Ser 1990; 73: 279-283. Applying Rayleigh test for periodicity.
155	Lean J. Evolution of the 155-day periodicity in sunspot areaas during solar cycles 12 to 21. Astrophys J 1990; 363: 718-727.
155	Silverman SM. The 155-day solar period in the sixteenth century and later. Nature 1990; 347: 365-367. "[A]lthough values between 150 and 160 days have been reported, I refer to it here as the 155-day period, for convenience"
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154	Kile JN, Cliver EW. A search for the 154 day periodicity in the occurrence rate of solar flares using Ottawa 2.8 GHz burst data, 1955-1990. Astrophys J 1991; 370: 442-448.
152-158	Verma VK, Joshi JC, Uddin W, Paliwal DC. Search for a 152-158 days periodicity in the occurrence rate of solar flares inferred from spectral data of radio bursts. Astron Astrophys Suppl Ser 1991; 90: 83-87.
154	Bai T. The 77 day periodicity in the flare rate of cycle 22. Astrophys J 1992; 388: L69-L72.
near 155	Carbonell M, Ballester JL. The periodic behaviour of solar activity: the near 155-day periodicity in sunspot areas. Astron Astrophys 1992; 255: 350-362.
152	Verma VK, Joshi JC, Paliwal DC. Study of periodicities of solar nuclear gamma ray flares and sunspots. Solar Physics 1992; 138: 205-208.
154	Bai T, Sturrock PA. Evidence for a fundamental period of the sun and its relation to the 154 day complex of periodicities. Astrophys J 1993; 409: 476-486.
~153	Cane HV, Richardson IG, von Rosenvinge TT. Interplanetary magnetic field periodicity of ~153 days. Geophys Res Lett 1998; 25: 4437-4440.
158	Oliver R, Ballester JL, Baudin F. Emergence of magnetic flux on the Sun as the cause of a 158-day periodicity in sunspot areas. Nature 1998; 394: 552-553 | doi:10.1038/29012
near 158	Ballester JL, Oliver R, Baudin F. Discovery of the near 158 day periodicity in group sunspot numbers during the eighteenth century. Astrophys J 1999; 522: L153-L156.
151-155	Lou YQ. Rossby-type wave-induced periodicities in flare activities and sunspot areas or groups during solar maxima. Astrophys J 2000; 540: 1102-1108.
153.9	Hady AA. Analytical studies of solar cycle 23 and its periodicities. Planetary and Space Science 2002; 50: 89-92.
156	Krivova NA, Solanki SK. The 1.3-year and 156-day periodicities in sunspot data: wavelet analysis suggests a common origin. Astron Astrophys 2002; 394: 701-706.
near 160	Ballester JL, Oliver R, Carbonell M. The near 160 day periodicity in the photospheric magnetic flux. Astrophys J 2002; 566: 505-511.
~5-month	Han Yanben, Han Yonggang. Time variation of the near 5-month period of sunspot numbers. Chinese Sci Bull 2002; 47 (23): 1967-1973. "Many scholars ... found similar periods of solar activity from other observations of the Sun. However, these periods are different, such as about 152-, 154-, 156-day, etc. Here we name it a near 5-month period (N5MP) since it is not definite."
154	Prabhakaran Nayar SR, Radhika VN, Revathy K, Ramadas V. Wavelet analysis of solar, solar wind and geomagnetic parameters. Solar Phys 2002; 208: 359-373. "The global wavelet spectra of these parameters ...exhibit the presence of a variety of prominent quasi periods around 16 years, 10.6 years, 9.6 years, 5.5 years, 1.3 years, 180 days, 154 days ..."
153	Bai T. Periodicities in solar flare occurrence analysis of cycles 19-23. Astrophys J 2003; 591: 406-415.
near	Ballester JL, Oliver R, Carbonell M. Return of the near 160 day periodicity in the

Point estimates of a cis-half-year (~154-day) periodicity, sometimes given with estimates of uncertainty and hypothesis testing

Period (days)	***Reference***
160	photospheric magnetic flux during solar cycle 23. Astrophys J 2004; 615: L173-L176.
151-158	Knaack R, Stenflo JO, Berdyugina SV. Evolution and rotation of large-scale photospheric magnetic fields of the Sun during cycles 21-23: Periodicities, north-south asymmetries and r-mode signatures. Astron Astrophys 2005; 438: 1067-1082.
~152	Chowdhury P, Ray PC. Periodicities of solar electron flare occurrence: analysis of cycles 21–23. Mon Not Roy Astronom Soc 2006; 373: 1577-1589.
155	Chowdhury P, Ray PC, Ray S. Periodicity of 155 days in solar electron fluence. Ind J Phys 2008; 82: 95-104.
150-160	Dimitropoulou M, Moussas X, Strintzi D. Enhanced Rieger-type periodicities' detection in X-ray solar flares and statistical validation of Rossby waves' existence. Mon Not R Astron Soc 2008; 386: 2278-2284.
158	Javaraiah J, Ulrich RK, Bertello L, Boyden JE. Search for short-term periodicities in the sun's surface rotation: a revisit. Solar Phys 2009; 257: 61-69.
155	Vaquero JM, Trigo RM, Vazquez M, Gallego MC. 155-day periodicity in solar cycles 3 and 4. New Astronomy 2009. doi: 10.1016/j.newast.2009.11.004
155-160	Zaqarashvili TV, Carbonell M, Oliver R, Ballester JL. Magnetic Rossby waves in the solar tachocline and Rieger-type periodicities. arXiv:0911.4591v1 [astro-ph.SR] 24 Nov 2009
154	Fischbach E, Jenkins JH, Buncher JB, Gruenwald JT, Sturrock PA, Javorsek D II. Evidence for solar influences on nuclear decay rates. arXiv:1007.3318v1 [hep.ph] 20 Jul 2010

This incomplete list (added contributions are cited in the references provided) suffices to indicate the variable nature of the period being discussed. Specifications of the decadal solar (Horrebow-Schwabe) cycle in which they are found point indirectly to the intermittency of the components being discussed.

In addition, we find an ~1.3-year far-transyear (Table 2) that is not only statistically but also clinically significant since transyears and quinmensals also characterize sudden cardiac deaths in some geographic locations some of the time, Figure 2 (3). The transyear in cortisol is tentative in view of the brevity of the series that covers only slightly more than 1 year, yet transyears are found in 17KS documented by a healthy man for 15 years and may be a contribution of glucocorticoids. No transyear was found in aldosterone, DHEA, testosterone or estradiol. The danger of extrapolating from time series that do not cover an entire cycle can be illustrated as leading to controversy about the effect of geomagnetics on myocardial infarctions, yet this fact, while rendering results tentative, should not prevent thorough analyses. A transyear in systolic blood pressure was associated with a damping, but not its loss, during the loss of a transyear in solar wind speed (3). Solar wind speed has, i.a., prominent nonstationary (aeolian) components with periods longer than (trans=beyond) a year: near transyears (1.00 year < [τ - CI {95% confidence interval}] < [τ + CI] < 1.20 years) and far-transyears (1.2 years $\leq$ [τ - CI] < [τ + CI] < 1.9 years) and a quinmensal. These nonstationary aeolian components were demonstrated longitudinally in BP and HR data from several subjects (2-4). Transyears and quinmensals may be partly genetically coded, as are circadians.

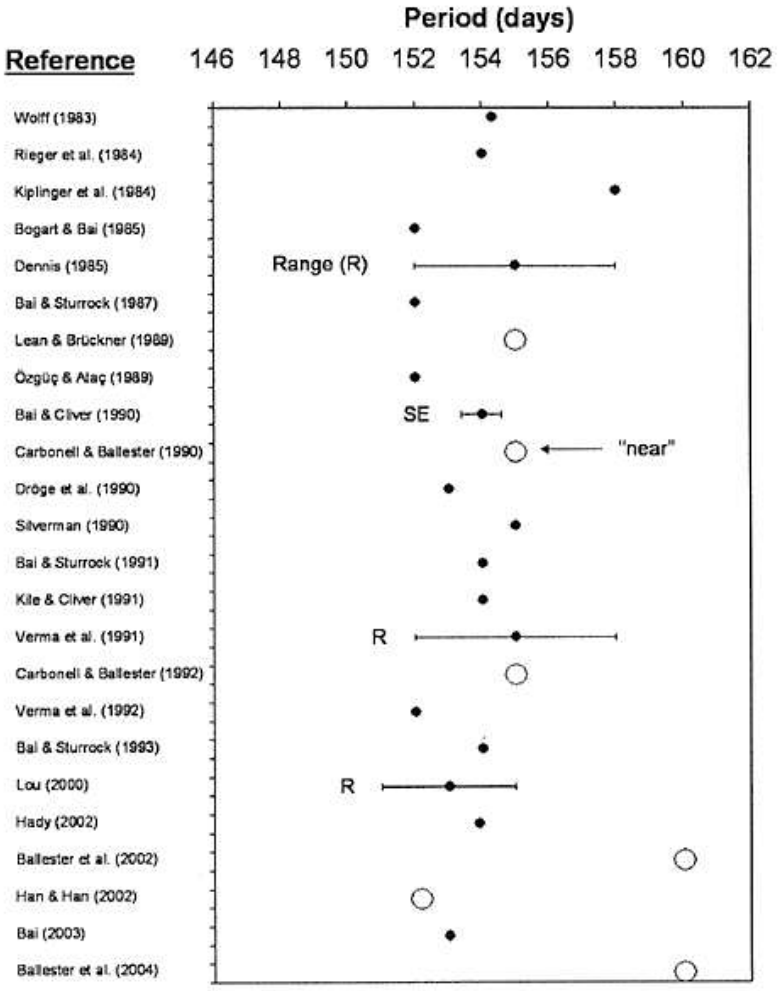

Fig. 1. © Halberg.

Table 2.

JF's Hormone Data 2010/01/18 - 2011/02/06 (MESOR ± SE: 0.913 ± 0.014): Cortisol

Years		Days		Hours		Hours		Hours	
Adj Per	**FundA**	**Adj Per**	**FundA**	**Adj Per**	**FundA**	**Adj Per**	**FundA**	**Adj Per**	**FundA**
1.30 (1.02, 1.59)	0.115 (0.077; 0.153)	145.28 (134.52; 156.04)	0.051 (0.009; 0.093)	24.52 (24.51; 24.53)	0.075 (0.037; 0.114)	24.12 (24.11, 24.12)	0.080 (0.040; 0.119)	24.00 (23.98, 24.00)	0.116 (0.077, 0.156)

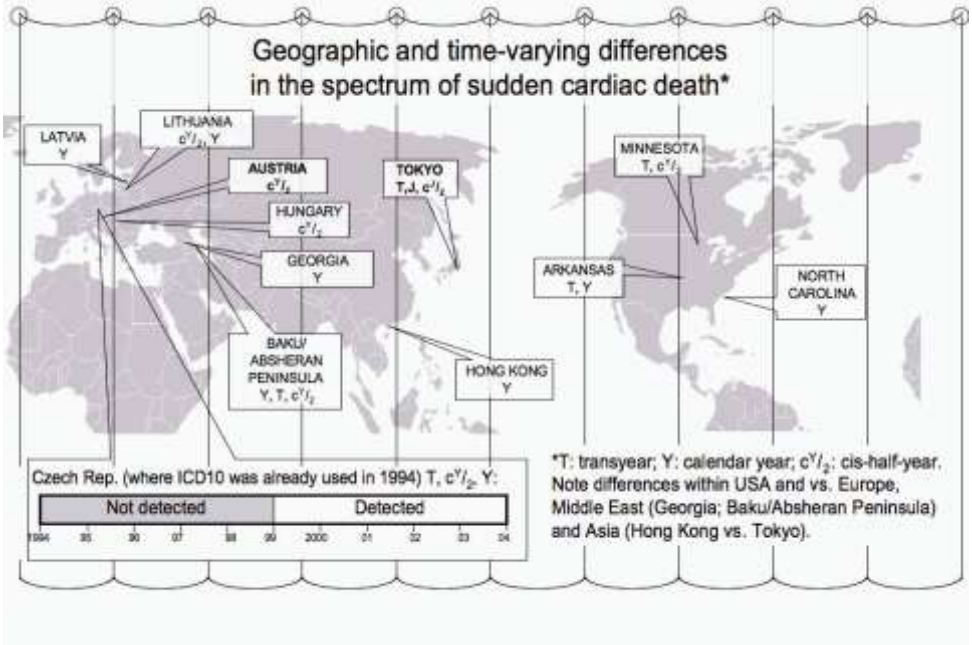

Fig. 2. © Halberg.

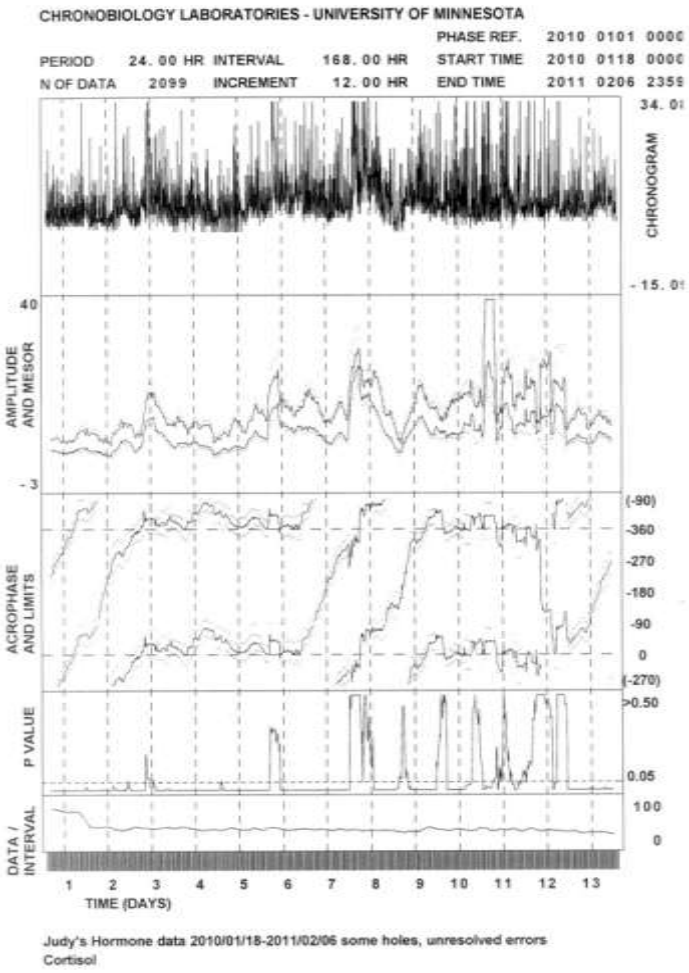

Fig. 3: JF's cortisol data 2010/01/18-2011/02/06: some holes, unresolved errors. © Halberg.

Elsewhere, we report also several circadian components in salivary cortisol that may coexist and alternate in prominence and thus characterize different subspans. At ~half-yearly intervals, the prominence of the circadian amplitude (A) alternates between that of an ~24.0-hour component having the largest A (during wellness) vs. one of 24.65-hours dominating (during unwellness). 2,099 salivary cortisol determinations are analyzed in Figure 3 and displayed as original data in the top row, in which great variability is readily apparent, also reflected in the lower curve of row 2, representing the variable MESOR, M. The distance between the two curves in row 2 is the circadian amplitude, which is yet more variable than the M, with peaks at or near the vertical dashed lines, which indicate 13 consecutive full moons. The acrophase in the third row shows, for more than the first 2 lunar cycles, a delaying time course, in keeping with a period longer than 24 hours up to the third dashed vertical line. The acrophase varies only relatively little around the hours after midnight in lunar cycles 3-5 and 9-11. In cycles 6-9, 12 and 13, it is again diagonal, with a delaying time course, indicating spans of adynamic depression as noted in more detail with the demonstration of multiple periods by a spectrogram (4) and by the double 24.00- and 24.84-hour nonlinear fit by one of us (GC). Thus the chronobiologic serial section of a 24.00-hour period sufficed to indicate when JF's salivary cortisol and thus her adrenocortical cycle was 24-hour synchronized or not. This finding only indicates a prominent period, but does not exclude the coexistence of multiple periods, as documented in this case (4).

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3. *Halberg F., Cornelissen G., Katinas G., Tvildiani L., Gigolashvili M., Janashia K., Toba T., Revilla M., Regal P., Sothern R.B., Wendt H.W., Wang Z.R., Zeman M., Jozsa R., Singh R.B., Mitsutake G., Chibisov S.M., Lee J., Holley D., Holte J.E., Sonkowsky R.P., Schwartzkopff O., Delmore P., Otsuka K., Bakken E.E., Czaplicki J.* International BIOCOS Group. Chronobiology's progress: season's appreciations 2004-2005. Time-, frequency-, phase-, variable-, individual-, age- and site-specific chronomics. J Appl Biomed 2006; 4: 1-38. http://www.zsf.jcu.cz/vyzkum/jab/4_1/halberg.pdf
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PUTATIVE SOLAR SIGNATURES CAN DIFFER AMONG VARIABLES AND CIRCADIAN ENDPOINTS AND IN INDIVIDUALS VS. POPULATIONS

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[2] Space Research Institute, Russian Academy of Sciences, Moscow, Russia;
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Background. Blood pressure (BP) and heart rate (HR), among other variables, were studied longitudinally in an adult individual (FH) around the clock for several decades to find that they undergo changes with several τs corresponding in length to cycles of solar activity, gauged by sunspots or solar wind speed, which has circadecadal and shorter components, Figure 1. A paradecadal cycle was also found for some variables studied longitudinally in the original data along with shorter periods also detected, corresponding to cycles in solar activity (3). The question raised herein is whether different environmental cycles can also be mimicked in different circadian

rhythm characteristics such as the Midline-Estimating Statistic Of Rhythm (MESOR, M) and the double circadian amplitude (2A) of the same variable of the same individual, and if so, whether this physiological-environmental pairing can differ from the M vs. the 2A.

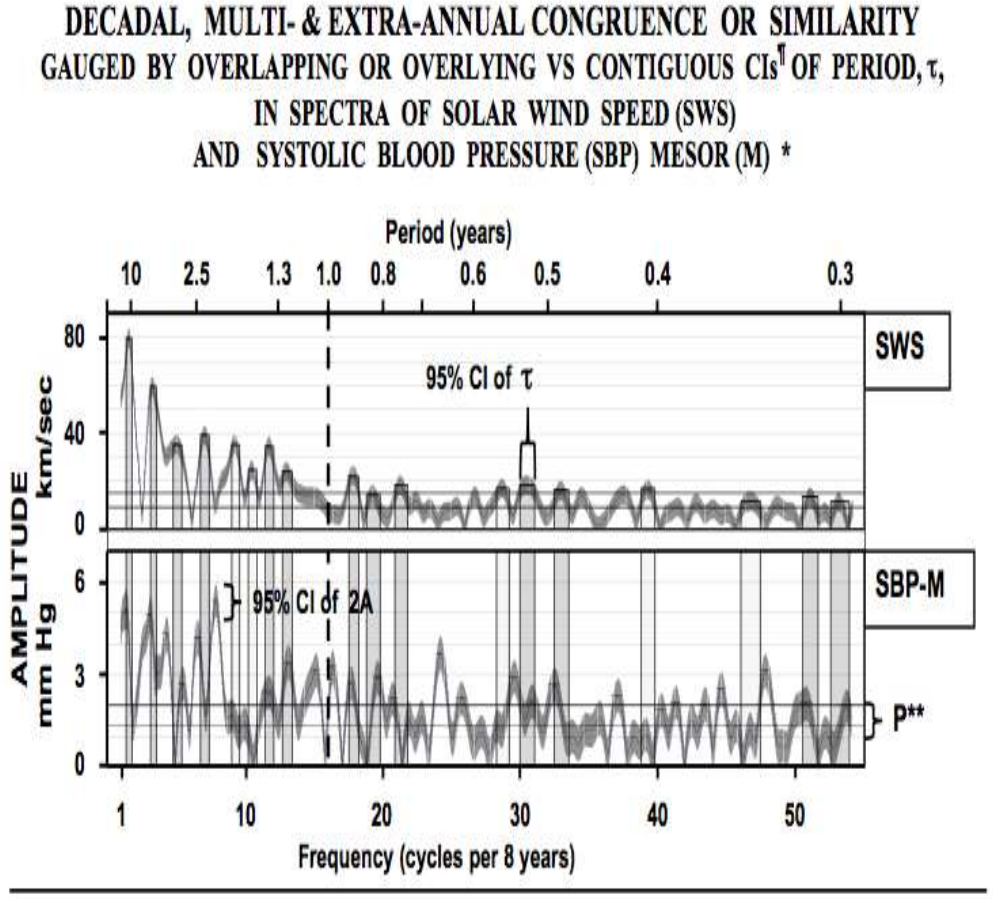
Results. A man (FH) was 68 years of age when he started a new series of automatic, including ambulatory BP and HR monitoring with interruptions (2). The original data's spectrum is aligned with that of the solar wind's speed in Figures 1A-1C. In addition, the BP and HR data were first analyzed in 24-hour or longer sections by the fit of a 24-hour cosine curve. The results of these fits were used as intermediate results called imputations. Thus the Ms, and separately the As obtained for consecutive sections of the original data by serial sections were constituted into separate time series of systolic (S) or diastolic (D) BP or (only) HR and were further analyzed by the nonlinear extended cosinor (4) and yielded, among others, decadal or multidecadal τs. More specifically, for SBP, Figure 2A, the M had a best-fitting τ of 11.8 years. The CI (95% confidence interval) of this τ extended from 11.4 to 12.1 years. The series consisting of the double circadian amplitudes of FH's SBP yielded a τ of 11.0 (10.5, 11.5) years that barely overlapped the CI of the τ of the series of the SBP-M, but both series qualify as circaundecennian or in a broader perspective as circadecadal. In turning to diastolic 2A, Figure 2B, the CI of the τ of 10.4 (10.1, 10.8) years overlapped neither of the CIs of the SBP-M or the SBP-A series, nor the CI of the 14.5 (13.8, 15.0) years of the DBP-M series. It could have been emphasized that the CIs are ordering and close to each other for the case of SBP and the 2A of DBP. But the CI of the τ of the M of DBP is certainly different. Moreover, the CIs of HR differ even more, overlapping the 30-year τ with their CIs. Both the M and 2A series of FH's HR, Figure 2C, have τs that overlap none of the CIs of τs of SBP and DBP. The τs best-fitting the HR-M and 2A were either longer or shorter than those fitting the characteristics of SBP or DBP. The longer τs of HR are in keeping with a paratridecadal τ, except for the qualification that the data are shorter than the period found, covering only 22 years. The validation of a tridecadal τ for FH's HR depends on his motivation to continue monitoring and on his age at death.

Discussion. These longitudinal findings can be viewed in the light of results of analyses of BP and HR in a population of newborns studied transversely, each baby contributing only one M and one 2A. The τ found for the series of Ms was of 8.29 years with the CI from 6.49 to 10.09 years for SBP and 8.67 years for DBP (6.48 to 10.56 years), and of 9.80 (5.51, 14.10) years for HR. The CIs of the τs for the six time series, three of Ms and three of 24-hour As of SBP and DBP and HR, all overlapped 10 years. They were significant ($P<0.001$) for the Ms of DBP and HR, with a P of 0.090 for the test of the zero-amplitude assumption for SBP, thus reaching borderline significance ($P<0.10$) in this variable as well (5).

Some of the individual's longitudinally assessed decadal and multidecadal rhythms differ drastically from each other in different variables of the same person's circulation and even in different characteristics of the same variable such as the 2A vs. M of DBP in FH. Some of the individual's τs do not correspond in length to the τ of a population of newborns. Even if they did, the mechanisms involved have yet to be clarified. The solar wind possibly blew for billions of years, and evolution may have influenced both characteristics in the past and may eventually have coded them genetically. These partly built-in features may now be selectively assorted with environmental putative counterparts in several, perhaps different ways, also still to be clarified. A subtraction-and-addition approach (2, 6) would be ideal if nature cooperated and the sun changed the τ or some characteristic of its decadal rhythm and the individual's and/or the population's rhythm of corresponding duration, both changed accordingly. It seems highly desirable to study the factors underlying the fact that HR can have infradians very different from SBP and DBP and that for 2 characteristics, the M and the 2A, of the same variable, DBP, we find different periods. For the clinical significance of these findings, see (7-9).

Perspective. Biological diversity in space is studied by genetics as genes. Chronobiology (Gk chronos = time; Gk bios = life; Gk logos = science) is complementary in a unified science as the study of biological diversity in time; it is gauged as time structures, i.e., chronomes (from chronos = time and Gk nomos = rule). Time structures in living matter and in the inanimate environment consist of deterministic and other chaos, trends and cycles. Chronomics, the mapping of and search for an understanding of associations between aligned time structures in and around

us, complements genomics, the mapping of genomes. Chronobiology and chronomics, virtual microscopes and telescopes, are both requisites for a new transdisciplinary science, and are both new tools, which resolve time structures. Chronomics compares, e.g., cycles in and/or around us, to assess the factors underlying any associations. Since data are usually not dense enough to assess all chaotic aspects and all very high frequency cycles and not long enough to see whether trends turn out to be cycles with long periods, unassessed variations inflate a noise term. Accordingly, the resolvable cycles, that can incidentally be generated by deterministic chaos, invariably have a noise term, which is the larger the sparser and shorter the available time series. Furthermore, many time structures, notably those of the physical solar system known to us, are highly variable rather than all deterministically fixed. Hence we must often deal with non-stationary aeolian cycles that lead us to paraphrase August Ludwig von Schlüzer's statement about history by inserting a measure of uncertainty: "History is moving [inferential, not only descriptive] statistics, and statistics is frozen [inferential, not only descriptive] history".

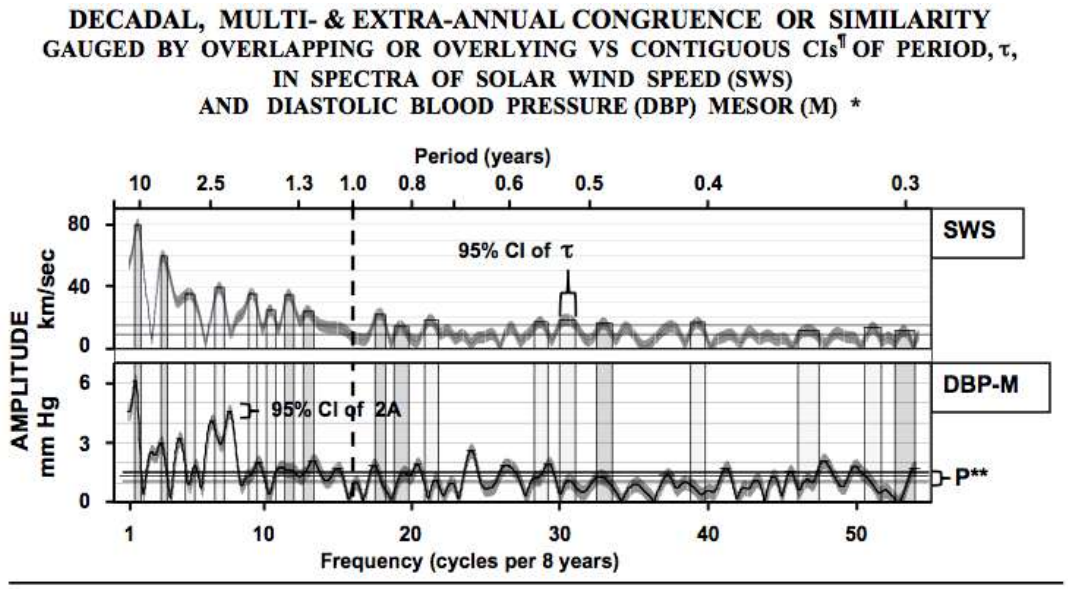


* SWS: daily data from ftp://nssdcftp.gsfc.nasa.gov/spacecraft_data/omni, N=5272. BP data: daily averages from Dec 1989 to Jul 2006 monitored ~ every 30 min (with gaps) by FH, a man of 70 y at start of records. N = 2684.

** Horizontal lines indicate ordering significance at the 0.001 and 0.05 levels only as a first approximation; until more robust methods become available, that are not dependent upon the assumptions of independence, normality and homogeneity of variance, a transdisciplinary congruence of periods and a "remove – replace" approach remain the criteria of importance. Congruence between components with amplitudes differing from zero with an ordering P betweein 0.001 and 0.05 are questionable.

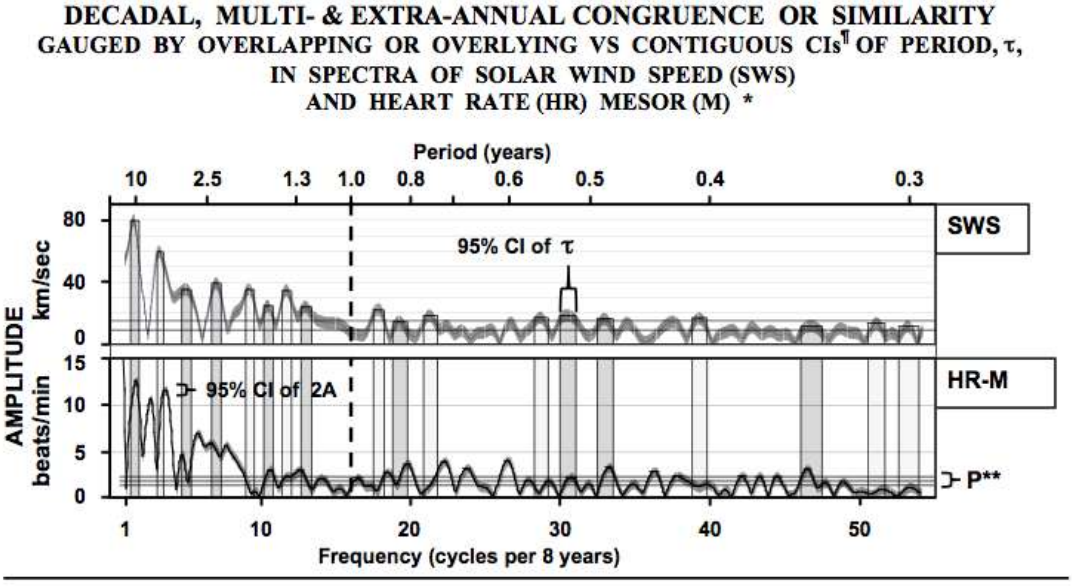
¶ CI = 95% confidence interval of τ (of each component fitted separately).

Fig. 1A. Extent of congruence among spectral periods in solar wind speed and systolic blood pressure (SBP) of FH, a man 68 years of age at start of measurement series. © Halberg.



* SWS: daily data from ftp://nssdcftp.gsfc.nasa.gov/spacecraft_data/omni, N=5272. BP data: daily averages from Dec 1989 to Jul 2006 monitored ~ every 30 min (with gaps) by FH, a man of 70 y at start of records. N = 2447.
** Horizontal lines indicate ordering significance at the 0.001 and 0.05 levels only as a first approximation; until more robust methods become available, that are not dependent upon the assumptions of independence, normality and homogeneity of variance, a transdisciplinary congruence of periods and a "remove – replace" approach remain the criteria of importance. Congruence between components with amplitudes differing from zero with an ordering P betweein 0.001 and 0.05 are questionable.
¶ CI = 95% confidence interval of τ (of each component fitted separately).

Fig. 1B. Extent of congruence among spectral periods in solar wind speed and diastolic blood pressure (DBP) of FH, a man 68 years of age at start of measurement series. © Halberg.



* SWS: daily data from ftp://nssdcftp.gsfc.nasa.gov/spacecraft_data/omni, N=5272. HR data: daily averages from Dec 1989 to Jul 2006 monitored ~ every 30 min (with gaps) by FH, a man of 70 y at start of records. N = 2447.
** Horizontal lines indicate ordering significance at the 0.001 and 0.05 levels only as a first approximation; until more robust methods become available, that are not dependent upon the assumptions of independence, normality and homogeneity of variance, a transdisciplinary congruence of periods and a "remove – replace" approach remain the criteria of importance. Congruence between components with amplitudes differing from zero with an ordering P betweein 0.001 and 0.05 are questionable.
¶ CI = 95% confidence interval of τ (of each component fitted separately).

Fig. 1C. Extent of congruence among spectral periods in solar wind speed and heart rate (HR) of FH, a man 68 years of age at start of measurement series. © Halberg.

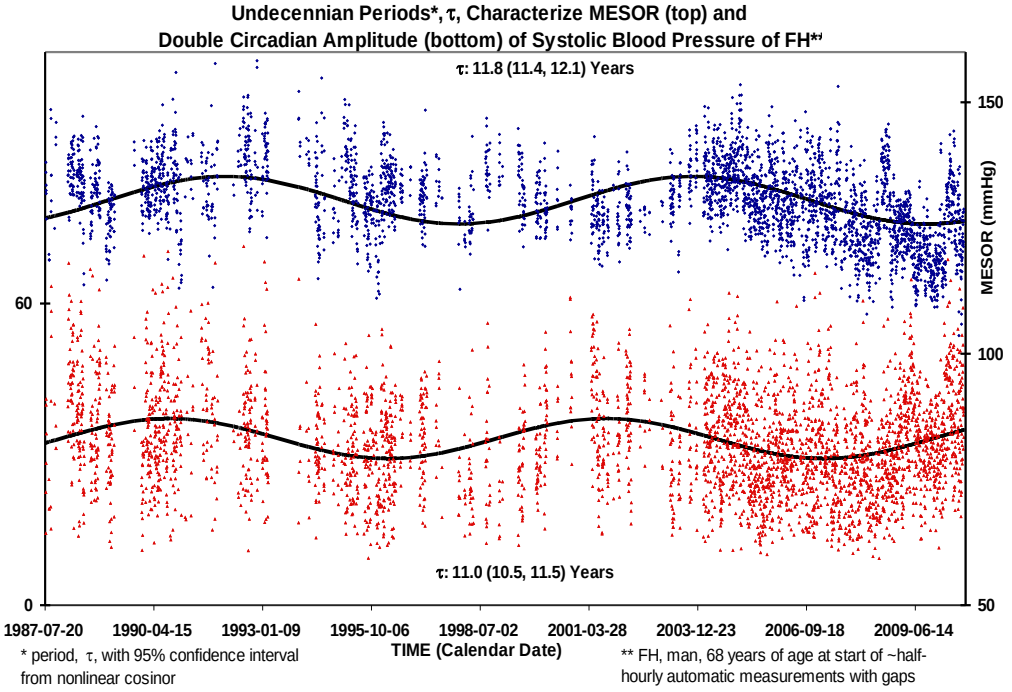


Fig.2A. Congruent environmental periods characterize the MESOR and double circadian amplitude of SBP of FH, a man 68 years of age at start of measurement series. © Halberg.

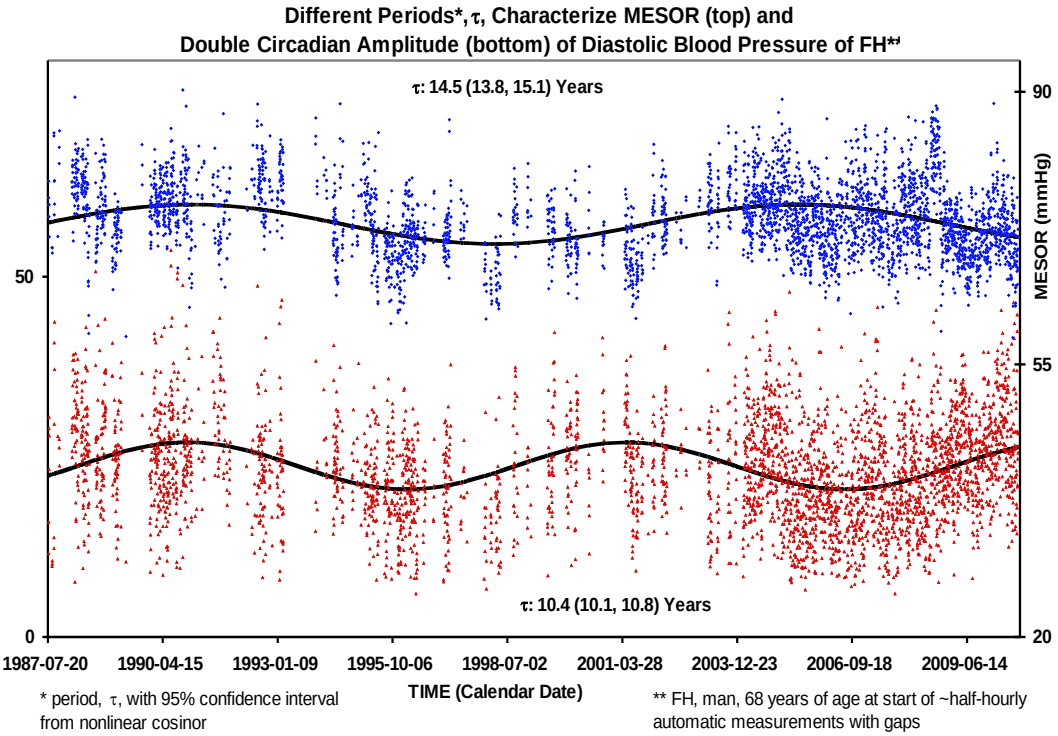


Fig. 2B. Lack of congruence periods characterizes the MESOR and double circadian amplitude of DBP of FH, a man 68 years of age at start of measurement series. © Halberg.

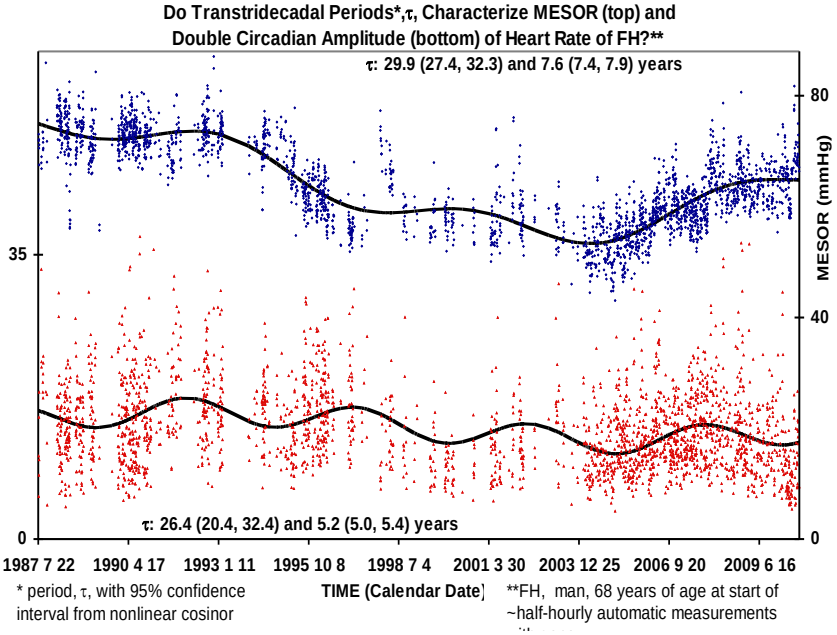


Fig. 2C. Similar paratridecadal and different cis-decadal (cis = on this side of, i.e., shorter than decadal) periods characterize the MESOR and double circadian amplitude of HR of FH, a man 68 years of age at start of measurement series. © Halberg.

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COMPETING TIDAL AND CIRCADIAN LUNISOLAR RESONANCE IN AN ARCHAEON

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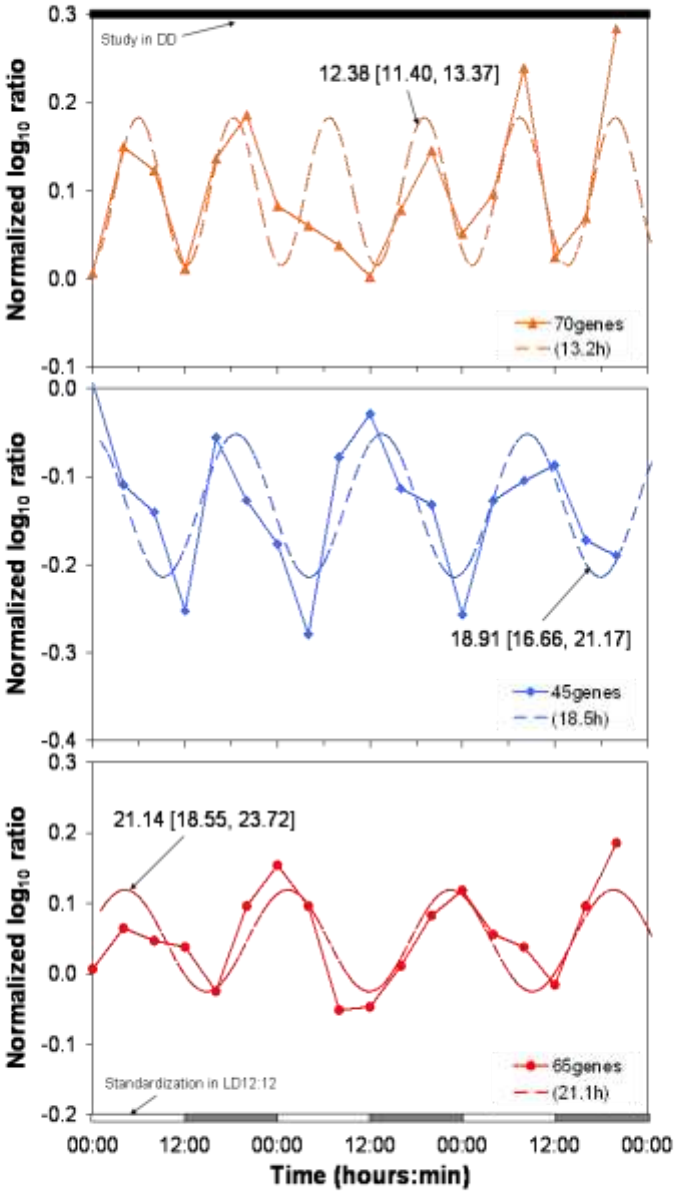
This presentation is dedicated to the memory of Hans Kaiser and complements our discussions with him in 1990 (Kaiser H., Cornelissen G., Halberg F. Paleochronobiology: circadian rhythms, gauges of adaptive Darwinian evolution; about 7-day (circaseptan) rhythms, gauges of integrative internal evolution. Progress in Clinical and Biological Research 1990; 341B: 755-762). The dogma and battle about circadians restricted to eukaryotes is history, and the declaration (decree) of a committee rejecting bacterial circadian periodicity on the basis of "too much mathematics" and failure to see bacterial periodicity macroscopically by the unaided eye by some short-sighted investigators is recorded (1). Earliest life may well be characterized not only by a circadian but also by a lunar (tidal) average period (τ) of 12.4 hours, which may have originally dominated in amplitude over any 24-hour or, more broadly, circadian component in any universal ancestor (2) or ancestors if life originated repeatedly (3).

This hypothesis is in keeping with the assumption that life originated at the bottom of the sea and with results of our analysis of data by Whitehead K. et al. (4), in which periodicity persisted for at least 72 hours in continuous darkness in three classes of mRNA profiles for 180 of the 290 genes detected as cyclers, with modes in the published Figure 1b histogram corresponding to periods of 21 and 12.5 hours. Our chrono-metaanalysis of data off Whitehead et al.'s Figure 3A replaces point estimates of the period (originally assessed by Lomb-Scargle periodogram) by periods with their CI (95% confidence interval) in [ ] of 12.38 [11.40, 13.37], 18.91 [16.66, 21.17] and 21.14 [18.55, 23.72] hours, Figure 1. Note that the first estimate covers the tidal period and the other two cover with their CIs a circadian period (of 20 to 28 hours) shorter than 24 hours, not covered by the CI. Since results were expressed as normalized log-ratios, amplitudes of major components could not readily be expressed as a percentage of the MESOR. In order to compare relative amplitudes among three curves, the MESOR was first back-transformed as bt-M=10^{M}, where bt-M is the back-transformed MESOR and M is the MESOR of the normalized log-ratios. Because amplitudes (As) cannot be back-transformed in a similar way since the back-transformation depends also on the MESOR, the range of predictable values was estimated instead. This was done by first computing the values at the nadir and peak of each curve as M-A and M+A, respectively, and then back-transforming these as $10^{(M-A)}$ and $10^{(M+A)}$. The range of predictable variation is thus estimated as R=$10^{(M+A)}$-$10^{(M-A)}$, and the relative range of predictable variation as rR=100*R/bt-M.

Results for rR of the three curves of Whitehead et al. (4) are 38.93%, 37.52%, and 33.31% (70-gene, 45-gene and 65-gene mRNAs). Comparing 70-gene/45-gene mRNAs yields a ratio of 1.037, 70-gene/65-gene mRNAs one of 1.169 (and 45-gene/65-gene mRNAs one of 1.126). Inverse ratios are 0.964, 0.856 and 0.888, respectively. In other words, the relative tidal amplitude was numerically the largest, slightly larger than those of the two circadian components, which were in the range we had reported for a meta-analysis in 1961 of original data by Rogers and Greenbank, published in 1930 (1).

Coexisting Built-in Luni-Solar Resonance in an Archaeon

From Tidal Cycle (top), over Lengthening Period (middle) to Free-Running Circadian Rhythmic (bottom) Transcription of Previously LD12:12 Synchronized Halophilic Archaeaon *Halobacterium salnarum NRC-1* Released into Continuous Darkness *



* Periodicity Persists for at least 72 hours in Continuous Darkness in Three Classes of mRNA Profiles for 180 of the 290 Genes Detected as Cyclers. Chronometaanalysis of data taken off Figure 3A from PLoS one 2009; 4(5): e5485 (K Whitehead et al. Diurnally entrained anticipatory behavior in Archae). Key lists period reported by authors, assessed by Lomb-Scargle periodogram. Arrow pointing to fitted curve reports period assessed nonlinearly by the extended cosinor together with its 95% confidence interval in [ ].

Fig. 1. Assessment by the extended cosinor of periods and their 95% confidence intervals of three classes of mRNA profiles for 180 of the 290 genes detected as cyclers by Whitehead K. et al. (4) in Archae kept for at least 72 hours in continuous darkness.

The extracircadian vs. circadian ratio later in phylogeny and in post-Lucy human ontogeny is greater than unity not only in human babies, pigs and crayfish (5), but also in an archaeon where the tidal component has the largest amplitude. Prokaryotic chemosignalling occurred in cycles that were a condition for the origin of life as well as for its evolution (6).

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RELATIVE PROMINENCE OF WEEKLY-TO-DAILY AMPLITUDE RATIO OF BLOOD PRESSURE CHANGES WITH AGE

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Aim. To check whether the increased prominence with age of the circaseptan-to-circadian and/or circasemiseptan-to-circadian amplitude ratio of blood pressure (BP) observed earlier individually and on populations could be detected in a pilot study on 9 subjects in 3 age groups.

Background. The biologic week is prominently expressed in early extra-uterine life (1, 2). A trough in mid-adulthood in amplitude ratios of the week and half-week versus day has been documented longitudinally in self-measurements taken about 5-6 times a day for over 4 decades (3), similar to changes with age observed transversely, Figure 1 (4, 5).

Subjects and Methods. As part of a Chronomics pilot study of the TsimTsoum Institute, 9 subjects in 3 age groups measured their systolic (S) and diastolic (D) BP around the clock at 30-minute intervals for one week or longer with an ambulatory monitor (TM-2430) from the A&D Company (Tokyo, Japan). The 3 groups consisted of 3 teenagers (2F/1M), 3 adults (1F/2M), and 3 elderly people (2F/1M). Participants were monitored once a month during 3 consecutive months in the fall of 2010. Two adults monitored more or less continuously during the entire 3-month span. Each record was analyzed by the extended cosinor (6-8). Least squares spectra were computed in the frequency range of 1 cycle per week to 1 cycle in 2 hours. At each trial period, rhythm characteristics were averaged across all 36 profiles by population-mean cosinor. The 7-day and 3.5-day amplitudes were expressed as a percentage of the 24-hour amplitude and the ratios were linearly regressed with age.

Results. A circaseptan component was detected with statistical significance ($P<0.05$) in 20 of the 36 profiles for SBP and in 14 cases for DBP. A circasemiseptan component was detected in 15 and 17 of the SBP and DBP profiles, respectively. Overall, the circadian component was the most prominent in the spectrum ($P<0.001$), accounting for 26% (SBP, Figure 2) and 20% (DBP, Figure 3) of the variance. Several harmonic terms contributed significantly to the circadian waveform. The 12-hour component accounts for 5% (SBP) and 4% (DBP) of the overall variance ($P<0.001$) and the 6-hour component accounts for 1.5% of the variance ($P<0.001$). An about 3.4-hour component that may correspond to the REM cycle is also detected for DBP ($P=0.049$). As expected, circaseptan-to-circadian and circasemiseptan-to-circadian amplitude ratios showed a concave relation with age, with a trough in mid-adulthood. The fit of a second-order polynomial of the circasemiseptan-to-circadian amplitude ratio versus age reached borderline statistical significance in the case of SBP ($R^2=0.141$, $P=0.081$; on $\log_{10}$ amplitude ratios: $R^2=0.159$, $P=0.058$), Figure 4.

Discussion and Conclusion. The larger prominence of the week and half-week versus the day early and late in life is corroborated in this rather small population involving subjects in an age range (17 to 71 years) narrower than that in earlier studies. Ultradian endpoints of interest in their own right (9, 10) and as a gauge of a non-sinusoidal circadian waveform deserve mapping on a population basis, as do infradians, for alignment with environmental cycles in longer and larger follow-up studies.

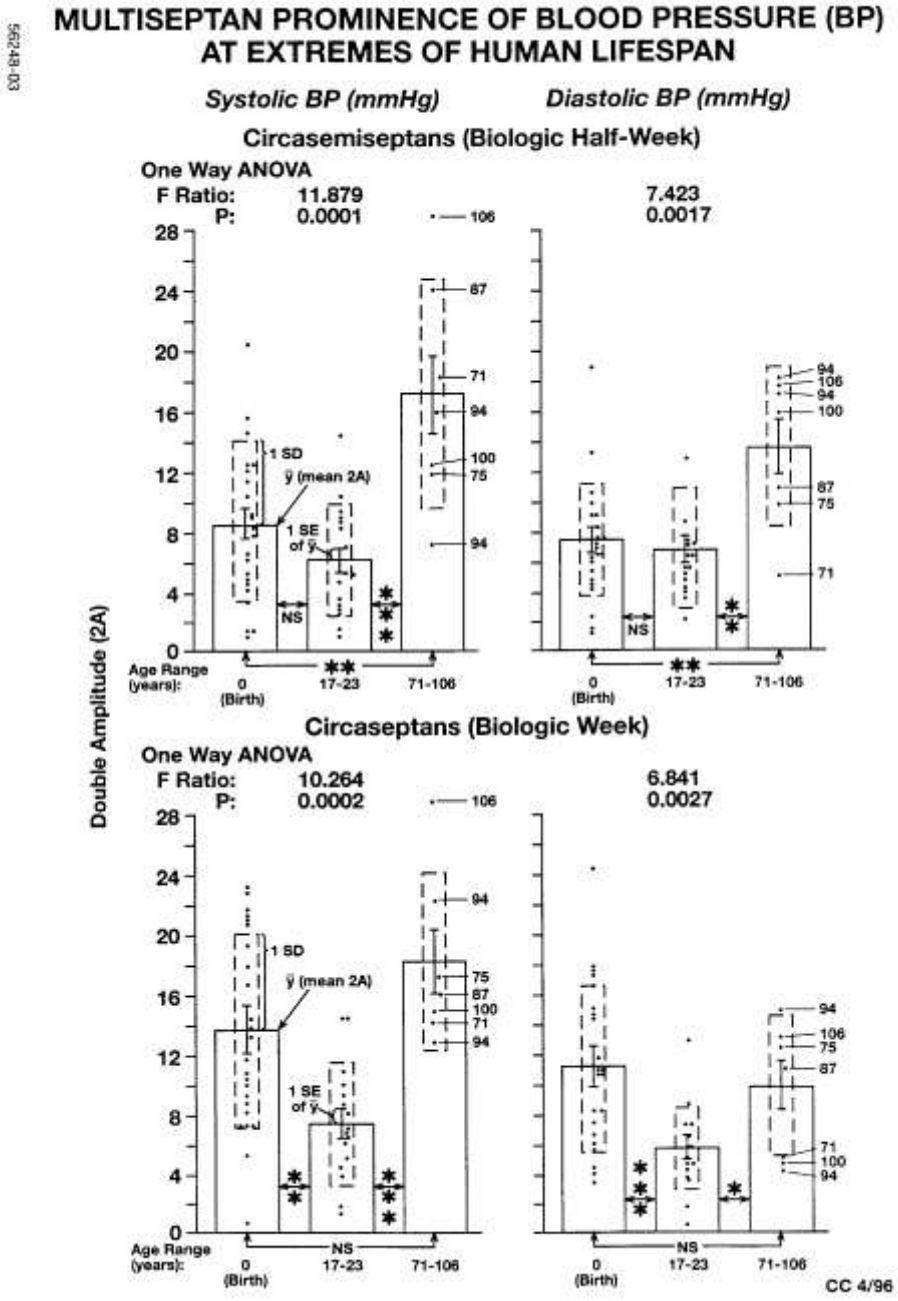

Fig. 1. From (4, 5). © Halberg.

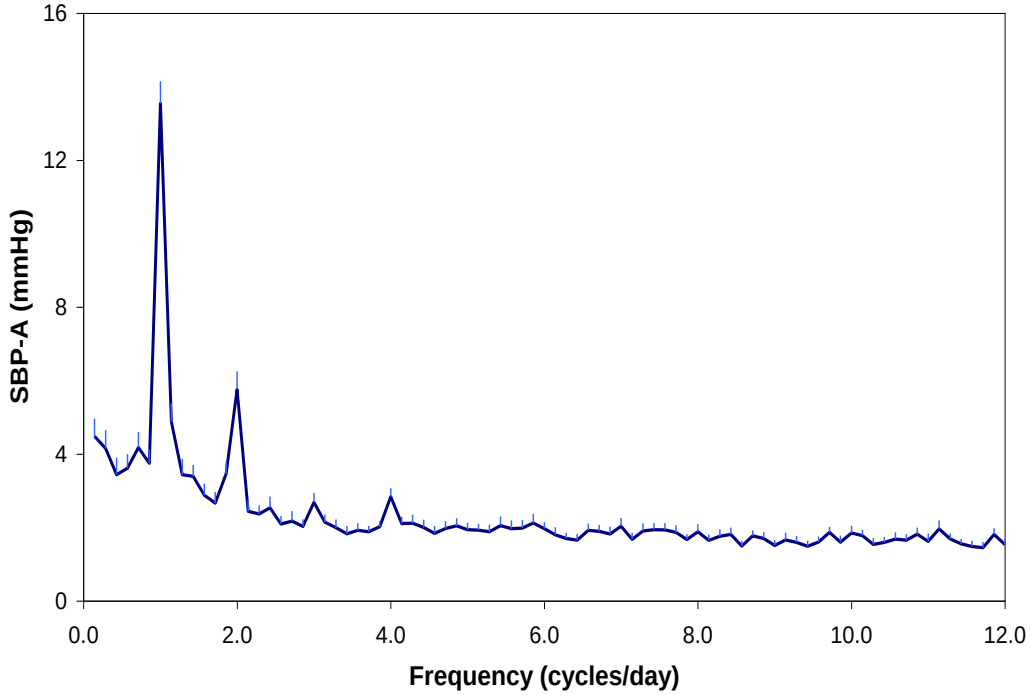

Fig. 2. Population-mean cosinor spectrum of systolic blood pressure of all 9 subjects in the pilot study. © Halberg.

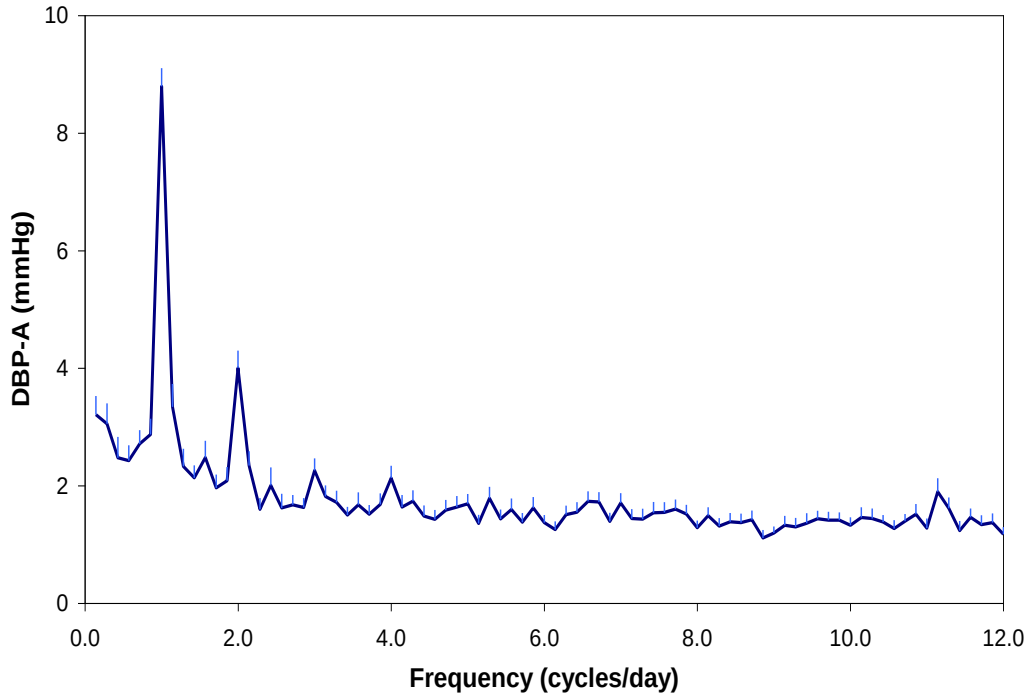

Fig. 3. Population-mean cosinor spectrum of diastolic blood pressure of all 9 subjects in the pilot study. © Halberg.

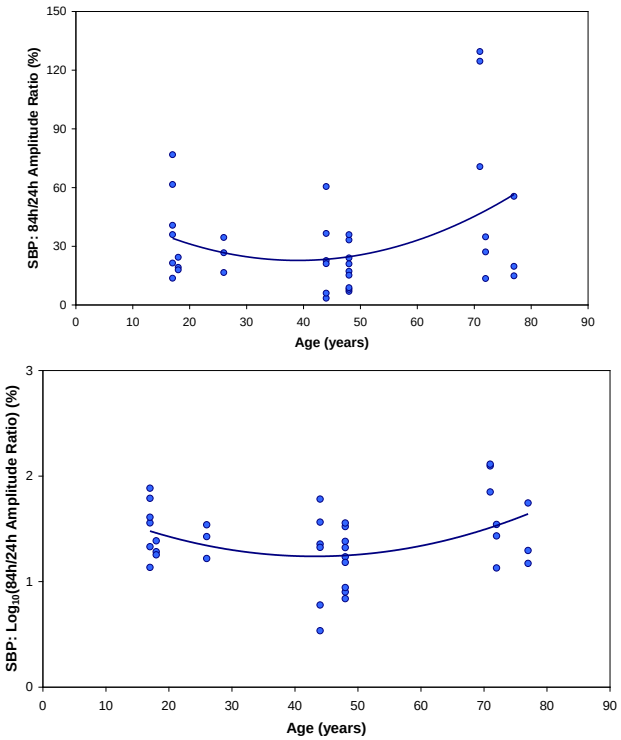

Fig. 4. Change with age in the circasemiseptan-to-circadian amplitude ratio of systolic blood pressure of the 9 subjects in the pilot study. Top: Amplitude ratios; Bottom: Log_{10}-transformed amplitude ratios. © Halberg.

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EARTHQUAKES, FEATURES OF THE DYNAMICS OF THE LITHOSPHERE, MIRROR THE HELIOSPHERE, AS DO PHYSIOLOPATHOLOGIC ASPECTS OF THE BIOSPHERE

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Aim. To examine whether major earthquakes occur randomly, or whether they may be characterized by cycles that may serve for helping the understanding of mechanisms underlying their occurrence, thereby allowing the development of precautionary measures to minimize their impact on populations and their infrastructures, whether or not the cycles also serve the prediction and thus the evasion of cataclysms.

Background. Earthquake prediction is often viewed as impossible by mainstream seismologists (1). The case against the predictability of earthquakes is built upon the fact that fractures and failure in bedrock deep beneath the Earth are notoriously intractable. Whereas the mapping of any cycles characterizing the occurrence of earthquakes is evidence for some sort of predictability, it is realized that such results are only statistical by nature and may not be sufficiently accurate to serve as a real prediction tool. But it may, at least, point to some putative mechanisms underlying the occurrence of earthquakes, and, as such, results from cycles may be a first step toward countermeasures.

Materials and Methods. A search of the NOAA (NESDIS/NGDC) website for Natural Hazards identified 331 earthquakes that occurred between January 1900 and June 2010 (accessed on 26 July, 2011). The parameters of the search were as follows: primary magnitude ≥ 1.0; MMI (Modified Mercalli Intensity) ≥1.0; deaths ≥ 10. A tsunami followed in 102 cases (30.8%). Focal depth averaged 29.74 km (range: 0-217); magnitude averaged 6.76 (range: 4.6-9.5); and MMI averaged 8.63 (range: 4-12). The number of fatalities varied from 10 to 242,000 (mean = 4,376), and the number of injuries varied from 1 to 374,171 (mean = 10,266). The monthly and 3-monthly incidences of earthquakes and tsunamis were analyzed by the extended cosinor (2-4).

Results. Least squares spectra in the range of one cycle per 100 years and 5 cycles per year identified components with periods of about 50, 11.5, 1.44, and 0.41 year(s), Figure 1. The first three components are also detected in the 3-monthly data, the last one being beyond the Nyquist frequency. Whereas the about 50-year component is less prominent in tsunamis, it is also detected with statistical significance, along with an about 12-year cycle. An about 2-year component characterizes tsunamis more prominently, along with an about 0.38-year cycle, Figure 2. An about 1.3-year component, more readily identified in the 3-monthly data, is somewhat less prominent but is statistically significant by linear least squares. Nonlinearly, all four components detected in the least squares spectra of earthquakes can be validated when considered separately. Fitted concomitantly, conservative 95% confidence limits for the amplitude that do not overlap zero can only be derived for the about 50-year component, whereas 1-parameter limits non-overlapping zero are obtained for the other three components, as shown in Figure 3. The model, fitted to the original monthly values is illustrated with the original data shown as 9-month running means. Similar results are obtained for earthquakes accompanied by tsunamis. The major component detected in the least squares spectrum is a cis-half-year, with a period of 0.377 year, somewhat shorter than that characterizing all earthquakes. Fitted separately, it is validated nonlinearly, as is an about 2-year component, not present in the spectrum of earthquakes. The about 50-year and about 12-year components are also detected, albeit only the 1-parameter confidence limits for the amplitude do not overlap zero in the nonlinear analyses. Fitted concomitantly, all four components have 1-parameter limits for the amplitude non-overlapping zero, as illustrated in Figure 4, together with 9-month running means.

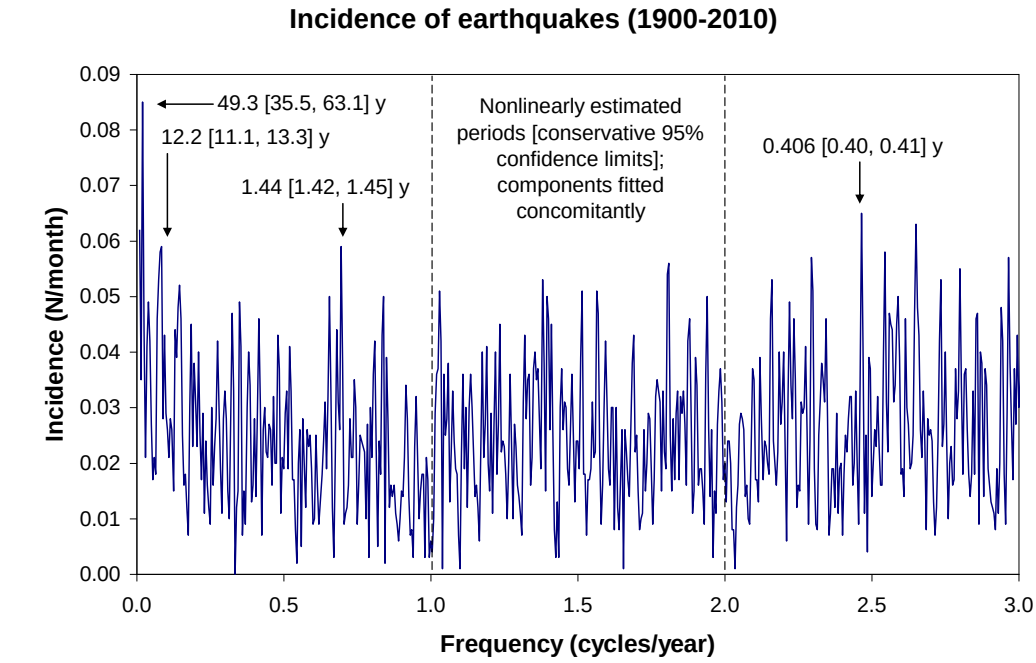

Fig. 1. © Halberg.

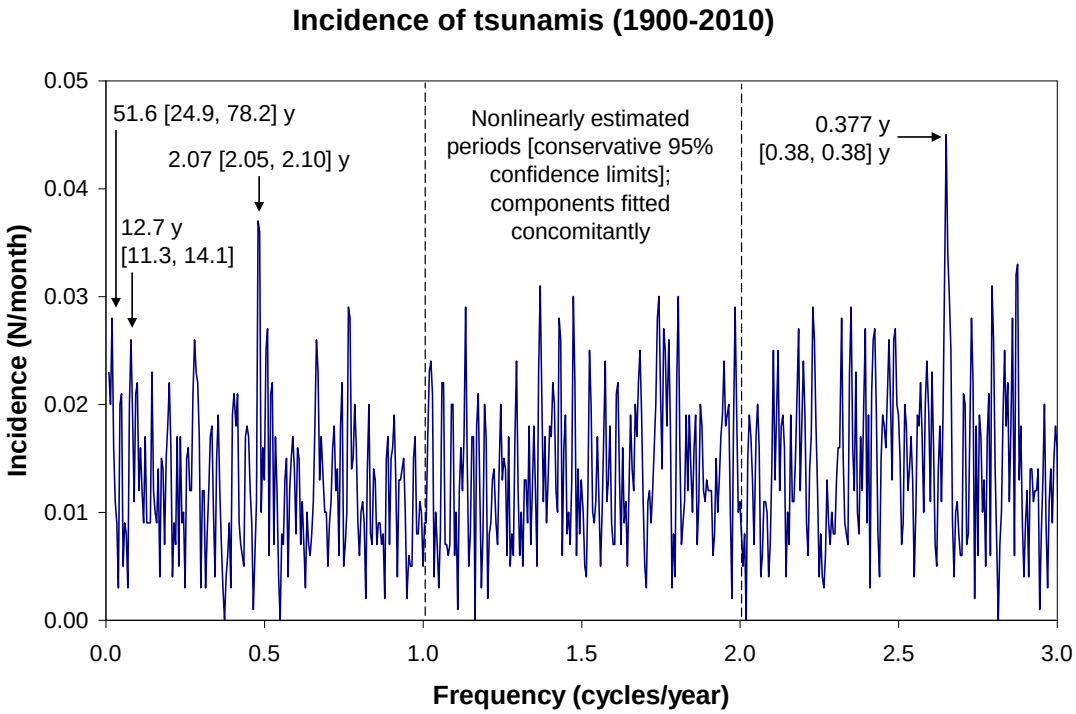

Fig. 2. © Halberg.

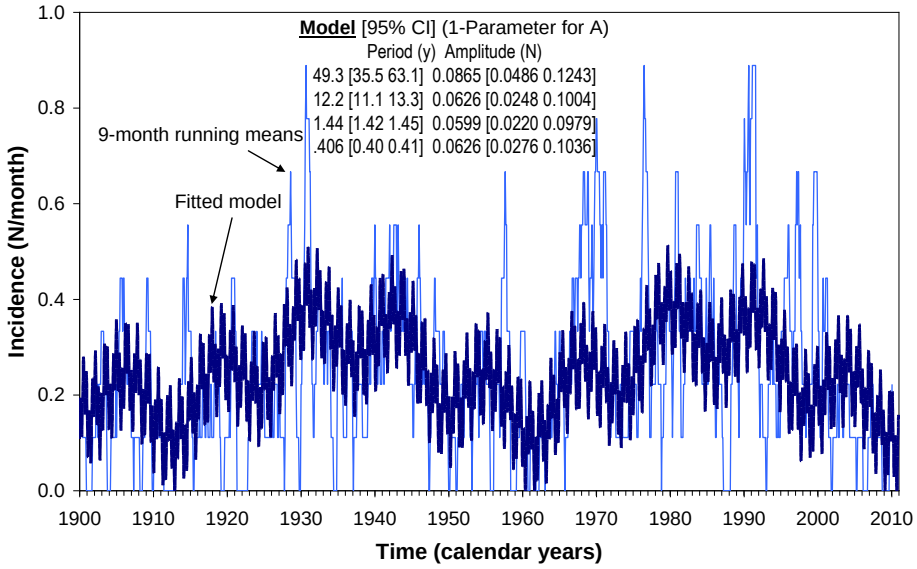

Fig. 3. © Halberg.

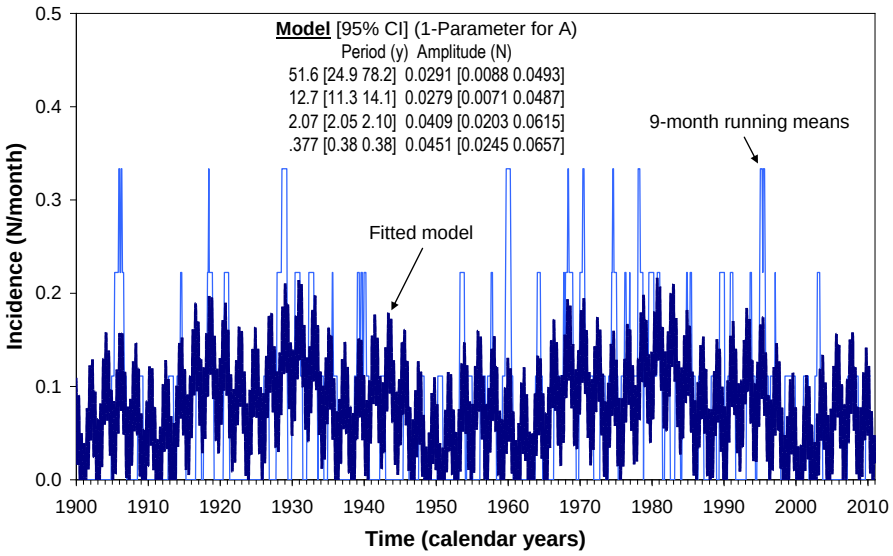

Fig. 4. © Halberg.

Discussion and Conclusion. Like economics and physiology, a statistically significant model of major earthquakes includes 1) Kondratiev's about 50-year cycle found first in economics (5) and thereafter in neonatal anthropometry (6-9) and also in the epidemiology of stroke incidence (10); 2) Horrebow-Schwabe's undecennian sunspot cycle (11, 12); along with a 3) far-transyear (about 1.3-year) component and a 4) quinmensal (about 5-month) cycle, characteristic of the solar wind's speed (13) and of solar flares (14), respectively, as they are also of the epidemiology of sudden cardiac death (15-17).

Congruent cycles (with overlapping or overlying 95% confidence intervals of their periods) are shared by the helio-, litho- and bio-spheres and are likely to characterize more broadly a thus structured in time chronuosphere, a term portmanteaud from the Greek chronos=time, the Attic Greek nous=mind and the Greek spairos=sphere".

A possible connection between sunspots and earthquakes was postulated in 1920 by Alter (18) on the basis of data taken from the Catalogue of Destructive Earthquakes compiled by Milne and from the Catalogue of Chinese Earthquakes. A short period of about 14.8 months is also

reported, corresponding to a transyear, along with a longer period of about 78 years (18). Relations between earthquakes (M≥6) and sunspot numbers, solar 10.7 cm radio flux and solar proton events have also been explored by Zhang (19), who reports that earthquakes occur frequently around minima of solar activity. During this stage, the frequency of earthquakes correlates with the maximal annual mean sunspot numbers, the maximal annual mean solar 10.7 cm radio flux, and whole-solar-cycle solar proton events (19). There is the postulate in solar and geophysics that disturbances in solar activity are transferred to the Earth by means of an electric effect. Energetic charged particles in the solar wind cause disturbances in the electric field of the Earth magnetosphere, propagating along the magnetic field lines from the polar regions toward lower latitude regions. Energetic charged particles can also directly disturb the electric conductivity of the Earth atmosphere via atmospheric ionization (19). Variations in electric tension underground have been postulated to underlie the triggering of earthquakes (20-22). It should be noted, however, that results herein point to a period of about 12.2 years, with a 95% confidence interval for the period ranging from 11.1 to 13.3 years, corresponding to a cycle length somewhat longer than that characterizing sunspots during the same 110-year span, estimated at 10.52 [95% CI: 10.48, 10.56] years, Figure 5.

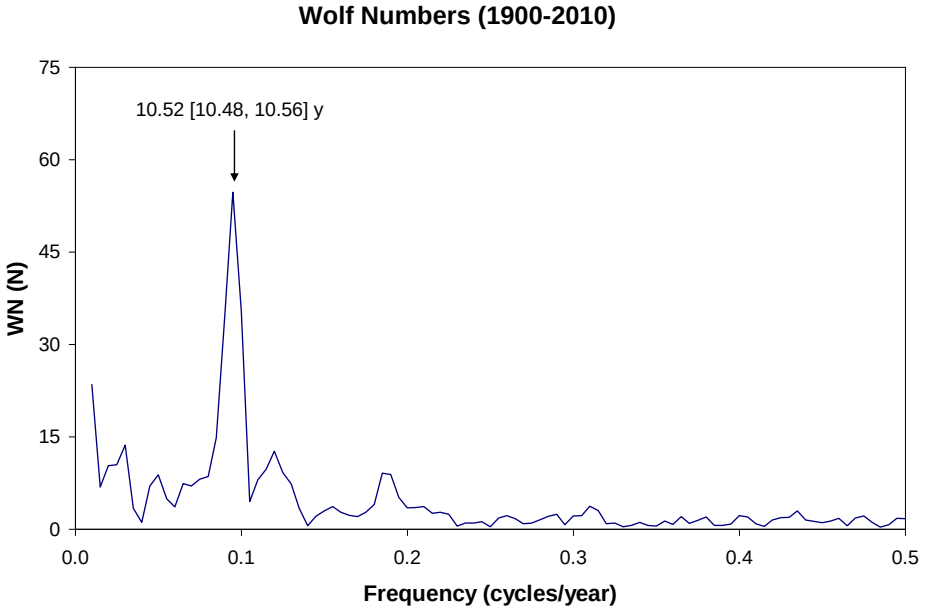

Fig. 5. © Halberg.

Anomalous changes in the about 0.01 Hz frequency range have also been reported in both geoelectric and geomagnetic fields before major volcano-seismic activity in the Izu Island region of Japan (23), an increase in variations in the geomagnetic field starting a few months before the onset of seismic activity, culminating before the nearby magnitude 6 class earthquakes.

Some seismologists have recognized that the largest earthquakes may not be evenly distributed throughout the 110-year-long seismic record (24). A big-quake cluster was identified that ran from 1950 to 1965, including 7 of the 9 greatest quakes of the 20th century. It was followed by a 36-year span without even a quake of magnitude 8.4 or greater (24), preceding a second cluster that may have started with the magnitude-8.4 quake off Peru in 2001. These observations are well in keeping with the about 50-year cycle detected in the data analyzed herein and found also in physiology, pathology and societal upheavals, Figure 6.

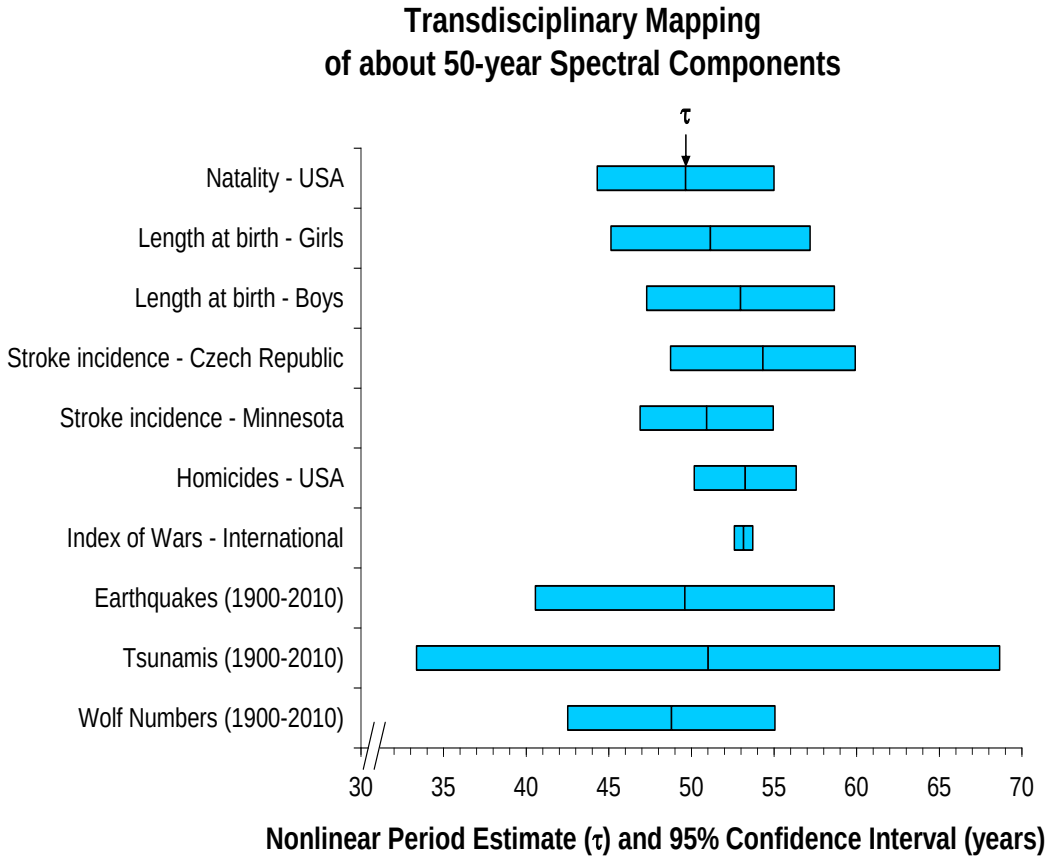

Fig. 6. © Halberg.

The influence of solar activity on seismic and volcanic activity has also been extensively studied by Khalilov and his school (25). Elchin Khalilov deserves much credit for his endeavors aimed at forecasting strong earthquakes by means of a specially-designed detector of super-long gravitational waves. According to his estimation, gravitational signals can precede strong earthquakes by 5 to 15 days, and can be detected in about 90% of occurrences, even when epicenters are as far away as 1,000 km from the monitoring station (26).

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INDISPENSABLE 24/7 CHRONOMICALLY-ASSESSED ABPM REPLACES PROVIDERS' OFFICE BLOOD PRESSURE, DETECTING CIRCADIAN ECFREQUENTIA AND EVEN DIFREQUENTIA

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Taking THE (single) blood pressure (BP) is a current sine qua non before any physical examination. But if the risk of a hard event like an ischemic stroke within 6 years increases with the diagnosis of multiple vascular variability disorders (VVDs) from below 5% to near 100%, reliance on a single office (and/or average of many home) BP measurement(s) at the start of an examination can be misleading: the single acceptable BP can neither diagnose nor rule out VVDs, including among them a high BP. Hence, indirectly, the cuff in the office for a BP assessment is responsible for likely millions of undiagnosed VVDs. Consequently, single cuff measurements are a hindrance, as already recognized in 1904 by Janeway (1), who did not wish to examine a patient before seeing a record of measurements revealing the periodicities (note plural) involved. In 2011, many periodicities have been mapped by chronomically interpreted decades-long ABPM and the consequences of alterations in variability are defined in outcome studies (2). Hence, eventually as the evidence is disseminated, the measurement in the caregiver's office, acceptable to care providers and recipients uninformed or unconcerned about VVDs, can be replaced by a C (chronobiologic/chronomic 24-hour/7-day)-ABPM which detects risks greater than hypertension that are otherwise undiagnosed (2). BP data can be collected in a way that can be analyzed by methods available on the yet-to-be-built website that implements on a large scale what a BIOCOS project currently does worldwide on a small scale (2).

An elevation of the MESOR, MH or MESOR-Hypertension and Mh or MESOR-hypotension are Vascular Variability Anomalies (VVAs) that become Disorders (VVDs) when they persist beyond the time of a load (3). MH and Mh are diagnosed when the BP MESOR (M) is above or below the upper 95% or lower 5% limit of gender- and age-matched clinically healthy peers. An elevation of the circadian amplitude above the upper 95% prediction limit of peers has been associated with an increase in cardiovascular disease risk larger than MH, even among certain MESOR-normotensive subjects. This condition, called CHAT (Circadian Hyper-Amplitude-Tension), can be iatrogenic in origin but, whatever its origin, is amenable to treatment.

An odd timing of the circadian rhythm of BP but not of HR (BP ecphasia) is also associated with a large increase in cardiovascular disease risk, notably when related to the presence of autonomic system dysfunction in patients with non-insulin-dependent diabetes mellitus. VVDs include an excessive pulse pressure (above 60 mmHg) and a deficient HR variability (HR-SD < 7.5 beats/min). These VVDs have been shown to be largely independent and additive (4). Figures 1-3 introduce an altered circadian period (ecfrequentia), differing with statistical significance from 24 hours while living in usual environmental conditions. This condition was encountered in a case of recurring adynamia lasting 2-3 months twice a year, affecting the circulatory and other variables (5). Assessment of VVDs has been shown, i.a., to work when "dipping" failed (6, 7) or even misled (8): the dipping was abnormal in healthy controls while patients with hypertensive retinopathy dipped acceptably (8). C-ABPM is continued for weeks or much longer, if an abnormality is detected and replicated rather than transient, while therapy is indicated. Therapy of VVDs with drugs can reduce the risk of hard events (or enhance it if given blindly) (9). Music (composed for the treatment of specific conditions, such as depression) (10) can relieve symptoms of yet another novel VVD, consisting of two circadian components in each systolic (S) and diastolic (D) BP and HR, associated with about half-yearly recurring, about 2 months lasting adynamic depression, i.e., vascular circadian difrequentia (Figure 4), documented to be an endocrine difrequentia as well (5).

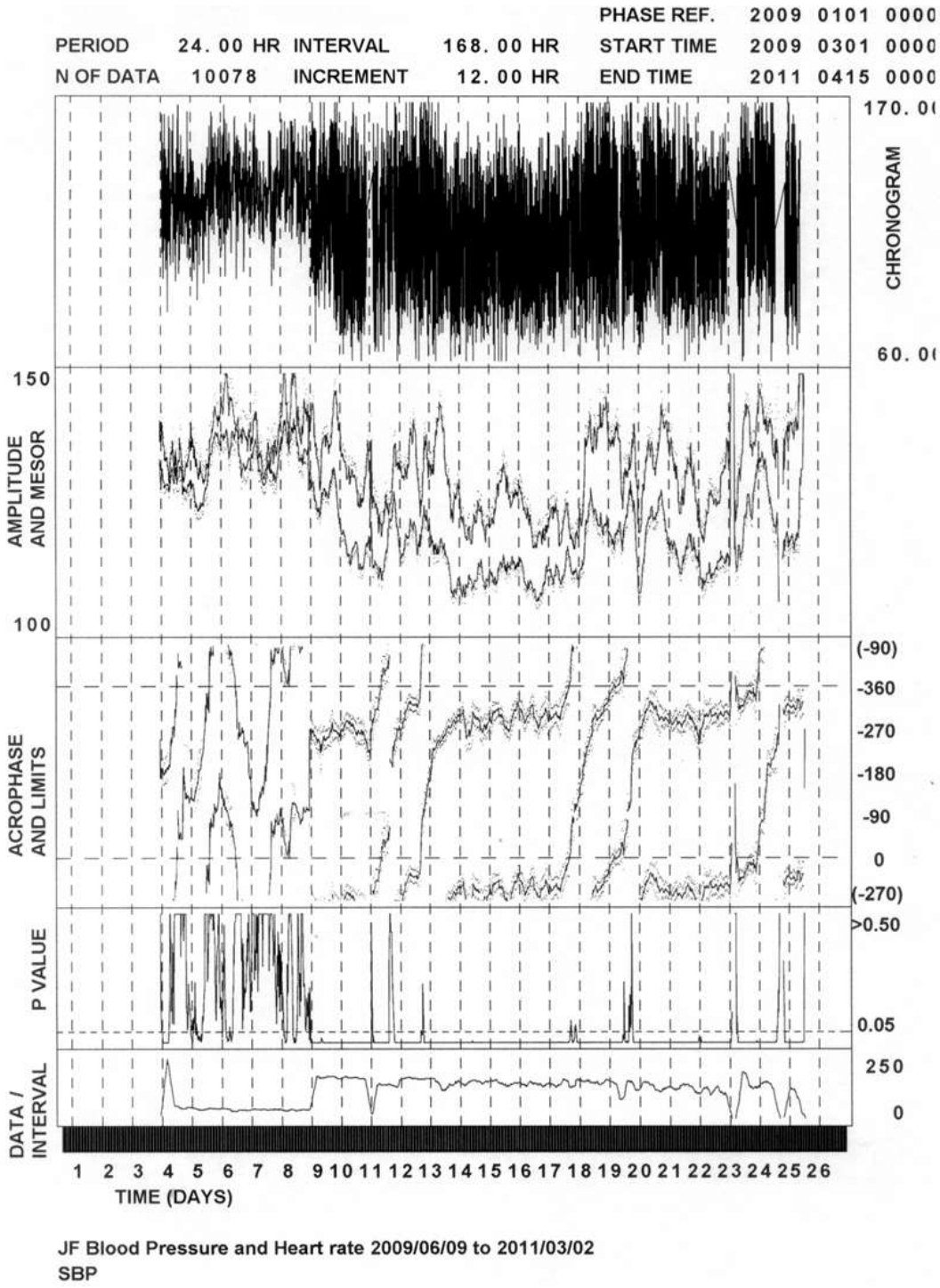

Fig. 1. Vertical dashed lines indicate full moons. Original systolic blood pressure data are displayed in the top row. Self-measurements switched to automatic monitoring around full moon #9, with data collected around the clock at hourly intervals. Accordingly, the circadian rhythm is more readily and more accurately detected, as evidenced by the lower P-value from the zero-amplitude test (row 4, dashed horizontal line corresponds to P=0.05), the lower MESOR (when including the usually lower nightly values) (lower curve in row 2), and the larger amplitude (distance between the two curves in row 2). Dots below the MESOR and above the amplitude indicate 1 standard error for their respective estimation. Dots bracketing the acrophase (row 3) are 95% confidence intervals. The time course of the circadian acrophase is relatively stable (horizontal) when JF is well but is progressively delayed during episodes of adynamia. © Halberg.

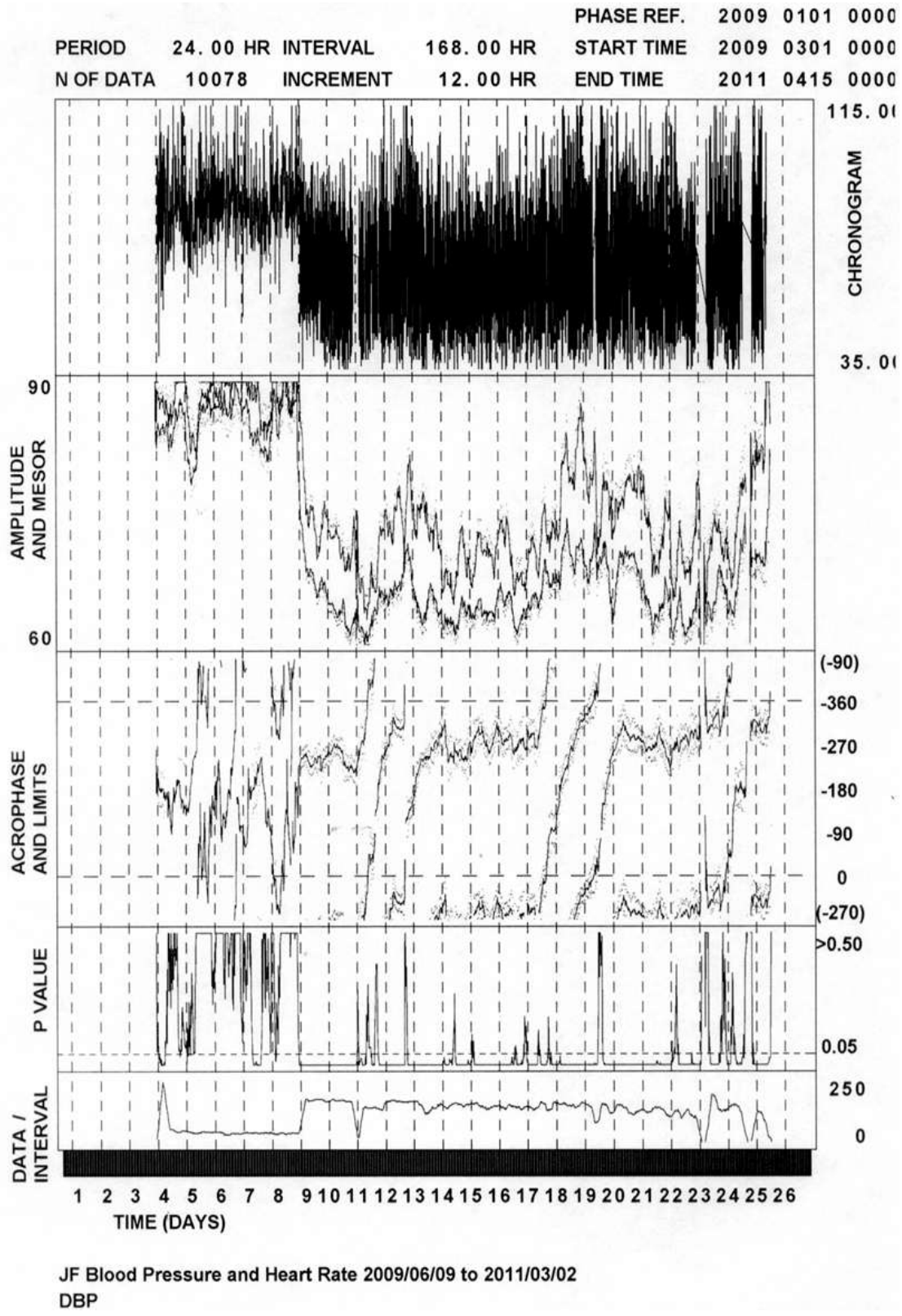

Fig. 2. Original diastolic blood pressure data are displayed in the top row. See legend to Fig. 1. © Halberg.

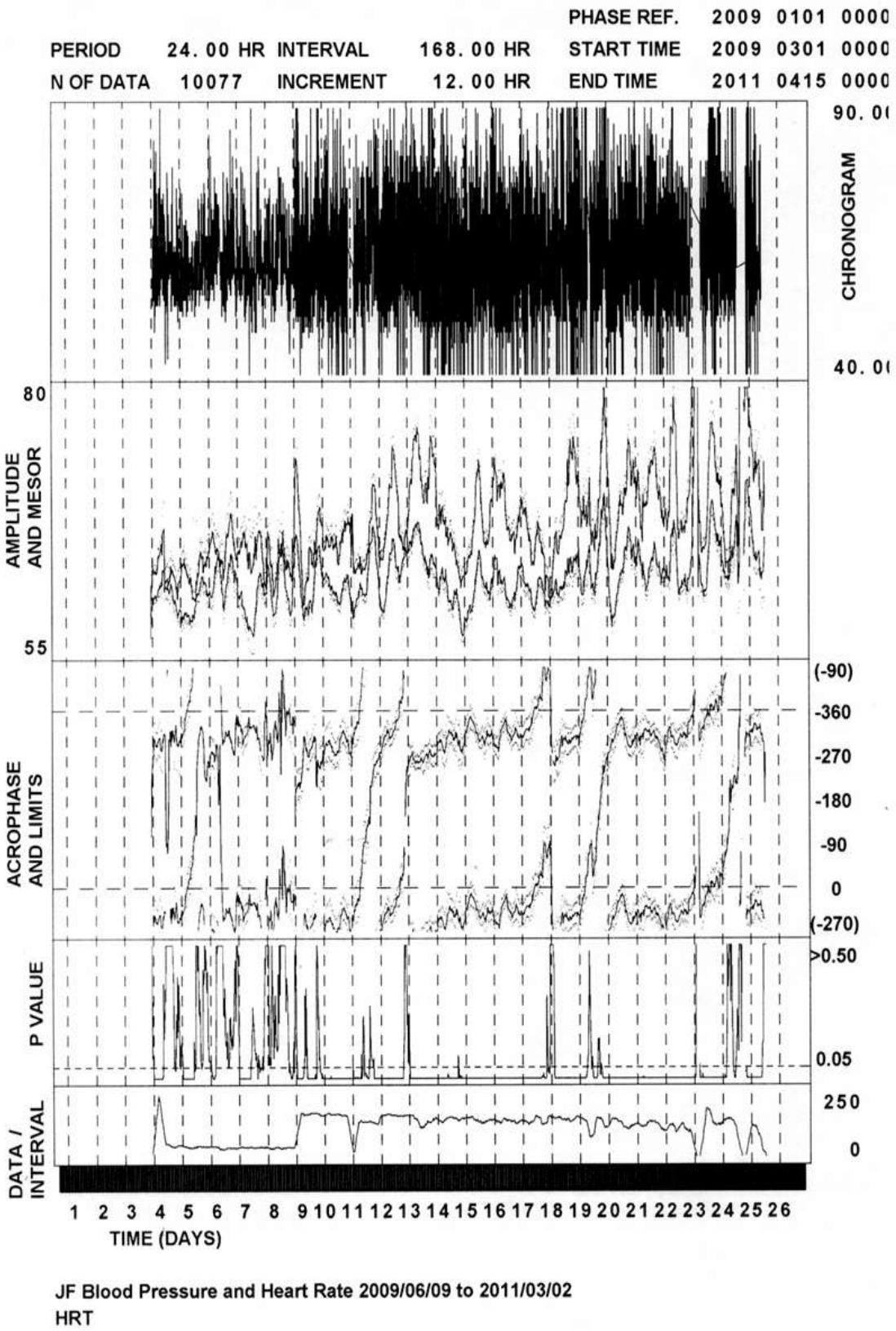

Fig.3. Original heart rate data are displayed in the top row. See legend to Fig. 1. © Halberg.

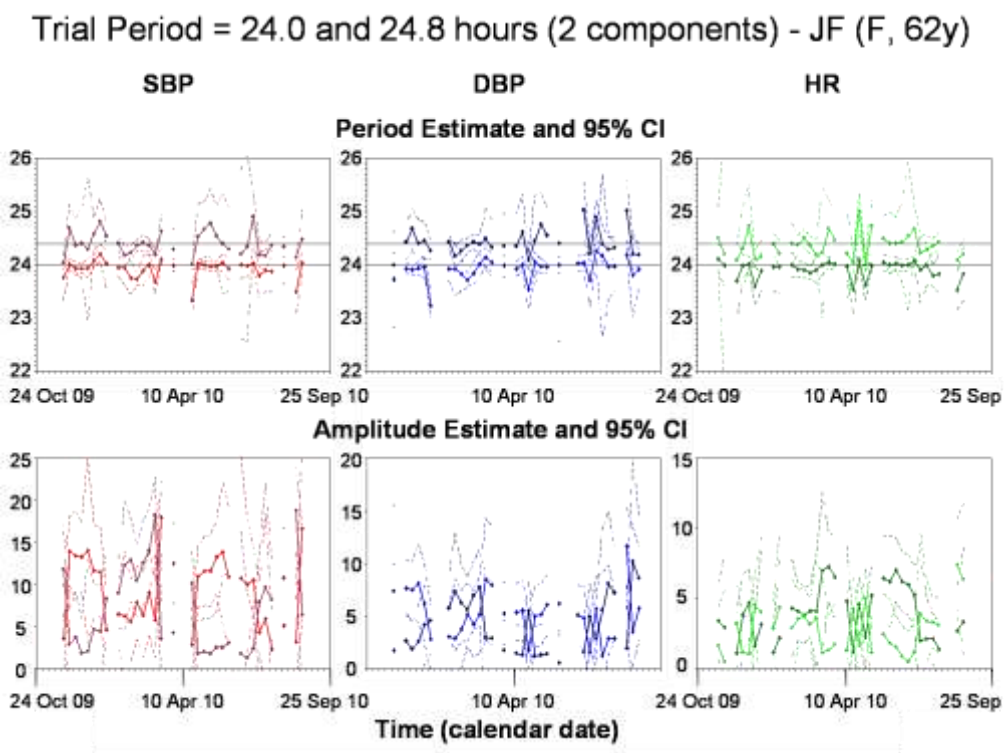

Fig.4. In the light of information accumulating up to December 2010, "free-running", as compatible with Figures 1-3 for JF, must be re-interpreted in this case as a likely ongoing competition between solar-societal and lunar days, with both leaving their mark nearly continuously. Temporally local analysis by the concomitant nonlinear fit of trial periods of 24.0 and 24.8 hours reveals, for the majority of about 1-year vascular C-ABPM monitoring by JF, the coexistence of at least two time-varying periods, one likely lunar, the other representing a residual solar-societal pull. A 24.26-hour component, compatible with the free-running period reported on unusual routines (11, 12) has been found in a 23-year old healthy man during the first year of his life on a self-selected schedule of sleeping and waking, coexisting with both 24.0-hour and 24.84-hour components as well as a 24.43-hour variation that may represent a compromise between the foregoing two periods, with all three of these components coexisting for 3 years (13). © Halberg.

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SCREENING FOR CEREBRO-CARDIOVASCULAR RISK REQUIRES CHRONOBIOLOGIC ANALYSES

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The aim is to replace reliance on office measurements of blood pressure (BP) and heart rate (HR) by continuous, as-one-goes, easily computer-analyzed self-surveillance. For this task, automatic analyses from BIOCOS (corne001@umn.edu) and eventually from a website are available (1-4). We recommend at least 7-day/24-hour Chronobiologically-interpreted (C) Ambulatory BP and HR Monitoring (C-ABPM). Otherwise, systematic chronobiologically-interpretable schedules of manual measurements are less reliable (5). In either case, a BP and HR summary can be aligned with a space weather report (6). An intermittent circadian overswing is demonstrated by monitoring for over 10 years with weekly analyses and in their light with changes in medication for GSK, a physician-scientist who needed the continued surveillance to avoid repeatedly recurring CHAT, shown to be gradually reduced if not eliminated (red in Figure 1). The same need likely concerns the millions of hypertensives who, like GSK, may well have undiagnosed complicating Vascular Variability Disorders (VVDs) that can be eliminated, sometimes by a change in timing of medication (7).

Office BP measurements and treating for a lifetime misses VVDs such as a circadian overswing (8), documented worldwide (9), constituting a greater vascular disease risk than a high BP (1, 2). That treatment timing can make the difference between harm or benefit has been demonstrated for FH with 240 mg Diltiazem HCl (7) and by YW with Hyzaar, a combination of 50 mg Losartan and 12.5 mg hydrochlorothiazide (10, 11). These findings reveal in common practice what may be lost in clinical trials, providing lessons which are no substitute for individualized supervision.

The chronobiologic approach is cost-effective, providing much more for less, by self-help implemented by automatic, now-available analyses of data preferably from C-ABPM or from self-measurements. As the editor of a journal in which some of us published our results put it (12), the opportunity of "not flying blind" is within the scope of a chronobiologic automatic analysis of 7-day/24-hour records (1, 2). This is best further implemented by analyses of 28-day intervals that in one case of recurring adynamia revealed the presence of two circadian components with periods of about 24.0 and 24.8 hours, reflecting perhaps the influence of both the Sun and the Moon (13). As

soon as affordable miniaturized instrumentation (e.g., on the wrist) becomes available, the preferred lifelong surveillance will be within reach for everyone.

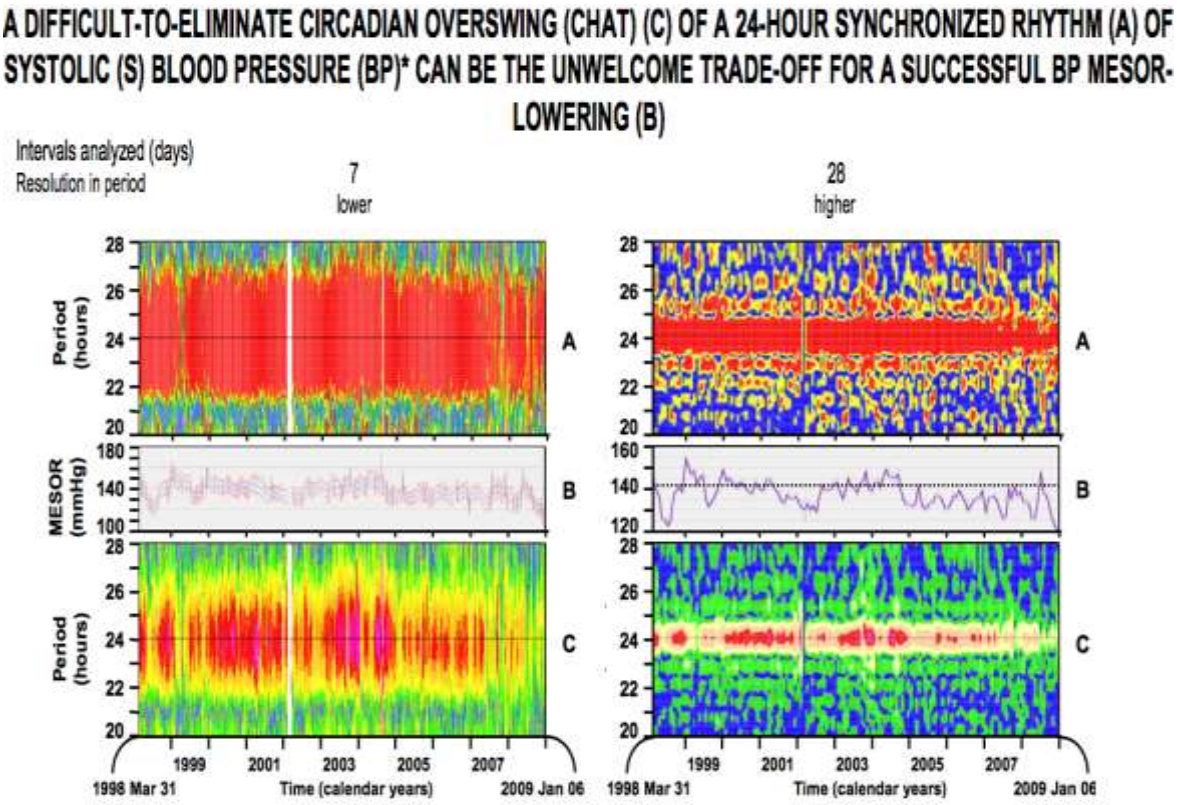

Fig. 1.

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FOUR CIRCADIAN AND TWO CIRCASEMIDIAN PERIODS IN SLEEP-WAKEFULNESS OF A MAN ON A SELF-SELECTED ROUTINE

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A free-running experiment (1), based on an hourly record of sleeping and waking by JFC (1990.02.19 to 1993.03.11, 1117 days), is here investigated. The original spectrum reveals a dominating 2-peaked about 12-hour (h) component, the slightly longer period, τ, of the second peak perhaps corresponding to a tidal τ. The peak at 24 h was also accompanied by a second smaller peak, perhaps corresponding to a double tidal τ, Figure 1.

Background. A double tidal 24.8-h (lunar) τ and another 24-h synchronized τ, were both present and alternated in prominence in a 61-year-old woman, JF, with a 20-year history of twice-yearly, 2-3 months, adynamic depression, during which the 24.8-h τ predominated while the 24-h synchronized τ had the larger amplitude, A, during relative well-being (2).

Results. As Table 1 shows, multiple τs also characterize a clinically healthy man, JFC, 23 years of age at start of recording. Coexisting with a 24-h synchronized and a 24.8-h lunar τ are the presence of a 24.26-h τ that may correspond to a free-running τ (3, 4), and a 24.4-h τ corresponding to perhaps a nearly equal pull by society and by the moon. Chronobiologic serial sections in Figure 2 with the fit of 24.00-h (rows 2 and 3) and 24.80-h (rows 4 and 5) τs to data in intervals covering 7 cycles (of the τ fitted) document the net result of the relative contributions and changing

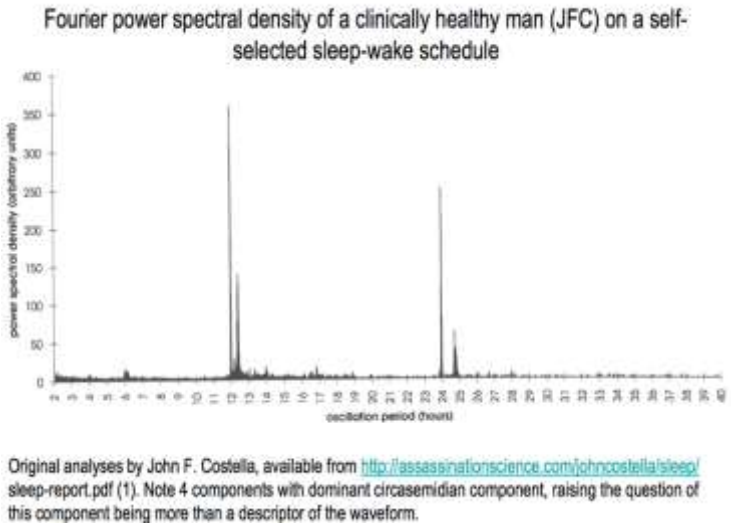

Fig. 1.

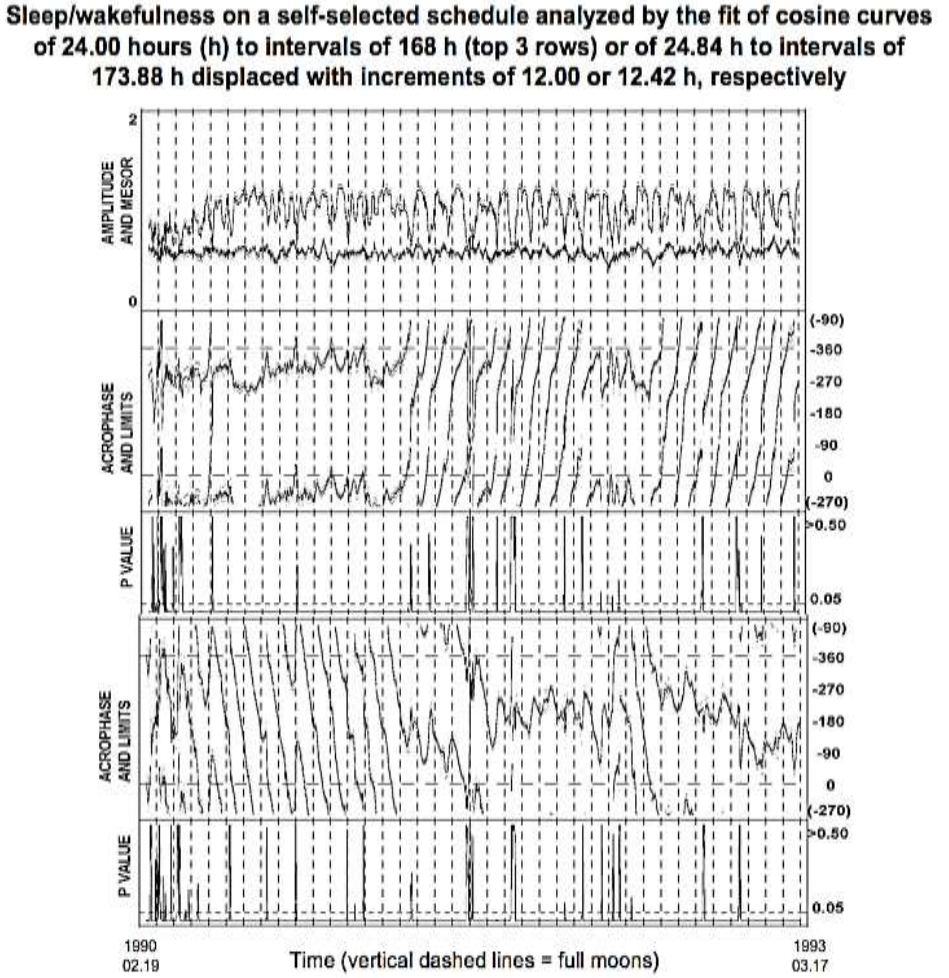

Fig. 2. © Halberg

prominence of societal (socidian), lunidian and other τs. Table 1 also shows that the As of 24.00-h and 24.84-h τs by far exceed the amplitudes of a possibly free-running τ or of an intermediate (compromise?) component, the latter resulting from similar pulls by society and the moon. By contrast to Figure 1, the half-day τ's amplitude is much smaller than that of the day. Multiple circadian τs, as such, in sleep-wakefulness on a self-selected routine need not be pathogenetic, at least not in a single well-documented case. Nonlinear analyses (5-8) of consecutive sections of time series validate the presence of both about 24.8-h and 24.0-h τs. While JF consistently demonstrated 2 τs in several variables, JFC demonstrates in sleep-wakefulness, in several different sections of time series, the coexistence of several circadian τs and their second harmonics.

Table 1.

Periods, amplitudes and acrophases* found in sleep-wakefulness on a largely self-selected schedule by JC**

Period (CI*)		Amplitude (CI)	Acrophase (CI)
Name	**Length (h)**		
Solar day	24.001 (24.000, 24.001)	0.25443 (0.2337, 0.2751)	-293˚ (-288, -287)
Lunar day	24.836 (24.833, 24.838)	0.10606 (0.0854, 0.1268)	-233˚ (-222, -244)
Compromise?	24.432 (24.427, 24.436)	0.05643 (0.0357, 0.0772)	-250˚ (-229, -271)
Free-running?	24.260 (24.252, 24.268)	0.03253 (0.0118, 0.0533)	-10˚ (-334, -47)
Half-day	11.999 (11.997, 12.001)	0.03204 (0.0113, 0.0527)	-356˚ (-319, -33)
Tide	12.414 (12.410, 12.418)	0.01728 (0.0034, 0.0380)	-199˚ (-131, -268)

*With uncertainties (CI, 95% confidence interval).

**A healthy man, 23 years of age at start of recording from February 19, 1990, to March 11, 1993 with linear-nonlinear rhythmometry by the extended cosinor (5-8). Local analyses by separate serial sections with 24.0-h and 24.8-h τs (in 1-week intervals) reveal the dominance, in alternation, of these 2 τs in the data.

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SPECTOGRAMS REVEAL MULTIPLE CIRCADIAN PERIODS WITH THEIR ALTERNATING PROMINENCE QUANTIFIED NONLINEARLY

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JF, a 62-year-old woman at start of study, monitored her blood pressure (BP) and heart rate (HR) hourly during about (~) 10 months, including downtimes of adynamia and depression lasting ~2 months, with desynchronization from the societal 24-hour routine of her sleeping and waking and, i.a., of her partly monitored wrist activity and vigor self-rating. Vigor/wellness showed the double tidal period of 24.8 hours in the first months of 2 out of 3 self-rated episodes of unwellness and loss of vigor. In Figure 1, data from Dec 2009 to Sep 2010 are shown as spectrograms obtained in Matlab by moving windows of 1 (top), 2 (middle) and 10 (bottom) months. Dark bands denote high amplitude peaks, seen in the circadian range with 1- and 2-month windows, notably during the depressive (adynamia) episodes (2 Jan-28 Feb and 7 Jul-16 Sep 2010, associated with prolongation of circadian period beyond 24.8 hours). Note in Figure 1 the greater pull toward 24.8 hours of BP than of HR. Also note the demonstration of multiple coexisting peaks in the circadian range between 24.0 and 24.8 hours. The particular two peaks at and near 24 hours with the 10-month windows (bottom) are in keeping with the coexistence of a precise 24.0-hour period and of one only slightly longer than 24.0 hours, perhaps of ~24.2 hours, in keeping with a free-running period reported on living routines outside the range of synchronizability of the circadian rhythm (1-3). The coexistence of multiple circadian components, with periods including one of ~24.0 hours and one of ~24.8 hours was demonstrated most of the time in analyses of JF's BP and HR data in 4-week intervals moved by 1 week (4). A different time structure is observed for a clinically healthy 60-year old woman who also monitored her BP and HR around-the-clock during the same 1-year span. Results from her data averaged over consecutive 4-hour intervals are shown in Figure 2. The 24-hour synchronized component is prominent and stable. Sidelobes likely represent modulations in amplitude, phase or frequency of the circadian rhythm by infradian components.

**Differential Circulatory responses to Lunar and Solar Days:
A Glocal (combined GLObal and LoCAL approach)
Analysis of Systolic (left) and Diastolic (middle) Blood Pressure and
Heart Rate (right) of JF (F, 62y).**

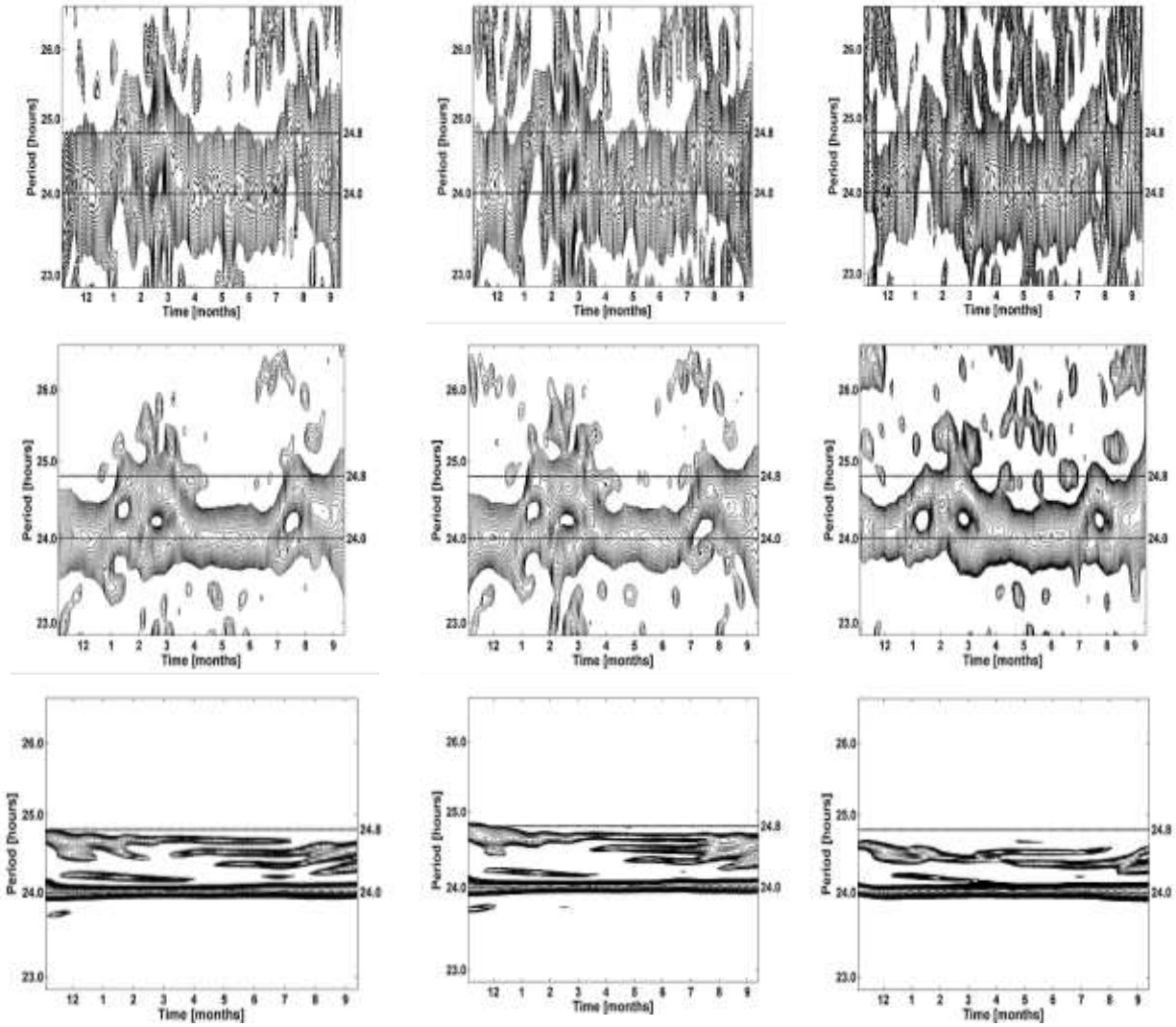

Fig. 1. Spectrograms using windows of 1 (top), 2 (middle) and 10 (bottom) months.

Primary Solar Influence on Systolic (left) and Diastolic (middle) Blood Pressure and Heart Rate (right) of GC (F, 60y)

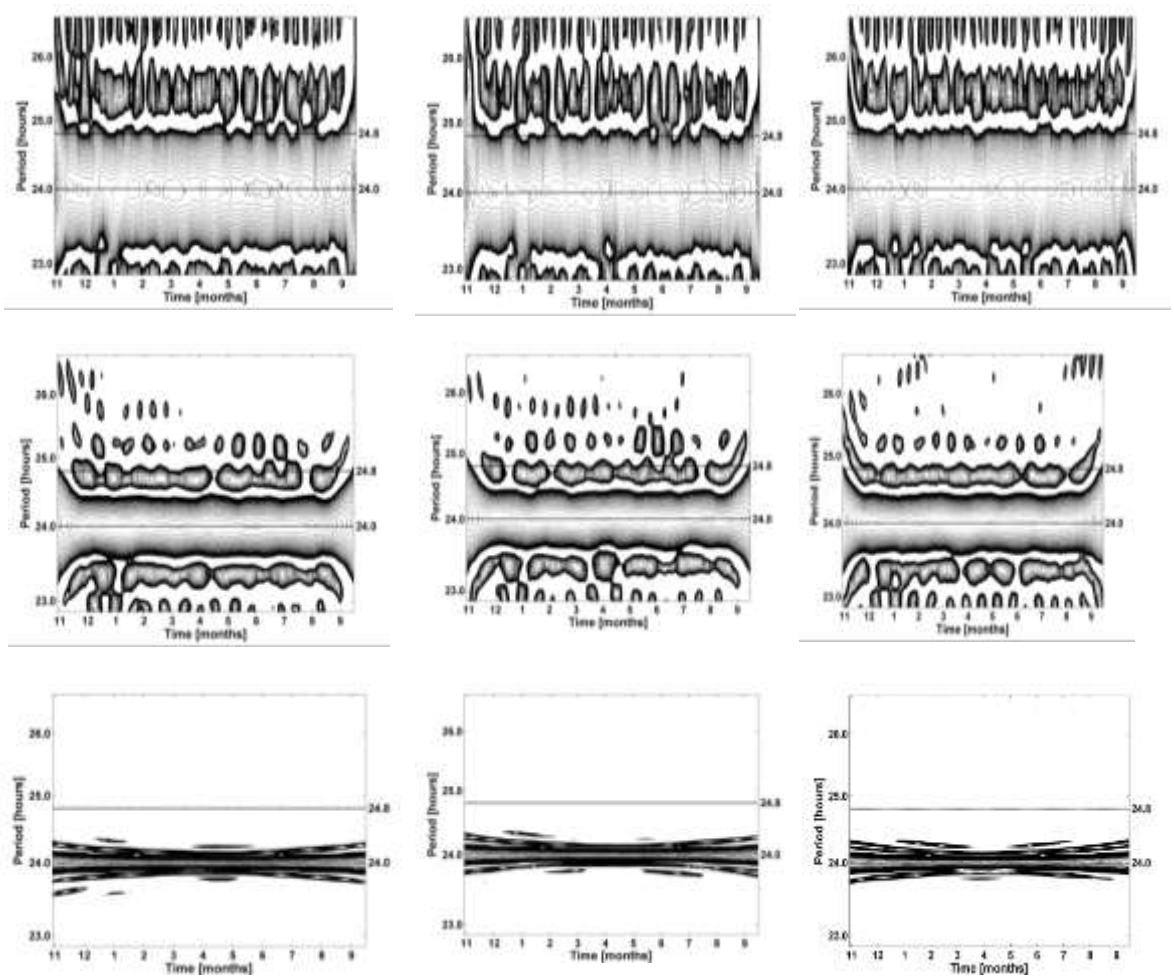

Fig. 2. Spectrograms using windows of 1 (top), 2 (middle) and 10 (bottom) months.

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SANOSON MUSIC THERAPY OF UNWELLNESS IN A CASE OF RECURRENT ADYNAMIC DEPRESSION WITH CIRCADIAN DIFREQUENTIA

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Summary

Music, specially composed to cope with depression, reduced unwell-being, notably pain, for 1 hour or for longer in JF, a woman 62 years (y) of age at start of study with a history of adynamia for 21 years, who during her depressed downtimes lasting over 2 months and recurring about every 6 months (except for the last 6 months) had unsuccessfully tried to obtain relief with drugs and non-drug procedures.

Background

Based on an interview with VB, the developer of a method dubbed "receptive music therapy" (SANOSON Personalized Music-Focused Auditory Stimulation Therapy), a set of music programs (I-MAT 1) was selected for use herein. I-MAT 1 is part of a program library which was developed based on research about any effects of music on human psychophysiology (1, 2). The physiological response to music can be evaluated using a range of parameters derived from records of electroencephalograms, heart rates (HR), HR variability, breathing rates, electromyograms, skin conductances and skin potentials. These variables were investigated for any influence on "rhythm", "tempo" and tone density in the frequency range associated with a given composition. The factors presumed to underlie the psychological response to music were investigated in the course of several hundred interviews conducted by a team of researchers based on the model of "morphological psychology" (1). This approach, if not theory, was developed in the 1960s by Wilhelm Salber in Germany (http://en.wikipedia.org/wiki/Morphological_psychology and http://www .wilhelm-salber.de/). The results of analyses of the interviews (2) revealed the kind and extent to which patients listening to the music reacted. When the music was already known, it was often associated with specific past events, which may have had a negative connotation for the given patient who may have wanted a change. The developer then initiated the composition and production of new music specifically aimed to address the different aspects associated with a given diagnosis, such as depression.

The efficacy of this therapy (3, 4) was previously evaluated for the treatment of depressive disorders in a randomized placebo-controlled study with over 200 participants (5).

Case report

We have investigated JF and report elsewhere (6) on her daughter FT, 41 y at start of study, and granddaughter LT, 3 y at start. JF had about (~) half-yearly episodes, for up to 2 or 3 months, of severe fatigue, sometimes including the inability to get out of bed, recurring half-yearly for 20 years. In two years of study, we found a circadian desynchronization of her sleep-wakefulness and blood circulation, as documented with reported full scans of 24 hours by the circadian acrophases (times of overall high values recurring in each cycle) of BP and HR for JF in ambulatory BP

monitoring at hourly intervals for a span including three consecutive episodes (downtimes) (7). A period of 24.8 hours was found in some variables in the first month of some of JF's episodes as well as in LT in 1 of 2 around-the-clock BP series, each covering over 7 days.

Extreme fatigue prompted tests for circadian vascular, adrenocortical and other endocrine desynchronization from society by 4-hourly around-the-clock salivary hormone monitoring for months to check on the need for synchronizing treatment. The family, JF in particular, had been looking, unsuccessfully, for medical help during the previous two decades until JF experienced some relief by earthing. By consultation with the senior author (VB), JF then received programs from SANOSON, designed and already tested in patients with depression (4). She self-rated the effect of music, as illustrated in part in Table 1, with the results presented in Figures 1 and 2. This as-one-goes rating is separate from the overall rating of music by comparison to other procedures, such as earthing and other drug or non-drug treatments.

A familial selenosensitivity to earth tides (that move skyscrapers by over 20 cm) is suggested by the moon's image, the double tidal period of 24.8 hours in the (unfalsifiable) computer output (not input) of JF's analyzed around-the-clock self-ratings of vigor in the first month of the first two episodes investigated and in the first month of a third explored downtime in her systolic (S) and diastolic (D) BP, HR and urine volume. In all episodes investigated, chronobiologic serial sections showed a circadian desynchronization of the adrenal cortex (cortisol, aldosterone and dehydroepiandrosterone) and of estradiol, testosterone and melatonin and of all other variables such as sleep, wrist activity and urine volume investigated (7-9).

In keeping with Figures 1 and 2, JF gives us this report on the effects of music (Finley J, personal communication):

First an update on my 2011 so far. The good times and bad times have diverged from all previously established patterns. Although I experienced the sleep desynchronization that is typical for Jan/Feb, my awake times were far more productive and pleasant than normal. I even enjoyed some outings, which are usually totally absent during those months. I was using music therapy during these two months and found it very beneficial. (I cannot say if the music therapy was solely responsible for the improvement during these months or not; but I can confidently say that the music therapy improved pain level and ability to accomplish tasks following its use.)

During Mar/Apr/May, I have been plagued with sleep desynchronization as well as being largely non-functional. Very few simple tasks could be performed following music therapy, and all travel had to be cancelled. Since negative emotions have rarely impacted my life post-menopause, I think it significant to mention that at May's full moon [JF's selenosensitivity is objectively documented by repeated findings of the double 24.84-hour period in the output (not input) of computer-made analyses of several of her variables] I found myself challenged by new technology (a phone smarter than myself!) and becoming so angry that I wanted to throw it across the room and hit my husband for getting it for me. He suggested that I go do music therapy and I was amazed at the quelling of my rage. So in addition to the physical benefit of the music therapy, I enjoyed the emotional benefit as well for the first time since the very first try (when I released emotion from the dog attack at Christmas).

The sleep desynchronization and inability to function lifted May 20 and I have been functional in sleep control and accomplishment since that time. Why the shift from previously established patterns? I cannot say for sure that these changes are due to either music therapy or earthing.

[...]

[FH] DID YOU HAVE TANGIBLE BENEFIT FROM EARTHING - ON A SCALE FROM 1 TO 10?

[JF] earthing results are difficult to evaluate, but would give it a 6 / music therapy is a real winner with a 10

This clearly subjective foregoing retrospective report is supported by the (also, but perhaps less) subjective prospective self-assessment in Figure 1, which (in the top row) plots the self-rating before and after music therapy, along different scales on the left and in the middle sections. Hence, attention is best directed in Figure 1 at the outset upon benefit reduction in the right section. Original ratings shown in the top are simply background for the rows below. In the second rows,

the lower curve is the MESOR (a **m**idline-**e**stimating **s**tatistic **o**f **r**hythm, a usually better average than the arithmetic mean, and the distance between the two curves in rows 2 of Figure 1 is the circadian amplitude. Both these measures vary greatly, as does the acrophase in the bottom rows of Figure 1. Validated infradian cycles in extent of benefit are seen by the naked eye on the right of Figure 1. Overall results are summarized in Figure 2. Without extrapolating beyond the scope of 1 case studied for only 56 days, the effect of SANOSON therapeutic music seems clear in the case of adynamic depression associated with circadian difrequentia, found for the circulation and associated with a complete circadian desynchronization during downtimes, documented for the six hormones examined, i.e., cortisol, aldosterone, dehydroepiandrosterone, testosterone, estradiol and melatonin, here examined in saliva collected every hour around the clock for a total of 11,700 hormone determinations (5, 6).

Specificity of SANOSON programs

Figures 1 and 2 are based on SANOSON program 1-D. JF had been given four music programs, with the suggestion that during a downtime only program 1-D may be of benefit. During her winter 2011 downtime she fell asleep during program 1-D; when program 1-F was played, she awoke with a myoclonus. The 3 programs other than 1-D were of benefit in the spans between episodes.

Problems remaining

VB suggests the possible merits of systematic vs. "as needed" timing; a comparison of the two approaches in this case was not done. Any marker rhythm other than discomfort or pain could also be considered to guide treatment timing. The demonstrated fact remains that music (10; cf. 11, 12), like other stimuli (13), including drugs (14-17), can have drastically different effects in different circadian stages.

Conclusion

SANOSON music therapy with 1-D was subjectively and specifically palliatively and transiently helpful, where other approaches during the preceding two decades were not.

Conflicts of interest

VB owns shares and acts in a supervisory role for SANOSON, the producer of the music dubbed "receptive". The other authors have no conflicts of interest to declare.

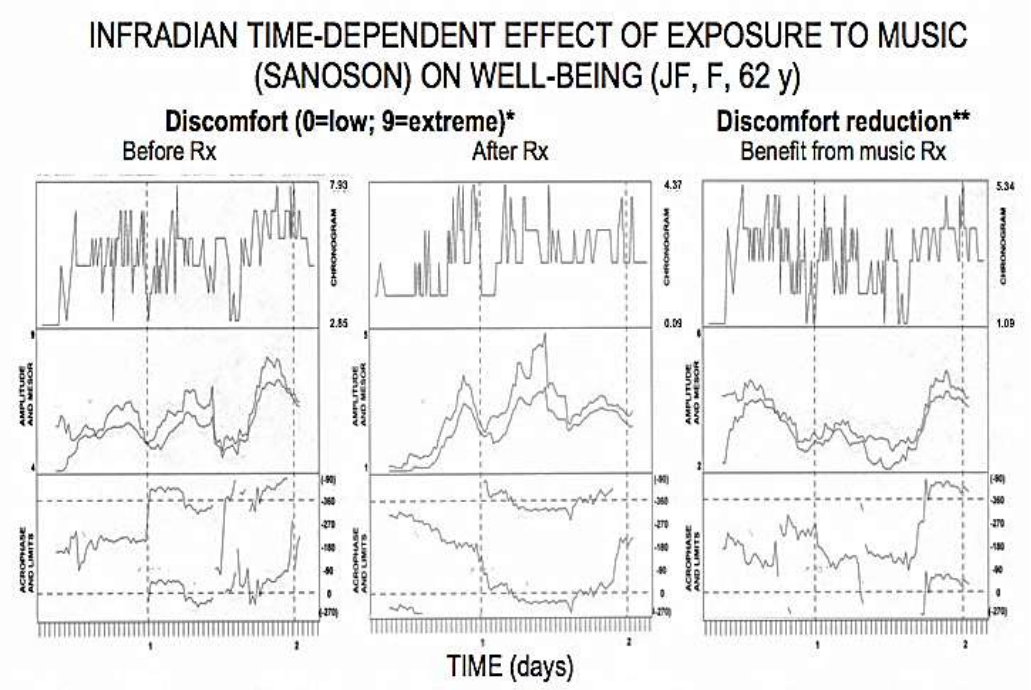
Table 1.

Rating and illustration of irregular timing of exposure to SANOSON programs of therapeutic music, applied at different clock-hours with a differing number of sessions/day as needed by JF, a woman 62 years of age*

DATE	TIME	PROGRAM	BEFORE	AFTER
29 12 2010	19:30	1-D	2	1
30 12 2010	02:30	1-D	2	1
30 12 2010	19:30	1-D	2	2
31 12 2010	20:15	1-D	1	1
02 01 2011	01:30	1-D	2	1
02 01 2011	12:30	1-A	1	3
02 01 2011	13:30	1-D	3	1
03 01 2011	15:30	1-D	2	1
03 01 2011	18:30	1-G	2	1
04 01 2011	14:00	1-G	2	3
04 01 2011	16:30	1-D	3	1
05 01 2011	06:00	1-F	2	1
05 01 2011	13:35	1-D	4	1
05 01 2011	17:30	1-D	3	1
05 01 2011	23:15	1-D	3	1
06 01 2011	06:00	1-F	3	1
06 01 2011	11:30	1-D	3	1

DATE	TIME	PROGRAM	BEFORE	AFTER
06 01 2011	16:00	1-D	3	1
06 01 2011	21:00	1-D	5	2
07 01 2011	06:00	1-F	5	1
07 01 2011	13:00	1-D	5	2
07 01 2011	17:00	1-D	5	1
07 01 2011	21:00	1-D	5	2
08 01 2011	01:00	1-D	5	1
08 01 2011	06:00	1-F	5	1
08 01 2011	11:45	1-D	5	1
08 01 2011	21:30	1-D	6	3
09 01 2011	02:15	1-D	5	1
09 01 2011	14:00	1-D	6	3
09 01 2011	21:15	1-D	5	1
10 01 2011	06:00	1-F	5	1
10 01 2011	12:00	1-D	6	1
10 01 2011	16:15	1-D	6	1
10 01 2011	20:45	1-D	4	1
11 01 2011	07:00	1-D	5	1
11 01 2011	12:00	1-D	5	1
11 01 2011	15:30	1-D	5	2
continued ...				

*In this evaluation, symptoms rated include heart palpitations; electric tingling from lower back rising up the spine and into the entire head and face; sudden, sharp joint pain; myalgia; sleep disturbance; and full-blown adynamia. The symptom rating system includes 1=none; 2=very minor; 3=minor; 4=somewhat limiting; 5=limiting; 6=beyond limiting; 7=first day of major; 8=repeated day of major; 9=first day of extreme; and 10=repeated day of extreme.



Ref. time: 1 Jan 2010; start time: 29 Dec 2010; end time: 23 Feb 2011 (N=160). Period: 24 h; interval: 168 h; increment: 12 h. Vertical dashed lines indicate full moon. Validated cycles in benefit are of 37.8 and 18.9 days.
*Note change in vertical scales between before and after Rx, in keeping with invariably positive benefit (right).
**Along inverted estimates.

Fig.1. © Halberg.

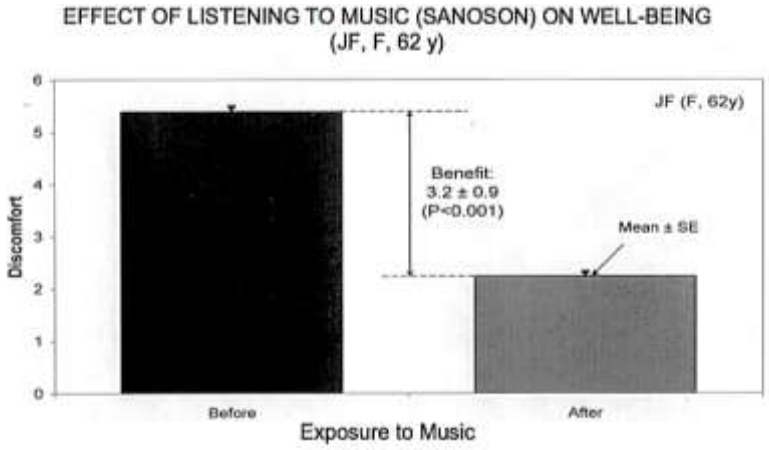


Fig. 2. © Halberg.

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CROSS-SPECTRAL COHERENCES OF POPULATION OR INDIVIDUAL HEALTH AND SPACE WEATHER

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We here report cross-spectral coherence of the incidence pattern of terrorism during 1968-2010, with Wolf's relative sunspot numbers, among others, at frequencies of one cycle in 28.5, 5.7, 3.27 and 2.46 days, Figure 1. Coherence was also found in similar spectral regions between myocardial infarctions (MI) in Moscow and the local geomagnetic index K near Moscow, and between MI and the Bz-GSE component of the interplanetary magnetic field (1), Figure 2. These results are in keeping further with coherence found between heart rate and blood pressure on the one hand and Wolf numbers and the planetary index Kp on the other hand, in data monitored at half-hour intervals over several years by a clinically healthy subject (2), Figure 3. Coherence as such is no proof of causal relations. Evidence supporting a non-spurious association is available from shared transyears (components with a period of about 1.3 years) found in the incidence of international terrorist acts during 39 years as well as in solar wind speed (SWS) and the antipodal index of geomagnetic disturbance (aa) that were particularly prominent in all three variables during solar activity cycle 22. The emergence of an about 1.3-year cycle in terrorism slightly lagged behind that in SWS or aa and persisted in terrorism after it damped in SWS and aa.

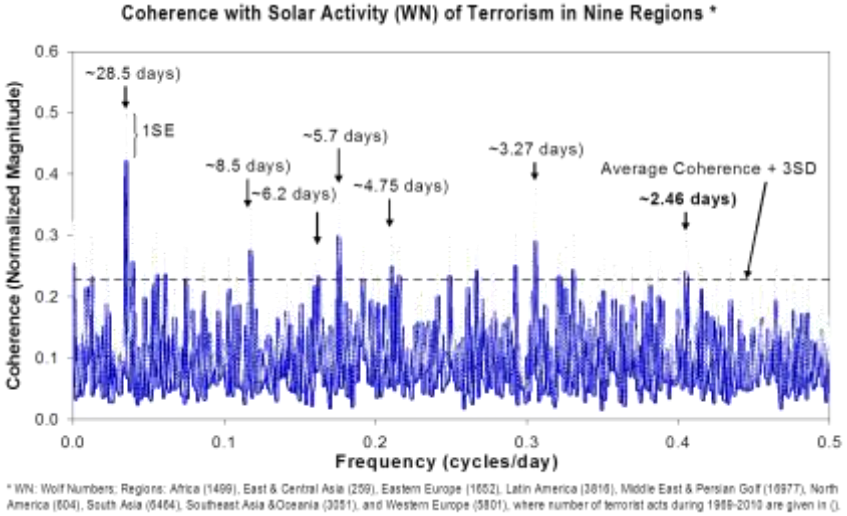

Fig. 1. © Halberg.

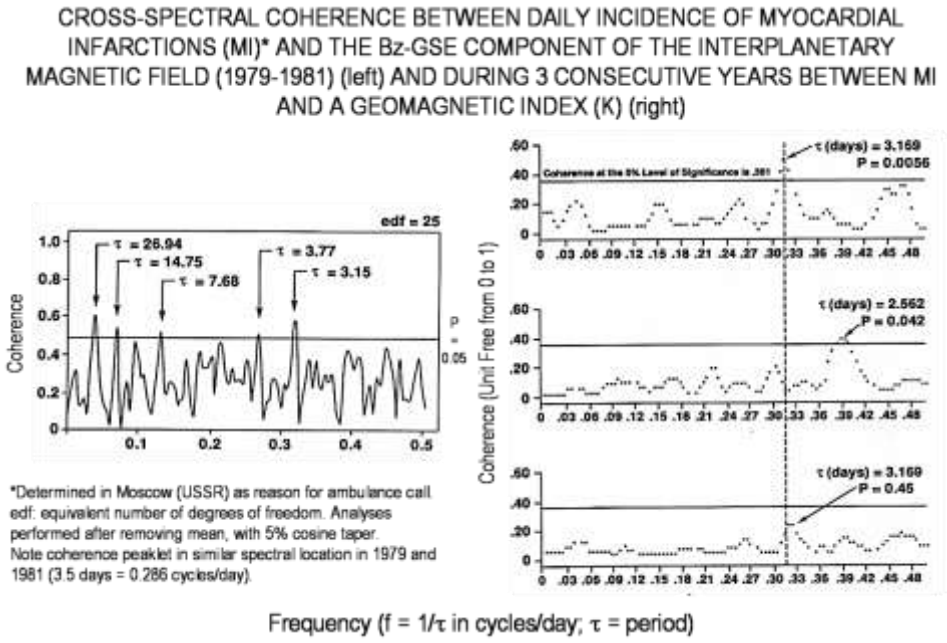

Fig. 2. © Halberg.

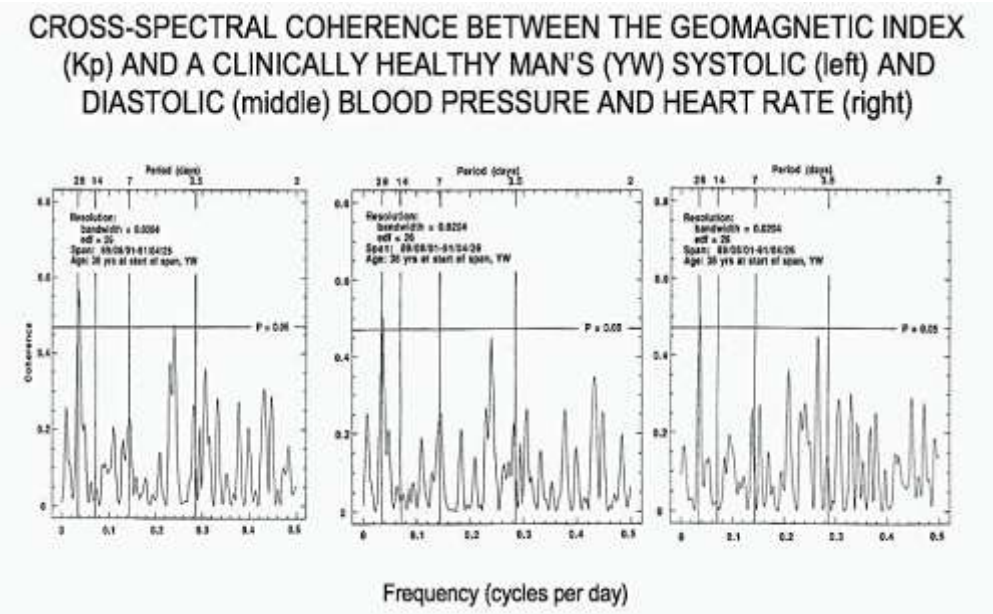

Fig. 3. © Halberg.

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META-ANALYTIC HISTORY OF CONGRUENT CYCLES IN SPACE WEATHER, THE HUMAN MIND AND OTHER AFFAIRS

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We need tools for understanding, predictions, alerts and the rational design of countermeasures of societal cataclysms, such as terrorism and war, and of natural disasters such as earthquakes, and may find these tools in data collected to avoid personal cataclysms such as massive strokes. In the same data, antecedents of the cataclysms, in the form of time structure alterations not found in various controls, may be sought. These could prompt the evasion of natural disasters and perhaps the avoidance of other man-made cataclysms. With historical data meta-analyzed herein, mapping the time structures of terrorist acts and of a host of environmental variables leads to putative triggers affecting the mind of populations, analyzable as cycles in individuals (9). Cycles in aggression and their periodic counterparts in our environment, far as well as near, currently (with notable exceptions; 1, 2) ignored in the West, have long been recognized in importance in Russia and its associated states (3-7). Yet in England, already in 1801, Sir William Herschel had raised concerns about the consequences in human and other earthly affairs, including crops, of an "ill-disposed" sun (8). Apart from the foregoing reasons, basic science needs to monitor not only the weather on earth and in extraterrestrial space, but also the consequences of space weather in populations and individuals. The mechanism involved can be studied at the cost of computer-aided self-surveillance for avoiding a stroke.

According to The Lancet, "public health systems were transformed on September 11, 2001, from an unappreciated utility to a central component of [we add "inter-"] national security" (10). Security requires more than training police officers and personnel at airport or border checkpoints, and ascertaining that a given white powder cannot spread anthrax. Forecasting or nowcasting weather in extraterrestrial space (e.g., 11, 12) for consequences on earth, preferably in the light of yet-to-be-extended investigations of environmental nonphotic (magnetic)-biospheric associations, may also be considered as a feature of international security in the light of accumulating evidence reviewed herein, within the scope of global concerns for populations coping with crime and broader aggression.

Public health systems (along with homeland and international security agencies) could routinely tackle much more than mere storage and descriptive reports of epidemiologic data. Automatized systematic monitoring with sequential testing of time structures of natality, morbidity and mortality statistics from various causes could complement monitoring of blood pressure and heart rate for personal self-surveillance. The pool of the same aligned physiological, epidemiological and physical environmental data could be examined for any role of space weather in human-made and natural cataclysms and may thus lead to countermeasures for societal health care. Education could achieve implementation of computer-aided self-surveillance of psychophysiological variables for strain assessment, vascular variability anomalies' detection and for the prevention of diseases such as stroke. As a dividend, by analyses of the same data, an indispensable international security system for alerting and preferably avoiding September-11-like events may be sought.

The importance of marked seasonal changes in environmental light and temperature notwithstanding, analyses of databases on terrorism reveal (in spectra) the absence thus far of a calendar-yearly component and the worldwide dominance of transyears (cycles with periods whose 95% confidence interval does not overlap the 1.00-year length, constituting a broad band around 1.3 years, drifting in the region ranging from 1.061 to 1.7 years. In 5 of 9 geographic locations at the precise calendar year length, there are actually spectral valleys rather than peaks, Table 1. In various biospheric data sets, nonstationary spectral peaks (periods, τ) correspond to those known to characterize changes in solar activity and/or geomagnetic disturbance. They can be validated by several glocal inferential statistical approaches (i.e., by combining the [glo**bal**] analysis of a time series as a whole with a [lo**cal**] analysis of consecutive sections of the series as a function of time). Based upon paired, since congruent, biospheric and environmental spectral components, one can

compare the behavior of cycles in and around us and test any effect in the biosphere of the subtraction (damping of the amplitude, A) and addition (amplification of A) in frequency bands of an environmental spectral component, if not by complete disappearance or replacement of an environmental spectral band (9; cf. 29).

Table 1.

Mostly transyear prevalence in spectra of terrorism incidence gauged by annual vs. para-annual amplitudes

Geographic region	N of incidents	Amplitude*		Amplitude ratio**
		$\tau_1 \equiv 1$ year	$1.75 < \tau_2 < 1.061$ years	
Local				
Middle East/Persian Gulf	16977	0.026 (0.996-1.023)	0.216 (1.39)	8.85
South Asia	6464	0.073 (1.006-1.122)	0.069 (1.47)	0.91¶
Western Europe	5801	0.007 (valley***)	0.045 (1.71)	6.43
Latin America	3816	0.016 (0.985-1.022)	0.047 (1.24)	2.94
Southeast Asia/Oceania	3051	0.021 (valley)	0.059 (1.72)	2.81
Eastern Europe	1652	0.005 (valley)	0.032 (1.18)	6.4
Africa	1499	0.009 (0.986-1.024)	0.021 (1.05)	2.33
North America	604	0.005 (valley)	0.011 (1.58)	2.2
East & Central Asia	259	0.002 (valley)	0.006 (1.68)	3.0
Global				
Whole world	40122	0.089 (0.973-1.007)	0.251 (1.70)	2.82

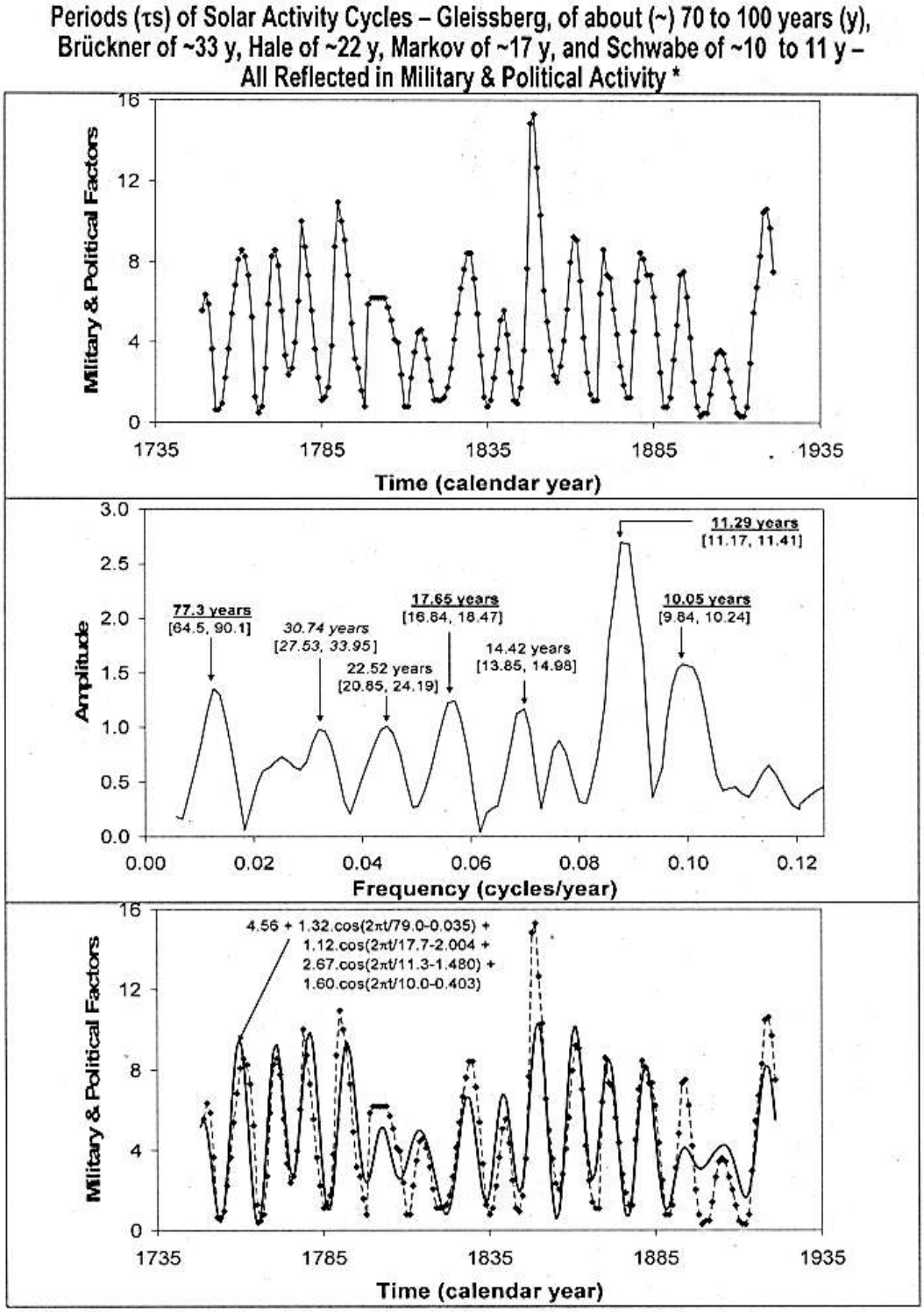
*Amplitudes (A, measures of extent of change) at periods, τ, of exactly 1 year (τ_1) and at a peak, τ_2, in a region of periods longer than 1.0 year and shorter than 1.75 years (transyears);

**Ratios of As of transyears vs. calendar years

***Valley: no confidence regions according to Marquardt for any As overlapping 1 year.

In this case the conservative 95% confidence interval of τ near exactly 1.00 year, does not cover that precise year length.

A transyear characterizing the incidence of international terrorism is prominent when this component is more strongly expressed in non-photic environmental variables. As an "addition approach", the appearance of a statistically significant transyear in solar wind speed (SWS) or in the antipodal geomagnetic index (aa) is followed, with a lag, by a statistically significant transyear (at the same 1.33-year τ). A subtraction approach in an individual's record of systolic blood pressure can be applied to data obtained as a dividend from serving primarily for personal self-surveillance aiming at the prevention of strokes and other personal adverse events. The same self-monitoring data, analyzed cost-effectively, immediately contribute useful marker variables for as-one-goes associations with forecasts and nowcasts of space and terrestrial weather, including magnetism, and for the recognition of potential threats to national and international security. Both an addition and a subtraction approach document an association of the prominence of an about (~) 7-day (circaseptan) component in heart rate with a similar component in solar activity by its amplification in the presence and damping, but not disappearance, in the absence of a solar circaseptan. Thus, the study of cycles represents a timely approach to the background of old knowledge.



* Original data stemming from the scholarship of Alexander Chichesky (top), analyzed by linear least squares spectrum (middle), complemented by nonlinear point and 95% confidence interval (in []) estimates of each component assessed separately. Concomitant fit yields 4-component model (underlined periods, middle) plotted with data (bottom).

Fig. 1. Data on military and political factors during 1749-1921 assembled by Alexander Leonidovich Chizhevsky (top) were analyzed by the nonlinearly extended cosinor. A least squares spectrum (middle) identifies peaks that happen to correspond, among others, to known solar activity cycles (and a candidate of 14.42 years). Periods are resolved with their tentative uncertainties as 95% confidence intervals listed inιο A model based on four of the components detected spectrally approximates the original data (bottom). © Halberg.

Background

The facts that there are sometimes spots on the sun and that a (magnetic) force acts on a needle may have been known to the ancient Chinese (13, 14), and sunspots were familiar to the ancient Romans. In Ferrara in 1651, Giovanni Battista Riccioli (13) surmised that a coincidence might exist between sunspots and changes in terrestrial weather. That aurorae cycle (15), as do sunspots, gained in interest once their circadecadal rhythms were recognized (16, 17) and thereafter ~33-year (18-22) and ~22-year (23) changes were recorded. Eduard Brğckner extrapolated that a paratridecadal cycle may be responsible for immigration into the USA from Europe and for the westward migration within the USA (24). Chizhevsky summarized, succinctly yet poetically, that life on earth is an echo of the sun (3; cf. 4) -- "Peut-ktre mkme nos sentiments et nos pensyes ne sont-ils qu'un faible ycho de ces vibrations du cosmos .... Involontairement, une antique idye nous vient a l'esprit: notre connaissance des phynomine s de la nature ne serait pas autre chose qu'un ycho, rezu par nos organes, des processus ryels de l'univers" ("Perhaps even our feelings and thoughts are just a weak echo of the vibrations of the cosmos .... Involuntarily an old idea comes to mind: Our knowledge of natural phenomena will not be different from an echo, received by our organs, of the real processes of the universe") (25). For his scholarly descriptive statistics, Chizhevsky was rightly offered a Nobel Prize, which Stalin forbade him to accept. Our meta-analyses of his data included in Figure 1 inferentially statistically validate his broad perspective and his reference to military and political affairs is further supported with data sets added by Suitbert Ertel (1), Raymond Wheeler (26), Miroslav Mikulecky (2) and Pavel Grigoryev et al. (6).

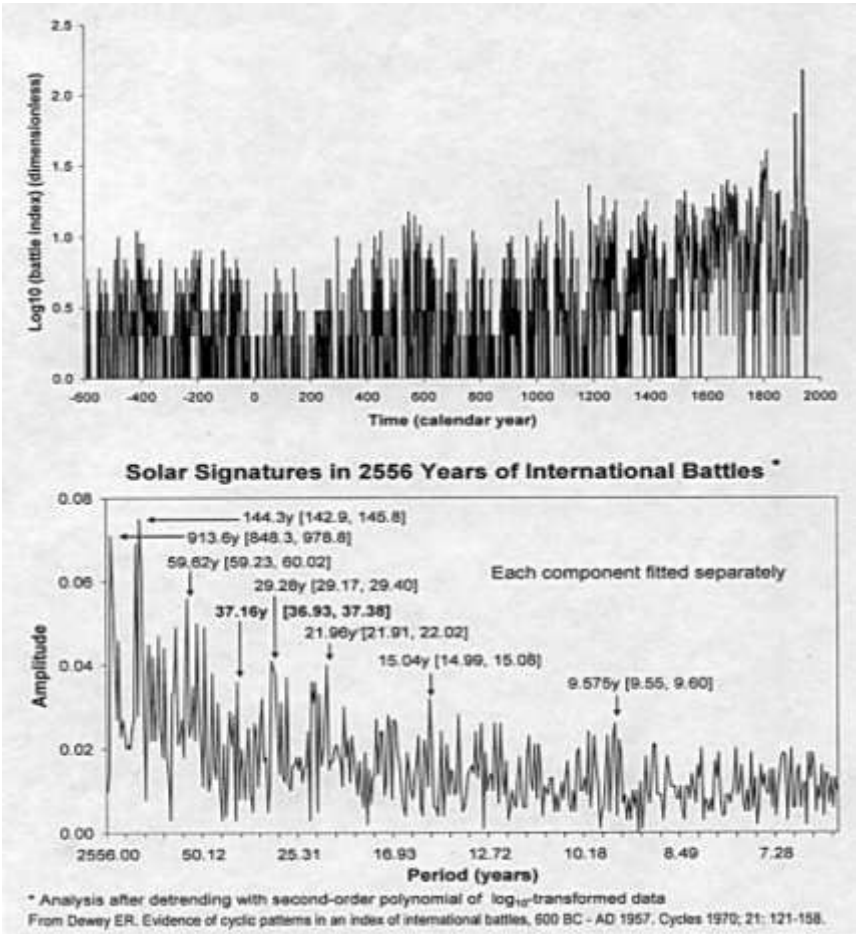


Fig. 2. Solar signatures in international battles from 599 BC to 1967 AD. Original data of Raymond Holder Wheeler (26) transformed into a spectrum looking for periods that the unaided eye cannot all find. © Halberg.

Chrono-meta-analyses

Chizhevsky's original data shown in Figure 1 (top row) reveal in our meta-analysis (second row) components all found in solar activity. A multiple-component model provides a good fit (bottom row). In 1982, Boris Vladimirskiy considered atmospheric infrasonics as a possible factor transmitting the effect of solar activity on the biosphere (5). Whatever the non-photic mechanism involved, we propose a complementary mandate for public health systems in general and strive in particular for the paradox of achieving a truly personalized computer-aided health care practice, with the use of the same data flowing (from individuals' cost-free self-surveillance) into a monitoring of a population's mass psychophysiology complementing the concomitant sequential analysis of natality, morbidity and mortality, in order to track solar activity with repeated passes over the accumulating database for the assessment of longer and longer periods, known to modulate psychophysiology and epidemiology (9). This tracking is also done by the meta-analysis of international battles, Figure 2.

Nelson et al., in their Global Consciousness Project, a large-scale network type system of the Princeton Engineering Anomalies Laboratory, noted correlations of continuous random data with major world events (27). This project reported reliable yet small changes in the output of up to 70 widely distributed random event generators (REG) in association with life-threatening situations experienced by groups of individuals. Wendt (28) analyzed nearly 250 events spanning solar cycle 23 (1998-2007) in the framework of polarity of the interplanetary magnetic field (IMF). He found associations between entropy changes of the REG output when it coincides with the groups' emotional arousal and a composite measure of the IMF polarity during the prior Bartels (about 27-day) synoptic solar rotation. Most substantial effects were reported for human violence such as bombings, assassinations and warlike acts ($r=0.648$, $P<0.001$). Results change little with different classifications of regions or types of violence.

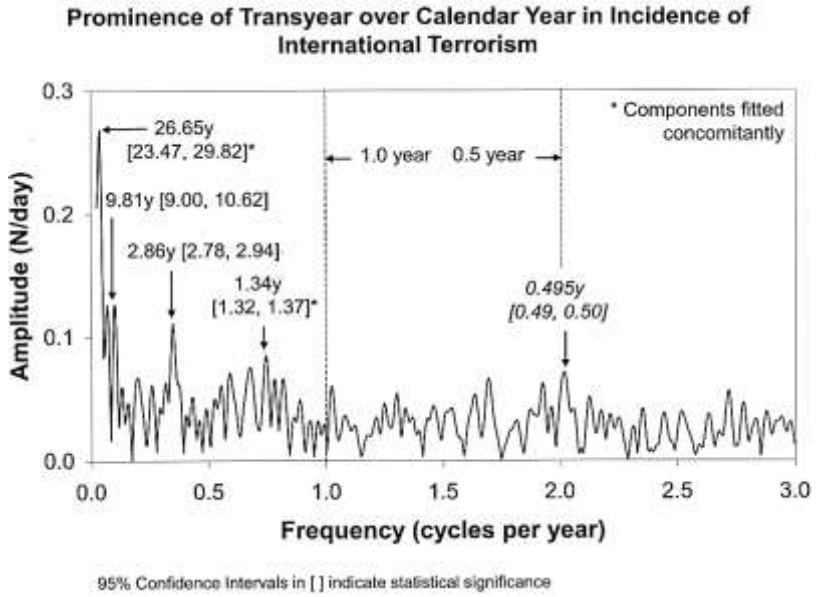
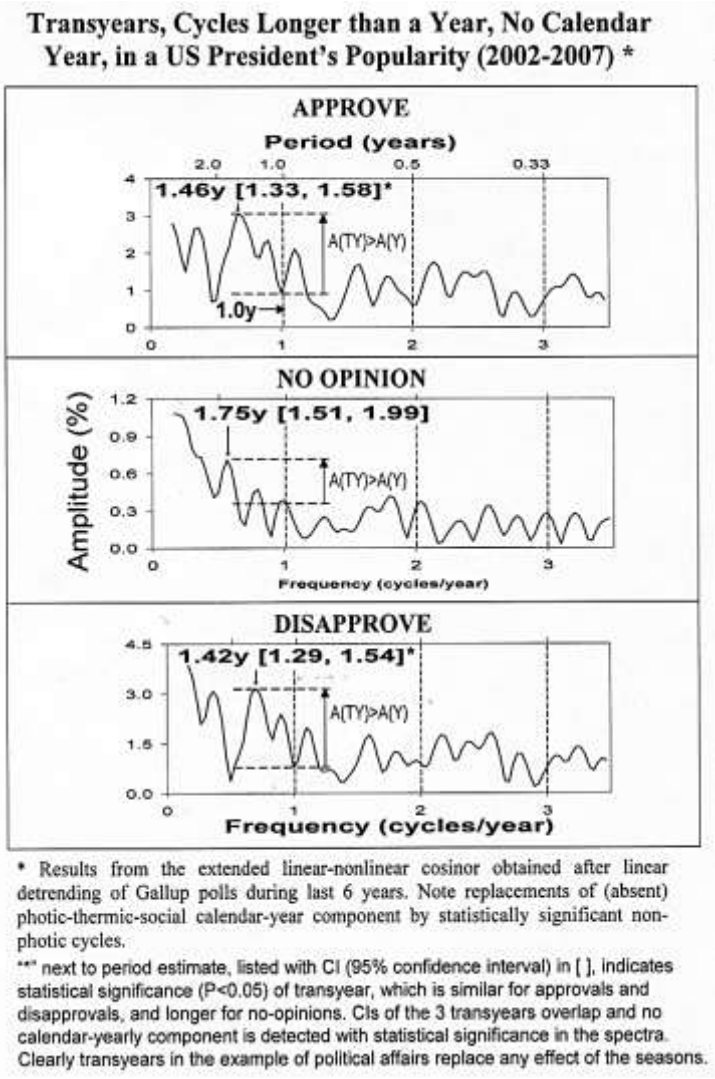


Fig. 3. Analyses by the extended cosinor of the incidence of terrorist acts (assessed monthly and expressed in number of cases per day) in a Memorial Institute for the Prevention of Terrorism (MIPT) database indicate cycles of nonphotic rather than photic solar origin. Whereas an anticipated yearly component is not detected in the least squares spectrum, a cycle with a period of about 1.3 years similar to changes characterizing solar wind speed and geomagnetic disturbances is validated statistically by nonlinear least squares, as shown by the 95% confidence intervals listed in [ ] for the period estimates obtained by nonlinear least squares. © Halberg.

In an attempt to examine the mostly unseen, non-photic effect of space weather while avoiding uncertain correlations among cyclic variables, the relative prominence of yearly vs. para-yearly spectral components is a major topic of this note. A transyear characterized the incidence of

violence and/or terrorism in the Princeton database (51 events during 1998-2007) (9). A yearly component was not detected, also using the Memorial Institute for the Prevention of Terrorism (MIPT) database, Figure 3, suggesting that non-photics may have a larger influence on terrorism than the yearly (seasonal) changes in light and temperature. Using data on suicide terroristic attacks in Israel, Iraq and Afghanistan (1062 cases, 1994-2008), Grigoryev et al. reported that geomagnetic activity significantly increased (P<0.0001) on the day of attack and that interplanetary magnetic field polarity "tends to change on the day before attack (P<0.03)" (6).



* Results from the extended linear-nonlinear cosinor obtained after linear detrending of Gallup polls during last 6 years. Note replacements of (absent) photic-thermic-social calendar-year component by statistically significant non-photic cycles.

"*" next to period estimate, listed with CI (95% confidence interval) in [ ], indicates statistical significance (P<0.05) of transyear, which is similar for approvals and disapprovals, and longer for no-opinions. CIs of the 3 transyears overlap and no calendar-yearly component is detected with statistical significance in the spectra. Clearly transyears in the example of political affairs replace any effect of the seasons.

Fig. 4. Entries in this graph are percent of samples, each of about 1,000 respondents, who approved, disapproved or offered no opinion, respectively, about the president's overall performance over his tenure to the date of a Gallup poll. An excursion around the overall trend at the beginning of the record may be related to the 9/11 terrorist attacks of 2001. The inclusion of these data might bias the detrending and results, hence the data actually used are limited to the following 6 years (polls between Feb. 2002 and Dec. 2007). Regression lines fitted to the latter or the complete series differ only slightly. Residuals from the linear trend fitted to the 6-year data were analyzed by the extended cosinor in linear-nonlinear rhythmometry. Periodograms reveal that approval and disapproval rates show neither a calendar-year nor a half-year component. Instead, both response classes exhibit a transyear, with a period of ~1.4 years. Earlier work suggested ~1.3 years as frequent markers of solar dynamics. Using 1.3 years as the initial value, the nonlinear analysis yields period estimates and 95% confidence intervals of respectively, 1.46 [1.33, 1.58] years and 1.42 [1.29, 1.54] years for the approval and disapproval ratings. No reliable trend could be detected in the No Opinion responses. The one-year spectral peak visible is not statistically significant. Apart from a long-term trend which cannot be assessed from the available records, the largest spectral peak corresponds to a period of 1.75 [1.51, 1.99] years. This 95% confidence interval slightly overlaps the period's uncertainty of the approval and disapproval responses. © Halberg.

Our analyses of the incidence of international terrorist acts during Feb 1968-Mar 2007 (downloaded from www.tkb.org/) identified several transyear spectral peaks (9). Of particular interest was the presence of an ~1.3-year component similar to that characterizing solar wind speed and the absence of a calendar yearly variation. As shown in Figure 3, the ~1.34-year component is but one of several peaks in this spectral region, whereas at precisely one cycle per year, spectral power reaches a trough as it did in political affairs, including the popularity in a Gallup Poll of a U.S. president (Figure 5). In order to examine the degree of generality of this finding, this database (now available up to 2010 from http://www.rand.org/nsrd/projects/terrorismincidents.html) was revisited with a complementary scrutiny of terrorism incidence in different geographic/ geomagnetic regions. Table 1 shows (with only one qualified since slight exception) that the transyear dominates over the calendar year, using the transyear-to-year amplitude ratio as a gauge, and finding a spectral valley at precisely 1-year in several regions. These results confirm that nonphotic solar influences may be stronger than the seasonal changes in light and temperature, in these cases, Figures 3-5, and some others thus far.

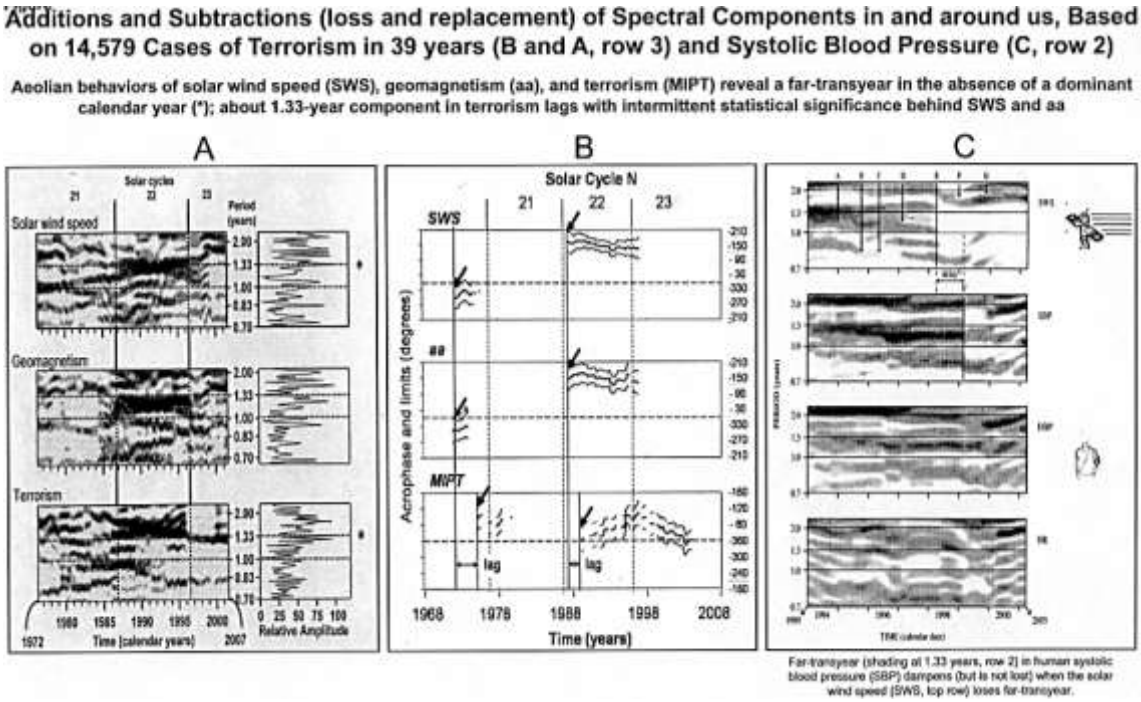


Fig. 5. In order to examine the extent of consistency of the ~1.3-year (transyear) component found to globally characterize the incidence of international terrorist acts (MIPT database), the data were analyzed locally by gliding spectral windows (A-left, bottom). This time structure is compared with that of solar wind speed (A-left, top) and of the antipodal index of geomagnetic disturbance aa (A-left, middle) in the same frequency range. The transyear is observed to be particularly prominent in all three variables during solar cycle 22, as seen from the darker shading at a frequency of about one cycle in 1.33 years. Changes with time of the phase of the transyear component, estimated at the average global period (B-middle) indicate further that statistical significance for terrorism relatively shortly follows (with only a lag) that in solar wind speed and geomagnetism and that it may persist after statistical significance is lost for the two environmental variables. Despite some expected wobbliness, the transyear appears to be relatively stable in all variables during most of solar cycle 22. A transyear is also detected in the blood pressure and heart rate of men and women of different ages (not shown). In particular, it is illustrated for a man monitored around-the-clock for 23 years, with interruptions (C-right, rows 2- 4). Compared with changes in prominence and frequency of this component in solar wind speed (C-right, row 1), the transyear in systolic blood pressure (C-right, row 2) is dampened but persists when this component fades in solar wind speed, suggesting that the transyear may be partly built-in while also amenable to resonance with environmental transyears (29). The fact that a predictable cycle characterizing the incidence of terrorism is also present in the physiology of individuals renders it amenable to monitoring and to further scrutiny for the eventual design of rational countermeasures. © Halberg.

Not only was there a congruence in frequency, there was also a concordance in time when the global spectral analyses are complemented glocally, by local analyses by gliding spectra and chronobiologic serial section, Figure 5 (left and middle). The transyear is detected with statistical significance in the incidence of terrorist acts when this component is particularly strongly expressed in solar wind speed and the antipodal index of planetary magnetic disturbance (during solar cycle 22).

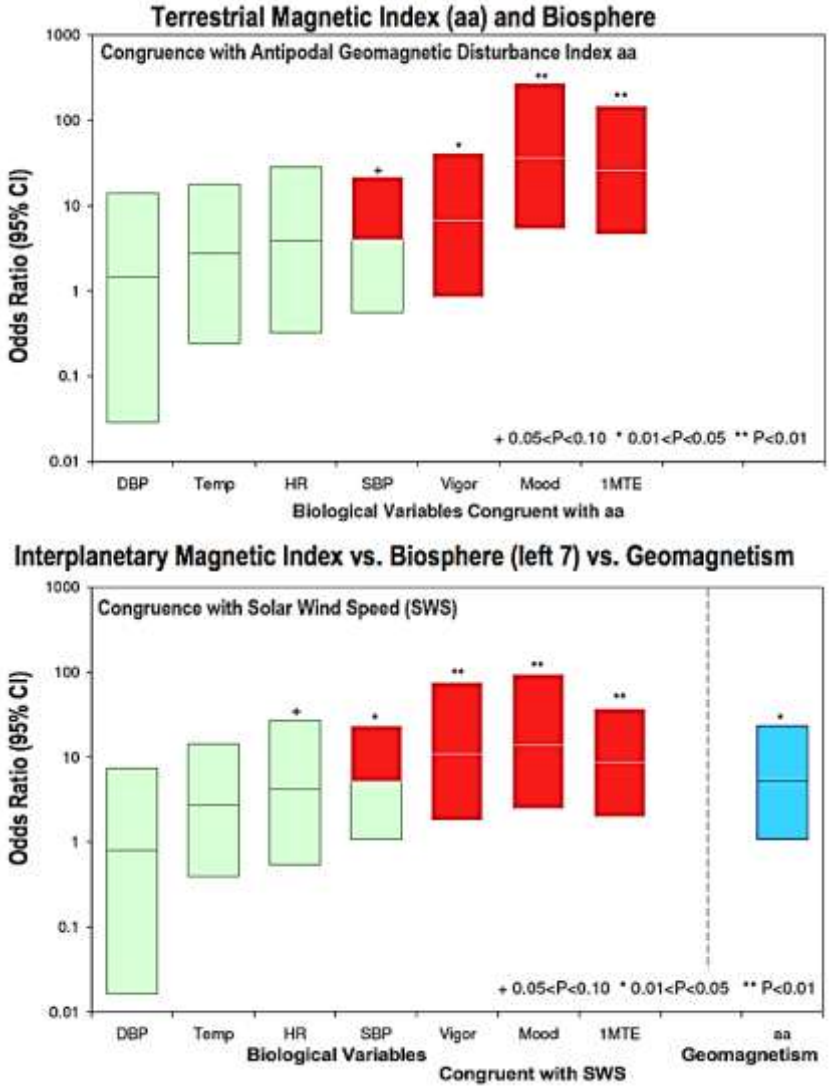


Fig. 6. Influence of the non-photic environment (gauged by solar wind speed, an approximation of interplanetary magnetism) and the antipodal index of geomagnetic disturbance aa) on human psychophysiology was assessed by means of the congruence of spectral components (in the frequency range of one cycle in 2.5 years to 3 cycles per year, defined by overlap of their 95% confidence intervals). The biological data stem from 40 years of self-measurements of oral temperature (Temp), systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) and of ratings of mood and vigor and the estimation of 1-minute by counting (1MTE), performed about 5 times a day by a clinically healthy man (30, 31). Congruences (assessed by means of odds ratios based on the noncentral hypergeometric distribution) found for 1MTE and for other variables more than equal that of the known association of helio- and geo-magnetism (bottom, last column on right of dashed vertical line). Mental functions show higher congruence than somatic functions. Among the latter, SBP is responsive, perhaps constituting a seemingly acceptable proxy for the mental functions. P-values are based on the non-central Fisher hypergeometric distribution, with 95% confidence intervals computed using Fisher's exact test, used since the null hypothesis was rejected in some, yet not all cases. © Halberg.

The human mind and space weather

The international meeting on Geochange in Istanbul, Turkey, September 19-21, 2011 (www.geo-change.org), organized by Acad. Elchin Khalilov of Baku, Azerbaijan (admin@geochange.org), has on its agenda the development of a consensus on the specifications for an international multilingual educative and researching website, automatically analyzing as a service the individual's data from vascular self-surveillance, eventually also processing epidemiological data and using the data flow from service and epidemiology for basic science research including the aim of eventually combating the ills of individuals and of the global population. It may be feasible to implement a system of personal and international security against natural and human-made cataclysms, so that the personal cataclysm of a stroke, a population cataclysm such as that of September 11, 2001, or the natural physical cataclysm of an earthquake may be prevented or evaded, as the case may be by multidisciplinary physical and biospheric monitoring. Results in Figure 6 for the first time allow an inferential statistical demonstration of cosmic effects upon the human mind, gauged by congruence (overlapping of the 95% confidence intervals of the biospheric periods paired with those in interplanetary or earth magnetism) in ratings of mood, of vigor and in 1-minute time estimation, and indirectly in systolic blood pressure.

In almost all cases, various time series used for Figure 6 were observed around the clock for ~40 years and summarized weekly, giving a total of 2080 (40 x 52) data points. All periods between 1/3 year and 2.5 years were considered by a global analysis. In terms of Fourier frequencies, the 1/3 year is 120 (3 x 40) cycles in the data and the 2.5-year period is 16 cycles in the data for a total of 105 Fourier frequencies (= 120 - 16 + 1). So, if we let N denote the number of frequencies under consideration, N = 105. (If, instead of 40, we considered 35 years, we would have N = 115 – 14 + 1 = 102, and results would not differ markedly from those obtained for N=105.)

Because we deal only with one biological and one cosmological time series at a time, our notation can be simple and avoid subscripts. We condition on the cosmological frequencies reported, and, in essence, assume that they constitute all and only those frequencies that matter in each of the cosmological data sets. That is, we ignore the fact that they resulted from data analysis and may have errors of omission (type II errors) and spuriousness (type I errors). We denote the number of frequencies at which a signal is detected for the environmental variable used as reference by U for universe, rather than C for cosmological (because C could also stand for congruent and/or common and may thus be confusing). For each biological sequence, we have three related random variables: 1) B = total number of frequencies corresponding to a statistically significant component; 2) C = number of biological frequencies with non-zero amplitude in common with the cosmological series; 3) A = number of biological frequencies that are NOT in common with the cosmological series. Relationship: B = A + C. The actual values assumed by these random variables will be denoted a^*, b^* and c^*. In this context, let us consider congruence as the proportion of biological frequencies found in the cosmological series, C/U (CU). The larger C/U, the stronger is the congruence. We assume that N and U are fixed and known. We assume that the frequencies in B are found by standard 2 degree of freedom F tests at $\alpha = 0.05$, and that all are equally likely.

The probability Pr(B=b) can be expressed as a hypergeometric Pr(C=c|B=b) times a binomial Bin(N,0.05).

Results of computations of P-values for associations of several biological variables with the antipodal geomagnetic disturbance index (aa) and for solar wind speed (SWS) as a measure of congruence are given in Figure 6.

Odds ratios more than match the generally accepted association of solar activity with magnetic disturbances on earth (30, 31). Clinical and life science investigators and practitioners who perform repeated determinations on different days could readily enter their past and future date- and time-stamped data into a comprehensive database that would become amenable to further studies of the ever-present role of chance in computing congruences in addition to comparing, among others, results on stormy vs. quiet days as a means for monitoring health effects of space weather. Associations of magnetic storms have already been documented with the pineal (39) and hypothalamus *in situ* (32), on cell division (33) and on the heart (34, 40) and circulation (35).

Summary and outlook

For the first time (35, 36), we have been able to present the long-sought inferential statistical evidence showing that the human mind is influenced by space weather in following the descriptive steps of Egeson, Brǧckner, Lockyer, and most competently by Chizhevsky. Meta-analyses have also been presented to associate space weather with human military-political and economic affairs. This meta-analysis of some of the literature validates, again in inferential statistical terms, the vision of pioneers and establishes, with its uncertainties, a spectrum of periods in the biosphere that mirror solar activity. For the first time, we also present odds ratios for the long-known relation of interplanetary and terrestrial magnetism and use these as a reference standard for the association of human mental functions on the one hand and either interplanetary or earth's magnetism on the other hand. A long history of claims is thus validated, at least in one case below the 5% level by using the criterion of congruent periods assessed as overlapping 95% confidence intervals of the periods compared.

In asking whether this association with the human mind is good, bad or indifferent, we can turn to religious proselytism and find, with qualifications of latitude-dependence, that the number of hours spent in the service of the church by the proselytizers reveals a didecadal sunspot or polarity Hale cycle (37). We also see the reflection of the decadal Horrebow-Schwabe sunspot cycle in human crime (38) and can recall in that same connection Raymond Holder Wheeler's data on 2,556 international battles, another echo of periods in the cosmos.

That these population phenomena relate to human well-being, that is to health was already documented by Chizhevsky for incidence of cholera; it can now be studied in individuals whose circulation also reflects the partly novel and transdisciplinary spectrum with non-photic components. The remove-and-replace approach applied thus far to transyears and about-weekly components must be extended as opportunities arise. Laboratory studies done opportunistically when a magnetic storm happens to precede the day of the study show that the pineal and the hypothalamus' melatonin *in situ* responds to a storm, a finding which has also been shown to characterize human salivary melatonin. The ECG is another human gauge documented to respond to magnetic storms, as is mitosis, at the cellular level a responder to magnetic storms (33). The latter are natural cataclysms, like earthquakes, volcanic eruptions, floods, hurricanes and tornadoes, that have caused hundreds of thousands of deaths and cost billions of dollars. They affect not only extra-high-voltage transformers (41), but also the human mind, more broadly health, and other affairs. Maintaining health to prevent strokes (if massive, personal disasters) is a self-sufficient aim. Studying the biospheric associations of other cataclysms in the same data may provide information concerning other human-made disasters such as wars and terrorism, and may tell us about biospheric antecedents of natural geochange and its cataclysms. The physicists' concerns (42, 43) may gain transdisciplinary support from computer-aided self-surveillance of blood pressure (9).

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DECADAL AND MULTIDECADAL PERIODS IN HUMAN BLOOD PRESSURE AND PULSE

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Blood pressure (BP) and heart rate (HR) are greatly variable in health or disease, changing from moment to moment, with an about 24-hour rhythm, from day to day, week to week and even along scales of decades. Ultradian periods (τ <20 hours [h]), a circadian τ (20-28 h) or, in a case with recurring (adynamic) depression, several τs in the circadian range and a set of partly novel infradian (τs >28 h), all were resolved with chronobiologically-interpreted around-the-clock half-hourly monitoring (C-ABPM). A casual measurement and a 24-hour profile are best replaced by the start of a minimal 7-day record or preferably by continuous, e.g., half-hourly lifetime monitoring, C-ABPM. As yet tentative reference values for the circadian rhythm in BP and HR allow the screening for Circadian Vascular Variability Anomalies (C-VVAs) (1), checking on whether circadian parameters (MESOR, circadian τ, amplitude, A, and acrophase, ϕ) lie within acceptable (90% prediction) limits of healthy peers matched by gender and age and, when possible, by ethnicity. MESOR-hypertension is a VVA, defined as an elevation of the BP-MESOR (a Midline-Estimating Statistic Of Rhythm, M, usually more accurate and more precise than the arithmetic mean), derived from fitting a model consisting of cosine curves with τs of 24 and 12 h to data collected as a non-negotiable minimum around the clock for 7 days at half-hourly or shorter intervals (1). Ecfrequentia, another VVA, is a condition when τ deviates from 24 h, with a CI (95% confidence interval) not covering 24.00 h. Infradian variations likely contribute to all circadian rhythm characteristics, exhibiting a selective assortment with physical environmental cycles (2). Analyses by the extended cosinor (3-5) were carried out on original unedited systolic (S) and diastolic (D) BP and HR data, and on the MESOR (M) and double 24-hour amplitude (2A) computed from consecutive 21-day intervals of an about 23-year (y) C-ABPM record from YW, a male physician 34 y of age at start of half-hourly monitoring. Analyses of the original data (OrD) and of their M are anticipated to be the same for long τs with some of the variability removed and hence are checks of the analytic method used. Their results are in agreement insofar as the τs have overlapping CIs (95% confidence intervals), Figures 1-3. SBP τs (and CIs) of M are (in y) 10.25 [8.38, 12.11]. SBP-2A τs are 19.4 [14.0, 24.8] and 7.61 [7.14, 8.08] y. DBP τs (and CIs) of OrD, and M are (in y) 33.1 [31.5, 34.6] and 10.5 [10.0, 11.0], and 34.8 [25.1, 44.5] and 10.6 [8.2, 13.0], respectively. DBP-2A τs are 23.3 [8.4, 38.3], 8.6 [6.9, 10.2) and 6.4 [4.6, 8.2] y. HR τs (and CIs) of

OrD, and M are (in y) 32.7 [27.1, 38.2] and 11.3 [10.6, 12.0], and 29.4 [26.2, 49.1] and 11.8 [7.3, 16.4]. HR-2A τs are 27.0 [20.8, 33.0] and 7.04 [6.22, 7.86] y. Selective assortment is found for the SBP τ M being decadal (corresponding to a Horrebow-Schwabe cycle in sunspots) while 2A has a longer τ (corresponding to Hale's sunspot bipolarity cycle and to its third harmonic). Results for DBP and HR are qualified by the fact that the estimated anticipated para-tridecadal τs are longer than the time series analyzed and hence await the results of analyses on continued monitoring.

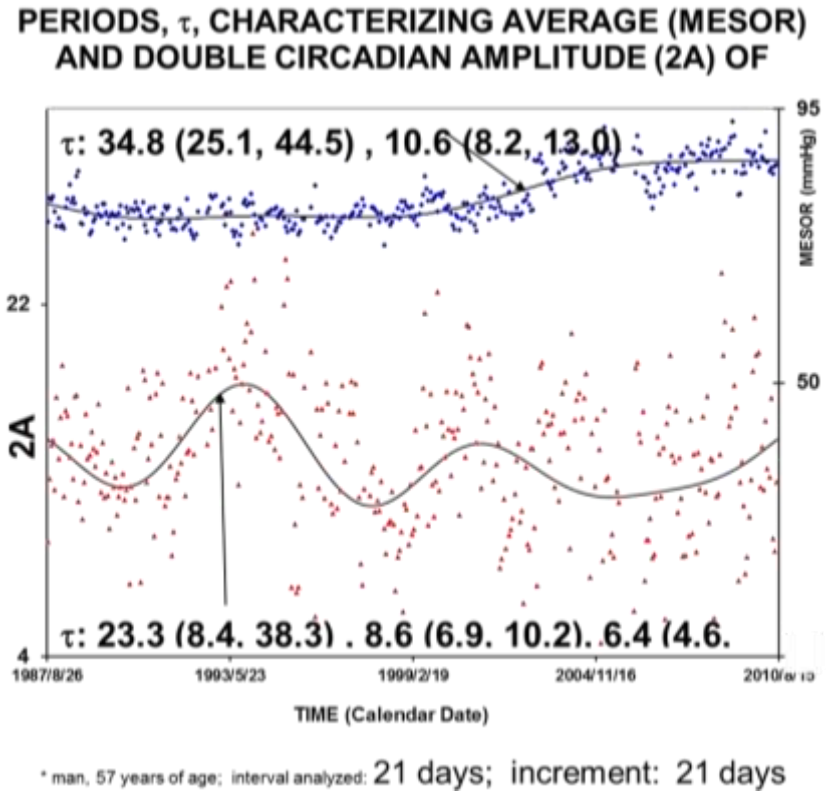
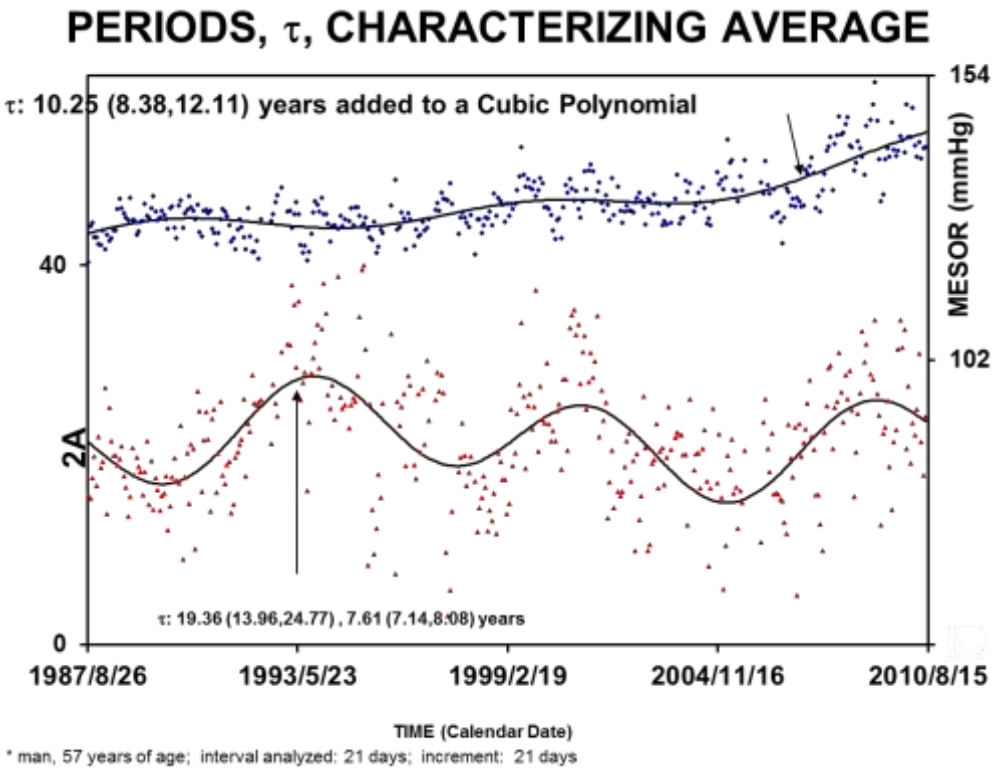


Fig. 1. © Halberg.



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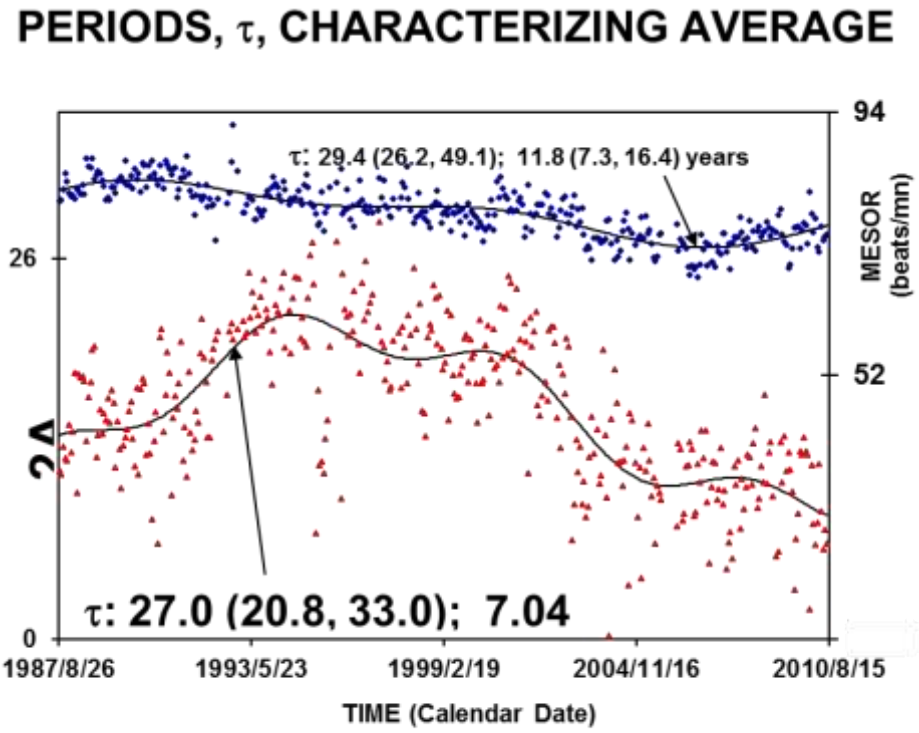

Fig. 3. © Halberg.

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TRANSITION FROM SUNDAY-ONLY MESOR-NORMOTENSION (PRE-HYPERTENSION) TO SUNDAY-INCLUSIVE MESOR-HYPERTENSION IN THE LIGHT OF INFRADIAN PERIODS IN 23 YEARS OF HALF-HOURLY MEASUREMENTS OF BLOOD PRESSURE AND PULSE

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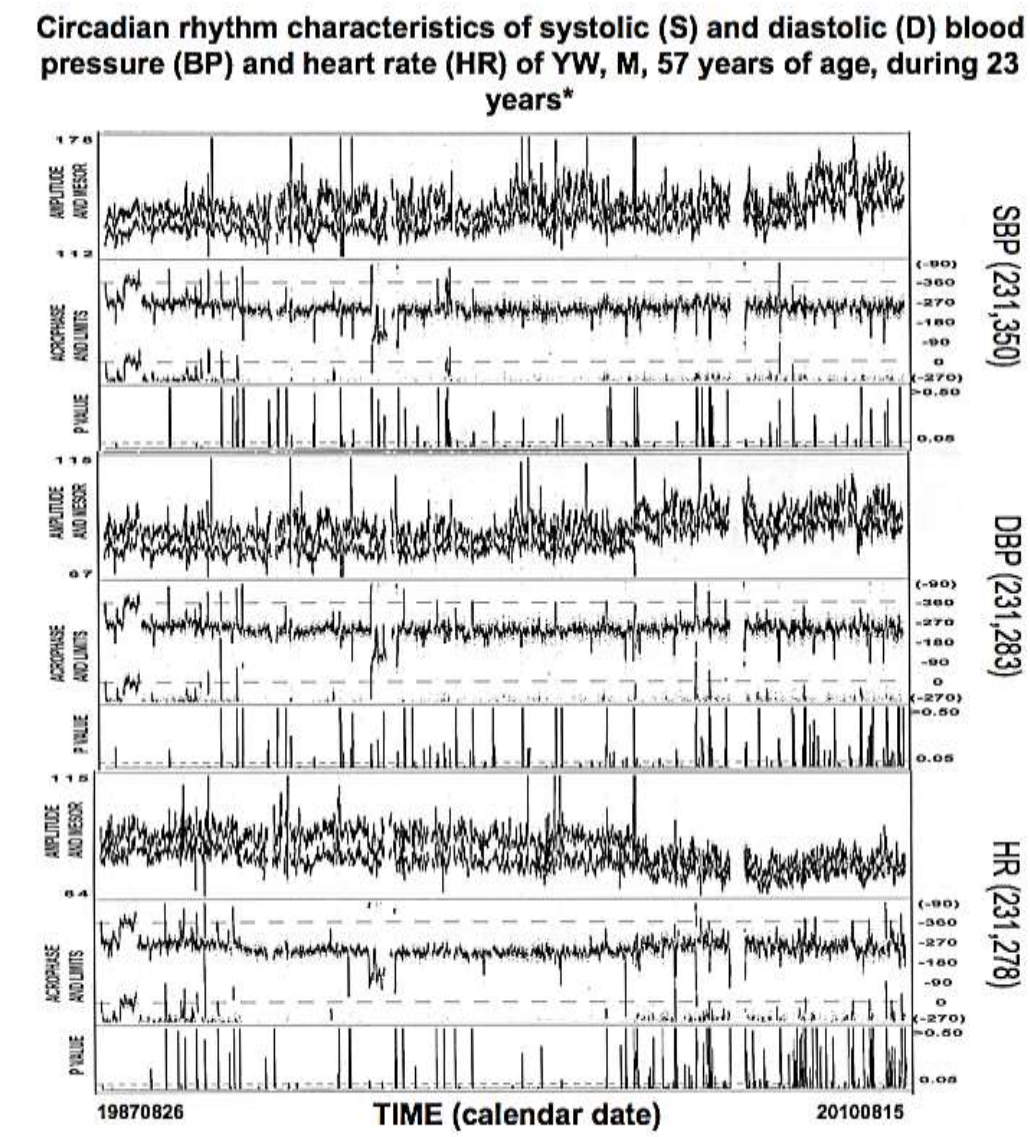
Aim. We wish to describe the longitudinal around-the-clock development of human MESOR-hypertension, eventually in the context of infradian variability (1). YW, a clinically active physician, has monitored his blood pressure (BP) for the past 23 years (since 1987) and has summarized his half-hourly data obtained around the clock for the past several years (2, 3) with a monitor manufactured by A&D (Tokyo, Japan) and earlier with one from Colin (Komaki, Japan), Figure 1 and Tables 1 and 2.

In January 2009, in the light of chronobiologic reference standards qualified by gender and age (in need of further improvement), YW had systolic (S) MESOR-hypertension (MH) during weekdays but was MESOR-normotensive during a vacation. His BP was lower on Sundays than on weekdays, in summaries of analyses completed in August 2010 on the data of the preceding months (Figures 2 and 3) and again from August 2010 to January 2011. In 2011, there is a statistically significant change by sign test: 7 out of 7 SBP MESORs have increased ($P<0.05$), Table 2. Different physical environmental cycles are detected in the case of YW's SBP, which shows a putative signature of an about 10-year Horrebow-Schwabe cycle in the MESOR, along with a trend and an about 19-year cycle with a non-overlapping CI (95% confidence interval) for the amplitude. Longer periods characterize the MESOR and the amplitude of diastolic (D) BP and heart rate (HR). They are all compatible with a para-tridecadal period since the CIs of the period all overlap 3 decades. Such modulations constitute a background for a scrutiny of the pertinence and consistency of the finding herein, in a limited time span of a transition from a "workday-MESOR-hypertension-Sunday-MESOR-normotension" to a "Sunday-inclusive-MESOR-hypertension".



*Period fitted, hours (h): 24 h; interval: 168 h; increment: 48 h. N of measurements in ( ).

Fig. 1. © Halberg.

More longitudinally monitored subjects, each with similar surveillance, are needed to explore whether this transition is also the case in other occupational strain-related high BP development (of MESOR-hypertension) generally (4) or only in special cases like YW and another lady, MA, a busy executive who during 1 month of monitoring also had a monthly MESOR-hypertension and Sunday MESOR-normotension. Continuous monitoring on populations could find out whether this transitional stage is found generally. It could clarify the role of work-imposed loads and recognition of the kinds of loads-inducing circadian vascular variability anomalies (C-VVAs) and may lead to preventive measures so that VVAs do not become disorders, VVDs (5). Only future continued monitoring can document whether transitions from a time-dependent weekday true white-coat hypertension (when it concerns a physician donning a white coat at work) to MESOR-hypertension on all days of the week can recur in both directions. MH constitutes an assessable gauge of strain in a physician or in an executive, the recognition of which in the stage of reversibility might be desirable to prevent the onset of true systolic Sunday-inclusive (and possible vacation-inclusive) MESOR-hypertension lasting through all of the stages of infradian, e.g., decadal rhythms that may differ in the circadian and infradian endpoints of BP, e.g., in the amplitude and in the MESOR (1).

SPHYGMOCHRON-TM

Monitoring Profile over Time; Computer Comparison with Peer Group Limits

Blood Pressure (BP) and Related Cardiovascular Summary.

Name:----------
Patient #: YW
Age: 57
Sex: M
Monitoring From: 1/16/2010 15:27
To: 8/15/2010 6:00
Comments:

CHRONOBIOLOGIC CHARACTERISTICS

	SYSTOLIC BP (mmHg)		DIASTOLIC BP (mmHg)		HEART RATE (bpm)	
	Patient Value	Peer Group Reference Limits	Patient Value	Peer Group Reference Limits	Patient Value	Peer Group Reference Limits
ADJUSTED 24-h MEAN (MESOR)	**142.4**	98.4-135.1 Range	86.5	60.3-87.2 Range	75.1	56.4-91.2 Range
PREDICTABLE CHANGE (DOUBLE AMPLITUDE)	22.95	6.4-39.40 Range	12.77	4.84-29.80 Range	7.32	5.26-36.20 Range
TIMING OF OVERALL HIGH VALUES (ACROPHASE) (hr:min)	16:01	11:48-17:40 Range	15:36	11:08-16:48 Range	16:48	11:44-17:20 Range

	STD (MIN; MAX)*	STD (MIN; MAX)*	STD (MIN; MAX)*
PERCENT TIME OF ELEVATION	68.1%	0.0%	0.0%
TIMING OF EXCESS	23:25 (hr:min)	0:00 (hr:min)	0:00 (hr:min)
EXTENT OF EXCESS DURING 24 HOURS HBI*	**65** (mmHg x hour)	0 (mmHg x hour)	0 (mmHg x hour)
10-YEAR CUMULATIVE EXCESS	236 (mmHg x hour)(in 1,000's units)	0 (mmHg x hour)(in 1,000's units)	0 (mmHg x hour)(in 1,000's units)

Individualized bounded indices: (STD = Standard)(Min = Minimum)(Max = Maximum)(HBI = Hyperbanic Index)

INTERVENTION NEEDED

No
Yes Drug Non-Drug

MORE MONITORING NEEDED

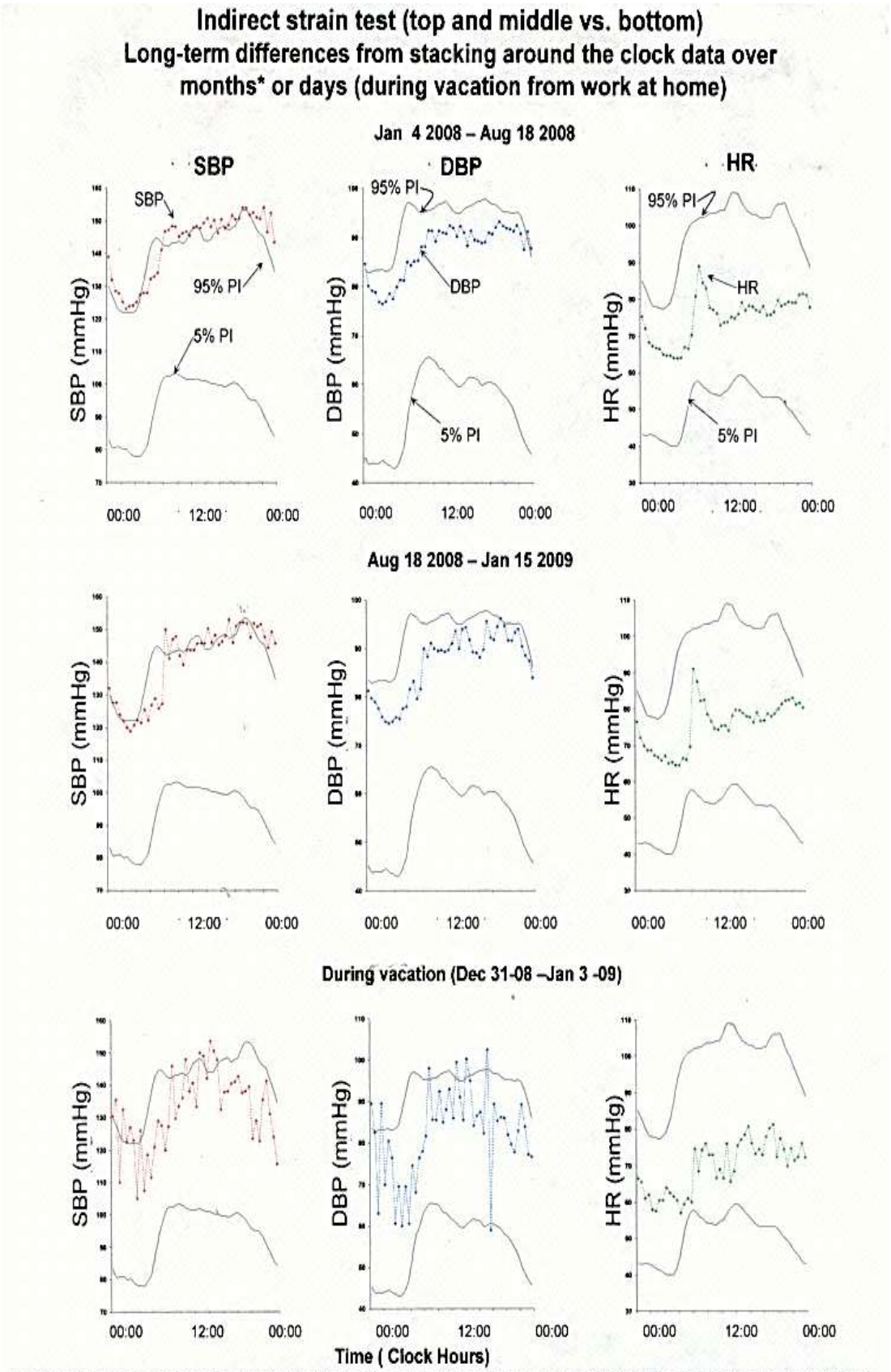
Annually
As soon as possible
Other specify_____

Systolic MESOR-Hypertension

Prepared By_____Germaine Cornelissen_____ Date_17_/_Aug_/_2010___

1) Unusually long standing or lying down during waking: unusual activity, such as exercise, emotional loads, or schedule changes, e.g. shiftwork; etc.; 2) Salt, calories, kind and amount, other, etc.

Fig. 2. © Halberg



*revealed better by spygmochrons than by eyeballing in circadian profiles of systolic (S) and diastolic (D) blood pressure (BP) and heart rate (HR) of physician-scientist, YW, 55 years of age in January 2008, during ~7.5 months (top), ~5 months (middle) and 4 days (bottom) of around-the-clock half-hourly monitoring. Dots: original values; PIs: prediction limits according to Nelson W, Comélissen G, Hinkley D, Bingham C, Halberg F. Construction of rhythm-specified reference intervals and regions, with emphasis on "hybrid" data, illustrated for plasma cortisol. Chronobiologia 1983; 10: 179-193.

Fig. 3. © Halberg

Table 1

Comparison of rhythm parameters among 3 spans*

		Systolic Blood Pressure (mm Hg)			
Span		MESOR	24h-A	24h-ϕ	(A,ϕ)
1. Jan-Aug 2008		142.6	11.76	-246	
2. Aug 08-Jan 09		140.1	13.56	-251	
3. Holiday (2008-09)		132.1	12.54	-226	
1 vs. 2 vs. 3					
	F	**32.174**	0.440	**4.598**	**2.501**
	P	**<0.001**	0.645	**0.012**	**0.045**
1 vs. 2					
	F	**4.247**	1.029	0.392	0.708
	P	**0.042**	0.313	0.533	0.495
2 vs. 3					
	F	**29.504**	0.246	**7.073**	**3.886**
	P	**<0.001**	0.621	**0.009**	**0.024**
		Diastolic Blood Pressure (mm Hg)			
Span		MESOR	24h-A	24h-ϕ	(A,ϕ)
1. Jan-Aug 2008		87.3	5.94	-236	
2. Aug 08-Jan 09		86.9	8.11	-242	
3. Holiday (2008-09)		81.9	9.08	-226	
1 vs. 2 vs. 3					
	F	**13.248**	1.896	1.129	1.457
	P	**<0.001**	0.154	0.327	0.219
1 vs. 2					
	F	0.324	**5.029**	0.618	2.827
	P	0.571	**0.027**	0.434	0.065
2 vs. 3					
	F	**13.581**	0.254	1.740	0.949
	P	**0.001**	0.616	0.192	0.391
		Heart Rate (beats/min)			
Span		MESOR	24h-A	24h-ϕ	(A,ϕ)
1. Jan-Aug 2008		74.9	4.92	-246	
2. Aug 08-Jan 09		75.8	5.28	-253	
3. Holiday (2008-09)		69.6	7.95	-253	
1 vs. 2 vs. 3					
	F	**21.029**	2.543	0.146	1.355
	P	**<0.001**	0.082	0.865	0.253
1 vs. 2					
	F	0.785	0.053	0.187	0.120
	P	0.378	0.819	0.667	0.887
2 vs. 3					
	F	**37.279**	3.392	0.001	1.697
	P	**<0.001**	0.069	0.975	0.189

*A: Amplitude; ϕ: Acrophase, expressed in (negative) degrees, with 360˚ ≡ 24 hours, 0˚ = 00:00. Results from parameter tests (Bingham C, Arbogast B, Cornelissen Guillaume G, Lee JK, Halberg F. Inferential statistical methods for estimating and comparing cosinor parameters. Chronobiologia 1982; 9: 397-439). For this time-microscopic assessment, the data during the 4 days of vacation in span 3 were removed from span 2 prior to analysis. Any discrepancy between estimates of M, A and ϕ in this table versus in Figure 1 may stem from the fact that original data are analyzed by means of a 2-component model in Figure 1, whereas for this analysis a single 24-hour cosine curve was fitted to the 48 half-hourly mean values obtained by stacking in each span separately.

Table 2

Transition from "true white-coat hypertension" in YW to systolic MESOR-hypertension

In YW, a physician-scientist, a comparison of vascular endpoints on Sundays with weekdays reveals acceptability of blood pressure (BP) on Sundays by contrast to weekdays in 2009 but not in 2011

	SBP-M	DBP-M	PP	HR-M	SBP-2A	DBP-2A	HR-2A	HR-SD	S-HBI	D-HBI	TCI
Jan 2009											
1. Sun	132.9	**83.0**	49.9	72.2	20.03	9.10	10.30	11.24	5	1	0
2. Mon	138.8	**86.9**	51.9	74.2	28.15	19.86	11.25	12.27	53	11	0
3. Tue	140.9	**88.2**	52.7	76.2	29.58	18.05	14.23	12.95	70	12	0
4. Wed	138.6	**86.2**	52.4	75.0	28.33	18.33	10.46	12.20	51	9	0
5. Thu	141.4	**88.3**	53.1	75.2	22.85	10.78	8.07	12.34	80	6	0
6. Fri	143.0	**88.4**	54.6	77.0	27.52	17.70	8.84	12.99	80	5	0
7. Sat	141.0	**85.6**	55.4	78.5	30.86	19.30	16.17	14.30	57	5	0
Jan 2011											
1. Sun	143.2	87.5	55.8	72.6	17.35	9.67	10.06	11.99	109	9	0
2. Mon	143.4	89.7	53.7	73.0	22.22	17.90	7.33	12.39	104	22	0
3. Tue	143.6	90.6	53.0	77.0	18.17	12.59	9.63	15.00	129	31	1
4. Wed	142.4	87.3	55.1	75.4	17.78	12.28	6.78	13.10	98	8	0
5. Thu	146.0	88.8	57.2	75.7	32.01	19.54	**3.80**	13.49	174	31	1
6. Fri	144.4	88.0	56.4	76.5	18.81	9.46	6.11	13.31	119	7	0
7. Sat	147.1	87.3	59.8	75.8	24.67	11.11	9.97	14.67	195	12	2

*S: systolic; D: diastolic; M: MESOR, a midline-estimating statistic of rhythm; 2A: double circadian amplitude; HR: heart rate; HBI: hyperbaric index; TCI: tachycardic index. In 2010, a lower value on Sundays for BP was also found for 30 series from 25 individuals, when the data of each subject were expressed as a percentage of their mean values, examined as a group by a one-way analysis of variance. The degree of generality of the transition from weekday- to all week-MH will have to be checked on others.

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EFFECT OF "SUPERMOON" ON EARTH SEISMOTECTONICS

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Introduction

It is well-known that supermoon – the maximum approximation of the Moon to the Earth. It usually presents an unpredictable tragedy for humanity. It is enough to remind that the number of dead or missing in Indonesia disaster was more than 230 thousand, while in Japan for more than 25 thousand people. It is assumed that the tragic earthquakes that occurred in Indonesia (2004 and 2005) and in Japan (2011) were caused by the subduction of the huge tectonic plates, but the direct cause of it became a lunar-solar tides, resulting from the closest approach Moon to the Earth, i.e. supermoon.

Discussion

The question of seismicity due to the tidal effects of the Earth, Sun and Moon studied in the middle of the XIX century by French scientist A. Perrey, he established frequency of earthquakes with lunar phases, the distance of the Moon from the Earth and its culmination. Earthquakes data due to periodic changes in tidal forces was given by N.N. Volodicheva, A.N. Podorolskim, R.B. Hoffman, A. Ryall, Charles T. Heaton, A. Polumbo, R.E. Uems. At the same time in other studies (L. Knoroff, J.F. Simpson, S. Shien, P.A. Reydelek, C. Tsuruoka, J. Vidal), this is denied. The most comprehensive survey of views about impact of lunar-solar tides on the geodynamic and, above all, seismic processes is given in V.A. Nikolaev and M.M. Dovbnicha [1ç4]. Judgments about the relationship of lunar-solar tides with geodynamic phenomena are ambiguous and are controversial for a number of issues. For more information about the geodynamic connection of phenomena in the lunar-solar tides can be obtained on the basis of joint analysis of the spatial and temporal characteristics of seismic events, occurrence and the simulation results of the stress-strain state of Tectonosphere caused by tidal influence of the moon and sun (E. Khalilov, 1998ç2011; B. Aslanov, 2004).

Laboratory gravity data of the State Astronomical Institute of Sternberg (SAI) suggests that the earthquake in Japan triggered an unusually strong convergence of the upcoming Earth and Moon. The observation of major earthquakes gave opportunity to identify some factor named "the influence of the tide". Assumed that some sort of "trigger" the disaster might have lunar tides in the ocean, which were observed in Chile, Sumatra and Haiti. However, research ways not explained. Number of researchers have different solutions of the problem [5, 6].

Intense earthquake with a focus located deeper than the crust indicated tectonic activity of Earth. A sign of tectonic activity of the moon can be any temporary effects on the moon, which is composed by catalog of B. Middlherstom [7], including the 630 earthquake and 370 temporary phenomena on the Moon for the period from 1904 to 1967. The existence of two types of relationship between tectonic phenomena on the Earth and the Moon was established:

1) trigger tidal influences through gravitational interaction of the Moon and Earth;

2) the relationship of tectonic processes of the Earth and Moon.

Concerning the mechanism of the tides it can be highlighted that "...the tides are happen due to the gravitational force that the moon affects on the Earth (Fig. 1). The gravitational force of the sun also affects the tides, but lesser. The tidal force as the derivative of the gravitational force is inversely proportional to the third power of the distance from the central body $1/R^3$. Therefore, the moon, which is much closer to Earth, despite it has smaller mass, creating a tidal force of almost 2 times larger than the Sun. The nearest point to the moon the earth (perigee) is attracted to it by 6 per cent stronger than the most distant point on the orbit of the Moon (Apogee).

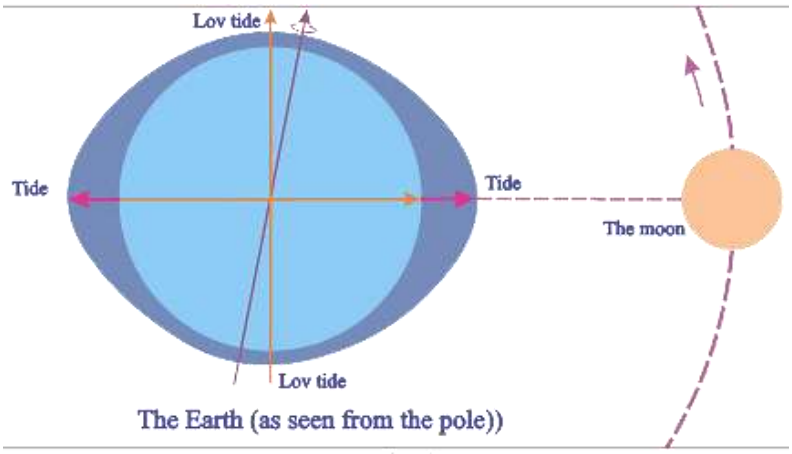

Fig.1. The scheme of lunar tides (http://coolreferat.com)

This difference of the forces stretches our planet along the Earth-Moon system. Lunar tide is moving in the Earth's surface followed by movement of the moon and sun - the sun. During a full moon and new moon when the moon and sun relative to Earth are roughly in line, their tidal waves are added, and comes "syzygial", i.e. enhanced flow. In addition, when approaching the moon to the earth, the tides are much stronger (approximately 3-fold) than usual. And in extreme close-ups of the moon to the Earth (Fig. 2), this difference increases further. ("Entry was posted on 09.05.2010, in the headings "Astronomy and Astrophysics").

It should be noted that under the law of gravitation the gravitational field is not homogeneous and has a direction toward the center of the attracting masses. Bowels of the Earth and the Moon, by themselves, are not homogeneous areas. Therefore, when Earth's gravity interact with the moon's the tectonic structure of mutually deformed. In this discussion are the other things: - why in the 2004-2005 and 2011 lunar tides have caused such a terrible earthquake, tsunami, which subsequently killed hundreds of thousands of people? Indeed, the maximum approximation of the Moon to Earth was observed in 1955, 1974, 1992 and 2005.

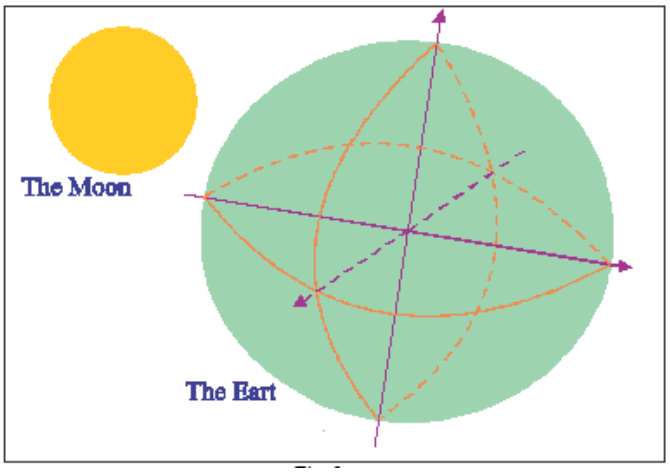

Fig. 2. Maximum approximation of the Moon to Earth March 19 2011. (According to NASA)

Tsunami in Indonesia that killed thousands of people, occurred in January 2005, just 2 weeks, and in March 2011 in Japan one week before the approach of the Moon from Earth. As you know, 19th March 2011 the convergence of the Earth with his companion led to a catastrophic earthquake in Japan, and Kamchatka sharply intensified activity of volcanoes. Locked in place of the earthquake in Chile, Greece and Russia. In Thailand, there were powerful tidal waves. March 19, 2011 the distance between the planet and its satellite was 356.6 thousand kilometers instead of

the usual 384.0 km in January 2005 - 356.2 km, 384.0 km instead. Above all, "supermoon" at this time coincided with the full moon (Fig. 2).

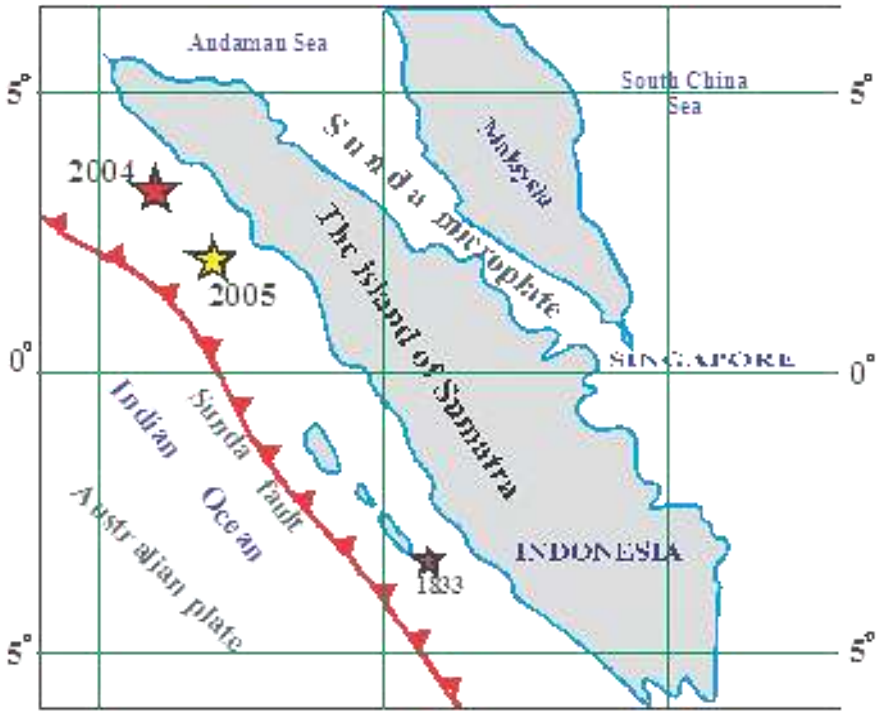

Fig.3. The epicenters of the last two earthquakes in 2004 and 2005 and a fragment of a tectonic map of Indonesia, site www.earthquake.usgs.gov

Results

It is known that earthquakes tend to occur when the stresses in the crust is a gap. The main source of stress – the "friction" blocks make up the lithosphere, or tectonic plates that make slow motion relative to each other. Earthquakes occur most likely where the boundaries of plates or microplates.

Fig. 3 and 4 show the epicenters of the earthquakes that occurred in Indonesia and Japan and tectonic maps of the fragments. On these maps shown where those junctions of tectonic plates and earthquake epicenters were. In other words, just west of Sumatra (Fig. 3), on the border of the Sunda microplate and Australian plate were located the epicenters of the last two disasters (2004 and 2005.) In the Indian Ocean, separated from each other by less than 300 kilometers, as occurred in 1833. At 150 km east of Honshu Island from north to south, the border (deep fault) two giant tectonic plates (Fig. 4). Pacific plate sinks beneath the Asian plate at a speed of 9 cm per year, where is the island of Honshu. Since the Asian plate is heavy and large friction, the sliding plate relative to each other is not smooth: the lower plate is constantly drags deep into the edge of the upper plate and crushes him. The bottom plate slides down sharply, while the upper springs up - and an earthquake occurs. Water, located over springing plates, gets a sharp jolt, causing a tsunami. In this region, earthquakes often occur by this scheme, but not strong. Thus, the main seismic zone intense focus is on the Pacific Ocean and includes several plates: Asian, Pacific and Indonesian. In 2011 March 11 for Japan, the Philippine plate crawled under Asian. Based on the analysis of the movement of tides of the moon on the Earth's surface (Fig. 5) in 2004-2005 and 2011. We can assume that the cause of sudden movements of plates, leading to strong earthquakes have been lunar tides. According to astronomical data [8ç12], the slope of the moon towards the earth's equator usually varies from 18 to 28 °. At the same time, elements of the lunar orbit, too, are not constant: periodically subjected to extreme changes. It has been calculated that in 2004-2005 and

2011 the angle was maximum. Typically, only 18 years and 7 months, when sites do a complete revolution in the ecliptic, the lunar orbit is again its original position. But from 2005 to 2011 was only about 6 years.

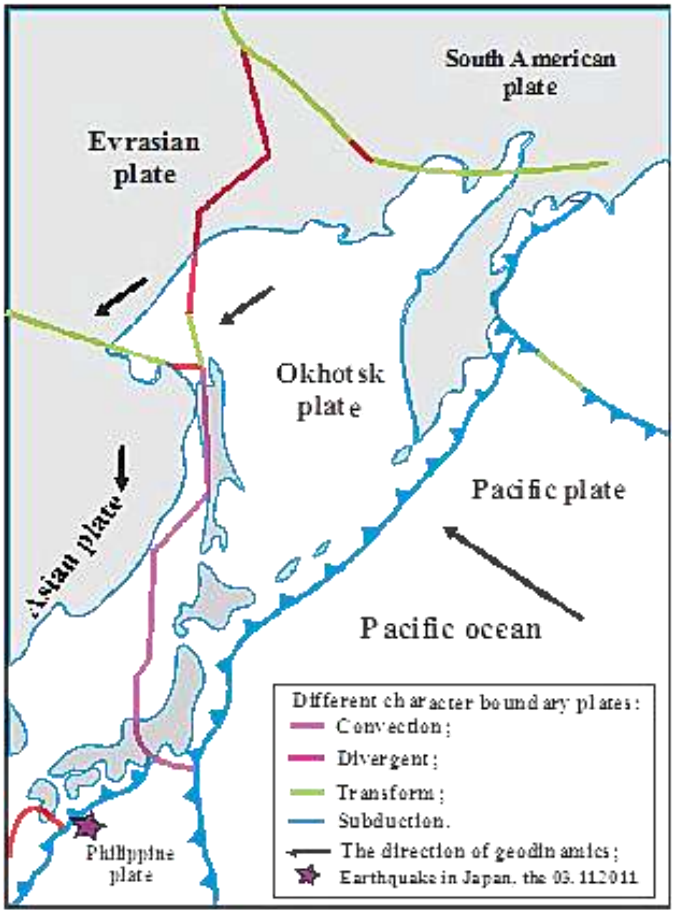

Fig.4. The epicenter of the earthquake 11.03.2011g. and a fragment of a tectonic map of Japan, site www.earthquake.usgs.gov

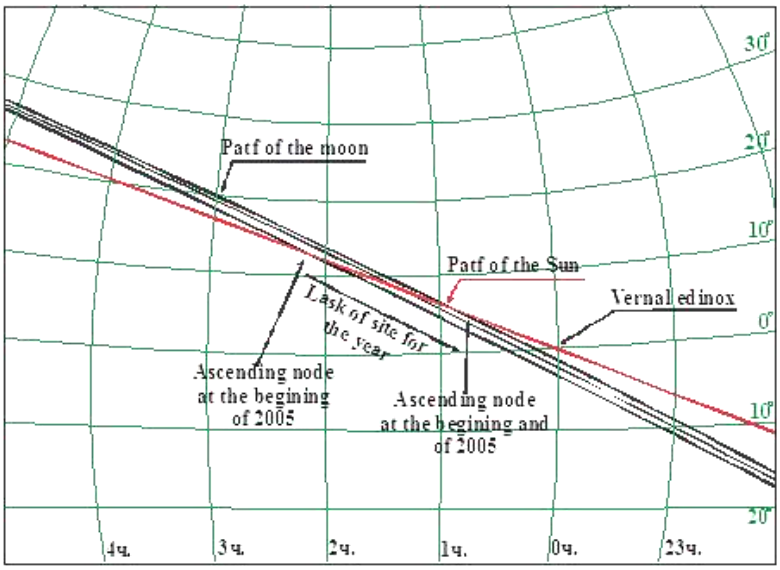

Fig. 5

Fig. 5. The path of the moon at the end of 2004 and in early 2005, site http://podlodka.info/education/14-astronomy/perturbations

Fig. 5 shows the direction of the path of the sun and the moon in late 2004 and early 2005. In 2004-2005 and 2011 sites directing the ways of ascent of the sun and the moon coincided with one another. If we project these trends the way to the surface of the Earth, they fall in 2004-2005 in Indonesia, and in 2011 – Japan (Fig. 3 and 4). Moreover, they coincided in the III quarter of the moon in its orbit. This means that the tidal influence of the moon is composed with the tide of the sun. The important thing is not the point of minimum convergence and the dynamics of growth of the tide, prior to this date. It should be emphasized another important fact: the motion of the tides of the moon on the Earth's surface are perpendicular to the lines stretch above the deep faults (Fig. 3 and 4). In these regions there have been provoked earthquakes and tsunamis. The essence of this fact is explained as follows:

It is known that the gravity anomalies in Bouguer reduction reflect the tectonics of the crust. In other words, the geometrical parameters of the geological environment are the main arguments of gravity anomalies in Bouguer reduction, i.e. if a unit is raised or lowered in relation to another, it appears in the gravitational field (Fig. 6).

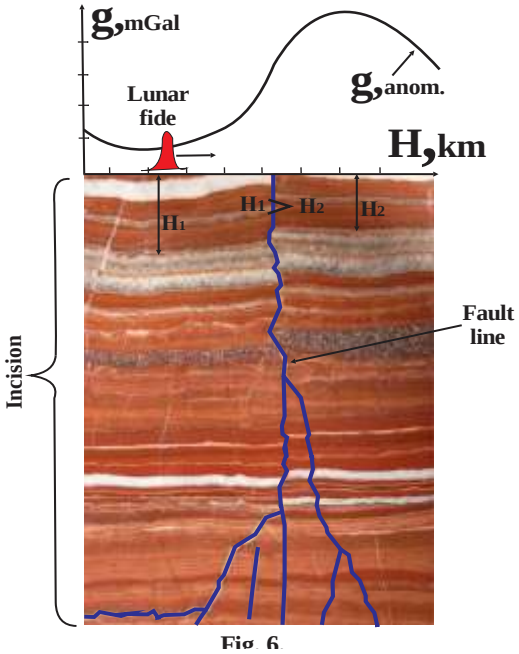

Fig.6. Geological-geophysical cross-section
(geological part of the section is taken from the site http://forum.drom.ru/arc/619018.html).
Compiled R.Niftaliyev, B.Aslanov

The figure shows the disjunctive folding, separated by deep faults. The path of the lunar tide, passing perpendicular to the fault plane, due to high tide and the intensity of gravity, geological environment is distorted. If a similar folding, has accumulated a tense situation, the tides will play the role of the trigger mechanism for earthquakes.

We believe that as a result of the lunar-solar tides in 2004-2005 and 2011 tectonic plates, were immersed on each other. With a sharp dive units, there was a loosening of the seabed, and the sharp jolt was sea water, which subsequently formed the tsunami.

Of course, another question arises: why, in 1955, 1974, 1992 do not occur such earthquakes? Based on the astronomical and tectonic aspects, this question can be answered as follows.

• lunar-solar tides, which may be a triggering mechanism for the conditions when an earthquake is ripe, but not push. In this case, the tide may be triggered;

• nodes paths climbing the Sun and Moon should be the same between them;

• structural and tectonic framework should represent the disjunctive folding, and the direction of the path of tides must be perpendicular to the lines trending deep faults.

The next "supermoon" can be observed November 14, 2016, when the convergence of the Moon and the Earth will be 356 511 km, and then - November 25, 2034 (356 447 km).

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11. http://forum.drom.ru/arc/619018.html
12. http://news.mail.ru/society/5699278/

ANALYSIS OF THERMAL SATELLITE AND GROUND BASED RADON DATA RECORDED PRIOR TO HARIPUR EARTHQUAKE, PAKISTAN: PRELIMINARY RESULTS

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Radon gas production occurs continuously throughout the Earth's crust, but when an earthquake is imminent the production of radon decreases in the compression zone near the epicenter and increases in stretching zones away from the associated fault. The release of radon ionizes the surrounding air and creates near-earth plasma in the form of long-living ion clusters. These changes can be detected by both ground- and satellite-based instruments. Investigations throughout the world over the past 15 years provide evidence, which indicate that significant variations of radon concentration may occur in association with major geophysical events such as earthquakes and volcanic eruptions (Al-Tamimi and Abumurad 2001; Chyi et al. 2005; Fu et al. 2005; Walia et al. 2005, 2006; Yang et al. 2005; Singh et al. 2006; Kumar et al. 2009). Due to such observed correlation, radon is considered as one of the few promising precursors for earthquakes (Kumar et al. 2010). In the last decade, several studies have recognized the anomalous behavior of radon gas emission from Earth prior to an earthquake that could be the sign of an imminent earthquake. It is believed that the radon is released from cavities and cracks as the Earth's crust is strained prior to the sudden slip of an earthquake (Chung, 1985; Teng and Sun, 1986). Similarly, Satellite thermal infrared (TIR) imaging data, from sensors on board satellite platforms, have been reported to record thermal anomalies in epicenter and adjacent areas in the Thermal Infrared (8-14μm) spectral range prior to major earthquakes and associations with fault systems (Ouzounov et al., 2006). The identification of such thermal anomalies is difficult to record from the ground based stations for a large area. The satellite telemeters measure these phenomena quickly round the clock and cover a large area. The satellite data have not only revealed stationary (long-lived) thermal anomalies associated with large linear structures and fault systems in the Earth's crust (Carreno et al., 2001; Fizzola et al., 2004) but also transient (short-lived) features prior to major earthquakes (Tronin et al., 2004a,b; Tramutoli et al., 2005). These short-lived anomalies typically appear 4–14 days before an earthquake affecting the regions of several to tens of thousands square km. It

displays a positive deviation of 2–4° C or more; and dies out a few days after the event. The thermal anomalies have also been observed at distances of 200–1000 km from the epicenters, between few hours to two weeks before the event occurred in China, Japan, Russia, Turkey, Mexico and Greece; (Liu et al., 2000; Tramutoli et al., 2001). In this paper we will present and discuss recorded radon gas anomaly along with variations in Thermal Infrared (TIR) transients and overall radiation field in the earthquake preparation zone prior to Haripur earthquake (m_b = 5.2, Lat: 33.871° N Long: 72.890° E, Oct 11, 2010).

Methodology and Data Sets

According to Planck's Law, each warm object on emits certain amount of thermal radiation at a particular wavelength depending on its temperature. For a much clearer picture, the relationship between Earth's surface, its brightness temperature and the spectral radiance can be understood by referring to Figure-1 (Lillesand and Kiefer, 2004).

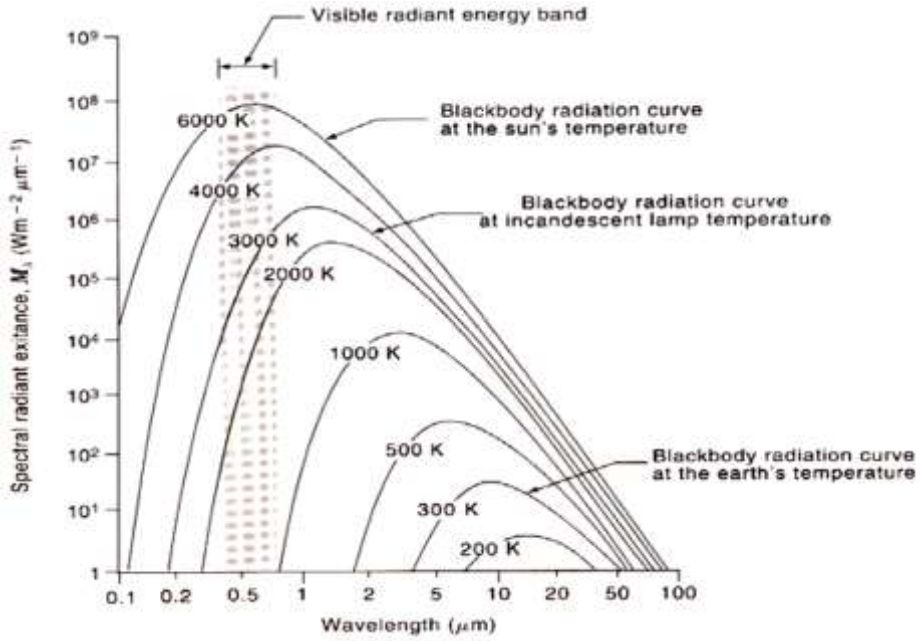

Fig.1. Black body radiation curves showing peak wavelengths at various temperatures

Satellite data of MODIS pertaining to calibrated radiance of cloud free day time was downloaded from the web site: http://laadsweb.nascom.nasa.gov/ for all the selected earthquake events. The grid of 3° Ç 3° was selected in such a way that epicenter of each selected earthquake lies in the middle of the grid for the analysis. The radiance data of each day, one month before and after the occurrence of earthquake, was critically viewed to ensure the cloud free data otherwise it would represent the radiance of clouds not the earth's surface. The radiance values were converted to surface temperature values, which is more physically useful variable and is the effective at-satellite temperature of the viewed Earth-atmosphere system. The following conversion formula (Liu, 2002) is used.

$$T = \frac{K_2}{\ln\left(\frac{K_1}{L} + 1\right)}$$

Where T is effective at-satellite temperature in Kelvin; K1 and K2 are calibration constant having value 666.09 Watts/ (meter2 * ster* μm) and 1282.71 Temperature degrees in Kelvin respectively and L is spectral radiance in watts/ (meter2 * ster * μm).

Results and Analysis

Analysis of Radon data:

CES is in process of establishing a network of Radon monitors across Pakistan to monitor the Radon anomalous signals prior to earthquakes (Fig. 2). Radon counts are recorded with one hour interval at each station. Data was averaged out by using 24hrs moving average method. The Analysis of Radon data recorded at nearest station (Nurpur) shows that the average radon counts in the area is 2-3 Pci/l, which were significantly increased to 6-7 Pci/l 1-2 days before the occurrence of earthquake (Fig. 3).

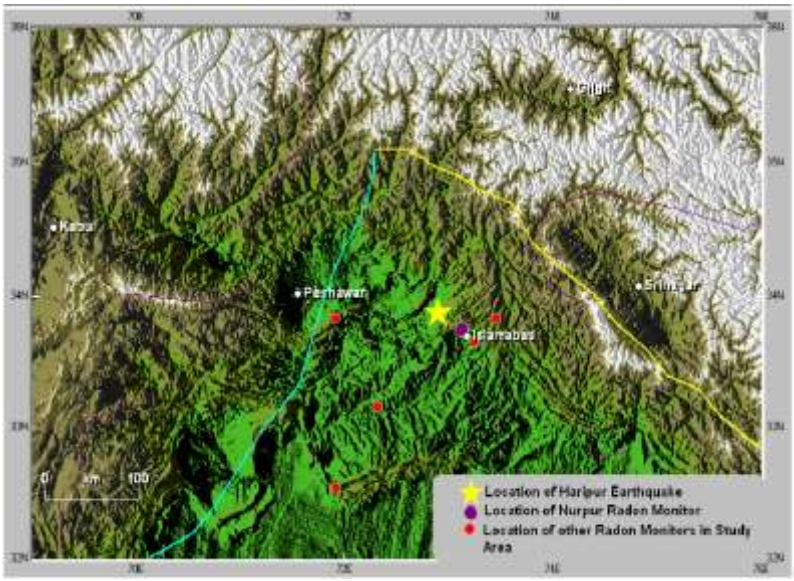

Fig. 2. Network of Radon monitors in northern Pakistan

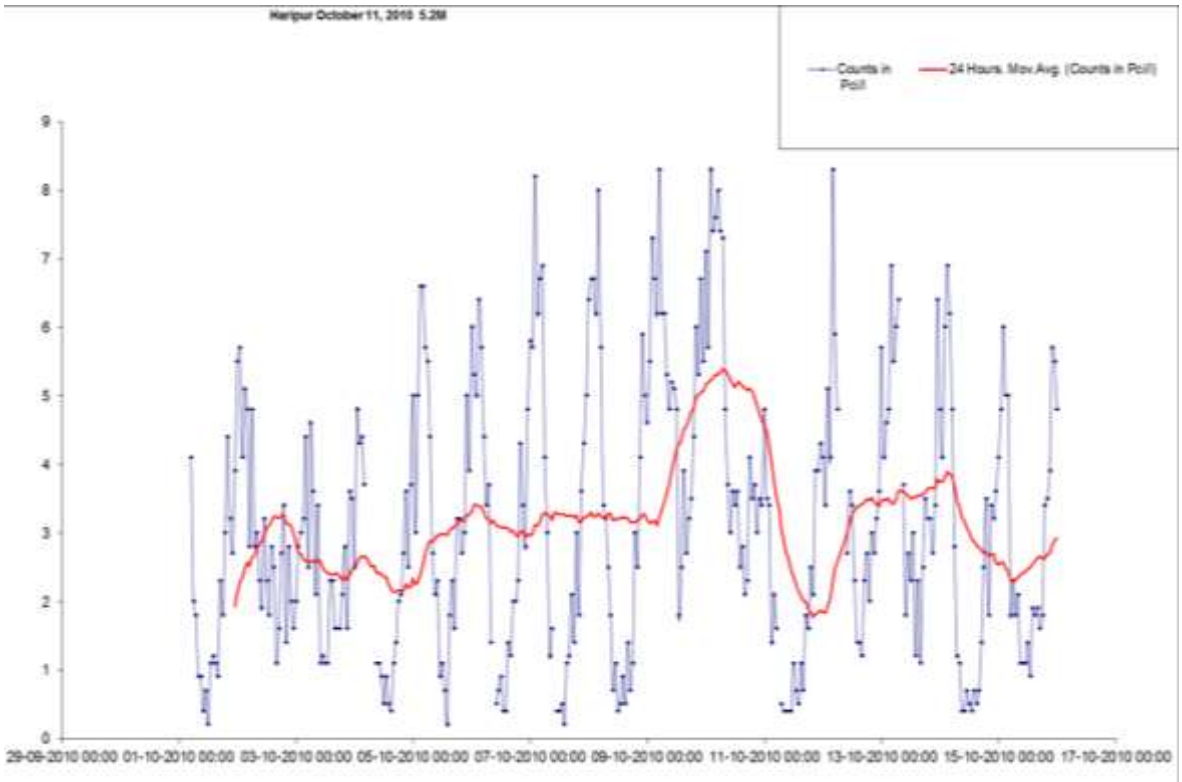

Fig. 3. Graph showing Radon counts in month of October, 2010

Analysis of TIR data:

Using ENVI software radiance values (minimum, maximum and average) and the corresponding surface temperature values were noted for all the processed data regarding the following earthquakes for analysis. As the normal temperature of the study area is not available we assume that minimum value of radiance/temperature is normal in the preparation zone for this study.

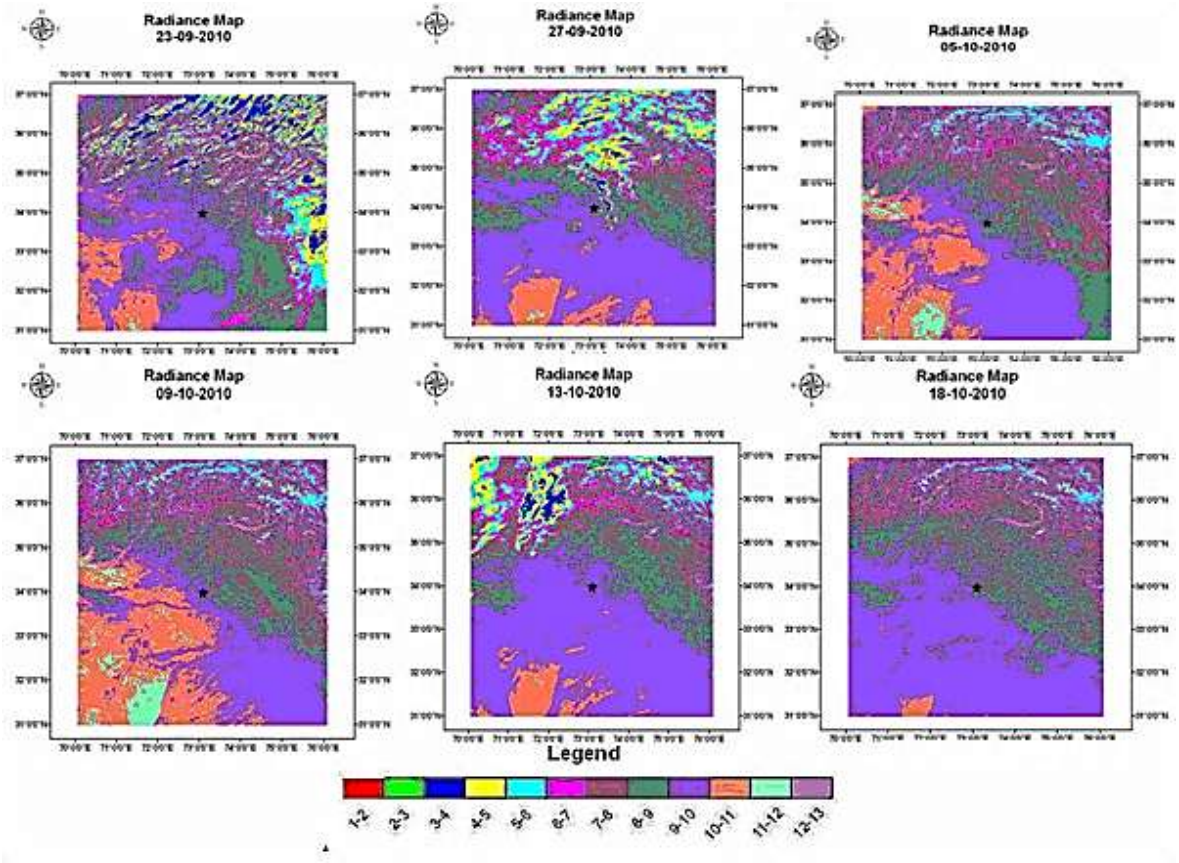

Fig. 4. Radiance values before and after the Occurrence of Haripur Earthquake

Table 1.

Radiance and Temperature values before and after the Occurrence of Haripur Earthquake

Date	Minimum value of radiance	Maximum value of radiance	Average value of radiance	Average Temperature Celsius
23-09-2010	2.50	11.85	7.82	15
27-09-2010	2.66	11.13	8.20	18
05-10-2010	3.82	11.79	8.75	22
09-10-2010	**3.54**	**11.61**	**8.89**	**23**
13-10-2010	2.18	11.03	8.36	19
18-10-2010	3.77	10.97	8.72	22

From the analysis of processed satellite data for radiance (Fig. 4) and surface temperature values for Haripur earthquake it was observed that the minimum average value of radiance/temperature in the ROI (Region of Interest) was 7.82/15 on September 23, 2010 which increased significantly and reached at maximum, 8.89/23 on October 09, 2010. It shows the energy concentration in the epicenteral region before the occurrence of earthquake. After the occurrence of earthquake the average value of radiance is decreased significantly i.e. 8.36. The radiance and corresponding temperature values before and after the occurrence of Haripur earthquake is given in Table-1 and corresponding graph is given in Fig. 5.

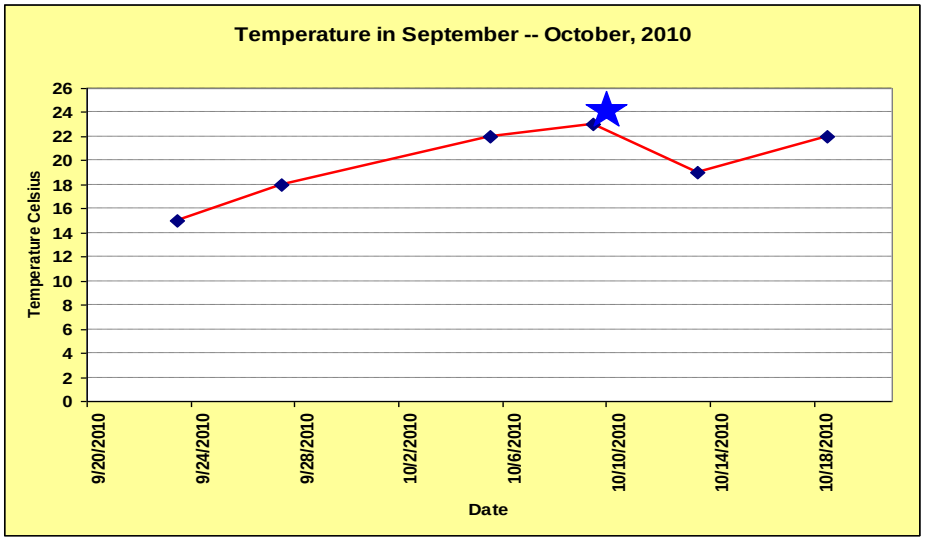

Fig.5. Variation of surface temperature before and after the Haripur earthquake

Conclusions

Analysis of Radon data reveals that the radon values increased from 2-3 Pci/l to 6-7Pci/l, 1-2 days before the event. From satellite-based study of anomalous behavior of thermal infrared radiation for Haripur earthquake, it has been observed that average temperature of earthquake preparation zone was convergent to highest level about 5–6 days before the earthquake. The average temperature also manifest decreased trend just 1–2 days before the earthquake and attains its normal value after the occurrence of earthquake. The variation of surface temperature from 1 to 5ºC was observed and maximum radiative energy was shifted towards the epicenter during this period. The location of epicenter was found within the anomaly area. The observed thermal anomalies confirmed the association with studied earthquake. Moreover, if the record of normal temperature of a specific region is available, then in case of thermal anomaly, the occurrence of impending major earthquake may be assured.

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INVESTIGATION OF SELECTED NARROW BANDS INTENSITY VARIATION OF THE SOLAR IRRADIANCE DURING YEARS 1981-2008

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1. INTRODUCTION

The Sun emits a wide variety of radiations, originating in different parts of the solar atmosphere (photosphere, chromosphere, chromosphere-corona transition region, corona). The solar radiation energy absorbed in the Earth's atmosphere has a significant effect upon the overall momentum balance in the stratosphere, mesosphere, and lower thermosphere and thus it plays an important role in the way the Sun influences the Earth's climate system.

Since the first space-flight measurements of solar irradiance in the late seventies, the Sun has been constantly monitored with a precision high enough to detect even variations of the order of 0.01% [1, 2]. Successful launch of SOHO mission at the end of the year 1995 became possible to fulfill simultaneous measurements of solar total irradiance and solar spectral irradiances in different wavelengths in order to identify the main mechanism responsible for solar irradiance variations. It is considered that the solar extreme ultraviolet and ultraviolet radiation (EUV&UV) dominates in the Sun-Earth connection processes as it is absorbed in the upper atmosphere and stratosphere of the earth and changes the chemical and dynamical parameters of those layers [3]. Solar UV originates mostly in the solar photosphere and chromosphere. Temporal variability of solar UV emission affecting the terrestrial environment makes considerable input in both short-term and long-term modulated processes [4]. UV and FUV irradiance shows close relation to the magnetic variability of the Sun during a sunspot cycles. The goal of our study is to investigate how well the irradiance variability of separate narrow wavelength bands coincide with the solar activity index - international sunspot number (ISN) for different solar cycles and estimate existing correlation quantitatively. The tasks of our study include investigation of variations of solar total and spectral radiation in connection with solar activity cycles 21-23 to reveal possible trends. The methods of investigation includes: a) extracting and compiling of observational data of selected quantities, b) creation of the homogeneous local dataset of formatted data suitable for following processing, c) statistical processing of investigated data (regressive analysis, correlation analysis).

2. DATA DESCRIPTION

Spectral irradiance data investigated in this paper were extracted from the NASA data archives. The NASA data centers provide interactive and direct access to a comprehensive set of solar spectral irradiance measurements from the soft X-ray (XUV) at 0.1 nm up to the near infrared (NIR) at 2400 nm, as well as the measurements of Total Solar Irradiance (TSI). The data contain hourly and daily measurements and are merged into ASCII text-files making data convenient for following processing. We have investigated the solar spectral irradiance (SSI) in the range of 120-300 nm for the solar cycles 21, 22 and 23, using spectral time series of FUV and UV obtained by SME (1981-1989, available wavelength range 115.5nm-302.5 nm), UARS (1991-2001, available wavelength range 119.5 nm – 425.5 nm) and SORCE (2003-2009, available wavelength range 116.5 nm – 1598.95 nm) experiments. Time series of solar spectral irradiance analyzed in this paper were been extracted from datacenters NSSDC, GDAAC and LISIRD. We have developed software for extracting and processing of narrow bands spectral irradiance data. The international sunspot numbers are used also. The data are produced by the Solar Influences Data Analysis Center (SIDC), World Data Center for the Sunspot Index, at the Royal Observatory of Belgium.

List of selected data used in the present analysis is given in the Table 1.

Table 1.

List of selected data used in the present analysis. Space flight experiments and data archives are indecated for selected data

Data selected for process sing	Origin Region	Spaceflight experiments and data archives				
		1981-1986 descending phase of the solar cycle 21	1987-1989 ascending phase of the solar cycle 22	1992-1996 descending phase of the solar cycle 22	1997-1999 ascending phase of the solar cycle 23	2003-2008 descending phase of the solar cycle 23
121.5 nm (Lyman-α) emission	Trans. Reg. of the Sun	SME (NSSDC)	SME (NSSDC)	UARS (GDAAC)	UARS (GDAAC)	SORCE (LISIRD)
200.5 nm emission	Chromosph	SME (NSSDC)	SME (NSSDC)	UARS (GDAAC)	UARS (GDAAC)	SORCE (LISIRD)
289.5 nm emission	Chromosph	SME (NSSDC)	SME (NSSDC)	UARS (GDAAC)	UARS (GDAAC)	SORCE (LISIRD)
300.5 nm emission	Chromosph	SME (NSSDC)	SME (NSSDC)	UARS (GDAAC)	UARS (GDAAC)	SORCE (LISIRD)
Int. Sunspot Number	Sun Surface	SIDC	SIDC	SIDC	SIDC	SIDC

3. DATA ANALYSIS AND RESULTS

The task of the presented study includes investigation of variations of solar spectral radiation in connection with the solar activity cycles 21-23 to reveal possible anomalous trends. Statistical processing of selected data includes following steps:

a) interpolation of missing data;

b) primary processing of selected data (timed average, smoothed average);

c) regression analysis of selected data to reveal linear trends;

d) determination and estimation of correlation coefficients for time series of selected data.

To compare solar spectral irradiance of narrow bands and ISN we have chosen the following wavelengths from the solar spectral irradiance database: 121.5 nm, 200.5 nm, 289.5 nm and 300.5 nm. Selected ASCII data have been reduced using the latest version of the program MATLAB.

We have interpolated daily values of data indices to get continuous and spectrally resolved measurements of the irradiance and more obvious trends of time series Variations of daily values of selected narrow band of SSI for the solar cycles 21, 22 and 23 are presented on Fig. 1-4.

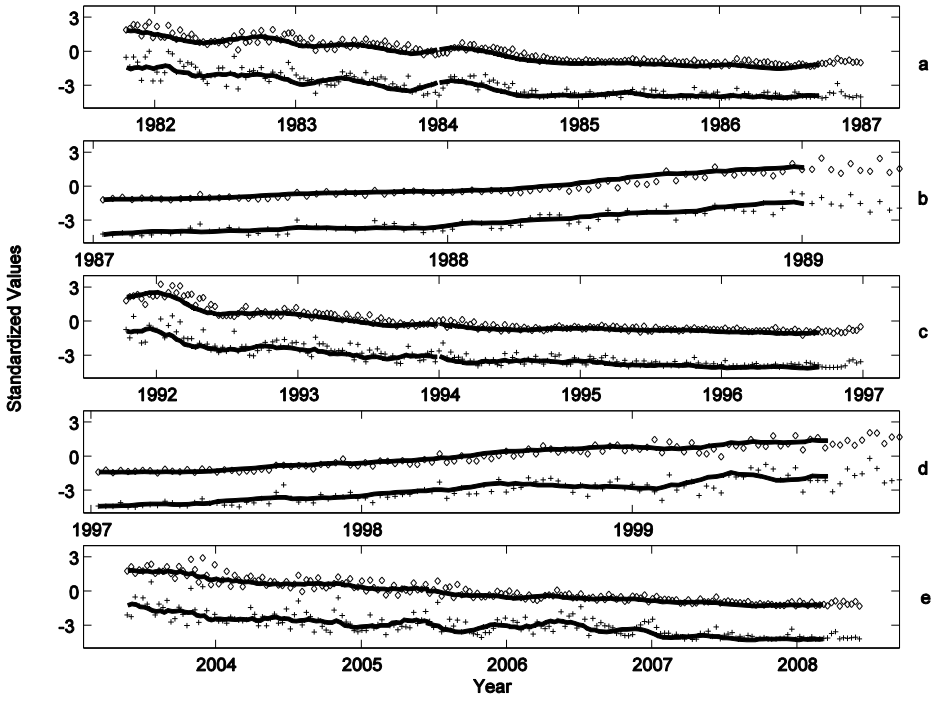

Fig. 1. Standardized values of 10-day averaged data of the 121.5 nm spectral line emission intensity (marked by ⊇) and sunspot number (marked by +) for solar activity cycles 21-23. Timed average values are shown as data points. Solid lines correspond to smoothed data creating by moving average made on 10 points basis; a) – decreasing phase of the solar activity cycle 21, b) – increasing phase of the solar activity cycle 22, c) – decreasing phase of the solar activity cycle 22, d) – increasing phase of the solar activity cycle 23, e) – decreasing phase of the solar activity cycle 23.

We have noticed a peculiar behavior in some regions of FUV and UV emissions of the solar spectrum. Figures 1-3 show that intensity variability approximately repeats the main trend of sunspot number for selected spectral lines 121.5 nm and 200.5 nm. But the anomalous behavior is indicated for spectral lines 289.5 nm and 300.5 nm (Fig. 3, 4). It is obvious that variations of intensity of these spectral lines of solar spectrum are not in good correlation with the sunspot number variations. Furthermore anti-correlation takes place between variations of intensity of 289.5 and 300.5 nm narrow bands and sunspot number variations for the decreasing phase of the solar activity cycle 23.

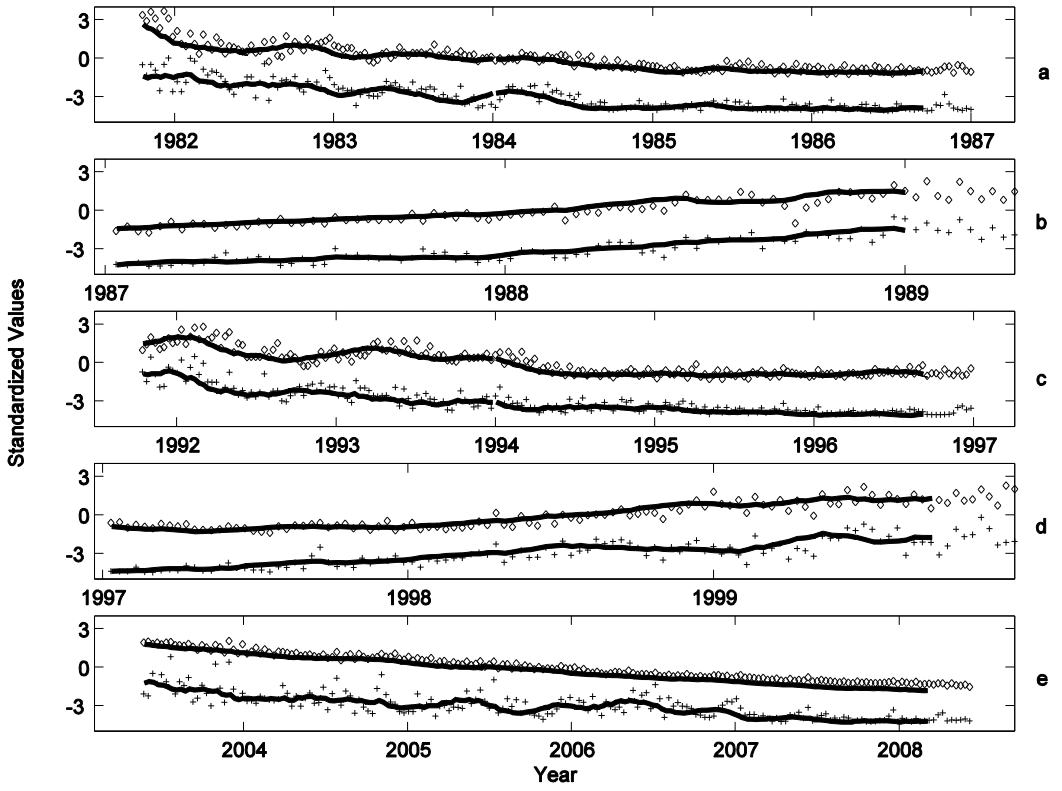

Fig.2. The same as in Figure 1 for 200.5 nm spectral line emission

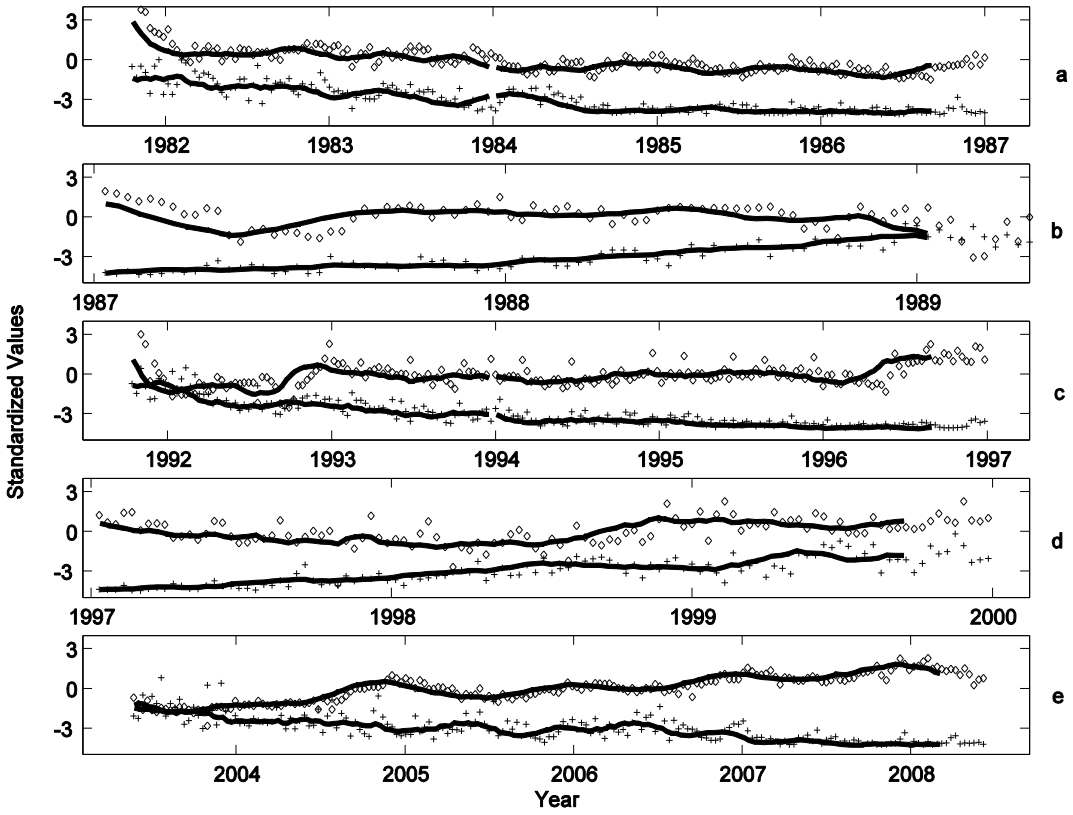

Fig. 3. The same as in Figure 1 for 289.5 nm spectral line emission

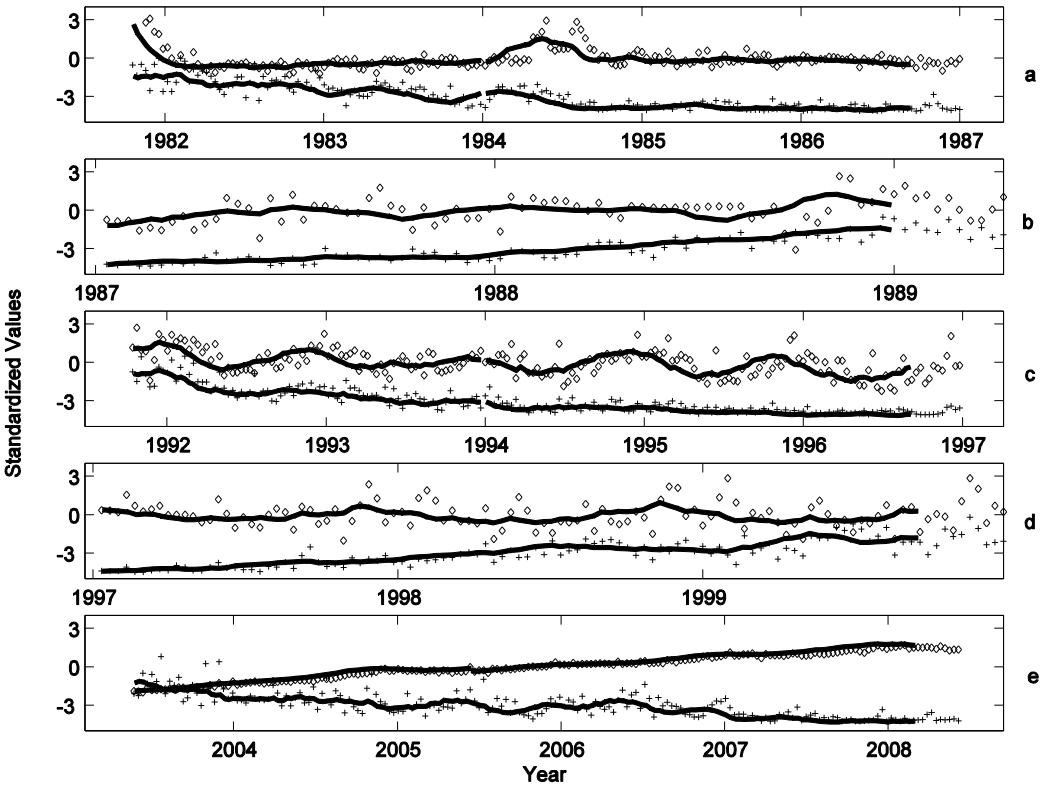

Fig. 4. The same as in Figure 1 for 300.5 nm spectral line emission

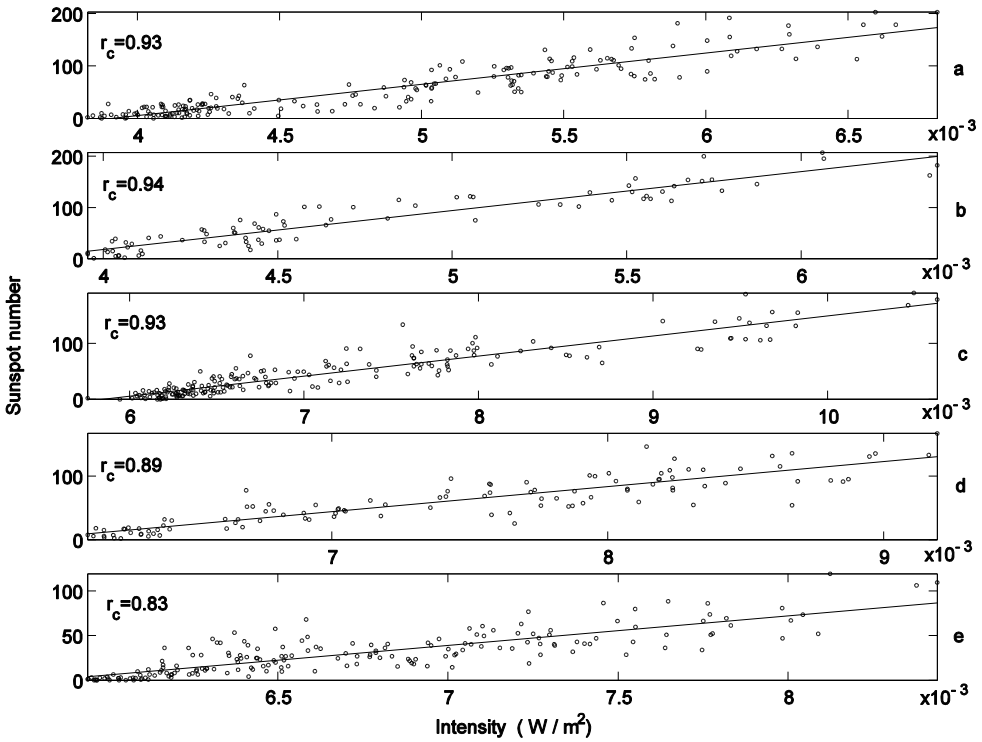

Fig. 5. Linear trends for relationships between ISN and 121.5 nm spectral line emission intensity for solar activity cycles 21-23. *a) – decreasing phase of the solar activity cycle 21, b) – increasing phase of the solar activity cycle 22, c) – decreasing phase of the solar activity cycle 22, d) – increasing phase of the solar activity cycle 23, e) – decreasing phase of the solar activity cycle 23.10-day averages are used. Solid lines correspond to linear fits computed by the least-squares method. Corresponding correlation coefficients are indicated.*

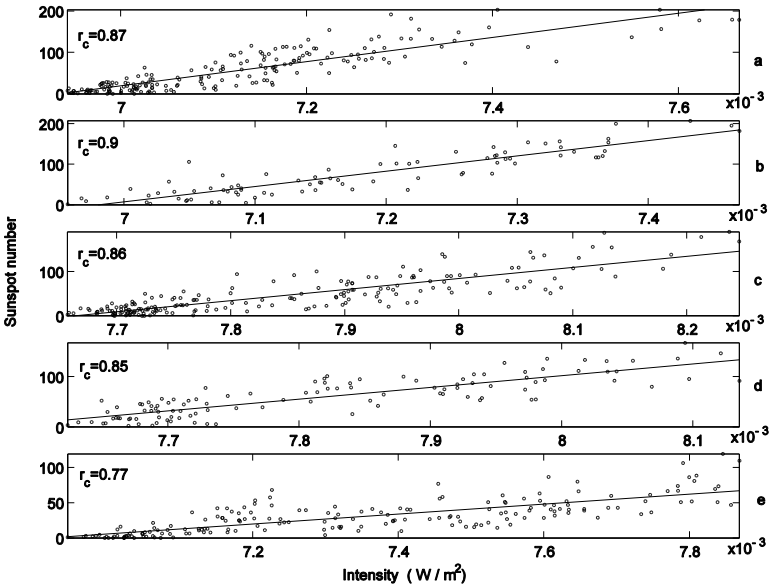

Fig. 6. The same as in Figure 6 for 200.5 nm spectral line emission

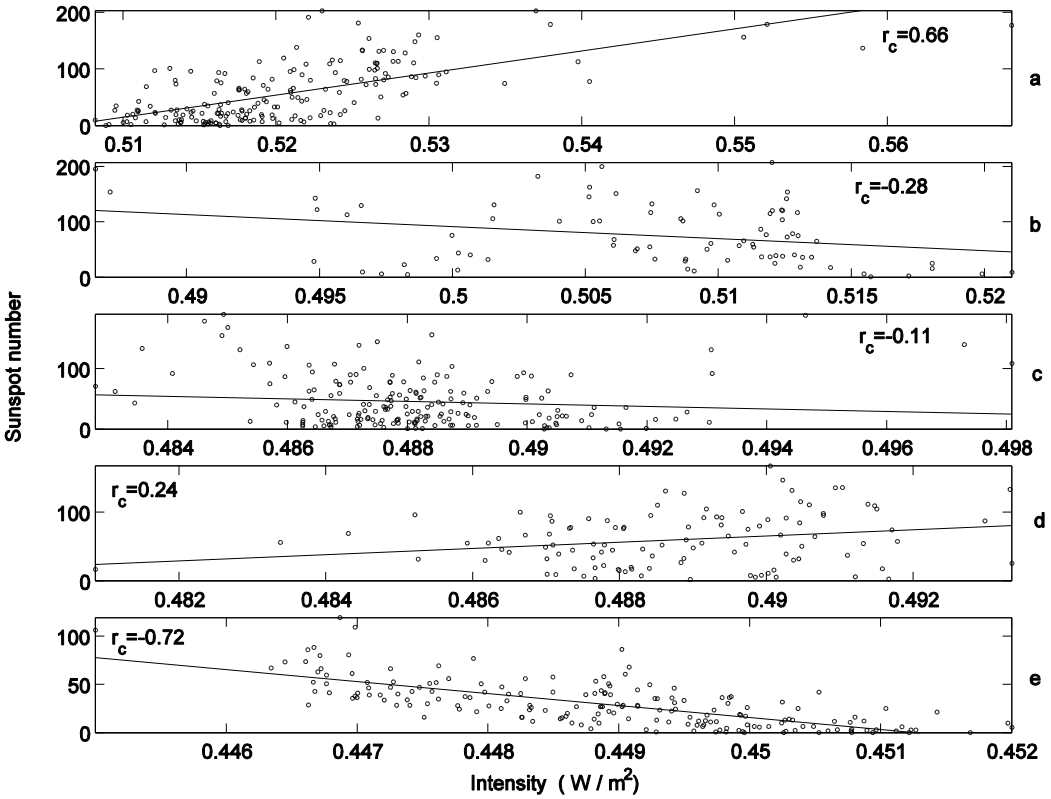

Fig.7. The same as in Figure 6 for 289.5 nm spectral line emission

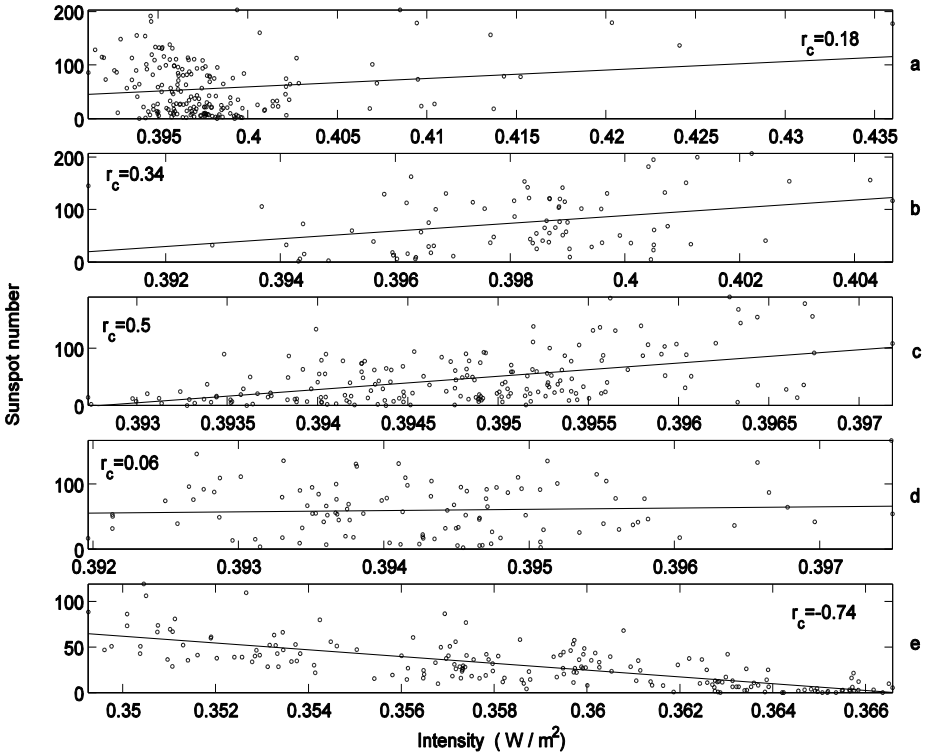

Fig. 8. The same as in Figure 6 for 300.5 nm spectral line emission

To explore correlation between solar spectral intensity variations and sunspot number during solar activity phases we investigated relationship between these parameters using 10-day averaged meanings and calculated correlation coefficients. Calculated meanings of correlation coefficients are given in the table 2. Confidence levels for the calculated coefficients are more than 95%.

We computed linear fits for the each of selected spectral intensities as well. Obtained results graphically are shown on Fig. 5-8.

Table 2.

Correlation coefficients are given between intensity variations of the selected narrow bands of solar spectrum, ISN (1981-2008) and TSI (2003-2008) for the solar activity cycles 21, 22 and 23. Data were smoothed by timed average made on 10 points basis

Years / Wavelength		1981-1986 (descending phase of the solar cycle 21)	1987-1989 (ascending phase of the solar cycle 22)	1992-1996 (descending phase of the solar cycle 22)	1997-1999 (ascending phase of the solar cycle 23)	2003-2008 (descending phase of the solar cycle 23)
121.5 nm	vs. ISN	0.93	0.94	0.93	0.89	0.83
200.5 nm	vs. ISN	0.87	0.90	0.86	0.85	0.77
289.5 nm	vs. ISN	0.66	-0.28	-0.11	0.24	-0.72
300.5 nm	vs. ISN	0.18	0.34	0.50	0.06	-0.74

We have calculated and estimated A and B coefficients of the linear regression $y = Ax + B$ for relationships between selected SSI and ISN by equations (1, 2) and (3, 4):

$$A = \frac{\left(\sum x_i^2\right)\left(\sum y_i\right) - \left(\sum x_i\right)\left(\sum x_i y_i\right)}{\Delta} \quad (1), \qquad B = \frac{N\left(\sum x_i y_i\right) - \left(\sum x_i\right)\left(\sum y_i\right)}{\Delta} \quad (2),$$

$$\sigma_A^2 = \sigma_y^2 \sum x_i^2 / \Delta \quad (3), \qquad \sigma_B^2 = N\sigma_y^2 \sum x_i^2 / \Delta \quad (4)$$

where x_i corresponds to 10-day averaged values selected from SSI data and y_i corresponds to ISN data, N is a total number of data, i indicates a number of measurement. Δ and σ_y are calculated by equations:

$$\Delta = N\left(\sum x_i^2\right) - \left(\sum x_i\right)^2 \quad (5), \qquad \sigma_y^2 = \frac{1}{N}\sum \left(y_i - A - Bx_i\right)^2 \quad (6).$$

Obtained results are presented in the Table 3.

Table 3.

Estimation of coefficients of linear fits for relationships between SSI and ISN for the solar activity cycles 21-23

Years		Coefficients of linear fits			
		121.5 nm	**200.5 nm**	**289.5 nm**	**300.5 nm**
1981-1986	A	$(5.96 \pm 0.17)\text{x}10^4$	$(2.93 \pm 0.12)\text{x}10^5$	$(3.90 \pm 0.32)\text{x}10^3$	$(1.57 \pm 0.64)\text{x}10^3$
	B	-233 ± 9	-23230 ± 85	-1974 ± 170	-570 ± 250
1987-1989	A	$(7.60 \pm 0.31)\text{x}10^4$	$(3.77 \pm 0.20)\text{x}10^5$	$(-2.16 \pm 0.83)\text{x}10^3$	$(7.41 \pm 2.29)\text{x}10^3$
	B	-286 ± 15	-2630 ±144	1170 ± 420	-2875 ± 900
1991-1996	A	$(3.59 \pm 0.10)\text{x}10^4$	$(2.51 \pm 0.11)\text{x}10^5$	$(-2.09 \pm 1.41)\text{x}10^3$	$(2.33 \pm 0.29)\text{x}10^4$
	B	-210 ± 7	-1920 ± 84	1070 ± 690	-9140 ± 1150
1997-1999	A	$(3.94 \pm 0.19)\text{x}10^4$	$(2.33 \pm 0.14)\text{x}10^5$	$(4.51 \pm 1.80)\text{x}10^3$	$(1.93 \pm 3.23)\text{x}10^3$
	B	-231 ± 14	-1760 ± 110	-2140 ± 880	-701 ± 130
2003-2008	A	$(3.31 \pm 0.16)\text{x}10^4$	$(7.07 \pm 0.43)\text{x}10^4$	$(-1.24 \pm 0.09)\text{x}10^4$	$(-3.71 \pm .25)\text{x}10^3$
	B	-190 ± 10	-500 ± 30	5600 ± 400	1360 ± 90

Coefficients given in the Table 3 estimate quantitatively the graphical results presented in Figures 1-8. Calculated meanings of the linear trend coefficients are in a good agreement with the graphical images.

4. DISCUSSION

Measurements of solar UV and FUV irradiance obtained by space experiments are particularly important because of their dominating role in solar-terrestrial connections.

We have investigated the variations of some narrow bands of solar spectral irradiance for the solar activity cycles 21-23. Investigations of de Toma et al. [6] illustrate the difficulty in using simple proxies and regression techniques to deduce physical sources of solar irradiance variability. According to our study it is found that emission of some solar spectral narrow bands does not agree equally well with the sunspot number index of the solar activity during decreasing phase of the solar activity cycle 23. Furthermore high level of negative correlation takes place for the decreasing phase of the solar cycle 23, but the negative correlation is absent for the solar activity cycles 21 and 22. In the Figures 3, 4 we can see the tendency of downward trends for intensity variations of the spectral lines 121.5 nm and 200.5 nm and upward trends for the intensity variations of the spectral

lines 289.5 nm and 300.5nm. It seems unusual because the selected spectral lines 200.5 nm, 289.5 nm and 300.5 nm belong to the same origin area of the solar irradiance.

It is considered that solar irradiance variations both the spectral and total are essentially caused by solar surface magnetism and thermal structures of magnetic features (sunspots, faculae) are responsible for variations of solar total and spectral irradiance [7-11].

Using contemporaneous helioseismic data from GONG and MDI [12] there are find anti-correlation between solar oscillation frequencies and activity proxies during the minimum between the solar activity cycles 23 and 24, in contrast to the behavior during the minimum between cycles 22 and 23. This result points to the fact that the minimum between the solar cycles 23 and 24 is unusual. By means of authors this also suggests that in addition to the surface magnetic activity, the variations in solar oscillation frequencies may be caused by some other effects e.g. changes in the structure of the Sun below the photosphere.

Anomalous activity in the ascending phase of the solar activity cycle 24 has been observed during June-August 2011. Intense solar flares and coronal mass ejections, produced in the Sun have provoked severe geomagnetic storms. The cause of this activity can be the unusual prolonged minimum period between solar cycles 23 and 24 with nearly 700 days without sunspots. As a rule the ascending phases of the solar activity cycles are characterized with a relatively higher activity than descending ones, but the early stage of the ascending phase of the solar activity cycle 24 has shown the particular high-level activity. This anomalous activity in the beginning of the cycle can play a significant role in further development of the solar activity cycle 24 and in forecasting of parameters of the upcoming cycle.

By our opinion the further detailed investigations in this direction will provide the more completed information in the field of solar-terrestrial physics.

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ABOUT SOME BEHAVIOR OF THE SOLAR TOTAL AND SPECTRAL IRRADIANCE DURING UNUSUALLY PROLONGED DECREASING PHASE OF THE SOLAR CYCLE 23

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3. INTRODUCTION

Variations of the solar spectral irradiance (SSI), in particular variations of the ultraviolet (UV) radiation play a significant role in the way the Sun influences the Earth's climate system [1]. It is considered that the solar extreme ultraviolet and ultraviolet radiation (EUV&UV) dominates in processes of solar-terrestrial connection. Solar radiation below 300 nm is almost completely absorbed in the upper atmosphere, stratosphere and changes the chemical composition and dynamical parameters of those layers and causes variations of the ozone concentration [2-5]. However, the contribution of UV and EUV radiation in the total solar irradiance (TSI) is rather small, only a few percent [6]. The solar cycle 23 is the best observed solar cycle at present, with obtained data from SOHO/ VIRGO mission starting in 1996, ACRIMSat/ACRIMIII missions starting in 2000, and SORCE/TIM mission starting in 2003. It is considered that the solar cycle 23 (years 1996-2008, with maximum of sunspot number in 2000) has got its own peculiarities and can be characterized as an anomalous one [7]. The cycle is weaker than its preceding cycles 21 and 22 almost in all of the solar indices – magnetic flux, sunspot area, faculae area, Mg II index, and 10.7 cm radio flux (but not in TSI). The burst of activity in December 2006 was very exceptional and untypical for a very late declining phase. The minimum phase of the solar cycle 23 has been unusually long, with nearly 700 days without sunspots. Such a number of spotless days have not been observed since 1933. The entire duration of solar cycle 23 was longer than duration of previous cycles 21 and 22. Besides, the solar wind was reported to be in a uniquely low energy state since space measurements begun nearly 40 years ago [8]. Many efforts are underway in order to understand what are the main mechanisms responsible for such a prolonged period with minimal solar activity as well as for other untypical events characterized the solar activity cycle 23. The peculiarities of the solar cycle 23 caused us to investigate whether the characteristics of solar spectral irradiance are different for this solar cycle than for other ones. Based on the consideration of abnormality of the solar cycle 23 we decided to find out some anomalous behavior in TSI and SSI variations for the years 2003-2008. The goal of our study is to investigate how well the irradiance variability of TSI and SSI of separate narrow wavelength bands coincides with the sunspot numbers variations for the decreasing phase of the solar cycle 23 and estimate existing correlation coefficients between SSI, TSI and SN.

2. DATA DESCRIPTION

The study in this paper is based on more than twenty years of solar total and spectral irradiance measurements obtained by space experiments. Spectral irradiance data were extracted from the NASA data archives. The data centers provide interactive and direct access to a comprehensive set of solar spectral irradiance measurements from the soft X-ray (XUV) at 0.1 nm up to the near infrared (NIR) at 2400 nm, as well as the measurements of Total Solar Irradiance (TSI). The data contain hourly and daily measurements and are merged into ASCII text-files making data convenient for following processing. We have investigated the solar spectral irradiance (SSI) in the range of 120-300 nm for the descending phase of the solar cycles 23, using spectral time series of FUV and UV obtained by SORCE (2003-2009, available wavelength range 116.5 nm – 1598.95 nm) experiment. Time series of solar spectral irradiance analyzed in this paper were been extracted from datacenter LISIRD. We have developed software for extracting and processing of narrow band spectral irradiance data. The International Sunspot number data and

total solar irradiance data are used as well. SN data are obtained from the Solar Influences Data Analysis Center (SIDC), World Data Center for the Sunspot Index, at the Royal Observatory of Belgium. TSI data products are formulated using measurements made by the SORCE/TIM instrument providing ongoing calibrated high precision values. Linear data interpolation inside the missing interval was used in the case when data were missed. We have interpolated daily values of data indices to get continuous and spectrally resolved measurements of the irradiance and more obvious trends of time series in the case when there were several data for a given day their values were averaged. As a result, the daily sequences of selected values were obtained.

DATA ANALYSIS AND RESULTS

Using software developed by us, we have chosen the following wavelengths from the solar spectral irradiance database: 121.5 nm, 285.5 nm, 289.5 nm, 300.5 nm, 393.36 nm and 587.59 nm to compare the solar spectral irradiance variations of the selected narrow bands with TSI and SN variations. 121.5 nm Lyman-α emission is originated in transition region of the Sun, 285.5 nm, 289.5 nm and 300.5 nm lines emission are originated in the solar chromosphere, 393.36 nm and 587.59 nm lines emission are originated in solar chromosphere as well. Selected ASCII data have been reduced using the latest version of the program MATLAB.

To locate above mentioned time series in one figure we use standardized values. Data are standardized by equation:

$$y_s = \frac{y_i - \bar{y}}{\sigma_y} \tag{1}$$

y_s – Standardized values;

y_i – Daily meanings of the selected data time series;

$\bar{y}$ – Time average meaning of the selected data time series;

σ_y – Standard deviation for the selected data time series.

Variations of standardized daily values of selected narrow band of SSI and sunspot number for the descending phase of the solar cycles 23 are presented on Figures 1-5.

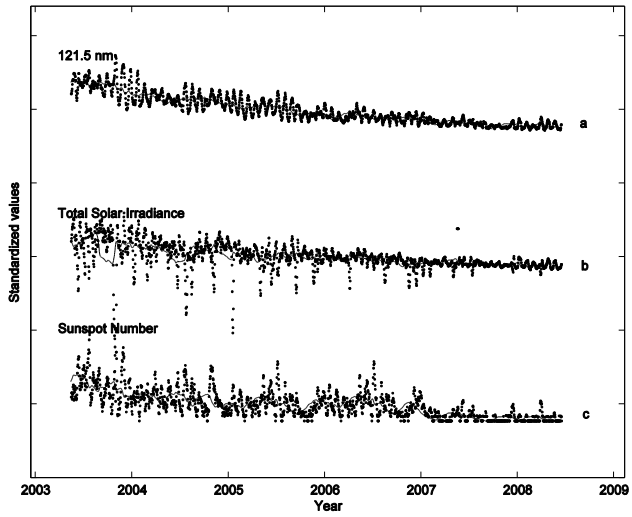

Fig. 1. Variations of standardized daily values of selected narrow band intensity 121.5 nm (a), solar total irradiance (b) and sunspot number (c). Daily meanings of amplitudes of irradiance intensities and sunspot numbers are standardized to the corresponding standard deviations. Standardized values are shown as data points. Solid lines correspond to smoothed data creating by moving average made on 61 points basis. The horizontal axis corresponds to the period 14 May 2003 – 14 June 2008.

We have noticed a peculiar behavior in some regions of FUV and UV emissions of the solar spectrum. Figures 1, 2 show that variability of some spectral lines clearly repeats the main trends of sunspot number and TSI for the decreasing phase of the solar activity cycle 23. However, some of them (Figures 3-5) indicate opposite behavior. We found that anti-correlation takes place between intensities of some narrow band of spectrum and TSI and SN in the cycle 23.

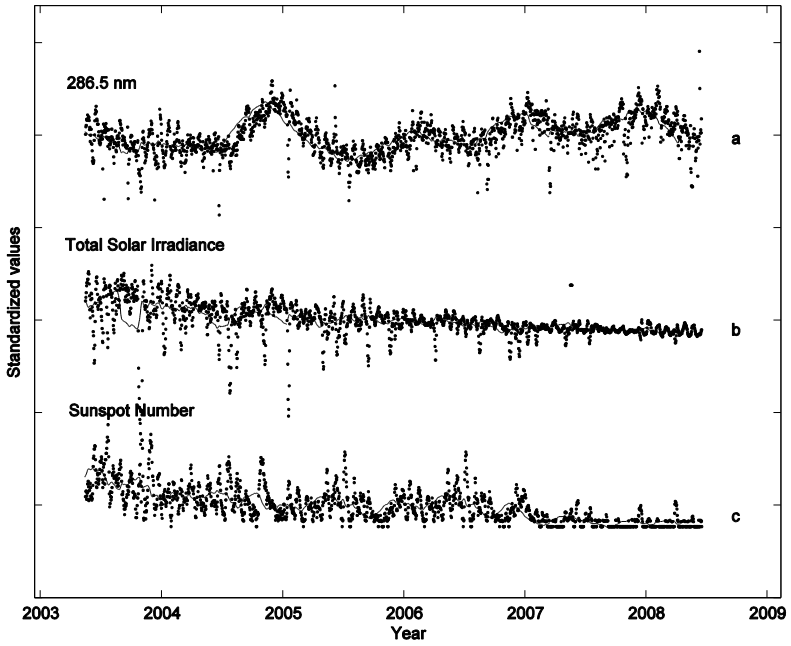

Fig. 2. The same as in Figure 1 for the selected narrow band intensity 286.5 nm.

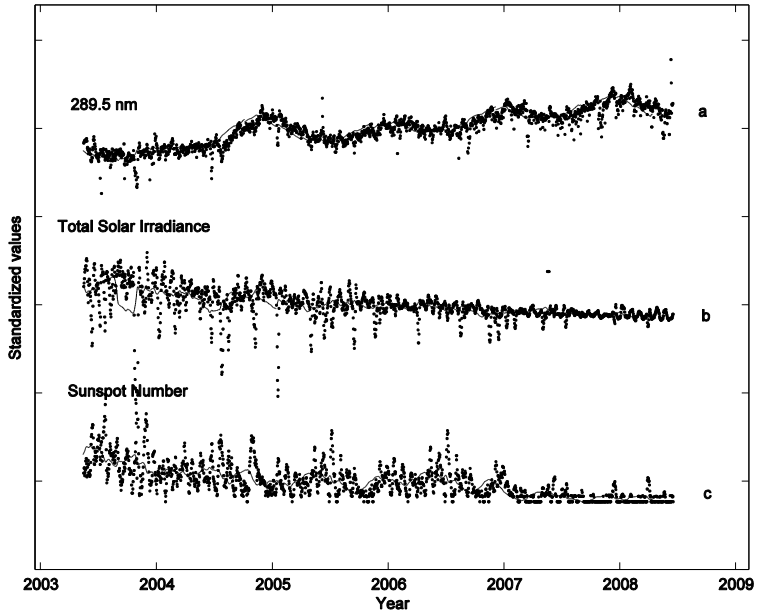

Fig.3. The same as in Figure 1 for the selected narrow band intensity 289.5 nm.

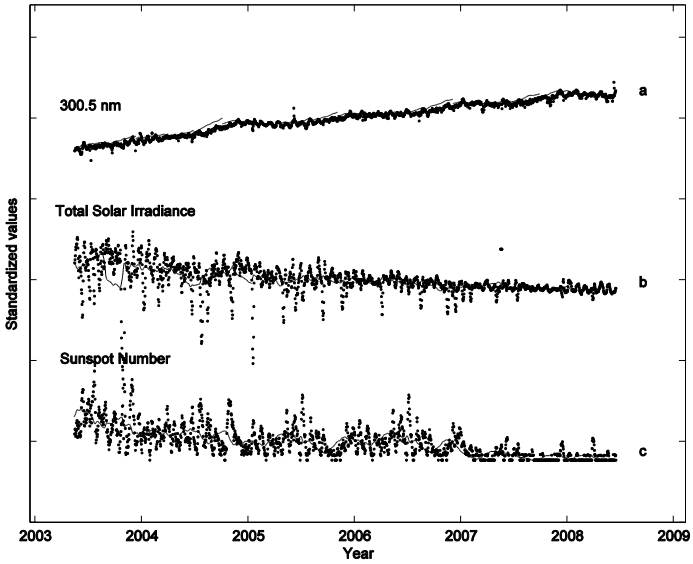

Fig. 4. The same as in Figure 1 for the selected narrow band intensity 300.5 nm.

To define correlation coefficients (r) between intensity variations of separate spectral irradiances, TSI and SN we used an equation:

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\left(\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2\right)^{1/2}} \tag{2}$$

where x_i and y_i correspond to the two different time series of running averaged values selected from SSI, TSI and SN data, i indicates a number of measurement, $\bar{x}$ and $\bar{y}$ are timed averages of selected data. We have calculated correlation coefficients between selected data. The results are presented in the Table 1.

Table 1.

Correlation coefficients are given between intensity variations of the selected narrow bands of solar spectrum and solar activity proxies (TSI and SN) for minimum period between solar activity cycles 23 and 24 (2003-2009). Data were smoothed by moving average made on 61 points basis

Correlation	121.5 nm	286.5 nm	289.5 nm	300.5 nm	TSI
121.5 nm	1	-0.36	-0.91	-0.97	0.78
286.5 nm	-0.36	1	0.70	0.48	-0.22
289.5 nm	-0.91	0.70	1	0.96	-0.79
300.5 nm	-0.97	0.48	0.96	1	-0.80
TSI	0.78	-0.22	-0.71	-0.80	1
SN	0.93	-0.40	-0.88	-0.91	0.70

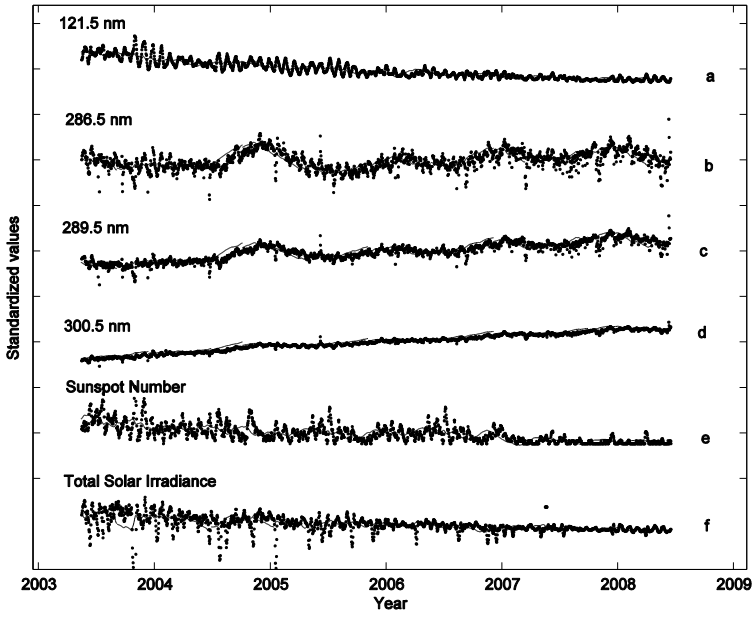

Fig. 5. Variations of standardized daily values of selected narrow band intensities 121.5 nm (a), 286.5 nm (b), 289.5 nm (c), 300.5 nm (d), sunspot number (e) and solar total irradiance (f). Daily meanings of amplitudes of irradiance intensities and sunspot numbers are standardized to the corresponding standard deviations. Standardized values are shown as data points. Solid lines correspond to smoothed data creating by moving average made on 61 points basis. The horizontal axis corresponds to the period 14 May 2003 – 14 June 2008.

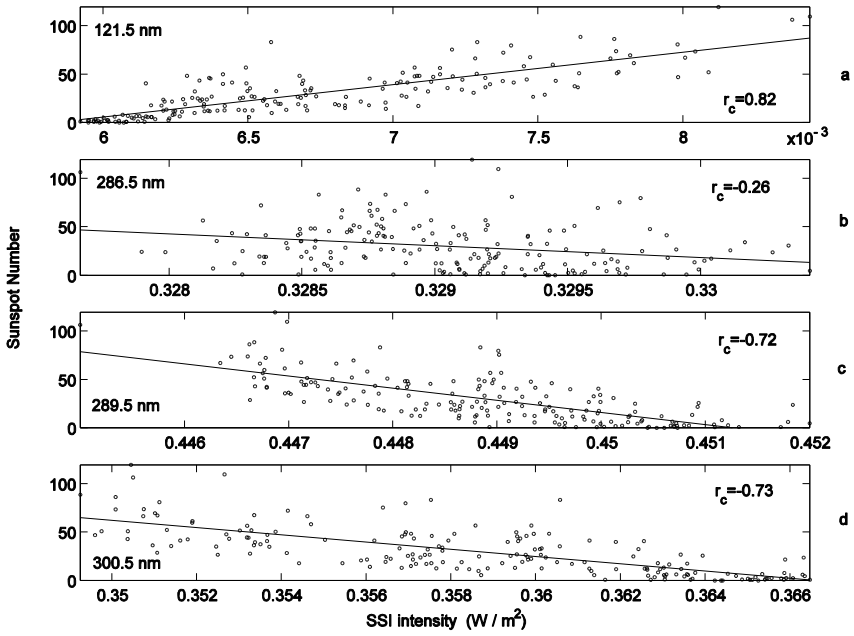

Fig. 6. Linear trends for relationships between SN and intensities of narrow bands of SSI. 10-day average meanings are presented. Correlation coefficients are indicated in the figure.

Correlation coefficients indicated in the Figure 6 are different from ones presented in the Table 1, because of different way of data smoothing. As it is shown in the Figure 6 and Table 1, positive high-level correlation is observed between narrow band of spectral range (121.5 nm, 285.5 nm) and TSI and SN. While negative high-level correlation is observed between narrow band

of spectral range (289.5 nm, 300.5 nm) and TSI, and SN. Consequently, we have obtained negative correlation between UV spectral ranges 121.5-285.5 nm and 289.5-300.5 nm. To demonstrate the linear correlation between SN and SSI of different narrow band we have plotted graphical relationship for these parameters. Results are presented in Figure 6. We have found linear trends (solid lines) for these relationships. We have calculated standard deviation for each case and estimated the accuracy of the linear trend coefficients. Confidence levels for all coefficients are more than 95%.

BEHAVIOUR OF INTENSITY VARIATION IN SOME VISIBLE RANGE OF SOLAR SPECTRUM IN INVESTIGATE PERIOD

Light from singly-ionized calcium ions is originated in the Sun's upper photosphere and chromosphere. Because the Calcium K Line (393.3 nm) is sensitive to magnetic fields, magnetically active structures show up high contrast against the surrounding chromosphere. Ca II K images give the possibility to see brightness along the edges of large convection cells called supergranules and in areas called plages. Therefore, Ca II K line provides important information on the large-scale magnetic field structure in the chromosphere.

He I 587.59 nm line also is originated in the chromosphere and its emission line belongs to the visible range of solar spectrum. This emission line is observed in prominences and plages, and it is sensitive to magnetic fields as well. To compare intensity variations of selected narrow band of UV and FUV with intensity variations of spectral lines of visual range of solar spectrum we have studied narrow wavelength band correspond to Ca II K and He I lines, which are originated in solar chromosphere. We used measurements extracted from data center LISIRD.

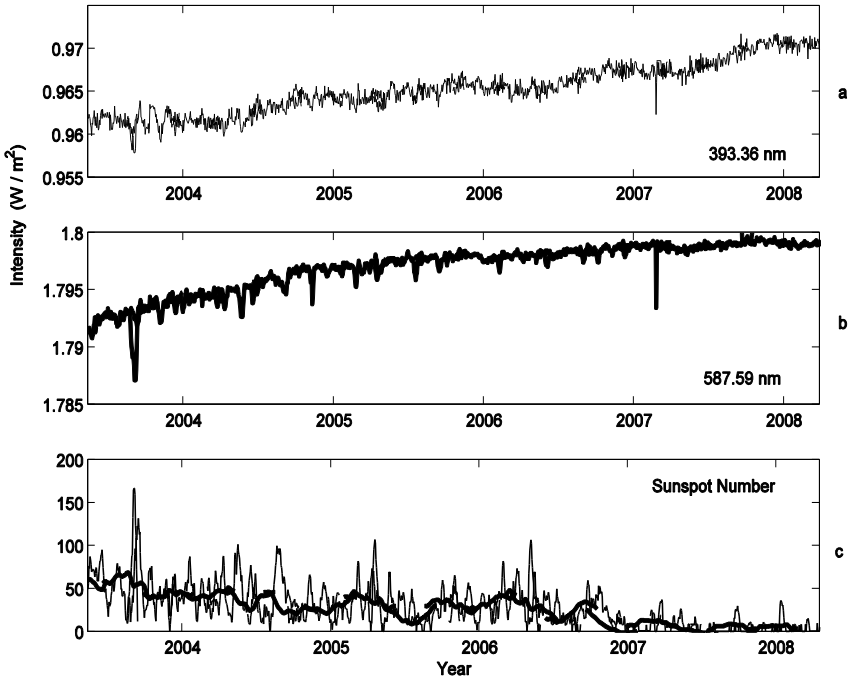

Fig. 7. Variations of daily values of selected narrow band intensity Ca II K 393.36 nm (a), He I 587.59 nm (b), and sunspot number (c). Data are shown as points. Solid line corresponds to smoothed data creating by moving average made on 61 points basis. The horizontal axis corresponds to the period 14 May 2003 – 14 June 2008.

As it is shown in Figure 7, Ca II K 393.36 nm and He I 587.59 nm lines emission indicate behavior similar to UV spectral narrow band in diapason between 289.5 – 302.5 nm.

DISCUSSION

Solar FUV and UV irradiance originates mostly in the solar photosphere and chromosphere. Temporal variability of solar UV emission modulates global climate processes of the Earth. Investigation of solar UV irradiance variability gives a good possibility for better understanding of physical processes existing on the Sun. Since the first space measurements of solar irradiance in the late seventies, the Sun has been constantly monitored with a precision high enough to detect even variations of the order of 0.01% [9, 10]. It is considered that the solar irradiance in the EUV and UV can be decomposed into different contributions, which makes the modeling of the spectral variability relatively easier [11-13]. Such a method of decomposition of solar irradiance necessarily implies a strong connection between the physical processes at different solar atmospheric layers [14]. Using contemporaneous helio-seismic data from GONG and MDI it is found that the changes in resonant mode frequencies during the current solar activity minimum period are significantly greater than the changes in solar activity as measured by different proxies. Further, both the GONG and MDI frequencies show a surprising anti-correlation between frequencies and activity proxies during the minimum between solar activity cycles 23 and 24 [15]. The frequencies of the global oscillation modes of the sun were used to learn about the seismic conditions of the solar interior during the current minimum phase. The variation of the oscillation frequencies with solar cycle has been the subject of many studies and is now well established. However, the physical origin of these changes is still an active field of research. The extended minimum activity epoch has provided an important period to analyze and interpret the frequency variations during quiet periods of solar activity [15]. Investigations of de Toma et al. [16] illustrate the difficulty in using simple proxies and regression techniques to deduce physical sources of solar irradiance variability. According our study it is found that emission of different solar spectral narrow bands does not agree equally well with other indices of the solar activity during decreasing phase of the solar activity cycle 23. In some cases, high-level negative correlation takes place. We consider that obtained anti-correlation is not caused by changes of optical characteristics of measuring instruments, as an unusual behavior is observed in the range of solar spectral irradiance 289.5-305 nm. The occurrence of an anomalous behavior of some narrow bands of solar spectral irradiance complicates understanding of physical processes taking place in the Sun. If the cause of this anomalous behavior is intrinsic to the solar UV irradiance then a model for corresponding mechanism requires further improvement. Furthermore, we have found anti-correlation between solar sunspot numbers and visual range intensity of solar spectrum near to Ca II K 393.36 nm and He I 587.59 nm belonged to chromospheric emission. Anti-correlation between appropriate helio-seismic frequencies and activity proxies during the minimum of the solar activity cycles 23-24 was revealed also according GONG and MDI data [15]. Revealed negative correlations between sunspot number and some solar spectral narrow bands of UV emission (289.5 nm, 300.5 nm), spectral lines (393.36 nm, 587.59 nm belonged to the visible range of solar spectrum), helio-seismic data (obtained by GONG and MDI) indicate that they are in close connection with the super-granules and plages. So the existence of the negative correlation can be explained by the reason that these objects are sensitive to the solar magnetic fields.

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SECTION 4.
Health care

VOLCANIC ERUPTIONS AND LANDSLIDES: HEALTH AND RE-SETTLEMENT FOLLOWING DISASTERS

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1. INTRODUCTION

This presentation offers a bi-national description of re-settlement and health in two countries (Ecuador and Mexico) following geophysical disasters. We use social networks as an analytic tool to understand individual's responses to the disasters and to the conditions following the disaster as communities were re-settled and re-located, as well as in communities affected by the disaster but not moved. The research reported on occurred in four communities in Ecuador and three communities in Mexico. A team of anthropologists and a geographer conducted the research using in-depth interviews, focus group sessions, participant observation, key informant interviews, and archival research in both Mexico and Ecuador between 2005-2010.The findings provide insight into the types of relationships that impede or facilitate recovery, and how resettlement or relocation affect the structure of those relationships. The four principal authors (Whiteford, Tobin, Murphy, and Jones) comprise a team of social science researchers who have been conducting research together and separately on hazards, disasters, and health for the past twenty-five years. This article reflects our most recent work together on National Science Foundation funded research projects in Mexico and Ecuador - two years of the group working together in the state of Puebla, Mexico, and most recently our research in and around the Ecuadorian volcano Tungurahua in the state of Cotopaxi. The central question of the research is how social networks affect recovery following a disaster, and how local people and the national authorities respond following disasters such as volcanic eruptions and mudslides. The aim of this research is to better understand local responses to national disaster policies in the attempt to improve both life-saving during the disaster, and quality of life following the disaster. In this article, we focus on quality of life and self-described health status in affected and re-located communities following disasters in two distinct types of settings; one following a deadly mudslide and the other, exposure to active volcanoes.

The objectives of these two bi-national studies were to determine how physical and stress risk factors create health symptoms in populations living in disaster-prone areas, and to understand the role of social networks in shaping the lived experiences of community members forced to relocate into artificial communities following the explosion of a nearby volcano or after a devastating mudslide. Contrary to other studies, our research findings in Mexico indicated that a low percentage of the interviewees living in disaster-prone areas reported negative physical health

symptoms. In the cases where health problems were reported, they tended to be associated with occupational activities and not with the effects of the natural disasters. These findings pointed to the fact that many factors determine physical health in these regions. The experience of health symptoms cannot be considered in isolation from the demographic characteristics of the population, the cultural context, and the local histories. In Ecuador, relocation was the clearest predictor of stress, lack of support and health problems. Our preliminary analysis shows that in re-settled communities men received more material and emotional support than women and that household conditions were worse in the resettlement and evacuated communities .Across-the-board and by all our measures, life in the re-settled and evacuated communities were worse than in the disaster affected communities. People who had been evacuated or re-settled had higher levels of health problems, more stress, and more depression than those who were not moved. These findings, we believe, should raise serious questions for those who work in disaster mitigation, response and recovery programs.

2. STUDY SITES: MEXICO

Two study sites, San Pedro Benito Juarez and Teziutlbn, were selected to represent communities that have been impacted by a volcano and a mudslide, respectively (Fig.1). The town of San Pedro Benito Juarez (San Pedro) is located in the municipality of Atlixco in the state of Puebla, approximately 11.5 km east of the volcano Popocatypetl. San Pedro has been subjected to effects from the volcano Popocatypetl of varying degrees. The town is the closest to the cone and it is under volcanic threat, because it lies in the area most likely to be hit by ashfall, lithic projectiles and pyroclastic flows. The active volcano has been relatively quiet over the last 100 years; however, it entered a new phase in 1994 when an eruption caused 75,000 residents to be evacuated. Eruptions have continued since 1994, and one additional eruption in 2000 necessitated formal evacuation proceedings. The population of San Pedro is 4,340 with approximately 817 households [1]. The town is primarily agrarian (cultivating corn, beans, and squash and raising livestock), but the community members engage in a variety of economic activities such as: selling of charcoal, commerce of agricultural and animal products, remunerated employment in nearby cities, and migration to the United States.

Fig. 1. San Pedro and Teziutlan, Mexico

Teziutlbn experienced a mudslide that forced the evacuation and eventual the relocation of many residents to a new community, Ayotzingo, a neighborhood within the municipality of Teziutlbn, but at the urban fringe of the city. Teziutlbn is located in the northeast portion of the state of Puebla in the Sierra Norte. While heavy rainfall is cyclical, the community does not routinely experience evacuations. However, in the fall of 1999 many communities in the Sierra Norte experienced a series of floods and landslides that took the lives of more than 400 people and destroyed the homes of 200,000 [2]. The neighborhoods that were most severely affected (La Aurora, Huehueymico, Colonia Juarez, Aire Libre, San Sebastian, Xoloco, Xoloateno, Mexcalcuautkam Atoluca, and La Gloria) were relocated to Lomas de Ayotzingo where the

Instituto Poblano de la Vivienda (Puebla Housing Institute) donated 35 thousand square meters to provide families with plots to build their new homes. Currently, different measures are implemented by local and state government authorities to inform the population of possible risks and the actions that might be needed in the event of a future emergency such as emergency booklets and radio messages in Nahuatl, the language of many surrounding rural populations [3]. In addition, there was a control site whose data are not included in this paper.

3. STUDY SITES: ECUADOR

In late 1999 and mid-2006, the highland Andean provinces of Tungurahua and Chimborazo, Ecuador suffered the devastating impacts of the eruption of the Tungurahua volcano and many communities had serious social and economic damage. Economic conditions have declined severely due to damage to local production and poverty has increased throughout the affected areas. The communities in the high risk zone (the areas closest to the volcano) in the two provinces were the most severely affected by the eruptions and were subjected to several mandatory evacuations. Evacuees were transported to shelters in less hazardous urban centers, such as Riobamba, Pelileo, and Ambato. Ashfall damaged and obstructed roads, schools and health centers as well as crops, animals and irrigation systems. In addition to the devastating effects the volcano had on household and regional health and economies, these eruptions also resulted in the permanent displacement and resettlement of thousands of former residents of the high risk zone around the Tungurahua volcano.

3.1 Penipe Viejo (affected, not evacuated)

Penipe is a small urban township that serves as the county administrative seat (cabacera cantonal) of Penipe County (*Canton Penipe*) in Provincia Chimborazo. At 10km south of the volcano, Penipe Viejo sustained moderate ashfall during the 1999 and 2006 eruptions, and light ashfall in the interim and ensuing time periods. Penipe Viejo was never evacuated for any of the eruptions. It served as a base of emergency response operations during the major eruptions and several local buildings were repurposed as shelters for evacuees from the parroquias in the high risk zone to the north. The eruptions affected Penipe economically, politically, demographically, and in terms of health and wellbeing.

3.2 Penipe Nuevo (re-settlement)

Penipe Nuevo is a resettlement community built as an extension of the urban center of Penipe Viejo. It consists of 285 houses, constructed by the Ministry of Housing and Urban Development and a multinational, faith-based NGO, Samaritan's Purse. The resettlement is a landless, urban resettlement populated by smallholding rural agriculturalists displaced from the northern parroquias of Bilbao, Puela, and El Altar in the wake of the 1999 and 2006 eruptions of Mt. Tungurahua.

3.3 La Victoria de Pusuca (re-settlement)

La Victoria de Pusuca (hereafter, Pusuca), is a small, land-based rural resettlement community, largely built by Ecuadorian NGO, Fundaciun Esquel. The hilltop resettlement consists of 45 houses occupied by smallholding rural agriculturalists primarily displaced from the northern parroquia of Puela, with a few from Bilbao and El Altar. It sits 5 km south of Penipe.

3.4 Pillate and San Juan (evacuated and returned)

Pillate and San Juan are two adjacent villages in Parroquia Cotalo, Canton Pelileo, Provincia Tungurahua. These two villages lie just west of the northern extents of Parroquia Bilbao, Canton Penipe, across the Chambo River. The two communities of approximately 35 households each are just 3 km west of the volcano and well within the high risk zone. They were evacuated for both eruptions in 1999 and 2006 and the villages suffered immense damages as a result of heavy ashfall, incandescent material, and tremor-induced landslides. In spite of this damage,

approximately 70% of the former residents of these communities returned to live in and rebuild the villages after each eruption. In 2006 Tungurahua began a period of activity far greater than 1999 or any intervening years. An estimated 7000 people were evacuated from the high risk zone around Tungurahua on July 15th (Ecuadorian Red Cross 8-4-07). At this time, there were still an estimated 3000 people living in shelters from the first eruption 1999. However, many families (at least 300) had returned to their homes and farms in the high risk zone since the prior eruption. The evacuations, although in many ways chaotic and frightening for all involved, ran much more smoothly and safely than in 1999 because residents had prior experience, were more prepared, and knew where to go [4]. Importantly, by 2006 there were dedicated shelters in place, although people report that conditions were scarcely better than they had been in prior shelters. However, there were many people who no longer wished to leave their communities and resisted evacuation at first. Many people slept in shelters and returned daily to the hillsides to tend their crops and animals, often leaving their children in the shelters during the day. The military issued identification cards to heads of households and frequently accompanied locals as they visited their property to prevent theft, malfeasance, and the return of villagers before the eruptions had subsided.

4. METHODS: DATA COLLECTION- MEXICO AND ECUADOR

Two separate survey instruments were employed in both sites. First, a short "Socio-Demographic Survey" collected basic demographic information for 1,379 randomly-selected individuals (710 from San Pedro Benito Juarez and 669 from Teziutlbn in 150 and 139 households respectively). Data gathered included information on age, gender, formal education, birthplace, marital status, language, and occupation. A more detailed survey ("Impact and Well-Being Survey") was administered to 200 randomly-selected participants from the socio-demographic survey. Fifty-seven (57) of the respondents were from San Pedro and 139 from Teziutlbn. Survey questions were comprised of nine variable groups, including demographic, evacuation experience, and beliefs toward the volcano/mudslide, household conditions, recent life changes, closeness to people, material possessions and resources, physical health symptoms, depression symptoms, and post-traumatic stress symptoms. For measure of well-being, commonly used scales were employed to assess post-traumatic symptoms (17 items) adapted from a modified version of schedule K of the World Health Organization's Comprehensive Interview Diagnostic Inventory 2.1 (21); depression symptoms (20 items) from the CES-D, including subscales of negative affect and lack of positive affect (22); and physical health symptoms (20 items) from the Physical Symptoms Checklist (23) including subscale for heart (3 items), respiratory system (5 items), muscles (5 items) and physical stress/level of energy (4 items). Also included was a question about being limited in capacity due to physical symptoms; living conditions (10 items) from the Ecological Stress Scale (24); perceived support (22 items) from the Provisions of Social Relations Scale, including subscales for support perceived from friends verses family verses mate/partner (25); and the number of 26 listed consumer items owned plus the number of rooms in their house, (excluding kitchens since many kitchens are separate and less permanent structures) served as measures of wealth. In this article, we present the frequencies of the variables associated with the reporting of health symptoms. Five focus groups were carried out in San Pedro Benito Juarez with women of mixed aged groups participating in the *Oportunidades* program at the local government Health Clinic (IMSS) and one focus group was carried out with 12 male members of the local town council. The purpose of these six focus groups was to document the participants' experience with the volcano, prior eruptions, support networks, local beliefs, and health consequences. Personal networks are comprised only of the individuals that one person knows (and who among them know one another). The interviewee was asked the following question to generate the other individuals in the network, "Please list 45 people you know by sight or by name with whom you have had contact or could have had contact if you needed to, in the past two years" [5].. They were asked for basic demographic information about a random subset of 25 individuals named, including sex, estimate of age, socioeconomic status relative to them, ethnicity, number of household members, degree of emotional closeness to them, whether affected by the volcano or not, and which of the individuals in the network knew

each other. In addition, they were asked to estimate the month of their last contact with each of the people in their network, and whether social, personal, financial or material support had been provided by anyone in the network. The same methodology was employed in Ecuador with samples of 302 individuals surveyed using the Sociodemography instrument, and 261 individuals surveyed for the Health and well-being questionnaire.

RESULTS

In the Mexico study, significant differences between the variable groups were determined using the Kruskal-Wallis test for nonparametric independent samples. Regression analysis was conducted for two scaled variables: total physical health symptoms and total post-traumatic stress criterion symptoms. Results indicated that well-being can be addressed from different outcomes concerning mental and physical health, economic status, ecological stress, and social support, determined in part by the characteristics of individuals' social networks. Our analysis suggests that in the Mexico volcano hazard site, education appears to be good predictor of health symptoms, while in the landslide site, sex and age were factors related to more health symptoms. Overall, more health and stress symptoms were reported in the landslide site than the volcanic site. While we are still analyzing the data, we intend that the results of this research can be used to inform and improve risk communication and educational policies in natural disaster prone regions. Data in Mexico were collected from approximately thirty questions which were used to determine the general characteristics of the communities. This information is presented in Table 1.

Table 1.

Demographic data from impact and well-being survey

		San Pedro (n=57)	Teziutlán (n=139)
		Percent	**Percent**
Age	18-27	25.4	3.6
	28-36	18.7	19.4
	37-45	18.6	26.6
	46-95	37.3	51.4
Gender	Male	41.9	30.2
	Female	58.1	69.8
Marital Status	Married/Partner	52.5	60.4
	Not married	47.5	39.6
Place of Birth	Same city	98.2	45.9
	Nearby area	-	31.1
	Same country	1.8	23.0
Formal Education	Range	NA	NA
	Average	NA	NA
	Categories		
	0 to 5	30.9	43.5
	6 to 8	30.9	27.5
	9+	38.2	29.0
Religion	Catholic	57.4	90.6
	Evangelical	42.6	2.2
	Other	-	7.2
Employment	Occupation		
	Peasant	83.6	2.2
	Student	10.9	-
	Store worker	1.8	2.2
	Other	3.6	26.6
	Laborer	-	27.3
	Work/Home	-	41.7

Impact and Well-Being Survey. Demographic data were collected from approximately 300 questions from 200 adult respondents selected from the socio-demographic survey. These data indicate that more females were interviewed in both communities (58 percent in San Pedro and almost 70 percent in Teziutlbn). Over half the respondents from both communities were married or living as such (52.5 percent in San Pedro and 60 percent in Teziutlbn), and similar levels of education were represented in both communities (between five and seven years on average). The demographic composition of the communities differed in age, location of extended family, birth place, religion, and occupation (Table 1). The average age of respondents in Teziutlbn (47 years) was significantly higher than San Pedro (43 years) (p=.041), with significantly older respondents (49 years plus) in Teziutlbn (50 percent) than in San Pedro (34 percent) (p=.001). Respondents from San Pedro had more family living elsewhere (about two on average per respondent in San Pedro compared to less than one in Teziutlbn (p=.001). Significantly more respondents in San Pedro (98 percent) were born in same city than in Teziutlbn (46 percent). Probably the most notable difference between the communities was religion, with a higher concentration of participants that affiliate with the evangelical religion in San Pedro (43 percent) compared to only two percent in Teziutlbn (p=.001). Additionally, the predominant occupation in San Pedro was agrarian (83 percent) compared to only two percent in the textile factory city of Teziutlbn. Respondents were asked to indicate if they experienced symptoms in the last month related to their physical health. The health symptoms involved complications with respiratory, cardiovascular, muscular, strength and energy level, (see Table 2). On average, Teziutlbn respondents reported a higher frequency of health symptoms than in San Pedro. The variables where a higher frequency of interviewees indicated that they had experienced the health symptom were: headaches, shoulder, hands, and arm problems, back problems, and hips, legs, knees, and feet problems. This higher rate of reporting was only visible in the interviews with people from Teziutlan.

Table 2.

Health Symptoms in Study Sites

		San Pedro Benito Juarez		Teziutlan	
		Count	**Percent**	**Count**	**Percent**
Headaches	Yes	27	47.4	**80**	**58**
	No	30	52.6	**58**	**42**
Sinusitis	Yes	12	21.1	37	26.6
	No	45	78.9	102	73.4
Throat problems	Yes	18	31.6	57	41.3
	No	39	68.4	81	58.7
Neck problems	Yes	17	29.8	50	36.2
	No	40	70.2	88	63.8
Pain in your chest	Yes	15	26.3	42	30.4
	No	42	73.7	96	69.6
Heart irregularities or palpitations	Yes	7	12.3	40	29.2
	No	50	87.7	97	70.8
High blood pressure	Yes	10	17.9	41	29.9
	No	46	82.1	96	70.1
Difficulty breathing	Yes	7	12.3	35	25.7
	No	50	87.7	101	74.3
Other lung problems	Yes	13	22.8	19	14.1
	No	44	77.2	116	85.9
Stomach problems	Yes	18	31.6	66	48.2
	No	39	68.4	71	51.8
Intestinal problems	Yes	9	15.8	44	32.1
	No	48	84.2	93	67.9
Shoulder, hands, and	Yes	21	36.8	**72**	**53.3**

		San Pedro Benito Juarez		Teziutlan	
		Count	**Percent**	**Count**	**Percent**
arms problems	No	36	63.2	**63**	**46.7**
Back problems	Yes	26	45.6	**69**	**50.4**
	No	31	54.4	**68**	**49.6**
Hips, legs, knees, and feet problems	Yes	27	47.4	**77**	**56.6**
	No	30	52.6	**59**	**43.4**
Swelling in the legs or ankles	Yes	15	26.3	35	25.5
	No	42	73.7	102	74.5
Problems with loss of balance or dizziness	Yes	10	17.5	44	32.1
	No	47	82.5	93	67.9
Change in weight, appetite or the desire to drink liquids	Yes	13	22.8	47	34.3
	No	44	77.2	90	65.7
Fever	Yes	13	22.8	25	18.2
	No	44	77.2	112	81.8

Data from the Ecuador study is still being analyzed; provisional results suggest social networks may strongly effect how individuals respond to post-disaster relocation and resettlement, and that individual self-reported health is linked to different patterns of personal networks.

Social networks can play an important role in support and recovery. We found that: social networks with strong ties and close relationships tend to be associated with greater levels of support than those with looser networks; close relationships in the affected site had lower levels of support than in other communities; social networks with only a few key connections were particularly important in the resettlement communities; individuals with such networks received higher levels of support than those with more complex networks. In addition such relationships were not found in the affected or evacuated communities; support from families differed amongst communities; evacuated individuals cited the highest levels of family support, followed by those in the affected community; the lowest levels were apparent in the resettlement communities; support from spouse or friends did not vary by community type; males received more material and emotional support in the resettlement communities than females. We found that household conditions were worse in the resettlement and evacuated communities than in the affected community; physical health conditions were worse in the resettlement and evacuated communities than in the affected community; stress levels were higher in the resettlement and evacuated communities than in the affected community; depression levels were highest in the resettlement communities.

6. CONCLUSION

The data from Mexico suggest that health status was shaped by contexts external to the disasters or re-settlement, for instance, the demographic constraints of age, economic status, occupation, proximity to family members of employment opportunities appear to be stronger predictors. Families who had been relocated showed little variation in health status or social networks in comparison to those who lived in affected but not re-settled communities. This is strikingly different from the Ecuador results concerning differences between re-settled and non-re-settled communities. In contrast, information gathered in Ecuador points to the fact that being resettled or being moved to a relocated community did affect one's health, particularly in terms of depression. In addition, social support varied with types of community. For instance, social networks with only a few key connections were particularly important in the resettlement communities. Individuals with such networks received higher levels of support (material, emotional and informational) than those with more complex networks. Such relationships were not found in the affected or evacuated communities. Evacuated individuals cited the highest levels of family support, followed by those in the affected community. The lowest levels were apparent in the resettlement communities. Males received more material and emotional support in the resettlement

communities than females. The household conditions in the resettlement and evacuated communities were worse than in the affected community. And, not surprisingly, physical health conditions were worse in the resettlement and evacuated communities than in the affected community. To add to these findings of concern, stress levels were higher in the resettled and evacuated communities than in the affected community, and depression levels were highest in the resettlement communities. These data are important for those concerned with moving people out of harm's way when faced with a disaster. Policy-makers and practitioners, politicians and local people need to understand the consequences of moving people from their homes and what kinds of communities are most negatively affected by such actions. Disaster managers face the arduous task of preparing communities for difficult situations before they happen so that when they occur, the members of the communities know how to protect themselves. The mitigation, response and recovery responsibilities of those involved in disaster management often emphasize early response, but this body of research suggests that the recovery phase may need greater attention. This article suggests that an often overlooked variable is how the larger quotidian context of life shapes peoples' concerns. Those contextual and daily variables shape community members' overall perspectives on their health, and may intervene on civil defense messages concerning hazards and potentials disasters. Given the data from this research, a message to those officials involved in disaster management may be to give attention to such things as community public health infrastructure and employment patterns that may intervene on community members' ability to incorporate disaster prevention messages as they normalize their existing hazards. It is hoped that the information presented here can be used to inform national civil defense policy, and improve risk communication and educational policies in disaster prone regions.

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MOBILE CELL MEDICAL COMPLEX, A NEW FORM OF IMPROVING PRIMARY HEALTH CARE TO PREVENT AND REDUCE THE RISK OF THE CONSEQUENCES OF EMERGENCIES AND NATURAL DISASTERS

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In recent decades, due to the increasing number and scale of emergencies on the planet Earth natural and man-acquired significance to the problem of improving the organization of first aid for the elimination of their consequences. According to the UN, only the last 20 years in the world as a result of natural disasters (earthquakes, floods, hurricanes, typhoons, etc.) affected about 1 billion people, nearly 3 million died. According to expert data, WHO notes that if a few decades ago was dominated by natural factors in injuries and deaths, but today, the share of anthropogenic and technogenic disasters associated with human activities in the production, transport and other spheres. At the beginning of the XXI century the problem of emergencies has taken on even greater urgency due to the fact that for natural and man-made causes of emergency has joined a factor of direct violence, threatening the individual regions, population groups and society as a whole - the terrorist attacks, local armed conflicts. Besides the enormous economic damage emergencies production, facilities, utilities, transportation, energy, infrastructure and overall economy of the region disaster, a major component of any disaster is human. Effect of ES on the medical-demographic situation of mortality, temporary disability, the disabled population. The economic cost of population losses in the emergency consists of damage to the national economy of the loss of people and lifelong disability, medical expenses and welfare of victims, the costs of compensation to victims and their families. Caused death, injury or loss of a breadwinner. In opposition to extreme threats involved significant human, logistic, financial and organizational resources of the country. All this makes it objectively necessary to develop an effective system of prevention, elimination and minimization of medical and demographic consequences of emergencies, ie what is the basis of service Disaster Medicine. Analysis of previous disasters and large-scale disasters has shown a lack of preparedness and public health agencies, medical personnel at all levels to work in extreme situations. The current adverse situation with the elimination of serious health consequences of emergencies, to ensure timely and efficient skilled emergency medical care requires a restructuring of emergency medical services. Training of medical staff knowledge and practical skills in first aid in emergency situations (10).

The territory of Kazakhstan by reason of the climatic conditions and a large area (2,725 square kilometers, or 2.7% of the land of the Earth) has a number of areas of natural and technological risks and significantly exposed to a variety of disasters. There are natural disasters such as earthquakes, mudslides, avalanches, landslides and avalanches, flooding, inundation and flooding, droughts and severe frosts, snowstorms and blizzards. In the seismic and mudflow zone are the most undeveloped and densely populated areas of the republic, where the focus 40% of industrial capacity are more than 6 million people. A significant number of industrial oil facilities, chemical. Coal and other sectors create an additional threat of man-made accidents. In addition, in recent years due to the worsening situation in Afghanistan has increased the likelihood of local armed conflicts and terrorist attacks in the southern and southeastern regions of the country. Thus, sources of emergency on the territory of the Republic is more than enough. In this connection, the task of organizing an effective health care services in an emergency in Kazakhstan is particularly relevant. Today, the Republic was a paradoxical situation, when a well-developed system of technical support disaster emergency, it is extremely underdeveloped Service for Disaster Medicine (thin staffing, poor resource base are not sufficiently developed problems, the system of planning and forecasting, the interface services and organizing care).

Given the specificity of spatial and natural environment of the Republic of Kazakhstan, in order to reduce the time emergency medical care, reducing the stages of evacuation and the approximation of specialized medical care to the fire disaster, an urgent need to create mobile medical units (by type medical unit of special purpose MUSP) airborne troops (by type of airborne troops of the Russian Federation Ministry of Emergency Situations) (9).

At the territorial level, there are no emergency medical service staff controls the constant readiness. Meanwhile, we know that the threat of the emergence or elimination of the health effects of accidents and natural disasters, the important role played by permanent duty and dispatch units authorized to take appropriate decisions for emergency measures.

Requires improving the system of interaction of state bodies, various departments and organizations in the field of emergency response in case of natural and manmade disasters.

In terms of training of service Disaster Medicine, the need for special training programs, training centers, departments, emergency medical service training bases. One of the important tasks of emergency medical service is the development of information and communication technologies, development of methods for planning, modeling and predicting the health consequences of emergencies, which the world paid attention. To achieve the precise organization of surgical services in the country in emergency situations of natural and man-made, as well as in cases of local armed conflicts require wastewater system acquisition and deployment of medical units, ensuring their readiness for immediate implementation of the tasks, training of personnel of medical units to the principles of medical evacuation measures in the foci of mass destruction, the population, improvement of the interaction of medical units of various departments in the organization of work to deal with emergency planning, surgical care and prediction of health consequences of disaster in each region and the solution of many other organizational issues. The implementation of these tasks requires first and foremost scientific justification to address them. This important aspect of a mobile medicine in the Republic of Kazakhstan is dictated by the times and marked in the Message of President of Kazakhstan Nursultan Nazarbayev (1), where before the three departments – the Ministry of Health, the Ministry of Transport and Communications, Ministry of Emergency Situations - has been tasked to make a decent primary care for all without exceptions and at any point in the country by creating a health-and-rescue-route points, control units, authorized to take appropriate decisions for emergency measures. Currently, research has developed a system of recruitment of health systems in rail, road and air transport, have to deal with the organization of medical care in emergencies. To properly and effectively address the practical problems of organization of PHC has developed special training programs designed mobile systems, training of doctors basic profiles. One of the important tasks of Emergency Medical Service (EMS) is to develop a sempai of information and communication technologies, development methods for planning, modeling and predicting the health consequences of emergencies, which the world paid attention. To achieve the precise organization of medical services in the country in emergency situations of natural and manmade, as well as in cases of local armed conflicts is necessary, spent a system of recruitment and deployment of medical units, ensuring their readiness for immediate implementation of the tasks, training of personnel of medical units to the principles of medical evacuation measures in the foci of mass destruction, the population, improvement of interaction between medical units of various departments in the organization of work on disaster management, planning and forecasting aid health consequences of disaster in each region, and the solution of many other organizational issues. The implementation of these tasks requires, above all, the scientific basis to address them. Scientific studies conducted in this direction since 2000, when the first Dzhaynakbaev N.T (2000) (2; 3; 4) experience was gained in the deployment of medical units, which showed high performance and prospects of the use of mobile medical facilities in large-scale emergency situations of natural and man-made order. To improve medical assistance to victims of disaster is a rapid response, health care, minimizing casualties, prediction and prevention of the risk of disaster. In these moments we have analyzed the system of recruitment for contingency medical units in the medical service of the railway. The paper presents the principles of acquisition of medical units, their staff number, order and amount of care. A feature of the system is created on the basis branch's and road hospitals not only stationary units specialized care team (SCT), but medical rapid reaction force - Medical emergency teams (MET) and visiting medical teams (VMT), which ensure the efficiency of medical response, conduct primary activities of emergency medical aid, medical triage and evacuation, thus ensuring the principles of timeliness, continuity and consistency of medical assistance. In essence, these medical units in the system of departmental medical service medical staff perform the functions of a rapid reaction force sempai Territorial Health (11). Specialized medical unit specialized care team (SCT) created the Medical Service of the railway, in contrast to the specialized units of the

territorial health care can function as a stationary mode, and turn around at the crash site. SCT made available on the main profile (trauma, surgical, therapeutic, resuscitation), but if necessary can be supplemented with related specialists - neurosurgeons, Combustiology, psycho neurology, toxicologists, including through training of core specialists in related fields. With the elimination of large-scale health effects of disaster on the railways used mobile medical units - MMSMT (mobile multi-specialized medical train), performing peacetime functions provide specialized on-site medical and preventive care to the population of small remote settlements of the railway. Staff, structure and equipment of medical train can adapt it for use in emergency situations, as a specialized mobile medical units (12). Experience in the deployment of medical units during command post exercises has shown its high efficiency in terms of improving the quality of diagnosis and urgent surgical states a choice of tactics of treatment. The prospects of MMSMT not only on the railways, but also for other large-scale emergency situations of natural and man-made order. MMSMT - is the realization in practice of the principle of modern medical care to victims of disaster - as close as specialized medical care to the accident site. One of the main advantages of emergency medical units on the railways is their creation on the basis of pre-planning and analyzing the structure of the dominant (so-called "rail"), injury, weather affected the quality, taking into account the capacity of medical services. Acquisition of medical units on the same principle can purposefully engage in disaster management the most appropriate medical capabilities; improve efficiency and quality of medical care to victims (8). Another major element in the system of medical aid to victims of disaster, certain aspects of which are presented in this paper is a medical sort. Overview of current trends in medical matters sorting showed the lack of common views on the criteria for sorting the formation of groups and their number, inadequate accounting for the complexity of treatment and evacuation signs of the formation of sorting groups, poor attention to the methods and technical equipment of the medical process of sorting and other shortcomings (13).

Taking into account these costs of medical sorting, based on analysis of the experience of medical sorting in railroad accidents, and local military conflicts, as well as the experience of the command staff and special tactical exercises, and offers ways to improve the medical sort:

1. Treatment and recovery teams classification sorting, color-coded status of victims. The principal advantages of the proposed classification are - Integrating the medical and evacuation signs, simplicity and efficiency, greater attention to victims with combined and the combined injury. Color code states affected, ease of medical personnel and other emergency services in health care and medical evacuation.

2. The use of bar coding system for the registration and identification of victims, the transfer of medical information about the victims on the stages of evacuation and a database of information about health consequences of emergencies. The system is simple to use, fast input and retrieval of information, its conciseness on a strip of tape, the ability to save, transfer and further use of information about the victims, not only for the identification of victims, but they are grouped in groups of sorting, labeling a condition that the amount and priority of the medical care and transportation. Bar code system is basically an electronic version of the primary medical documentation (medical records of the primary card), but significantly enhanced by the quality and quantity of information embodied and method of use. The use of bar coding of information seems to be promising way to improve not only the medical sort, but the whole process of medical evacuation support victims of emergencies (5).

One of the new, promising, but at the same time, neglected areas of development and improvement of emergency medical aid to victims of disaster, is predicting the health consequences of emergencies. As you know, in spite of the suddenness and unpredictability of natural disasters and man-made disasters, by virtue of medicine based on the analysis of the effects of similar disasters that occurred earlier, to predict the approximate number of victims and survivors at this or other disasters, nature and type of predominant lesions, the necessary forces and means for assistance. The presence of such predictions can effectively prepare for medical interventions to mitigate the consequences, to increase efficiency and quality of care. Predicting health effects of the disaster will more effectively address issues of organizational and tactical plan, first of all - the systematization and ordering medical events and developing an algorithm based on their action health service, which is a prerequisite for success in an emergency. In this regard, the use of new

technologies is justified and promising. Developed its own computer software modeling and forecasting of health consequences of emergencies on the rail. The basis for the creation of the program served as a retrospective analysis of medical consequences of crashes on the railways between 1985 and 1995, which found certain patterns, relations, and particularly the health effects of various types of accidents on the railway (6). This paper presents the author's computer program simulation of emergency situations, predict possible health effects and necessary medical care, manpower and equipment for its support. The program allows you to quickly solve the problem of information and the index, medical evacuation, logistical disaster management. The program provides automatic prediction of victims and survivors, the structure of injuries, the number of required medical units and other emergency settings to the type of crash, the presence of hazards, terrain, distance to the nearest health facility (NHF) and other conditions. The proposed program of forecasting based on mathematical analysis, computer simulation of emergency situations can be used to create a database of information about the health consequences of disasters. Also the program can be used as a textbook in the form of a virtual tactical training exercises in preparation of personnel emergency medical services in emergencies, with case studies used in the program will be as realistic as possible the specific emergency. With further refinement and adaptation of the program can serve as dispatching information tracking, reporting and responding to health aspects of various emergencies. Currently, research has developed a system of acquisition of medical facilities for rail, road and air transport, designed to address issues of medical care in emergencies. To properly and effectively address the practical problems of organization of PHC has developed special training programs designed mobile systems (MC), physicians are trained basic profiles. Public Foundation "Asar-Bereke", with the support of the First President launched the first in the country project to provide affordable high quality medical care to people living in remote regions of Kazakhstan with the use of mobile diagnostic center, which for years had more than 15,000 surveys, traveled more than 48 000 km, visiting the most remote parts of Kazakhstan, as well as areas of ecological and natural disasters (1). The greatest relevance of this project gained BMD in the light of last year's, when the floods in the village of Almaty region Kyzylagash endangered the lives of people who did not have access to the outside world, when in the East Kazakhstan region of snow jams were hundreds of cars, and some drivers and passengers needed a doctor. In the southern regions, one after another occurred traffic accidents involving passenger buses, and ambulance could not cope with the volume of victims (5). Given the latter fact, one of the initial stages of the establishment of mobile medicine in the country was determined to ensure national routes care and rescue points (RCRP). Each item will consist of two modules for medical - this clinic with medicines and medical equipment and service, which will house a communications, control and home office area. Each (RCRP) will rescue ambulance equipped with medical and rescue equipment. In the classic version of the project also provided adjacent to the helipad item. Along with this, an important focus in the development of the transport of Medicine identified mobile hospitals, which are both auto and airmobile. Throughout the country planned to increase the number of such car clinic to 50 units. Given the need for urgent delivery of victims from remote areas with long, will intensify the development of air ambulance service. The mobile medical complex (MC) is made based on off-road vehicles and runs in standalone mode at any temperature and weather conditions. Diagnostic Medical Center is equipped with modern equipment (ultrasound, digital X-ray and endoscopic equipment), and allows you to create an electronic database of emergency, to handle data in digital format, to video archive and consult on-line mode with leading clinics and specialists of the country. MC module has its own life support systems, electricity, lighting, heating, ventilation and air conditioning. The use of portable mobile systems equipped with the necessary diagnostic and laboratory equipment will improve the first aid and to provide specialized medical care of victims at the crash site. Thus, complete coverage of the transport component of health care would make (PHC) medical mobile, and highly accessible (7).

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USING 'LITOVIT' SERIES PRODUCT AS PART OF COMPLEX THERAPY APPLIED TO BURNED PATIENTS

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HEALTHCARE SPHERE: REHABILITATION

Thermal injuries are the most severe kind of all traumas; recovery requires involving the biggest amount of the organism's own adaptation resources as well as medical efforts and means. The following objectives must be completed when treating a patient with burns including:

- correction of metabolic disorders;
- fighting infection and intoxication;
- local treatment of burn injuries.

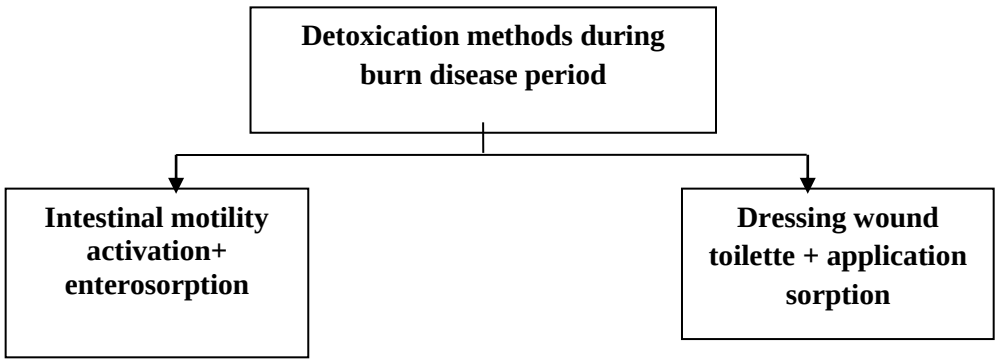
The main objectives during the second period of burn disease, that is acute ambustial toxemia, is detoxication of the organism, prophylaxis of anemia, hypoxia, heart failures, correction of metabolic disorders, prophylaxis and reduction of post-surgery complications (see fig. 1).

Enterosorption combined with intestinal motility activation and application sorption, alongside traditional therapeutic methods, are especially important when conducting complex detoxication therapy. Therefore the use of sorbents of 'Litovit' series based on natural zeolite is seen as relevant in this case. Adding 'Litovit' to the course of medication therapy ensures effective sorption of toxic substances since it eliminates endogenic intoxication caused by burn disease and

normalizes intestinal motility. Application sorption achieved through using zeolite-containing sorbent 'Litovit-M' contributes to removing various infectious agents from the wound, faster healing of the wound as well as recovery of skin integuments.

The degree of endogenous intoxication syndrome manifestation depends on the effectiveness and resources of anti-toxication mechanisms on the level of tissues and the organism as a whole. In case of functional inadequacy of anti-toxication and regulatory systems the amount of endogenous toxins in the organism grows, which leads to the weakening of the organism's resistance aggravated by severe disorders of the immune system structure and functions. In this regard including sorbents of 'Litovit' series that are based on a natural mineral called zeolite into the complex therapy of patients suffering from burns is especially important.

Diagram of complex detoxication therapy for acute ambustial toxemia (L.I. Gerasimova, 1995).



Research into the effects of 'Litovit' on the condition of burned patients was conducted at the burn center of the hospital surgery clinic of the Novosibirsk state regional clinical hospital (A.S. Polyakevich supervised by E.M. Blagitko, 1996-1998). During the experiment 26 patients suffering from burns were selected. Their average age was about 46 years, total area of burned skin surface was on average 1.5% while the severity of burns was III to IV degree. Experimental group of patients was administered 'Litovit' in the powder form, 1 dessert spoon 2 times a day taken with not less than 150 ml of water. 'Litovit' was taken by the patients for 15 days, then a 5-day break followed. After that, the break length was prolonged to 10 and more days. In case some patients had difficulties taking the product, it was administered in the form of suspension together with the above-mentioned amount of water or through a nasogastal probe. Laboratory values of the patients under study were dynamically assessed in the course of the treatment process. It was determined that on the 25th day of the complex therapy the contents of hemoglobin among the experimental group patients increased, on average, by 23% (compared to the initial level of 99 g/L), whereas the increase observed in the control group was only 2%.

Table 1.

Dynamics of average concentrations of blood electrolytes among the patients of experimental group

Time of Experiment	Ferrum, mg/kg	Magnesium, mg/kg	Calcium, mg/kg	Sodium, mg/kg	Potassium, mg/kg	Zinc, mg/kg	Copper, mg/kg
Start	358	33.5	49.2	1913	1567	5.21	0.88
15th Day	418	33.0	52.2	1887	1570	5.21	0.94
25th Day	477	36.8	61.2	1953	1849	6.34	1.02
Δ, %	+23.9	+9.9	+24.4	+2.1	+18.0	+21.7	+15.9

Table 2.

Dynamics of average concentrations of blood electrolytes among the patients of control group

Time of Experiment	Ferrum, mg/kg	Magnesium, mg/kg	Calcium, mg/kg	Sodium, mg/kg	Potassium, mg/kg	Zinc, mg/kg	Copper, mg/kg
Start	414	33.2	50.6	1924	1565	5.69	0.89
15th Day	412	36.0	52.7	1741	1522	5.52	0.9
25th Day	425	36.1	60.1	1859	1532	6.58	1.0
Δ, %	+2.7	+8.7	+18.7	-3.4	-2.1	+15.6	+12.4

Total blood protein in the experimental group rose by 18% (initial level was 60.2 g/L), and at the same time the increase in the control group was equal to 4%. By the 25th day the amount of blood leukocytes among the experimental group patients decreased by 48% ($16.2*10^9$/L) and by 39% in the control group. The amount of leukocytes in the urine decreased by 87% in the experimental group (initial level was 12 per power field) and by 71% in the control group. The decrease of average values of the leukocyte-intoxication index in the experimental group equaled to 70% (initial level being 6.3) while the decrease in the control group was 58%. By the 25th day average contents of urea fell by 42% in the experimental group (initial level being 6.9 mmol/L) and by 18% in the control group. By the 25th day the contents of total blood bilirubin decreased by 32% (initial level being 12.5 mcmol/L) while in the control group this value decreased by 26%. Study of the results of testing blood samples taken from the experimental and control group patients for the contents of micro- and macro-elements presented in tables 1 and 2 provided an opportunity to monitor the processes of electrolyte exchange in the human organism suffering from burn injuries as well as the corrective effects of 'Litovit' on mineral homeostasis.

At the beginning of burn injury the contents of mostly intracellular cations (potassium, magnesium etc.) in blood may be increased, which testifies to thermal injury (manifested through the increase in the permeability of biological membranes) in case of burning a mass of muscular tissue whose cells have significant internal volume. Then a decrease of the concentration of mostly intracellular and mostly extracellular electrolytes in blood occurs since both of these electrolytes are being lost through the burned surface. Using the given data it can be concluded that 'Litovit' contributes to more active process of recovering the amount of ferrum, potassium, sodium as well as other micro- and macro-elements.

Appropriateness of using 'Litovit' is confirmed by a shorter period of hospitalization for patients who were administered this product (this period is on average 8 days shorter than the period of hospitalization for patients from the control group).

The conducted research into the use of 'Litovit' for treatment of patients with burns statistically proved that the burned patients from the experimental group (compared to the control group, which was not administered 'Litovit') who received 'Litovit' showed improvements in the results of blood tests and urinalysis as well as the biochemical blood analysis. All this allows us to amplify the following features of 'Litovit' that testify to the relevance of its use as an effective component of the patients' complex therapy:

- expressed antianemic action (an increase of hemoglobin in the experimental group was 23% higher than that of the control group);
- Activation of biological synthesis processes (growth of total blood protein in the experimental group was 14% higher than that of the control group);
- sorption and anti-toxication effects that confirm the effectiveness of using 'Litovit' as part of endoecological rehabilitation concept and in order to form 'artificial lymph node', which contributes to relieving the load from the lymphatic system and the liver and kidneys (in the experimental group the decrease of the amount of urea was 24% lower and a decrease of the amount of bilirubin was 6% lower than that of the control group);

- immunostimulating action (a decrease of the amount of leukocytes in blood was 9% lower and a decrease of the amount of leukocytes in urine was 16% lower; a decrease of LII was 12% lower in the experimental group than that of the control group);
- reduction of hospitalization period for burned patients (8 days shorter for patients of the experimental group than the hospitalization period for patients in the control group);
- active process of recovering the amount of blood micro- and macro-elements крови (K, Mg, Na, Ca); [1]
- effective removal of heavy metals (Pb, Hg) from the organism. [2]

Despite the intensive development of therapeutic methods for treatment of wounds and burns the problem of suppurative-septic complications does not only remain acute in surgery and other spheres but is becoming even more significant due to the worsening of environmental conditions, decrease in the organism's resistance to pathogenic factors of the external and the internal environment and the increase in the resistance of bacterial population to antibiotics. (V.G. Nikolaev). Detoxication activities used for treatment of wounds and burns include application sorption, which is a type of sorption detoxication of the organism that speeds up the healing of wounds and the recovery of skin integuments and mucous membranes through sorption extraction of toxins from wounds. Covering the wounds with absorbing bandages containing absorbing agents applied on them contributes to removing bacteria and their feeding medium – dead cells and wound discharge. In order to achieve that, sorbents based on carbonic polymers artificially synthesized by the chemical industry have been developed and are used in surgical practice.

To study sorbents based on natural zeolites and introduce them into surgical practices advanced experimental and clinical research that determined the mechanisms of biochemical, morphological, pathogenic effects on the wound infection process produced by the natural ion-exchange sorbent was carried out at the surgical infection department of the Novosibirsk state regional clinical hospital in 1997-1998. Using 'Litovit-M' for local application as part of complex therapy for patients with septic wounds (including burn wounds) and trophic ulcers in order to improve treatment results was assessed. The research showed that using 'Litovit-M' for local treatment of infected and septic wounds contributes to faster wound cleansing, which consequently shortens the first period of the wound process characterized by the absence of sufficient local anti-infection barrier and a dangerous possibility of local progression and generalization of infection. If 'Litovit-M' is used during the second phase a protective cap is being formed; it eliminates contact between the wound and the environment, which prevents re-infection, optimizes reparatory processes and allows for smaller number of manipulations in the wound. Being non-allergic and thanks to selective ion exchange 'Litovit-M' normalizes local homeostasis and immune response. Using wound dressing with 'Litovit-M', which has high absorption properties, as part of complex therapy of suppurative-septic and burn wounds allow for sharp reduction of the wound's own toxic properties, cleanse the wound of its suppurative contents and necrotic tissues, which is accompanied by growth of granulations and, consequently, faster epithelialization of the wound surface. At the same time the patients start showing significantly fewer signs of intoxication, their general condition improves and the treatment period shortens. [3]

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ZEOLITE-CONTAINING PRODUCTS OF "LITOVIIT" SERIES RESEARCH OF SORPTION ACTIVITY

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SECTION – HEALTH CARE: FIRST AID

Intoxication is a special condition that may occur at any disorders and diseases with manifestations depending upon poisonous, toxic effects of different substances on the organism, as well as upon severity of the condition. However, intoxication is not limited only to such manifestations; it also results in serious dysfunctions of internals.

Development of many diseases is accompanied with the specific condition that is medically called endogenous intoxication or endointoxication. If poisonous substances enter the body from the outside (with food, through skin, lungs and mucosa), this is called exogenous intoxication (or poisoning). Intoxication is a specific acute pathologic process that needs emergency medical aid. An outcome of intoxication usually depends on how promptly and efficiently medical aid is rendered to a patient.

One of the ways to treat intoxications associated with environmental pollution and entering contaminants is to regularly administer enterosorbents of natural origin based on zeolite that bind and remove toxins from the body. A large number of research studies focusing on sorption activity of the standard component of natural zeolite coming from the Kholinsky Field and derivative products of the "Litovit" series allow recommending them to be used for new directions of health care, including sorption therapy. These directions are becoming more and more important for solution of the global problem – human ecology. **Products of "Litovit" series provide a simple, readily available and at the same time efficient method for mono- and complex therapy and for prevention of environmentally induced conditions.** This paper presents some data from experimental in vitro studies of "Litovit–M", data from preliminary animal studies, as well as clinical trials that allow estimating this product as enterosorbent. In vitro and in vivo studies aimed at sorption activity of "Litovit – M" are conducted by the Research Institute of Pharmacology at the Tomsk Scientific Center of the Siberian Branch, Russian Academy of Medical Sciences. Based on the results of in vivo experiments aimed at research of **"Litovit – M"**, it is concluded that the product is **efficient in relation to alkaloids (atropines), barbiturates (ethaminals – sodium), tricyclic antidepressants (amitriptyline), in arsenical poisoning, poisoning with toxic metals (copper, barium, lead).** "Litovit–M" was investigated by in-vitro experiments in rats in order to confirm the obtained results. As a result of the completed studies, "Litovit –M" shows its efficiency as enterosorbent in relation to atropine, amitriptyline, digitoxin, as well as organophosphorous compounds. **It can be concluded from the data of these experimental studies that "Litovit – M" reduces degree of endogenous intoxication in relation to poisonous substances listed above in an efficient way. This confirms its sorption properties (see Tables below).**

Table 1.

Adsorbing activity of activated carbon and "Litovit–M" in relation to atropine in in-vitro experiments

Adsorbent under study	Atropine concentration, mg/L		Adsorbing activity, mg/g
	Initial concentration	Concentration after contact with adsorbent	
Activated carbon	50.0	2.93 ± 0.17	11.77 ± 0.04
Litovit – M	50.0	13.77 ± 0.37	9.06 ± 0.09

Table 2.

Adsorbing activity of activated carbon and "Litovit–M" in relation to ethaminal – sodium in in-vitro experiments

Adsorbent under study	Ethaminal – sodium concentration, mg/L		Adsorbing activity, mg/g
	Initial concentration	Concentration after contact with adsorbent	
Activated carbon	200.0	139.0 ± 4.0	3.8 ± 0.2
Litovit – M	200.0	128.0 ± 5.0	4.5 ± 0.3

Table 3.

Adsorbing activity of activated carbon and "Litovit-M" in relation to amitriptyline in in-vitro experiments

Adsorbent under study	Amitriptyline concentration, mg/L		Adsorbing activity, mg/g
	Initial concentration	Concentration after contact with adsorbent	
Activated carbon	50.0	0.8 ± 0.5	12.30 ± 0.00
Litovit – M	50.0	2.0 ± 0.1	12.00 ± 0.03

Table 4.

Adsorbing activity of activated carbon and "Litovit-M" in relation to lead acetate in in-vitro experiments

Adsorbent under study	Lead acetate concentration, g/L		Adsorbing activity, mg/g
	Initial concentration	Concentration after contact with adsorbent	
Activated carbon	1.0	0.689 ± 0.010	77.9 ± 2.7
Litovit – M	1.0	0.604 ± 0.030	99.0 ± 7.6

Due to anthropogenic factors and disasters, adaptation of the living organism to environmental effects is a very important problem that needs to be urgently addressed. Radiation exposure is one of the most serious factors. Not only consequences of nuclear tests and accidents are a threat of radiation injury. **A constant, everyday problem** is landfilled and non-landfilled radioactive waste that results in buildup of radionuclides in plant and animal bodies, including human body. **Decontamination of different environments from radioactive substances, including detoxication of the human organism, has become one of the important problems in XX century and still remains the same in the XXI century.** Numerous experimental studies, including ones conducted by the Institute of Clinical and Experimental Lymphology at the Siberian Branch of the Russian Academy of Medical Sciences (ICEL, SB RAS), show that one of the most efficient methods to reduce specific radioactivity of body organs during excretion of cesium-137 is "Litovit – M". The sorption properties of "Litovit-M", namely its efficiency for excretion of radioactive elements, was studied by the Institute of Experimental and Clinical Cardiology at the Siberian Branch of the Russian Academy of Medical Sciences in cooperation with employees of the Environmental Endocrinology Laboratory of the Research Clinical and Experimental Medicine at the Siberian Branch of the Russian Academy of Sciences, employees of the Novosibirsk State Medical Academy and employees of the Siberian Federal Healthy Nutrition Center.

Results of the study show that:

1. "Litovit–M" has the strongest radiation protection property as compared with other sorbents realized due to stimulated excretion of incorporated cesium, with more significant reduction in specific radioactivity of the liver and reduced development of destructive changes in the body.
2. "Litovit–M" reduces activity of destructive processes in liver against the background of a radiation injury and ensures a higher integrity of the liver as compared with other sorbents currently used.
3. "Litovit–M" stimulates plastic pH-potential of liver cells in case of a radiation injury and ensures faster rehabilitation of this organ.

4. "Litovit–M" allows efficiently reducing degree of endogenous intoxication in case of a radiation injury; due to this, it is reasonable to administer these products according to the recommended dosage after entering radionuclides in the body.

Therefore, "Litovit–M" contributes to extraction of toxic metabolites and radiotoxins from blood and pericellular space, thereby ensuring maximum integrity of cellular structures, interrupting the cascade mechanism underlying the pathogenetic chain of stress disorders due to adaptable redistribution of activity of protection and compensatory systems at the stage of change in energetic and plastic reserve.

The experiment based on exposure of rats to radioactive cesium shows that animals kept on diet with addition of "Litovit–M" have demonstrated a more significant reduction of specific radioactivity of all organs that animals kept on other diets. In particular, radioactivity of testicle and brain was, respectively, 40% and 28% lower as compared with animals kept on standard diet. **The experimental data conclusively demonstrate that "Litovit–M" stimulates excretion of radioactive cesium from the body in the most efficient way as compared with other sorbents.**

CLINICAL STUDIES

I. Efficiency of "Litovit–M" as enterosorbent is confirmed by the report "Clinical Trial of Enterosorbent "Litovit–M" for Acute Intoxications". The studies were conducted by the Moscow N.V. Sklifosovsky Scientific Research Institute of First Aid under the guidance of professor A.S. Ermolov, correspondent member of the Russian Academy of Medical Sciences.

The clinical trials have shown that **"Litovit-M" can be administered for poisoning of any degrees, including poisoning with psychotropic drugs.** Administration of "Litovit – M" is accompanied with reduction of amitriptyline level in the stomach by 91%, leponex by 89% and finlepsin by 77% that demonstrates partial "capture" of toxicants and suggests that sorbent dose need to be increased by 9.11 and 23.0%, respectively. In case of poisoning with a mixture of toxic agents, a dose must be maximum, i.e. 100 grams. "Litovit – M" is well miscible with water; mixed with water, it forms a suspension that easily passes through a gastric tube. This facilitates administration of it in seriously ill patients. As compared with activated carbons, "Litovit – M" does not stain. Due to this advantage, it will find a wider area of application as compared with activated carbon.

Conclusion: clinical trials of "Litovit – M" for acute intoxications show that:

1. "Litovit – M" is an efficient enterosorbent that reduces concentration of psychotropic toxicants in the gastric contents by 77 – 91% and, in combined administration with the "basis therapy", reduces concentration of toxicants in the blood by 65 – 90%.
2. "Litovit – M" is safe and well-tolerated by patients with acute diseases.
3. "Litovit – M" does not inferior to enterosorbent "Microsorb – P" in efficiency and even superior to it in several aspects.

II. Efficiency, tolerance and safety of "Litovit – M" in patients with occupational intoxication at combined use of "Litovit – M" with standard (basis) therapy of these diseases has been studied by the Clinic of Occupational Pathology of the Research Institute of Hygiene (Ministry of Health of Russia) that it is a clinical base of the Human Ecology Department, in cooperation with the Course of Occupational Diseases of the Novosibirsk State Medical Academy (Ministry of Health of Russia).

Conclusion: clinical trials allow making a general conclusion on efficiency of the enterosorbent "Litovit – M" as the pathogenetically substantiated component of etiotropic non-specific therapy for chronic occupational intoxications. **"Litovit – M" included in the standard therapy course contributes to improvement of functional condition of main barrier and detoxifying organs and systems, correction of primary pathogenetic toxicity mechanisms of industrial poisons.**

III. Efficiency of "Litovit – M" for excretion of heavy metals was studied in the clinical trial conducted by the Chelyabinsk State Medical Academy at the Ministry of Health of the Russian Federation.

One of the most hazardous toxic substances is heavy metals. Therefore, it is a paramount task to excrete them from the body and, therefore, to eliminate the damaging action of heavy metals on the body.

The results of the studies are presented in the Table.

Table 5.

Content of toxic elements in the blood of patients under study at the 1st and 30th days of administration of the biologically active food supplement "Litovit-M"

	Cadmium (Cd)	**Lead (Pb)**	**Copper (Cu)**	**Chrome (Cr)**	**Nickel (Ni)**
1st day	0.42 ± 0.06	9.4 ± 2.1	16.0 ± 1.1	8.9 ± 0.15	3.2 ± 0.08
30th day	0.2 ± 0.08	0.61 ± 0.12	7.65 ± 0.2	0.4 ± 0.02	0.62 ± 0.07
The biologically active food supplement "Litovit-M" has shown the following efficiency as enterosorbent in relation to different elements:					
	52.4%	93.5%	52.2%	95.5%	80.6%

The products of "Litovit" series are indicated not only for complex therapy (professional intoxications, intentional and unintentional poisoning with drugs, including psychotropic drugs etc.), but also as food supplement for compensation of inadequate adaptation syndrome (elimination of risks associated with adverse environmental effects on the organism). **Preclinical and clinical studies conducted by different medical research and clinical institutes show that the products of Litovit series are not only safe, but also efficient products recommended as enterosorbents to different groups of population with different states of health, as well as for stress situations against the background of anthropogenic and natural disasters.**

ZEOLITE-CONTAINING PRODUCTS "LITOVIT" SERIES ADAPTATION OF ORGANISMS IN HIGH LOAD CONDITIONS

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HEALTHCARE SPHERE: REHABILITATION

Extreme conditions are natural disasters, consequences of terrorist acts, large-scale accidents and technogenic catastrophes as well as unfavorable or unusual climatico-geographic and working environment.

Modern methods and means cannot completely protect people from extreme factors of the environment, and overcoming these factors requires excessive use of the organism's natural reserves, which eventually causes deep structural disturbances in the organism. Therefore it is very important to seek and practically use effective measures of prophylaxis and medical care for specialists working in extreme occupational conditions or performing activities that require straining the adaptation mechanisms: rescuers, fire fighters, military people, sports people as well as specialists that have harmful working conditions, miners, for example. No doubt that such support is also needed by the people who live in extreme natural areas or stay in extreme environment caused by natural disasters. These measures must: eliminate or significantly limit the harmful impact of extra load on the organism, ease adaptation to working in complicated conditions, such measures must also be used for rehabilitation and ensure people's ability to work for many years to come. One of the promising development directions here is using the organism's own protective resources. For example, non-specific therapy allows for fighting harmful effects

through increasing resistance of the organism achieved by activating its protective mechanisms. To attain this, various natural immunomodulators and biostimulators are used. Immunomodulators evoke adaptation reactions in the organism on compensatory level (curative effect) and/or hyper-compensatory level (increase of the functional health threshold) (A.G. Malyavin, 1995).

Main requirements set for this kind of products can be characterized by the rule that the specified doses of such medications must have no specific harmful effect on separate systems of the organism but stimulate neuroendocrinal and immune system, which make up a unified adaptation mechanism (E.A. Korneva et al., 1988, L.H. Garkavi et al., 1977). Among a wide range of adaptogenes and immunomodulators of natural origin the products of 'Litovit' series take a special place, since their main constituent is the natural mineral zeolite with the unique properties of selective ion exchange, selective sorption and catalysis. Products of 'Ltovit' series have adaptogene properties and ensure non-specific immunological reactivity of the organism, which gives the latter time for improved specific immunological alteration. As a result of conducted research into adaptogene properties of 'Litovit', it was found that protective reactions of the organism were on a high level and despite the presence of the causal factor, the disease (organism normal functioning disorder) either does not occur or occurs in the light form and only at early stages. First data on the fact that taking zeolite under extreme conditions can cause the development of adaptive reactions in the organism appeared back in the nineteen nineties (V.A. Titov).

Scientific and Production Company 'Nov' conducted complex research of 'Litovit' product series at:

- Scientific and research nutrition institute of the Russian academy of medical science,
- Novosibirsk state medical academy,
- Scientific and research institute of clinical and experimental lymphology of the Siberian department of the Russian academy of medical science, (SRIandEL SD RAMS)
- Siberian medical university (the City of Tomsk),
- Commission for cancerogenic factors at the healthcare ministry of the Russian Federation (the City of Moscow),
- Institute of general human pathology and ecology of the Siberian department of the Russian academy of medical science (the City of Novosibirsk),
- Anti-doping Center of the healthcare ministry of the Russian Federation

Examples from research materials

It is known that adrenal glands play the leading role among many systems that ensure the constancy of the organism's internal environment and activation of protective and adaptive reactions. At the first stage of **'Litovit'** research conducted at the SRI and EL SD RAMS in 2000 it was found that this product **has adaptogene properties demonstrated under the conditions of acute and chronic toxic impact** on animal organism. In this regard, studying the peculiarities of structural response of adrenal glands in the conditions of pharmacological correction of pathological states with the help of 'Litovit' series products was seen as relevant. At the second stage of research the influence of 'Litovit-B' on the structural organization of adrenal cortex under the conditions of endo- and exotoxicosis was studied. Composition of 'Litovit-B' includes standard component of natural zeolite, rootstock and root of burnet, wheat bran and rye bran. Studies of structural alterations of adrenal glands in the conditions of combined endo- and exotoxicosis showed that using phyto-mineral complex 'Litovit-B' significantly changes the response of adrenal glands to endo- and exotoxicosis. Combined **biological effect of adaptogenes on intact animals showed that processes preparing the organism for various kinds of impact and ensuring faster subsequent recovery of homeostasis are being developed within the organism.**

Conclusion

Phyto-mineral complex 'Litovit B' when administered to normal animals:

1. Does not cause morphological alterations in the adrenal glands that could testify to suppression or deterioration of their function.

2. Has an anti-stress effect manifested in the conditions of combined endo- and exotoxicosis, thus preventing hypertrophy of the adrenal cortex zona fasciculate.

3. Has a favorable effect on the structural organization of adrenal cortex in the conditions of combined endo- and exotoxicosis since it ensures intactness of the cortex reticular zone, which, from the functional viewpoint, can be regarded as one of the organism's own anti-stress systems.

Cases of poisoning with medications are quite frequent in medical practice. The research conducted at the Sklifosofsky research institute of first aid was devoted to the use of 'Litovit-M' for treatment of poisoning with medications (digitoxin, amitriptyline, atropine etc.).

Besides studying the effectiveness of the sorption properties of the specified product the research of 'Litovit-M' influence on the death rates and lifetime of animals was conducted.

The research results showed:

In the group of animals that were administered 'Litovit-M' 2 of 6 animals died during the first twenty-four hours, **their lifetime from the moment of poisoning was 2.1 times longer than that of the control group.**

Group	Death rate, %	Lifetime, min.
Control group	67.0	84.0
Absorbent carbon	33.0	118.0
'Litovit – M'	33.0	175.0

Conclusions according to the research results:

Using 'Litovit-M' quickly enough after poisoning has a marked cardioprotective action, it reduces death rate of animals within the first hours after poisoning caused by heart failure.

Administering 'Litovit-M' after poisoning with digitoxin prolonged average lifetime of the dead animals twofold, contributed to death rate reduction within the first hours after poisoning, prolonged average time of registering disorders in cardiac rhythm and conduction, reduced the amount of extrasystoles, which was accompanied by other types of cardiac rhythm and conduction disorders. Additionally, 'Litovit-M' was more effective compared to absorbent carbon. Studies conducted by these scientific institutions as well as leading clinics of Russia such as the Novosibirsk regional clinical hospital, the Novosibirsk regional cardiology center, the Chelyabinsk medical academy clinic, Radiological medicine center (the City of Chelyabinsk) showed that **Litovit series products improve adaptive capabilities of the organism, contribute to the increase of stress-resistance abilities** (at periods of maximum loads), removing heavy metals from the organism as well as producing immunomodulating and anti-anemic effects. 'Litovit' series products have a wide range of biological effects that solve practically all the problems found in the sphere of bracing impact on the organism.

It is known that almost all medications used in the clinical medicine have various adaptive properties (cardiac glycosides etc.) but these medications solve the main problem almost without any effects on the systems responsible for adaptive alteration of the organism. Adaptogene action of 'Litovit' is based on developing preparedness of the organism for stress-reaction (increase in the activity of the main stress-limiting system of the organism - adrenal cortex, two of its main components, to be specific, - glucocorticoid and mineralocorticoid component) due to regulating the distribution of biometals and, in the first place, their provision of the organism's anti-oxidant ferments and enterosorption and removing toxic products of exogenic and endogenic origin from the organism.

'Litovit' may be assigned to the line of adaptogenes that increase the level of endogenic protective resources of the organism and bring it to the condition of non-specifically increased resistance or increased stability.

The specified peculiarities of the effects of 'Litovit' product series are a powerful prophylactic means for supporting endoecological condition of the organism within physiological norm and increasing the resistance of the organism to extreme factors.

ASSESSING MEDICAL AND BIOLOGICAL VALUE OF 'LITOVIT' SERIES PRODUCTS

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HEALTHCARE SPHERE: REHABILITATION

Medical and biological value of zeolite-containing products of 'Litovit' series is conditioned by:

- the presence of mineral constituents that originate from natural zeolites of clinoptololite row of carcass aluminosilicates;
- technological manufacturing process that includes thermo-mechanical activation operations.

Biologically active food supplements present at the territory of the Russian Federation are subject to mandatory state registration and declaration. The confirmation of MEDICAL AND BIOLOGICAL VALUE of the products being purchased, apart from the product's safety, is of great importance to customers. In order to provide customers with true information about properties, quality and effectiveness of products (not only their safety) the unified national system of food products' quality monitoring called "Healthy Nutrition Is the Health of the Nation" that determines and controls the compliance of products to standard requirements and additional criteria of effectiveness has been established in Russia.

'Litovit' product series has undergone the voluntary certification procedure in the sphere of medical and biological value as well as international voluntary certification according to quality management system ISO 9001:2008. Confirmation of the declared medical and biological value (CC certificate of compliance No. OS001.R.0069.09.06 dated September 20, 2006) and quality management system (THE INTERNATIONAL CERTIFICATION NETWORK: RU Q 00903) has been received. Each individual package of the product that has undergone the voluntary certification bear special marking of the following systems:

Inspections include systemic three-level control (control of raw materials, control of ready products at the production facility and an independent control of the ready products) of quality and medical and biological value in order to:

1. Exclude the possibility of influence on the safety and quality of technological procedures,
2. Confirm the effectiveness of methods of using the products for various health conditions, including the confirmation of **COMBINABILITY** (i.e. compatibility) of components that are not only included in the product composition but also the compatibility of 'Litovit' with other products.

The 'Litovit' series products can be relevantly used at all stages of the organism internal environment homeostasis:

- rehabilitation of pericellular space
- catalysis,
- correction of contents of mineral substances.

On the basis of the results of medical and biological value assessment performed for the product line, 'Litovit' is included into the Methodic recommendations formulated and approved according to the requirements of the Russian Academy of Medical Science Scientific Council for Medical Nutrition Problems and the Russian Federation Ministry of Health and Social Development.

Scope of using 'Litovit' series products is based on the natural properties of the standard component of zeolite (clinoptilolite) as well as clinical research:

3. Selective sorption. The primary criterion of 'Litovit' effectiveness is the effectiveness of poison capturing. **Significant gradients of toxicants in the contents of the stomach characterize 'Litovit' as a highly effective enterosorbent.** Other indirect criteria (reducing the concentration of poisons in blood, improving the values of endotoxicosis) also testify to the product's therapeutic usefulness. **'Litovit' is an effective enterosorbent that ensures reducing the concentrations of psychotropic toxicants in the contents of the stomach in cases of acute oral poisoning by 77-91%, and if the product is included into 'basic' therapy the concentration of toxicants in blood is reduced by 65-90%.** In case of poisoning with a mixture of toxic components, the calculated single dose of 'Litovit' must be maximal – 100 grams. 'Litovit' is safe and is well received by patients with acute poisoning. (N.P. Bgatova, A.V. Luzhnikov, Ya.B. Novosyolov).

- Selective ion exchange (mineral homeostasis normalization). An important aspect of product effectiveness is cellular and molecular mechanisms of 'Litovit''s influence on biocidal properties of blood neutrophils. The volunteers who took 'Litovit' showed more active recovery of micro- and macro-elements in the blood that resulted in an increase of energy production as well as the organism antioxidant activity, which ensured more active progression of regeneration processes and reduced the hospitalization period by 1.3-2.5 times (studies of 'Litovit' effects on patients with infectious and non-infectious inflammatory processes). (Yu.I. Borodin, N.N. Mayanskaya).

Biocatalysis (I.A. Belitsky, 1990). The ability to compensate for the INSUFFICIENT ADAPTATION SYNDROME in the modern conditions including periods of natural disasters. 'Litovit', in the first place, allows increasing the level of endogenic protective resources of the organism and bring it to the condition of non-specifically increased resistance or increased stability. Using 'Litovit' produces significant effect on the resistant system of the organism and the character of its adaptive reactions. The effect is manifested through activating the **system of mononuclear phagocytes,** mostly in the system's effect section of Kupffer's cells, increase of the phagocytary ability of leukocytes, amplification of biocidal properties of neurophiles and blood – an increase in the intensity of luminol-dependent chemical luminescence. The peculiarity of the function of adrenal glands among the animals that were administered 'Litovit' was the fact that amplification of steroidogenesis, which ensures the increase of the level of corticosterone in blood in response to identical stress action, was not accompanied by the switching of mineralocorticoid and glucocorticoid synthesis ways. Adrenal cortex responded by proportional amplification of glucocorticoid and mineralocorticoid synthesis. The authors suppose that this fact testifies to higher stability of the functioning of adrenal glands as an organ or a more adequate condition of regulatory systems under the conditions of taking natural zeolites that contribute to the development of adaptive reaction classified by L.H. Garkavi et al. (1977, 1979) as an activation reaction. (A.V. Efremov, G.N. Shorina). 'Administration of 'Litovit' inside the human organism of virtually any age significantly increases functional activity of separate internal organs, first of all, the organs that are able to synthesize hormonal agents, disintegrating them from the whole spectre of inter-organ response of the organism as a whole in response to an impact of unfavorable factors of the external environment', (S.V. Kaznacheyev).

Signature features of 'Litovit':

1. The product has no pharmacokinetic properties, i.e. none of its concentrations can be found in biological fluids of the organism. 'Litovit' is not sucked in inside the gastrointestinal tract, it does not get into blood as a crystal, it passes through the organism in transit, interacting with the internal environment on the level of selective sorption (being the sorbent with a maximally large sorption area formed by thin pores that are able to instantly disrupt the balance inside the organism. Therefore, **other sorbents with a large sorption area that are unable to conduct selective sorption,** are seen as irrelevant today).
2. Overdose is impossible: this fact was clearly proven by clinical and pre-clinical studies. Recommended dose of the product is specified on the original package.
3. The product has no contraindications.
4. 'Litovit' can be used not only as part of the complex therapy (for treatment of occupational intoxications, deliberate and accidental poisoning with medications including

psychotropic agents etc.) but also as a food supplement in order to compensate for the insufficient adaptation syndrome (eliminate the risk of harmful environmental effects on the organism).

Conclusion: The value of 'Litovit' and its effectiveness is based on the complex impact of its properties, which conditions the immunomodulating and antioxidant influence of 'Litovit' and the increase of regeneration processes in the organism, which allows using 'Litovit' as entero-donorsorbent to different categories of the population living in a certain environment and having various health condition, including taking 'Litovit' during the periods of natural cataclysms.

VIRAL-BACTERIAL MIXED INFECTIONS AND THEIRS CLINICAL AND CYTOMORPHOLOGICAL APPEARANCE

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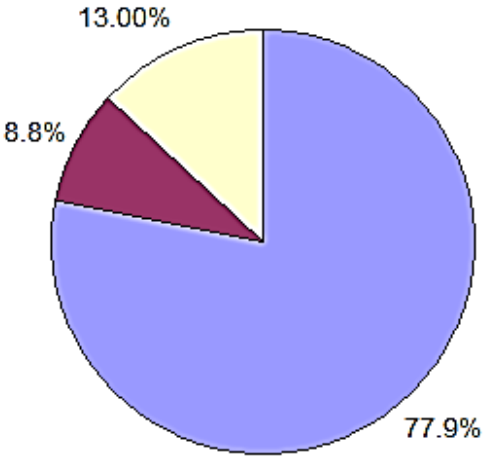
Despite of the fact of impressing and encouraging successes achieved in a fight against pathogenic microorganisms it is still necessary to admit that at the beginning of the new millennium the infectious diseases are present the most important problem of the medicine and public health i.e. the established fact of infectious affections growth that is caused by conditionally –pathogenic or opportunistic microorganisms. Especially we need to emphasize the role of virological and bacteriological mixed infections in addition to clinical manifestation of pathologies at present time. The above mentioned is also favoured by number of increased people with the concomitant diseases, immunodeficiency and also social and economical problems. The expansion of international contacts also playing a big role in increase of "imported" infections that have been registered as a sporadic before. While talking about infectious pathology as well as about modern conditions in a world we also have to underline that one of the most important problem of the humanity is a fight with the bioterrorism.

In this case the specificity of infectious pathology study is the most important problem nowadays. It's known that during selection process of biological agent for implementation of bioterrorist act the preferences are given to agents with aspiration mechanism of infection as during aerogenic mode of infection it is easy to infect a lot of people especially in a place of concourse. There is a possibility of spreading of nosocomial infection with a double mechanism of transmission – aerogenic and orally-faecal. The symptom complex is defined by the pathology progressing inside of lungs where the different stages of specific pneumonia could be noticed. As in this case the object of research will be a material taken from the sick or dead people the questions regarding increase of effective methods of laboratory diagnosis should be emphasized especially. In this connection the value of high sensitivity and specificity of applied methods of laboratory diagnosis should be clear. Taking into account all of the above mentioned the complex researches on study of mixed infection specificity (viral-bacterial) on children of postnatal period with burdened acute respiratory infections, in anamnesis of their mothers – puerperants have been carried out by us. The material taken from 68 children of postnatal period and their mothers puerperants has been researched by us. The virological researches have been made by applying of fluorescent antisubstances express method – MFA (Coons A.N. direct method). [1, 2]. During bacteriological examination the standard methods of segregation and identification of pathogens have been applied. [3]. As a result of researches the important etiological role of mixed infections has been find out in children's infectious pathology (77.9%) at bacteriological infection (8.8%) and viral (13.0%).



The spectrum of viral-bacteriological population consisted of virus of B influenza+ Candida alb.; A/H3N2/+E.col+Strept. pyoqenes influenza viruses, virus of A influenza + Staph.aureus, PC-viruses + Candida alb.; Mc.pneumonia + influenza virus A/H1N1/. Anamnestic data detected the acute respiratory infections (ARI) of mothers before the childbirth and after it that most probably became a reason of newborn infection. The clinical picture of infection pathology of children of postnatal period has been characterized with the following appearances: encephalitis, encephalomeningitis, pneumoniae, bronkhopneumoniae, abnormality of central nervous system (CNS). For mixed infections more longer duration of disease with residual effects has been characterized. Taking into account significant spread of mixed infections for newborns during perinatal period with quite serious pathologies of viral- bacterial diseases it is interesting to identify the specificity of histological appearances of viral, bacterial and mixed infections at cellular level. The culture of cells RD (line of the cells taken from human's rabdosarkoma), virus strain of A influenza /Baku/799/82/HONav2/ in a dose of 100 $TCID/_{50}$, the culture Staph. aureus in a dose of 700 colony-forming units has been used during research. The cultivation of cells and infection of their culture with RD has been made in accordance with the generally accepted virology methods [4]. Pathomorphology researches have been carried out with the generally accepted histology methods [5] together with the department of pathanatomy of Azerbaijan Medical University.

Analysing in comparative aspects the degree of cells population destruction it is necessary to conclude that the most destruction of cells at infection with viral-bacterial mixedture.

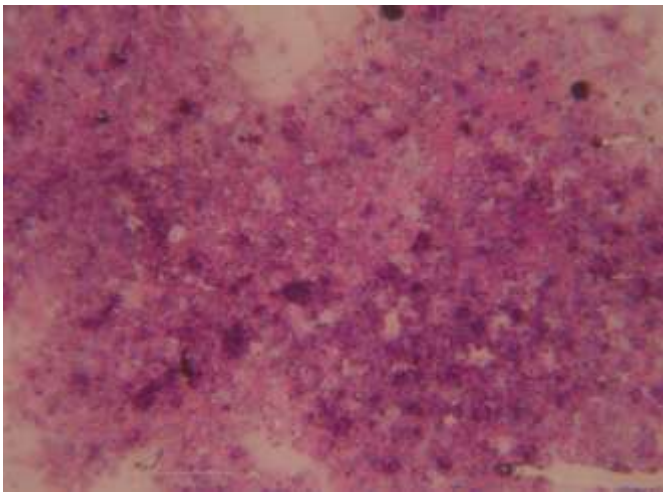


Fig. 1. Infections with Staph-aureus marked: degenerated cells with the symptoms of dystrophy and necrosis in different levels of destruction

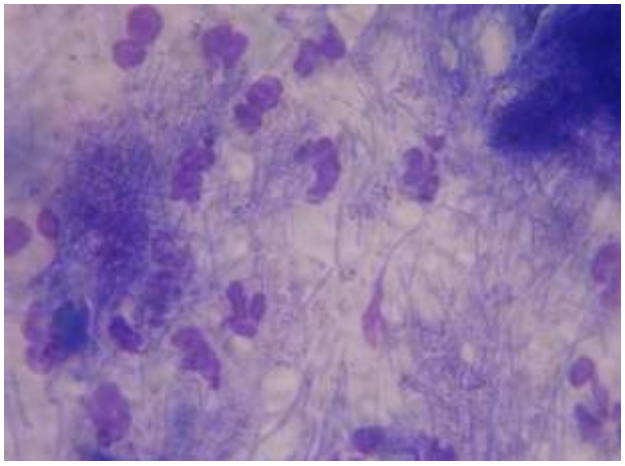


Fig.2. Infected with virus of A influenza /HONav2/ marked: nuclear membrane is not irregular, partially interrupted. In cells cytoplasm there are light eosinophilic inclusions

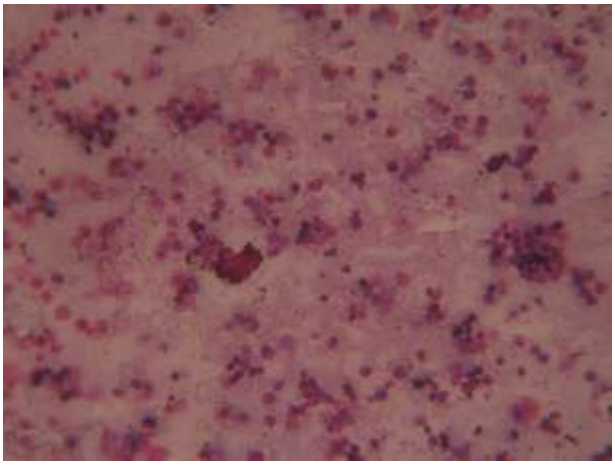


Fig.3. Infected by mixedture of bacterial flora (Staph-aureus) + virus of A/ HONav2/ influenza marked: entire lysis of cells

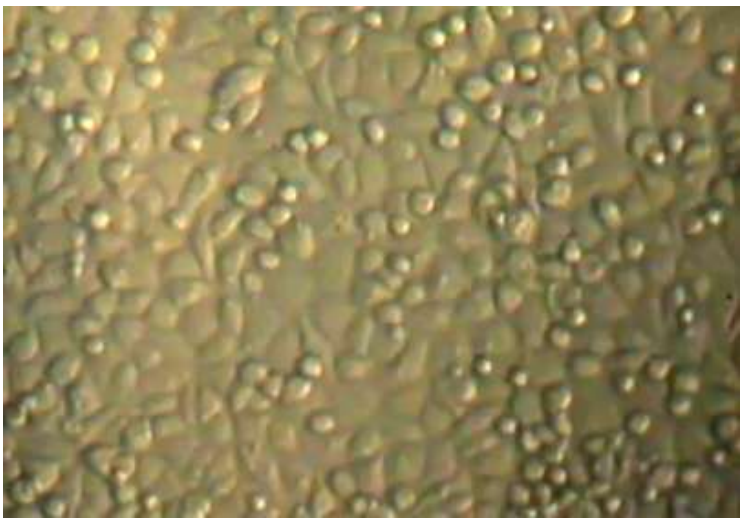


Fig.4. Control of cells – not infected culture of tissue RD

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CONCERNING ISSUES, ASSOCIATED WITH SPREAD AND INDICATION OF VIRUS FLORA IN AQUEOUS MEDIUMS

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The results of virologic investigation of material from ill children with acute flaccid paralysis (AFP), persons contacting with them, healthy contingent of children and samples of wastewater in Azerbaijan for period from 2008-2010 have been presented in Article. The spectrum of enteroviruses, circulating among population in indicated region with determination of fact of "wild" poliovirus strain absence has been determined.

Water is the most important element of natural resources. It is the main component of organisms and also it serves as the habitat of human being. Human being shall be provided with fresh water, which corresponds to the requirements currently valid. Together with that, under condition of anthropogenic pollution, it is very difficult to achieve such situation.

The extreme hazard is microbial water pollution. Due to abovementioned, one of the actual problems of modern time is necessity of regular monitoring of water bacterization, including monitoring of wastewaters, which are partially used in agriculture. Concerning abovementioned, it is necessary to add the very important fact, which increases actuality of problem, regarding monitoring with viruses indication in aqueous mediums - fact of existence of biological terrorism, presupposed local distribution of biological agents (BA). Abovementioned presupposes permanent control over implementation of provisions of Biological Weapons Convention and its improvement. (1, 2) It is necessary to reconsider the tactics of epidemiological observation, the task of which is identification of reasons of infectious patients (artificial or natural) in combination with regular monitoring and studying of virus flora spectrum in used water.

Taking into consideration the specifics of virus infections, one of the actual problems in the framework modern medicine is necessity of regular monitoring and taking of currently possible preventive measures regarding prevention of occurrence of virus infections, which can be epidemically spread. Especially, it is necessary to outline poliomyelitis, which is pregnant with known consequences. It is necessary to mention that for the last 10 years due to initiative of WHO, the liquidation of poliomyelitis has been achieved in many countries and in 2002, the European Region has been certified as region, which is free from poliomyelitis. Nevertheless, it is necessary to mention the situation in the world, when the risk of "wild" polioviruses importation from countries, where poliomyelitis has not been liquidate yet, is significant. It is confirmed by reporting data of 22nd session of European Regional Committee on Poliomyelitis Liquidation Certification that outline the fact of existence of population groups with high-risk level and territories, which are

Table 1

Results of virologic studying of material from ill children with acute flaccid paralysis (AFP), persons contacting with them, healthy contingent of children and wastewater samples on the territory of Azerbaijan for the period from 2008-2010

Year	Amount of examined children with AFP	Result of virologic studying	Amount of contacting persons	Result of virologic studying	Amo-unt of healthy persons	Result of virologic studying	Amount of wastewater samples	Result of virologic studying
2008	31	Adenovirus -4 NPEV – 2 Cox A_{10}-1 Polio 3-2	33	-	42	Cox B_{1-6}-1 $ECHO_4$ -1 Polio +EV-1 $ECHO_{11}$ -1		Cox $_{A7}$-1 $ECHO_4$ -9 $Polio_3$-2 NPEV -5 $ECHO_6$ -1 $Polio_2$-1 $ECHO_{33}$ -1 Cox B_{1-6}-3 $ECHO_{11}$ -2 Polio +EV-1 Polio +EV-2 $ECHO_{20}$ -2
2009	46	NPEV – 3 Cox $_{1-6}$-1 $ECHO_{25}$ -1 Polio $_{2+3}$-1	49	CPA-1 Adenovirus-1 NPEV – 2 Cox B $_{1-6}$-1	37	-	234	ECHO 7-2 NPEV-3 Polio 3-2 ECHO 1-1 ECHO 11-5 Polio 3-2 Polio 3+EV-1 Cox B 1-6-1 ECHO 30-1 Polio2+ NPEV2 ECHO 20-1 Polio2-4 Polio1-1 Polio2+ECHO 11-1 Polio2+NEVP -2 Polio2+NEVP -1
2010	29	EV-2 Polio-1	26		-	-	140	$ECHO_7$-2 Polio +EV -1 NPEV – 8 $ECHO_4$-2 Polio +EV -1 Polio $_2$ -2 Polio $_3$ -1 EV – 20

Note : NPEV - non-polio enteroviruses
CPA - cytopathogenic agents
EV - enteroviruses

not properly involved into corresponding arrangement and were epidemiological indexes concerning supervision over poliomyelitis and indexes of immunization are enough low. (3) In

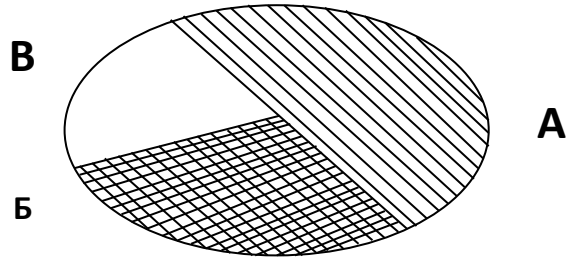
connection with abovementioned, during the postliquidation period of poliomyelitis, the issue concerning regular monitoring over acute flaccid paralysis (AFP) in order to follow-up the movement of enterovirus formation is actual, particularly regarding poliomyelitis viruses and prevention of "wild" poliovirus strain importation into the regions, which are free from present infection. Identification of patients with acute flaccid paralysis (AFP) is the standard method of epidemiological supervision over polioviruses on the endemic territories or in countries, which recently were endemic. Taking into consideration all above-mentioned facts, the virologic laboratory for diagnosis of poliomyelitis has been created in Azerbaijan in 1996 under guiding and with assistance of the Ministry of Health of Azerbaijan Republic and European Regional Bureau (ERB) of WHO. Laboratory works together with Department of Microbiology and Epidemiology of Azerbaijan State Extension Course Institute for Medical Practitioners named after A. Aliev. Work is performed according to "Global Program for Poliomyelitis Liquidation" and currently virologic diagnosis of acute flaccid paralysis (AFP) is implemented guiding by the National Action Plan on "Support of Status of Territory, which is Free from Poliomyelitis for 2008-2010" and Emergency Action Plan under support of WHO. From 1996 till present time, virologic diagnosis of acute flaccid paralysis (AFP) is performed on the whole territory of Azerbaijan Republic with systematic epidemiological and virologic studying of enteroviruses spectrum, separated from wastewater and healthy child contingent. Considering wastewater as permanent receiver of enteroviruses in ambient environment and taking into consideration relatively insignificant labour intensity of investigations under application of wastewater observation method in comparison with method of individual examination, we applied Riordan method – method of enteroviruses concentration from wastewaters. (4) In the process of virologic investigations we have applied research methods, which are common-used in virology, with application of tissue culture HeLa, Hep_2, RD (5, 6).

The results of virologic investigation of samples from patients with acute flaccid paralysis (AFP), samples from persons, who have contacts with ill persons, samples from healthy child population and wastewater samples from various regions of Azerbaijan for the period from 2008-2010 are presented in Table 1. As it is seen from diagram for indicated period, we have examined material from 106 patients with acute flaccid paralysis (AFP), 108 persons, who have contacts with ill persons and 496 wastewater samples taken in 8 districts of Azerbaijan: Gazakh, Akstafa, Sabirabad, Saatli, Imishli, Jalilabad, Lenkoran, Astara, Sumgait and Zykhk treatment station of Baku city. In the result, the spectrum of viruses, circulating among population of Azerbaijan has been determined and absence of "wild" poliovirus in circulation has been confirmed. Finally it is necessary to note that according to the WHO data (1), the main priority task for the nearest year shall be liquidation of breakouts and termination of circulation of wild" poliovirus of the 1st type in the endemic countries.

The second priority task is necessity to achieve real operative progress in the framework of epidemic fighting. The third global priority is immediate introduction of innovations and results of scientific researches.

А 496 – wastewater samples
Б 108 – samples from persons, who have contacts with ill persons
В 106 – samples from patients with acute flaccid paralysis (AFP)

DIAGRAM



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THE RELEVANCE OF AZEOMED IN MEDICINE

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Zeolites are natural microporous silicon crystals. There are about 200 zeolite species in nature. Natural zeolites are a product of volcanic activity when stones, ash and aqueous solutions of salts are fused and crystallized. Zeolites are natural microporous silicon crystals with a property to absorb and retain firmly within its structure. Zeolite's uniqueness is that it selectively absorbs harmful substances without directly interacting with vitamins and amino acids. Thus, unlike many sorbents with the classic usage time not exceeding 2 weeks, zeolites can be used for a long time because they do not absorb nutrients (vitamins, amino acids, fatty acids) from the human body. Zeolite just cannot absorb them because of the small size of its pores.

"AZEOMED" is capable of selective exchange of particles; while taking away harmful substances, "AZEOMED" simultaneously supplies the body with missing micro- and macroelements. This mineral is completely harmless for human use as demonstrated by chemical analysis and toxicological studies verified by scientists around the world.

The main difficulty in application of zeolites in medical practice was the technological processing of natural zeolites. Although the first zeolite studies were conducted early in the past century (1913), no one in the world until 1966 could secure their purification and enrichment for utilization in food industry and medical practice. Of course, they had been long applied in agriculture and water purification but non-standardized, unenriched zeolites are dangerous to use in medicine. In the United States and other countries they even learned how to synthesize zeolite. But it turned out to have completely different properties because unlike the natural one, it lacks selective ion exchange and the characteristic structure.

Natural zeolite is not absorbed in the gastrointestinal tract neither does it enter blood but rather passes through, interacting only at the selective exchange and sorption level while in contact with blood vessels and lymphatic vessels of the intestinal wall, giving or taking away micro- and macroelements and catalyzing biochemical reactions.

The Institute of Clinical Pharmacology of the Russian Academy of Sciences, Moscow Department polyclinic №4 and other medical institutions have carried out clinical tests on zeolites within the complex treatment of cirrhosis, hepatitis and hypercholesteremia. The medics compared a zeolite-based preparation with "Smecta", its closest analogue, in treatment of acute intestinal infections and intoxications. Using zeolite can reduce the length of hospital stay while its cost-effectiveness as compared to "Smecta" within the northern autonomy only produces 100 million

ruble economic effect annually. The preparations developed on the basis of this wonderful mineral have anti-stress, immunomodulatory, radio-protective properties as well as a pronounced effect at diabetes mellitus, viral hepatitis, cancer intoxication, intestinal infections, and skin lesions. It also improves regenerative function.

The studies have shown that taking the "AZEOMED" preparation leads to patients' recovery and tolerance to chemotherapy and radiation therapy without side effects at all or with less severe side effects. The "AZEOMED" powder for local application on skin surface has a pronounced healing effect with the majority of patients suffering from slow-healing injuries, mycotic lesions of feet, moist gangrene, herpes, and facial skin problems.

Interesting case: patient Najafova Zumrud, 51 year old, diagnosis: anorectal abscess, diabetes mellitus, intoxication. Upon arrival to the clinic the glucose level in blood was 22m/l, leucocytes $10x10^3$, Hgb 70 g/l, Westergen 68, body temperature 38,7°C.

In the clinic the abscess was cut, necrotic parts removed. The patient's condition was heavy, with severe intoxication. The patient was prescribed "AZEOMED" in a dose 3 pills a day, on the sixth day the body temperature normalized, purulent parts of the wound decreased, the glucose level in blood 12 m/l (insulin prescribed). The wound was cleared within a month, Hgb 107 g/l, leucocytes 6, erythrocytes 4,54, Westergen 38.

At the same time we received a patient with chronic paroproktit, the wound was cleared in 7-8 weeks. He was not taking "AZEOMED".

I used "AZEOMED" for parients with post hysterectomy syndrome. In my opinion, repeated treatments using "AZEOMED" can reduce the appearance of the syndrome of endogenous (metabolic) intoxication.

The latest clinical trial prior to writing of this article was conducted on a patient with the following diagnosis: diabetes mellitus, insulin-dependent, moist gangrene of the left foot, the condition after amputation of the right lower limb. The patient was given "AZEOMED" in a dose of 4 to 8 tablets per day. The gangrenous foot was sprinkled with "AZEOMED" powder 2-3 times a day. As a result of the therapy, moist gangrene passed into dry one, there were neither symptoms of intoxication nor a characteristic smell in the patent's room. This was of great importance for the patient as he rejected limb amputation.

We have an extensive clinical experience of using "AZEOMED" bio-additive among both patients and healthy population.

Healthy people who were taking "AZEOMED" indicated improvement of their general condition, burst of energy, and normalized sleep. Many of them also mentioned improvement of the nail condition and reduction of hair loss. Some had the condition of their facial skin improved, especially if the pills were taken while applying the powder on the problematic facial skin. They also indicated the increased resistance to colds.

From September 2008 to September 2011, I was conducting observations over patients with various nosologies. In view of the fact that I work in septic surgery and we have cancer beds, the main research was done on this group of patients.

Some good results were obtained in patients with ulcerative colitis complicated by diarrhea.

1. Imanova Lamiya, 38. Diagnosis: enterocolitis, diarrhea.

Conventional therapy did not yield the desired effect. Within 5 days after prescribing "AZEOMED" diarrhea symptoms were gone. To fix the effect, she took "AZEOMED" for a month: 4 pills a day for 15 days followed by 2 pills a day.

2. Kerimova Irada, 42. Diagnosis: Chronic ulcerative colitis, irritable bowel syndrome, swelling of the splenic angle.

The patient had a severe diarrhea and was being prepared for surgery. Prior to the operation, she had been prescribed "AZEOMED" in a dose of 8 pills per day along with conventional therapy; diarrhea symptoms were gone, the patient received postoperative chemotherapy. In addition to chemotherapy, she was given a dose of 4 to 10 "AZEOMED" pills a day. Currently, the patient is preparing for the second phase of the operation, taking "AZEOMED in a dose of 2 pills a day.

3. Ragimova Valida, 75. Diagnosis: Rectal cancer. Intoxication.

The patient was prescribed "AZEOMED" in a dose of 10 pills a day during the preparatory period for the operation. Symptoms of intoxication decreased. The operation was successful. The patient refused chemotherapy. Postoperatively, the patient was prescribed 8 pills a day. 3 years

have passed since the surgery, the patient is feeling well and periodically takes "AZEOMED" in a dose of 4 pills a day.

4. Huseynov Vahid, 35. Diagnosis: Post-injection gluteal abscess. Sepsis.

Following the incision of the abscess, the wound was washed with "AZEOMED" powder. In addition to conventional therapy, he was given "AZEOMED": 12 pills a day for the first 3 days followed by a gradually reduced dose. The wound was cleared within 5 days as compared with the conventional treatment.

5. Tahirov Rufat, 50. Diagnosis: Erysipelatous inflammation of the left lower limb, phlegmonous form.

Body temperature 38.5 on arrival.

Along with taking antibiotics (Ceftriaxone 2g daily), he was taking "AZEOMED" in a dose of 8 pills a day. He had his leg sprinkled with "AZEOMED" powder. The patient's recovery time was cut in half.

The second group of patients with different types of allergies

1. Aliev Rovshan, 18. Diagnosis: allergic dermatitis caused by long-term use of antibiotics. He was treated with sodium thiosulfate, claritin, polyphypam, with a little improvement. Polyphypam was canceled and replaced with "AZEOMED".

1 pill every hour on the first day, 6 pills a day on the second day. Allergy symptoms began to fade away on the second day. Subsequently he was given 4 pills a day until complete recovery.

2. Madatova Valida, 51. Diagnosis: Bronchial asthma. Allergy to house dust and pollen.

Has been suffering from bronchial asthma for about 25 years. Increased frequency of bouts up to 18-20 attacks a day upon arrival in Baku. She uses "Servent" preparation to stop the bouts. When she started taking "AZEOMED", the number of attacks dropped to 5-6 times a day. Good result has been obtained in treatment of patients with toxic infections. In such cases, patients were prescribed a one-time dose of 15 "AZEOMED" pills after gastric lavage.

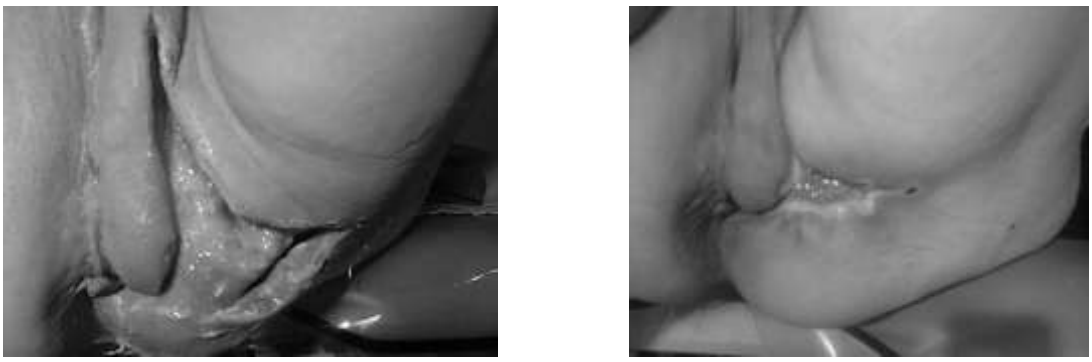

Fig. 1.

Fig. 2.

The third group is cancer patients receiving chemotherapy and radiation therapy.

1. Aliyeva Tarana, 48. Diagnosis: post-mastectomy state.

She underwent 3 courses of chemotherapy, felt bad after the second course, had nausea, vomiting, weakness. Started taking 4 "AZEOMED" pills a day, then on her own initiative increased the dosage to 15 pills a day. The third course of chemotherapy went without complications.

2. Hasanov Eldar, 67. Diagnosis: Stomach cancer, third stage.

Refused to be operated upon. Underwent a course of radiotherapy. Felt weakness, lethargy, loss of appetite, fatigue. He was given 1 pill of "AZEOMED" every 40-45 minutes per day with subsequent dose reduction. Got up an appetite a week later, started taking walks. He died 10 months later from the metastases.

A unique case in my practice: patient **Fatullayeva Kenul Zahir gizi, 28**, case history 1851. **Diagnosis:** condition after postpartum rupture of the rectal sphincter, sphincter insufficiency of the 2-3 degrees.

On the 3rd day after the plastic surgery on the rectum, the patient got diarrhea threatening the freshly performed difficult operation. The patient was prescribed a relevant treatment; however, the stool failed to normalize. I prescribed "AZEOMED" by 1 pill - times a day; literally on the second day the stool became normal and we managed to avoid a re-operation.

3. Isaeva Indira, 28. Diagnosis: Fibroadenoma of the right mammary gland.

She took "AZEOMED" by 2 pills 3 times a day for 3 months. The tumor size decreased by 7 mm. After a break, she has recently begun the 2nd course of taking "AZEOMED". Good results were obtained in patients with anemia. Following literally a week of taking "AZEOMED", hemoglobin returned to normal. There are results of laboratory analyses available. It should be noted that all patients I have observed had positive dynamics while taking "AZEOMED" preparation. This preparation caused no complications when taken for a long time and in large doses. Only a few patients had constipation.

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ANTHRAX AND THE POSSIBILITY OF ADSORPTION OF NATURAL ZEOLITE

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This period is characterized by a number of global social problems of mankind and one of them is the issue of biological terrorism.

As a striking biological agents in terrorist acts apply a number of viral and bacterial flora.

Based on the number of signs of infectious diseases as the most likely biological agents in the combined category A, causing less damage to the B category, does not danger seriously now-category C. Anthrax is concern to the category A. In order to tactical it is possible to use highly patogeneous, but with low contagiousness of pathogens that cause local damage. By the time accumulated enough evidence to evaluate the degree of danger of biological terrorism. The objects of threats: clinics, clubs, schools, shops, offices and other places visited. Aum Shinrikyo is known for bioterrorist attacks, which took 8-10 attempts to use aerosol of B. anthracis and toxin in the subway and around government buildings [1].

In 2001, the U.S. application of B.anthracis led to the disease anthrax 22 people, including 11 in an inhalation form [2]. This simptomycomplex defined bronchopneumonia and hemorrhagic

mediastenit and regionar limfadenit.Except it is defined hemorrhagic meningitis (50% patients) and one-third of patients' local necrotic nidus, with hemorrhagic inflammation in the lung [3].

Given the urgency of infection in the above mentioned plan and be thought an infection that has some value as long health and for animal cases we monitored for infections on the territory of Azerbaijan in parallel with the search for remedies of the infection.

RELEVANCE RESEARCH

Despite the significant impact of economic decline because of the influence of anthrax disease in recent decades and dispute of large-scale preventive measures, the disease continues to be registered in many countries, as well as in our country, where the main activity of population in rural areas is cattle breeding. Under the natural conditions, because of the anthrax disease suffer primarily herbivores, mainly large and small cattle, horses, pigs and others animals who have usually demon anthrax symptoms. However, a well-known fact should be noted, during the overcoming of the causative specie barrier by humans, the anthrax disease can be manifested by complex of fairly clinical appearances [4, 5, 6].

Despite the relatively small percentage of incidence of the anthrax infection marked by the people, mentioned above infection is very difficult from the pathogenetic point of view, and can cause very serious pathologies. The causative agent of anthrax, along with the variola virus and Yersinia pestis of the most effective agents that can be used as a biological weapon [5, 7]. Anthrax manifests itself in three main clinical forms: cutaneous, pulmonary, and intestinal. In debilitated and malnourished people as a complication of clinical form can develop anthrax septicemia. In modern conditions the search for new effective methods of diagnosis and treatment of anthrax is relevant. Healing properties of natural minerals are known from ancient times and are widely used to treat various ailments in the form of various drugs used as inward, ointments, applications, and as powders. One of the most visible, but little-known examples of use of therapeutic action of minerals, is a phenomenon of litofagy. In connection with this problem the purpose of the study was to identify possible adsorption capacity of domestic zeolite- natural sorbent on Bacillus anthracis- spore and vegetative of its forms.

MATERIAL AND METHODS

As an antigen STI vaccine was obtained from non capsule anthrax bacillus, which consists of living spores of avirulent vaccine strains. (Anthrax is a live vaccine; lyophilisates of which is for the preparation of a suspension for subcutaneous and cutaneous sponge application).

Manufacturing of vaccine is conducted by Central Research Institute of the Ministry of Health and Defense of the Russian Federation, (Russia, Kirov, FSI, and 48 Central Research Institute of the Russian Defense Ministry). Anthrax is a live vaccine consisted of 10 cutaneous or subcutaneous doses of 100-1 ml.). Bacteriological studies have been conducted by standard methods of bacteriology [8].

In the conducted experiment the antigen was inoculated on Petri dishes with meat-peptone agar in test tubes with meat-peptone broth. There are 4 billion microbial cells in 1 ml of vaccine for cutaneous method, the vaccine for subcutaneous use contents of 100 million of 1 mg of 100 million microbial bodies which were dissolved in 1 ml of saline, inoculated in test tubes with meat-peptone broth.

After 24 hours of incubation at 37°C from the broth suspension cultured grown loops have been inoculated on Petri dishes with meat-peptone agar.

RESULTS AND DISCUSSION

There are combined minerals under the name of Zeolite, in family of which are included about 50 species. The most common among them are: thomsonite, natrolite, heulandites, stilbene, phillipsit and laumoniet. There can be white zeolite, as well as light green, pink, yellow, occasionally brown, golden-orange and red. During the experiment has been a used dose of zeolite in 400 mg. Applied enterosorbent is the basis of clinoptilolite containing additional dolomite in the following ratio components of mass: clinoptilolite-70%-80%; dolomite-20%-25%. In the experiment of adsorption of culture have been used enterosorbent spore forms of the antigen,

another word, from the ampule with the antigen, dissolved in 1 ml. saline. During the experiment has been also used a dose of antigen 200: (another word, a dose of 0,5 million microbial bodies, which gave 120 plaques in meat-peptone agar (see Table).

On the expedient zeolite has been superimposed with a bacteria consisted fluid in the mentioned above doses. After 2 hours of adsorption eluate has been sown into Petri dishes with meat-peptone agar. At the same time the culture of Bacillus anthracis has been sowing in the mentioned above doses without the expedient zeolite as a control over the antigen.

Table

The formation of plaques in the experimental and control variant of sowing

The dose of antigen in dilutions (In millions of microbial cells)	Plaque formation in the IPA (number)
0,5	120
1	200
Control (no zeolite)	0

As can be seen from the table, selected doses of antigen respectively yielded 200 and 120 plaques in meat-peptone agar. In experimented cups with sown eluate of the antigenic culture, another words, Bacillus anthracis has not grown up, another words, the plagues has not been observed.

Known studies in the literature mention about the components of vaccine adsorbed in aluminum hydroxide, used as an adjuvant, efficiency and safety of which is confirmed by the Food Drug Control Administration, USA (FDCA). The obtained result allows us to conclude the high adsorption capacity of the studied sorbent- zeolite which has at its turn little inferior to aluminum hydroxide.

Conclusion

These results indicate an identified opportunity of study the adsorption enterosorbent, which can be used in intestinal form of anthrax, and possibly with septicemia.

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APPLICATION OF NATURAL ZEOLITE "AZEOMED" AS AN ADSORBENT OF CYTOMEGALOVIRUSES

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Increasing concerns about the danger of bioterrorism provides for the need to protect the public as well as develop effective counter-measures. In this regard, our research focused on identifying methods how to treat medical cases of infectious pathologies. Laboratory tests show that one specific approach could be found in the application of the adsorption methodology, provided through the use of effective agent (BPA) activators of infectious diseases. Moreover, laboratory tests and studies show that the process of adsorption through a natural process can function as an effective neutralizing agent of the virus-bacterial flora. In short, our laboratory research aimed at studying the actual effectiveness of the naturally-occurring zeolite mineral deposit found in the region of Tovuz in Azerbaijan. The mineral is currently used in the preparation of "Azeomed" medication which is found clinically effective in the treatment of infections caused by the cytomegavirus through the process of adsorption.

Studying viral infections which account for more than 80% of human infectious pathology is one of the topical issues of medicine. Human cytomegaly virus (HCV) Cytomegalovirus hominis) was first singled out in 1956 in children who died from a generalized infection.

Cytomegaly is an opportunistic infection. The virus can exist in the human body for a long time, neither revealing itself at all nor causing any pathologic symptoms. It can be found in healthy children's tonsillar tissue, urine and salivary glands. It is only when the balance between the human body and the virus is disturbed as a result of weakened defense factors that the virus begins to multiply intensively and can lead to lesions of various organs (1).

Although the majority of women of reproductive age are infected with the cytomegalovirus (2, 3), the infection is mostly latent. However, the cytomegalovirus can be reactivated during pregnancy. The reactivation course may be symptomless, but in pregnant women the virus can be transmitted vertically with subsequent miscarriage, premature birth, maldevelopment, and fetal death caused by congenital defects (4, 5). Special attention should be paid to women of reproductive age with compromised obstetric history (spontaneous miscarriage, stillbirth, congenital diseases etc.) (1).

The problem of detecting the active cytomegalovirus infection (ACVI) in women belonging to the category as well as reducing or even eliminating ACVI activity prior to planned pregnancy is considered a topical issue. From this point of view, it is possible to use natural absorbents as a sorbent of an infected person's contaminated cells.

Materials and methods

Natural zeolites are a new sort of mineral raw materials. The wide range of use of high – silicon zeolites is conditioned by their unique adsorptive and ion exchange properties, chemical and mechanical stability, high acid and radiation resistance.

It has been established that utilizing zeolites as medioprophylactic food additives yields a number of positive clinical effects.

Considering the above-stated, it was of interest to investigate experimentally the possibility of relieving the body of desquamated virus-containing cell population and possibly of cytomegalic viruses circulating in blood and lymph and found in urine, saliva, breast milk etc. For that purpose, some research was done on the absorption potential of natural zeolites; the tested silica-containing raw material consisted of zeolite-clinoptilolite with additional introduction of dolomite with the following ratio of the components, mass%: clinoptilolite 70-80, dolomite 20-30; the enterosorbent was made in the form of a pill with copper in the amount equal to or less then 10% of the total mass, introduced for binding purposes. In our studies on the adsorption potential of the abovementioned sorbent, we applied conventional virologic methods of research along with identifying non-toxic doses of preparations (6).

On the basis of the previously identified non-toxic dose of the preparation (zeolite) on RD tissue culture (cell line obtained from human rhabdomyosarcoma), a zeolite dose of 500 mg (0,0005 mg/ml – 5th non-toxic dose MND) was used during the experiment.

The experiment involved examination of pregnant women who underwent a preventive check-up. Two methods were employed to detect the presence of the infection in pregnant women:

1. The enzyme immunoassay (EIA) method using "Cytomegalovirus JgG-Elisa" test system (7) (Enzyme immunoassay for the qualitative determination of the JgG-class antibodies against the cytomegalovirus (CMV) in human serum). Only for in vitro diagnostic use. Product number CMVGO115 (48 Determination).

2. The cytological method of detecting CMV among desquamated cells in urine sediment (owl's eye test) (8).

Essence of the experiment:

Cell suspension from urine sediment was centrifuged at 2500 rpm for 30 min, then the supernatant fluid (urine) was exfoliated and poured off. The cells remaining in the residue were dissolved in the "Igla MEM" growth medium with double quantity of amino acids and vitamins. The cells were counted in a Goryaev chamber (9).On calculating the number of cells in the obtained suspension, those cells were layered in the amount of 1ml over the tested sorbent.

Following a 30-minute contact, the cells were counted in the eluate, thus identifying the adsorption potential of the tested zeolite specimen.

At the same time, the pregnant women were examined for being infected with CIV using the immune-enzyme method "Elisa".

The data obtained by conducting EIA "owl's eye" test together with the calculation of infected cells before and after urine adsorption on the tested zeolite were analyzed in a comparative aspect (Table 1).

Of interest is a question of possible cell desorption from the surface of the tested zeolite after adsorption.

For that purpose, a desorbent - saline solution in the amount of 1 ml was added to the zeolite with the cells settled on it; after a two-hour contact, the researchers counted the number of cells in the eluate, which were desorbent from the surface of the tested zeolite following the desorbent's action.

Table 1.

The result of adsorption of cell suspension from urinary sediment of pregnant women infected with CIV, on natural zeolite as compared with EIA and "owl' s eye" test indications

№	Number of cells in urine sediment, per ml			EIA indexes and "owl' s eye" markers		
	Before adsorption on zeolite	After adsorption in eluate	Desorption indexes	Diagnosis	EIA index	"owl' s eye" marker
1	7375000	30	2	CMVJgG	36,8	+
2	6250000	20	2	CMVJgG	40,0	+
3	5900302	20	3	CMVJgG	32,9	+
4	3500450	10	2	CMVJgG	15,5	+
5	3903330	10	1	CMVJgG	5,6	-

As a result, high adsorption capacity of the tested sorbent's specimen, that is, 100% cell adsorption has been revealed; the absence of cell desorption from zeolite is a positive factor.

The revealed adsorption potential of the examined zeolite specimen is a good recommendation for the mineral to be taken as a food additive to remove infected cells from the body.

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ABOUT THE PROBLEM Y.ENTEROCOLITICA

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The problem of probable using of infectious agents as biologically afflicting agents (BAA) during terroristic acts with deliberate application of biological formulations is urgent presently. In connection with the aforesaid, it is required to practice primary measures for prevention of biological terrorism. It is known that the concept of biological war has been existing for a long time and in a certain extent develops in present times, having different content in dependence on political environment, level of biological sciences development and technical achievements. Therefore, it is necessary to establish permanent control of compliance with provisions of Biological and Toxin Weapons Convention, including such weapons development.

Today the problem of biological terrorism comes to the fore, presuming local dissemination of biological agents (BA). Various information sources state that the list of probable biological agents includes about 34-39 infectious agents causing diseases of different etiology and toxins. It can appear to be hard to identify an origin of infection in cases of applying any agents circulating in a certain areas, including ones causing naturofocal diseases.

Zooanthroponosis agents can be most probably applied with several natural mechanisms of transmission. Given the above is the need to find effective ways and means to combat the infection. In this regard, we undertook to study the adsorption properties of natural zeolite «Azeomed» relatively Y. Enterocolitica.

Yersiniosis (syn.: intestinal yersiniosis) is a disease of the group of zoophilous sapronoses caused by Yersinia enteroolitica. It is characterized mainly by the fecal-oral mechanism of transmission of the causative agent, intoxication, exanthema, lesion of the gastrointestinal tract and joints, susceptibility to protracted and chronic course and the formation of immunopathologic syndromes. The genus Yersinia belongs to the family Enterobacteriaceae.

Three of the eleven species are pathogenic to humans: Y.pestis, Y.enterocolitica, and Y.pseudotuberculosis. Y.enteocoitica is an oxidase-negative, nonlactose-fermenting, aerobic, gram-negative coccobacillus. It ferments glucose, galactose, and mannose; reduces nitrates, and does not produce hydrogen peroxide. The organism is motile at 22°C to 25°C but not at 37°C, These properties help to differentiate it from Y.pestis and other Enterobacteriaceae.

Y.enterocolitica grows well on ordinary media, such as blood, MacConkey medium, heart infusion, and Salmonella-Shigella agars, although a selective agar medium has been developed specifically for its isolation. Y.enterocolitica strains have been differentiated into approximately 70 serogroups (based on somatic O antigens) and six biotypes. Eleven of the serogroups of Y.enterocolitica commonly cause human disease. Most animal and environmental isolates. Serogically, the most frequent serogroups associated with human infection are 0:3; 0:5, 27; 0:8; 0:9.

Y.enterocolitica is widespread in nature. It is present in the gastrointestinal tract of wild and domestic mammals, in the environment (surface water, sewage) and in certain foods (meats, dairy products, sea food, and vegetables). Most of the known pathogenic biogroups are associated with definitive animal hosts, especially the pig. In case-control studies, a correlation has been demonstrated between infection and the consumption or handling of raw or undercooked pork products such as chitterlings. Gastrointestinal infection with Y.enterocolitica appears to be most common in developed countries within the temperate zones. The organism is cold-adapted and capable of multiplication at low temperatures. Water-and food-borne infections have been documented, as has person-to-person transmission in family and community outbreaks. The significance of food product contamination during processing is underscored by the organism's ability to grow in properly refrigerated food, including raw and cooked meat and milk.

Y.enterocolitica has emerged as a significant cause of transfusion-associated sepsis. Factors contributing to this are the ability of the bacterium to multiply at 4°C and to utilize iron liberated from aging erythrocytes. The incubation period for intestinal infection is typically 4 to 6 days, varying from 1 to 14 days. The excretion of the bacteria in stools continues for a few weeks after cessation of the symptoms. Y.enterocolitica usually causes diffuse inflammation at the ileum and colon, with infiltrates in the lamina propria and superficial ulcerations in terminal ileum and colon. Mesenteric lymphadenitis, with reactive germinal centers and sometimes microabscess formation, often is associated. In most cases, the appendix is grossly and histologically normal or shows only mild inflammation. The usual route of acquisition of Y.enterocolitica is through the ingestion of food or water contaminated with the bacteria. Prior to the initiation of an infectious process, this microorganism undergoes a temperature adaptation in the human host, making use of both chromosomal and plasmidassociated virulence determinates that are temperature regulated. Y.enterocolitica is primarily a gastrointestinal tract pathogen, with a propensity for extarintestinal spread under appropriate host conditions (immunosuppression, iron overload). Gastrointestinal infection may present as an enterocolitis in young children or as an acute mesenteric lymphadenitis and terminal ileitis mimicking appendicitis in older children. Acute gastroenteritis is the most common presentation in young children (under 3 years of age). Symptoms include diarrhea, usually accompanied by fever, vomiting, and abdominal pain. Stools usually is mucoid or bloody. The abdominal pain usually is colicky, diffuse, or localized to the right lower abdomen. Y.enterocolitica can be recovered from stools, mesenteric lymph nodes, throat swabs, peritoneal fluid, or blood. Isolation from otherwide uncontaminated material, such as blood or lymph nodes, is not difficult because Y.enterocolitica grows on ordinary media. Serology can aid diagnosis, especially during outbreaks. Infection can be confirmed by demonstrating increases in serum antibody titer after infection. Antibodies usually are detected from 8 to 10 days after onset of clinical symptoms and persist for several months. Serologic response often is absent in infants. Y.enterocolitica can crossreact with Y.pseudotuberculosis and with other organism. A common antigen is shared by Y.enterocolitica serotype 0:9 and species of Brucella. This cross-reaction has caused great concern because of the confusion it can create in the serological detection of Brucellosis in cattle, pig, and other animals, and in the serological diagnosis of both Brucellosis and Yersiniosis in humans.

The essence of the solving task is in the spreading of assortment of enterosorbents relative to Y. Enterocolitica. In the experience have been taken:

– Bacterial culture of Y. Enterocolitica (model: diagnostic erythrocyte enteric Yersinia antigen (09) for diagnostic purposes);

– Culture of transplantable cell lines L-20B (mouse embryo fibroblasts, derived from transgenic mice), used for identifying of non-toxic dose of the proposed enterosorbent based on zeolite-clinoptilolite and dolomite.

For the experiment was taken the enterosorbent of 500 mg on basis of the revealed non-toxic dose of preparation (zeolite + dolomite) on tissue culture L-20B in the amount of 0.0005 mg/ml (5th non-toxic dose) (1).

For diagnosis of yersiniosis was applied macromethod setting of IHT (Indirect hemagglutination test) in polystyrene plates.

Before the formulation of the reaction the macromethod each lunula of the polystyrene plate is wiped with 70% ethanol, then is washed 5-6 times with the purified (distilled) water, then each lunula is wiped dry.

In formulating the contents the IHT the content of the ampoule with erythrocytic diagnostics is diluted in 10 ml of 0.9% sodium chloride solution to obtain 1% of suspension.

The content of the ampoule with serum coli-Yersinia 09 (1:5) is diluted in 5 ml of 0.9% of sodium chloride solution, is received the dilution 1:25.

Preparation is diluted in accordance with the rules of asepsis.

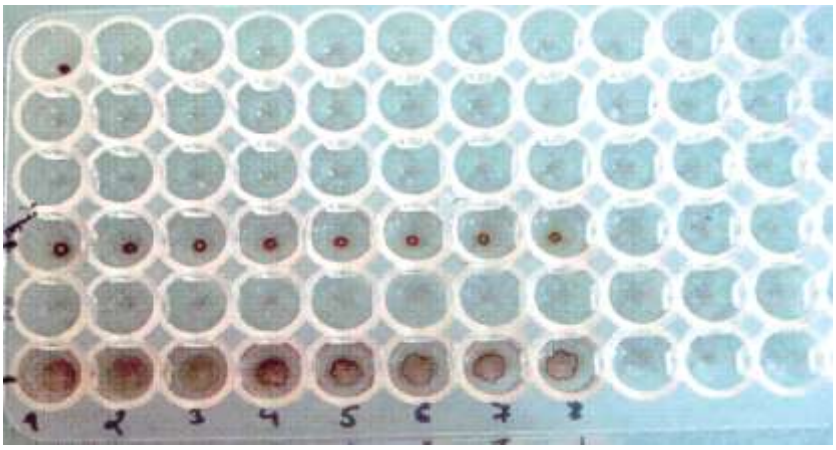
In each of 10 lunules is brought in 0, 5 ml 0.9% sodium chloride solution. Then, in the first lunula is brought 0.5 ml of the studied serum, diluted 1:25 and is made a double dilution of 1:50 to 1:6400 by moving out from one lunula into the other at 0, 5 ml and mix their contents of at least 3-4 times.

After that, into each lunula is added 0.2 ml of 1% suspension of diagnosticum.

At the same time there are made the provided controls: serum diagnostic and antigen: (diagnosticum – in 0,5 ml of 0,9% of sodium chloride solution 0.2 ml of 1% suspension diagnosticum;

2 – the studied serum – 0.5 ml in a dilution of 1:50 and 0,2 ml of 1% suspension of the Control erythrocytes; and 3-control serum – 0.5 ml serum of enteric Yersinia 0.9 ml in a dilution from 1:50 to the titer shown on the ampoule and 0.2 ml of 1% suspension of diagnosticum.

Plates are lightly shaken, holding with both hands in a horizontal position, and is left it for 1,5-2 hours at a temperature of 37 ± 1°C, then at temperature 20± 2°C for 14-18 hours, after which the reaction is taken into account.



Accounting of the reaction is carried out according to the four-cross system:

4 + – all erythrocytes are agglutinated and evenly is covered the bottom of the lunula;

3 + – are agglutinated almost erythrocytes, in their background there is a little-noticed ring of settled nonagglutinated **erythrocytes**

2 + – along with the even agglutination at the bottom of the lunula there is sediment from nonagglutinated erythrocytes in a small ring or "buttons"

1 + – the majority of erythrocytes are not agglutinated and settled as a small ring with irregular edges in the center of the bottom of lunula

--- no signs of agglutination.

Diagnostic titer of antibodies of the tested serum is considered the last dilution, which gives a clear agglutination of erythrocytes and can be rated no less than 3 +.

The reaction of Indirect Hemagglutination Test with the tested serum is considered the positive if with the control serum in the dilution equal to the titer, listed on the ampoule, there is a positive reaction, and in the control lunula with the tested serum and non-sensitized erythrocytes the reaction was negative.

This method has been checked on the proposed enterosorbent.

On the surface of the tested enterosorbent (500 mg) was layered the dissolved in 10 ml 0 9% sodium chloride solution (1% suspension), erythrocyte diagnosticum.

15 minutes after the contact there was joined the dissolved antigen and the eluate after adsorption of the antigen with the titred control intestinal Yersinia serum 09 (1, 2 rows on the panel – Fig. 1).

Thus was established the full adsorption of antigen on the proposed enterosorbent:

1 row – positive hemagglutination (4 +),

2 row – complete absence of erythrocyte diagnosticum

3 row – additional control of the absence of antigen (negative hemagglutination).

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TRACE ELEMENTS IN MEDICINE

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Trace elements have important and extensive effects on the body, the ability of micro-and macro-elements which increase the intensity of energetic processes in living organisms and enhance its protective function are well known. In certain amounts, without causing toxic effects, they have a high biological activity, as an essential part in many enzymatic reactions, they can be used not only as a prophylactic, but also for therapeutic purposes, and they take their rightful place in the field of alternative medicine. One of the great representatives of this complex is the biologically active mineral Azeomed created from natural zeolite of Aydag deposit in Tovuz region of Azerbaijan. It has been known for a long time that the intake of many drugs is positive and dangerous at the same time, sometimes lethal, artificially suppressing or stimulating the function of various systems of the body. The toxic effect of drugs is regarded as a side effect very often. The diagnosis: Drug disease has become quite common in recent years, which is also requires serious consideration in choosing treatment methods for general practitioners. On the other hand, man has always sought to have a healthy body and the search of the elixir of youth and longevity shook the brain of everybody.

Commonly used antibiotics have changed the responsiveness of the organism, infectious diseases are often asymptomatic, and the disease findings of many diseases are atypical. A lot of diseases are appeared nowadays which were not diagnosed earlier and not included in the existing classifications. This is atonement for the mindless human impact on the nature, which destroys the ecological balance, pollutes the atmosphere. The ecological situation is becoming threatening to humankind every day. The man has no time to adapt to changes of the nature which he created himself.

It is possible to use this amazing set of micro and macro-elements and its compounds that are given to us by nature, "Azeomed" can be used in many areas of medicine. I used it in different age groups as an independent agent in mototherapy for preventive measures or in multimodality therapy to enhance the effect of drugs, to reduce side effects and to shorten period of treatment. This good source of calcium ion-exchange and other micro and macro-elements has a greater effect

in the complex use than every element taken separately. Every of them has its own point of application which does not interfere the action of another, thus their complex effect increase the function of the organ and body in whole. I used "Azeomed" extensively in pediatric practice: for newborns it was used to close the fontanel timely, to form the skeleton in correct way, to have teething less painful. It was also used in the treatment of childhood functional diarrhea, and problems of infants' adaptation in the first months of their life, where it is very important not to destroy the inherent immune capabilities of the organism. These children were developing actively, almost without any kind of diseases, and if they were ill, they recovered easily and quickly. It was noticed a good appetite, a positive emotional state, less painful teething, self-correct movements. These children began to walk, sit, and have better developed verbal skills before their peers.

Children from 1 year to 3 years old and a 3 to 6-7 - years were distinguished by the fact that during the seasonal viral infection, they had short-term temperature and rapid recovery, without complications, recovery of physical condition of the body. Relapses were observed during further intake of "Azeomed". In a family where there were ill children and adults - parents got ill repeatedly. School-age children receiving "Azeomed" for preventive measures had good academic results, less fatigue, good sleep, less irritability, normalization of body-weight indicators. I recommended "Azeomed" to elderly patients as preventive measures. It is necessary to take into account that aging is, paradoxically, a condition which the young child or young person can not understand, who are full of strength and energy, a middle-aged man who has neither the time nor the wish to stop for a moment and ask yourself this question and the elderly person, who does not want to believe that his age is not distant, unattainable future, but a reality at the door. So what is it? Aging affects all organs and systems, all organic structures and their functions. Immune mechanisms and adaptation of an organism are broken; it can lead to memory impairment, decreased mental and physical abilities of the body. The muscle and bone mass, weight are lost, the blood pressure, pulse, hemoglobin are changed, the transport of oxygen into the tissues is disrupted with age, the brain is particularly affected in this case. Over-nutrition or malnutrition, dehydration or excessive fluid intake cause serious harm to health of the man. Unfortunately, aging and diseases in this age group are distinguished by a slow start, without marked symptoms. And visit to a doctor as a rule it is often already in neglected conditions. Tendency to believe that the old man has had his day it is wrong, but it will be possible to keep the activity for a long period of time if the mechanisms of aging study in depth. The most notable changes take place in the period from 60-70 years.

The person retires during this period, he has some free time, and he begins to feel the "irrelevance". Experiences of this kind can lead to permanent stress. It can be very useful to recommend "Azeomed" to such patients as a constant mineral dietary supplement in small quantities with a variable intake of nutritious food. A necessary condition is also a healthy lifestyle, muscle activity. The disease makes the man older, and intake of trace elements helps to resist this process. They have a positive effect on the body, help to regulate and stimulate metabolism. The question of longevity for the elderly is reduced to the treatment of chronic diseases in which one of the first places belong to the intake of micro and macro-elements. For example, "Azeomed" has been added to elderly patients who were treated for one or another disease. Persistent improvement of health, with a fairly long-term remission, stabilization of the blood pressure, cheerfulness during the day, getting adequate sleep at night, improved memory, fewer dissatisfaction, and increased overall life status were indicated in the course of treatment. Usually I recommend them small doses to suit the individual characteristics of each patient - 1 tab. 1-2 times a day for one month with the intervals between doses is 2-3 weeks, because chronic administration may reduce reactivity of medicine.

Unfortunately, the intake of "Azeomed" at a young age is not suitable as preventive measures. But it is necessary to start the fight for the longevity in the youth, systematically and steadily trying to improve, support the work of the internal mechanisms at the level as in the flush of youth. Good results were obtained in the complex treatment of patients with diseases of locomotor system: arthrosis, arthritis, osteoarthritis, fractures, and sprains. The treatment time is reduced, quality of life is improved in patients. In athletes' member teams of male and female who received "Azeomed" were marked the best performance while still maintaining its strength and

quick recovery of shape, "Azeomed" has the Anti-Doping certificate of international Anti-Doping Committee.

In the treatment of somatic illnesses it was traced the positive dynamics of the chronically ill people of disbacteriosis: the number of coliform bacteria and intestines bifidobacterium flora restored within 1 to 2 months when the usual treatment is required more time. "Azeomed" was recommended in gastrointestinal disease: viral hepatitis A, B, C, chronic pancreatitis, cholecystitis, colitis, enterocolitis, gastritis, peptic ulcer disease with increased secretion of acidity, ulcers, duodenal ulcer, constipation, and tendency to diarrhea as a sorbent, the activator, the amplifier of chemicals, while creating an immunomodulator by altering their functional properties at the same time. I recommended it to patients with cancer, to reduce the negative effect of chemicals or radiation therapy, to improve the quality of life taking into account the absolute proven safety of the medicine. There were more 700 patients during the period of my observation. Some of them were,

Children – 240, boys – 125, girls – 115.

Diarrhea – 176, anemia – 193, cerebral palsy – 2, Rachitis – 64, viral infection season - 204, and childhood diseases - 37, upper respiratory tract infection – 29, lower respiratory tract disease – 18, Kidney diseases – 11, Cystitis – 5, Rheumatism – 16, locomotor system: lordosis, kyphosis, myasthenia, retarded physical development – 9, Newborn – 24, Disbacteriosis – 21, Enuresis – 16, Allergy –32.

Adults – 537. Men – 364. Women – 173.

Diseases of the digestive tract – 453. Urogenital system – 289, Oncology – 9, Diseases of the nervous system – 167, Viral infections – 341, Pregnant – 27, cardiovascular system – the 42 diseases of joints and spine -165, Systemic diseases – 3, Diabetes mellitus – 5, TB – 2, Poisoning – 15, Anemia – 49, Allergy – 18, Parasitic diseases – 98, Skin diseases – 54.

It is recommended to intake in tablet form, or in the form dissolved in water which is necessary to be dusted off and given according to the Tibetan method, in small doses. Intake can also be as before, during, and after having meal, or during daylight hours. In conclusion, we try to draw attention to the value of the expansion of clinical research and studies of micro and macro-elements in people as for prophylactic and therapeutic purposes. Taking into account that the twenty-first century is the century of struggle for health and microelementology is a science of the future. The correction of the imbalance of micro and macro-elements in the healthy and the sick person can be compared with the role of genetic factors in shaping health. And we are able to use a unique product that was given us by nature for use in our daily work of healing. It's worth it.

LITHOPHAGIAL METHODS ADAPTATION TO ADVERSE ENVIRONMENTAL FACTORS

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Carried us over a 35-year study of various aspects of the phenomenon of instinctive lithophagy among different groups of animals (birds, reptiles, herbivorous mammals, some predators) in different regions of the former Soviet Union, as well as analysis of published materials that examine different aspects of instinctive lithophagy among animals and humans in other regions of the world, allow us to make a generalized conclusion that the cause of instinct in lithophagy always striving of organisms eaten by common natural minerals of the weathering crust of rock to adjust the material composition and functions of its various systems, which may be a mismatch due to various adverse environmental stress factors. In fact, it is a recurring problem of adaptation of organisms to the development of stress under the influence of adverse geological, geophysical, space physical and evolutionary factors prevailing instinctive universal method of correction of such violations with the use of natural minerals. Stress in animals caused by environmental factors, may be exacerbated by pregnancy, molting, as well as injuries and other

pathological conditions. Reasons of lithophagy applied to specific cases may be quite different. These differences can be distinguished on the basis either of the primary causes of stress factors (such as geochemistry and biogeochemistry, especially given the area's climate, the proportion of toxic plants in the feed, etc.), or from a secondary set of relevant causal violations in the body. The very possibility of correcting the body through the same type of properties due to lithophagy enjoyed by many supergene minerals (formed in the weathering zone of rocks) in terms of regulation of physiological, informational and energetic processes in living organisms.

For minerals, have a pronounced adjusting-stabilizing properties in relation to living systems, is safe to carry minerals of smectite and kaolinite, chlorite, hydromicas, vermiculite, some types of zeolites (mainly heulandite, clinoptilolite, mordenite, phillipsite and natrolite), and also - some form of silicon. Favorable in relation to their activity in mammals has numerous experimental confirmation.

Among the already identified properties of the above minerals, which can be used to compensate for the different disorders in mammals can note the following: the ability to adjust to the body of the alkali and alkaline earth elements (due to ion-exchange reactions and sorption processes on lattices of frame-and mineral-gel ion exchangers, formed in the intestine); the ability to supply the necessary and remove excess biophylic trace elements, as well as bioactive form of silicon - impact on the overall metabolism by activating and prolonging the action of enzyme systems in the digestive tract; a beneficial effect on the symbiotic microflora and water balance in the digestive tract, the immune status, the processes of tissue regeneration. All of the above minerals also have the ability to detoxify the body. Here you can see that the biological activity possessed by all, without exception, natural minerals, but not all of this activity is aimed at stabilizing the structure and functions of body systems (not utility or harm caused by dose).

The choice of minerals animals (and man) is determined by geological and geochemical features of lithogenic mineral complexes that are distributed in their habitats. Thus, in regions dominated by relatively young volcanic rocks of granitoid composition of herbivorous mammals consumed by man and is dominated by minerals zeolites, smectites and opal-like variety of silicon oxide.

In the territories of ancient platforms and in the mountains, composed of ancient metamorphosed volcanic and sedimentary complexes in the intake of minerals is dominated by finely dispersed form of quartz, hydromicas, chlorite, and kaolinite group minerals.

Lithophagy in herbivorous birds and other cloaca animals, unlike mammals, is more regular. At the same time often consumed widely used in the weathering crust silicon-rich minerals (quartz, feldspar). Lithophagy of birds always focused primarily on the regulation of ion balance in the digestive tract by selective removal comes into contact with food excess elements in ionic form in the intestines are accumulating to silicon-oxide gel.

CORRECTION OF DYSBACTERIOSIS IN APPLICATION OF AZEOMED NATURAL ZEOLITE

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This paper provides data on the revealed selective adsorption of pathogenic and non-pathogenic strains of colon bacillus E. coli on natural zeolite sorbent "AZEOMED". The obtained data is the experimental verification of clinical observations a priori on the correction of dysbacteriosis.

Imbalance of normal intestinal flora which plays an important role in protection of the body from pathogenic microbes is one of the topical problems of medicine today. Permanent disturbances of microbial cenoses are called dysbacteriosis (dismicrobiocenosis), with affections of intestinal microflora apparently prevailing among them.

It should be noted that there is quite a wide spectrum of indications for bacteriological diagnosis of intestinal dysbacteriosis: long-run infections and disorders when it is impossible to single out the pathogenic enterobacteria; lingering period of convalescence after suffered intestinal infection; dysfunction of the gastrointestinal tract on the background or after antibiotic therapy or in persons in permanent contact with anti-microbe preparations (1).

Gastrointestinal dysfunction can also be in patients with malignant growth diseases, in persons suffering from dyspepsia disorders, in persons being prepared for surgery on the abdominal cavity organs, in premature or injured newborns and in the presence of bacteremia and purulent processes difficult to treat (ulcerative colitis and enterocolitis, pyelitis, cholecystitis, etc.).

Clinical researches show that in the majority of patients with functional constipation, imbalance of the large intestine's microflora is observed, which is mainly expressed in the lower number of bifidus bacteria and lactobacilli and higher (compared to normal) content of conditionally pathogenic enterobacteria and streptococci (2).

Dysbacteriosis has been revealed in patients with constipation; however, etiological and pathogenetic interaction of microbial imbalance and colonic motor activity has not been studied enough.

It should be noted that some relation has been found between intestinal and vaginal dysbacteriosis in bacterial vaginosis, which is a topical problem of the part of medicine dealing with skin and venereal diseases.

For correction of dysbacterioses, it is recommended to take eubiotics – coli-, lacto-, bifidobacterines, ect. (3).

Meanwhile, extensive utilization of the unique properties of zeolites in various industry branches has become especially popular nowadays. Involving new types of minerals in the industrial production is one of the important tasks of the national economy.

This to a great extent applies to the problem of expanding the area of application of natural sorbents.

It should be noted that the demand of various branches of industry for zeolites has been increasing continuously, and high-silica natural zeolites find wider use.

Among high-silica natural zeolites, clinoptilolite has a special place; it is the most widespread zeolite in sedimentary rocks, resistant to action of high temperatures and corrosive mediums.

Possibilities of practical application of clinoptilolite are determined by its most valuable qualities, which are the special ion-exchanging ability and molecular sieve properties.

There have been recent researches on application of zeolites as natural sorbents in medicine. There are some data on positive effect of the complex of dietary fibers, enterosorbents and cultured milk foods which normalizes the large intestine' microenvironment (4,5). An obtained data analysis according to L.V.Blokhina and A.M.Kochetkov has revealed the fact that at initial stages of large intestine disbacteriosis in patients with functional constipation syndrome, adding specialized cultured milk foods (BIFIDOK) or BAS "LITOVIT" to food containing dietary fibers, enterosorbents or bacterial complexes has positive effects. Growth inhibition of the conditionally pathogenic microflora has been observed, along with a stimulating effect on the growth of symbiotic microbes: bifid bacteria, lactobacilli and Escherichia coli. In the majority of patients, elimination of colonic stasis and restoration of the body's microbiological balance has been observed (6).

Taking into account available clinical observations on the disbacteriosis-correcting effect in application of natural zeolite-containing products, of interest was to experimentally verify those observations.

The purpose of this study was to investigate the adsorption capacity of AZEOMED mineral complex as to the bacterial flora, on the model of pathogenic and nonpathogenic strains of Escherichia coli, E. Coli.

The experiment involved methods generally accepted in bacteriology (7, 8). The experiment for revealing sorptive properties of zeolites regarding the bacteria mentioned above consisted in layering a certain dose (10^7 – from 100 to 1000 colonies) of bacterial flora (700-7000 un.) of pathogenic and non-pathogenic strains in the quantity of 1 ml on zeolite and keeping it for two hours followed by seeding the culture from the supernatant liquid to selective mediums and

comparing the number of colonies after being adsorbed on the investigated zeolite "AZEOMED" (1 pill, 500 mg).

In bacteriological researches, the adsorption degree was determined using the "colony count" method, that is, by comparing the number of colonies in control and the number of colonies after the adsorption of bacterial flora on zeolites.

There was found a complete absence of colonies in Petri dishes with the selective medium of E.Coli bacteria of the pathogenic type and permanent germination of colonies of non-pathogenic E.Coli strains.

The obtained data corroborated a priori clinical observations for correction of disbacteriosis using natural adsorbents, in particular, using "AZEOMED" as a sorbent.

The above-mentioned results can be a basis for correction of vaginal disbacteriosis.

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SECTION 5
Emergency management and communication systems

SPECIAL COMMUNICATION SYSTEM FOR NATURAL DISASTER AREAS "SATPAG"

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1. INTRODUCTION

Recent large-scale natural catastrophes such as devastating earthquakes, tsunamis and floods in Japan, Chile, Haiti, Italy, Indonesia, Pakistan, Australia and other regions have demonstrated that failures in conventional and special communication systems are one of the most pressing and topical problems of emergency management and search and rescue operations in the areas affected by large-scale natural disasters. This is due to the collapse of receiving and transmitting cellular communication systems, transmitters and other systems of transmitting and receiving information.

Effective coordination of activity of all involved public administration systems, rescue services, ministries and agencies during both emergency situations caused by natural and human-made disasters and response efforts largely depends on accurate and failure-free operation of communication systems and telecommunication resources.

In the vast majority of cases, people in disaster areas during large-scale natural disasters find themselves isolated from outside information and have no idea what action to take: to wait for on-site assistance, or to move in any direction from the place where danger is expected; or which routes might be the most secure, where and when to wait for humanitarian aid, etc. Not only does that complicate the work of rescue services but also leads to panic and chaos among people caught in disaster areas.

Often, in the same position in disaster areas find themselves state employees who may lose contact with central government agencies and have no connection with huge masses of people. Informational chaos multiplies the adverse effects of natural disasters.

It becomes apparent that the existing mass communications systems: cellphones, handheld transceivers, Internet, etc. lose their effectiveness and functionality in large-scale natural disaster areas. Special means of communication such as existing satellite phones and communication systems cannot be available today to the general public and most government officials. Therefore, a completely new technical solution is needed to effectively provide wide masses of population and civil servants who find themselves in large-scale natural disaster areas, with targeted information. The International "SatPag" System, a fundamentally new type of one-way information communication may serve as such communication system.

2. BRIEF OVERVIEW OF EXISTING AND NEXT-GENERATION COMMUNICATION SYSTEMS FOR EMERGENCY MANAGEMENT IN NATURAL DISASTER AREAS

U.S. experts say that today the U.S. high-capacity telecommunications network includes, along with communication systems of special (governmental, diplomatic, intelligence, military) and common (telephone, paging, trunking, cable, satellite, etc.) use, Internet resources as well /1/. According to experts, most of the mentioned information communication system may significantly lose their efficiency in a single moment as a result of a natural disaster, accident, terrorist attack or other emergency.

The head of the U.S. Department of State Collin Powell, speaking of the tragic events when he was in Lima (Peru), said: *"Never in my life have I felt my uselessness to such an extent as on September 11. For 7 hours (of my flight to the U.S.) I was unable to contact by phone and get information about what was happening in the capital city (Washington, D.C.) although there were two radio broadcasting centers on our route. And I am the Secretary of State"*.

It is no wonder that during those tragic hours in Washington, D.C. and New York, the conventional telephone communications (landline and cellular) were virtually paralyzed as a result of hundreds of thousands of user calls coming almost simultaneously and blocking the overloaded telephone exchanges. According to U.S. experts, the maximum allowable number of calls from New York telephone users on September 11 was exceeded by 14 times compared to 10 times during the San Francisco earthquake on October 17, 1989. According to other data, the nation's largest telecom operator AT&T received on that day 100 million more phone calls than usual.

After the September 11 events, the following programs were designated as priority areas for further development and improvement of the NCS, being a basis for the U.S. telecommunications infrastructure during emergency situations: "Hot Line – Emergency Response Link" – ERLink /1/, "Advanced Intelligent Network" – AIN /2/, "Alerting and Coordination Network" – ACN /3/, "Government Emergency Telecommunications Service" – (GETS) /4/, "National Coordinating Center" – NCC /5/, "Communications Resource Information Sharing" – CRIS /6/, "Shared Resources" – SHARES, "Telecommunications Service Priority" – TSP /7/, "Wireless Priority Service" – WPS /8/.

For prompt notification and alerting of government agencies and rescue services within the "Hot Line" (ERLNK) program's pilot project, a relevant website will be created in the Internet to contain all the necessary information about accidents, catastrophes, terrorist attacks, hurricanes, floods, earthquakes and other emergencies in the U.S.

As part of the program for creation of the "Advanced Intelligent Network" (AIN), it is planned to provide public switched network (PSN) / 9 / users with flexible access to any service (telephony, SMS, paging, data transmission, Email, HTML, FTP, WAIS, WAP) based on application of the ISDN data transfer standard technology, which has become widespread in the U.S. over the past 10 years, as well as intelligent terminal equipment (PCs, cellular and landline phones, fax machines), without involving any Internet provider or telecoms operator. At the same time, requirements for access management and choosing the service priority will be met.

The main objective of the program for modernization and development of the "Government Emergency Telecommunications Service" (GETS) is to provide technical support for secured communication for U.S. government users in emergency situations when appropriate communications resources (lines, channels, switching centers) may be disabled, blocked or overloaded. The system's technical capabilities are realized through flexible and prompt priority-based resource redistribution and traffic reconfiguration concerning both federal (FTS, DISN, DTS), and commercial (AT&T, MCI WorldCom, Sprint) public telephone networks based on digital technology and the Internet. Providing access and connection for over 50,000 subscribers is carried out by a unified automated procedure (tone dialing of the combination: 710-NCS-GETS" + PIN + user number), regardless of their location and based on the personal identification number – PIN according to which the urgency category and priority of the call are established. The ultimate goal of this program is the gradual transfer of all the results achieved in the course of its implementation (technical solutions, technologies, standards, procedures and rules of communication) to the national level in order to create the National System of communication in emergency situations (Emergency Telecommunications Service - ETS). Thus not only the

government's uninterrupted operation but also life activity of the total U.S. population when removing the consequences of emergencies will be secured. For priority-based provisioning and restoration of telecommunications services in the interests of national security and for prompt emergency response, the Federal Communications Commission has launched a special program titled "Telecommunications Service Priority (TSP)". As part of the TSP program, a telecommunications operator duly instructed to provide NCS services is given preference over other operators in the priority of provisioning and restoration of telecommunications services and enjoys support of government agencies.

To mobilize joint action of telecom operators to restore telecommunications resources and services in emergency situations when the wired general usage telephone network is overloaded or completely blocked, the NCS has created a special "Alerting and Coordination Network" (ACN) for conference-mode information exchange among regional emergency response centers. For that, dedicated telephone lines can be used, organized on the basis of short-wave and satellite radio communication systems. Depending on the level of damage and losses associated with emergencies, there are three categories of difficulty of recovery operations for NCS telecommunications resources and services. The recovery operations of the third (highest) category (NTMS Response Level III) are carried out in emergencies directly affecting the national security of the United States or by personal order of the President, as it was on September 11, 2001. Within these operations, special (central and local) response teams and staffs are formed (National Emergency Management Team, Communications Functional Group, Regional Emergency Management Team, NTMS Operating Centers) from representatives of the federal government, industry and authorities (of a state, county, district, city) who assess the damage and organize all works on restoration of telecommunications resources and services to the required extent.

To organize wireless communication for authorized agencies of the U.S. government under emergency conditions, the "Shared Resources" project (SHARES) aims to modernize the currently used national short-wave communication network which includes virtually all receiving and transmitting short-wave radio communication centers of civil and military ministries and agencies in the US (1040 in total), as well as personal stations of amateur radio operators. According to the existing agreement – "Memorandum of understanding between the American Radio Relay League and National Communications System", U.S. amateur radio operators (over 400,000), in accordance with the rules and regulations adopted by the Federal Communications Commission on the basis of the Disaster Relief Act of 1974, *undertake to make their facilities and frequencies accessible to the U.S. government represented by NCS to transmit urgent messages in times of emergency.*

According to the communications regulations, any subscriber within the U.S. territory can have at any time of day and night access to the resources of this network at fixed frequencies (over 250) to transmit formalized emergency messages in the interests of national security and for prompt warning of the public.

The main purpose of the modernization of this system is to increase its preparedness to work in emergency situations due to: auto-sensing and forecasting the condition of the conducting layers of the ionosphere; conducting quarterly and scheduled weekly training connection checks; unification of standards and communications equipment; introduction of the packet switching technology and IP protocols.

"Wireless Priority Service" (WPS) is one of key programs for modernization and development of the U.S. NCS the after the September 11 events. The importance of this program is eloquently and convincingly evidenced by the fact that its realization is monitored not only by the Pentagon but directly from the White House where the number 1 user of this communication system in times of emergency is. What the new system is capable of was demonstrated during the ceremony dedicated to the memory of victims of the New York terrorist attacks when President George W. Bush, while in a crowd of many thousands of his compatriots, successfully got connected to the White House with his cell phone literally from the first attempt, which could not be said of correspondents and others around vainly trying to make a call through the overloaded telephone network of the megalopolis.

Russia, too, realizing the urgency of this problem, has begun to abandon the use of conventional cellular communication systems in public administration, law enforcement and

security agencies, rescue services. For example, to create a more robust communication system in St. Petersburg, the Unified Operational Trunked Radio System (UOTRS) was created. Prior to the creation of UOTRS, St. Petersburg authorities and public services traditionally used a variety of communication systems. As a result, the effectiveness of direct cooperation between different municipal services and emergency services of the city was insufficient both in daily operations and in times of emergency. The order by St. Petersburg Governor V. Yakovlev, signed in 1999, establishing the Unified Operational Trunked Radio System (UOTRS) and defining the principles of cooperation of various city services, not only was crucial for the choice of communication system but also has become a fundamental solution in city management. This system uses the operational radio communication to connect all municipal and departmental on-duty services for efficient management of the city's activity and coordination of actions in times of emergency. It is commonly known that during an emergency such as a major accident, fire or terrorist attack, other types of communication are ineffective. In particular, cellular systems begin to malfunction under heavy traffic coming from a single point and making a radiotelephone call takes many minutes, although sometimes every second counts in such situations. Moreover, dialing a seven-digit telephone number in a crisis situation is often not as easy as in everyday life. UOTRS is a closed hierarchical communication system intended for use in both routine and emergency mode. UOTRS comprises 226 operating radio stations. Its structure includes: City Administration, territory departments of regional administrations, the Office of Civil Defense and Emergency Situations, St. Petersburg Committee on Transport, departments of the Interior Ministry and the Main Directorate for Road Traffic Safety, and the city's largest plants such as "Lenenergo", TEK SPb" and others. According to the decision of the State Telecommunications Commission № 57 of 02.07.2003, the TETRA standard and its modifications are recognized as the most promising for the creation in Russia of professional trunked radio communication networks for government bodies at all levels, especially for those engaged in national defense, security and law enforcement, as well as for the needs of a number of agencies and large corporations.

Presently, almost each of these institutions has its own radio communication network. However, progress of the new trunked communication technologies is experiencing serious difficulties because of the impossibility of a smooth transition from the working technologies to the new ones.

When it comes to large-scale destruction, the use of trunked communication systems faces similar problems and does not allow target-oriented information transmission on a mass scale and, simultaneously, selectively to the public to coordinate its actions.

Meanwhile, the problem of data communication on a mass scale for the public and government employees, on the one hand, and selectively, on the other hand can be solved by a fundamentally new system in the world of information and communication technologies, which is "SatPag".

3. WHAT PROBLEMS DOES "SatPag" SOLVE?

What is "SatPag"?

"SatPag" is an International Satellite System of one-way communication with the user in the mode of information transmission in the areas of large-scale natural disasters, similar to paging. At the national or regional scale, "SatPag" can be built based on using high-capacity central radio broadcast stations.

Unlike conventional paging, transmitting information with the "SatPag" system consists in selective radio broadcast of targeted information to either individual users, small groups or an unlimited number of people in disaster areas, depending on their location, Fig.1. A special activation code enables signal reception in only those SatPag receivers (satpagers) for which the information is intended; the rest do not react. No dedicated channel is used for the pagers; instead, there is a live radio broadcast which allows an unlimited number of people to be users of this international network without connecting to it.

Fig.1. Transmitting information to natural disaster area using "SatPag" system

The "SatPag" system can be used to transfer information to the population in natural disaster areas, to rescue services, government employees, for management of troops, rescue teams in mountains, for management of special operations and counter-terrorism measures as the information is encrypted with a special code and decrypted immediately after reception in the pager itself. The encryption code is floating.

Fig.2. Covering Earth's entire surface using "SatPag"

"SatPag" can use the system of radio broadcasting satellites controlled by the base satellite which receives information from the Earth-based control station, Fig.2.

Thus, the main problem of information coordination for large masses of population and government employees trapped in natural disaster areas lies in destruction of surface information and telecommunication systems. On the other hand, even if these systems are partially functioning, their overload increases dozens or hundreds of times, blocking thereby their operation. Using standard radio broadcasting satellite systems for transmitting information to the public and government employees is impossible since completely different instructions are needed for people in different locations within an emergency zone, and public servants.

"SatPag" effectively solves all these problems. On the one hand, the "SatPag" system can send needed information to an unlimited number of people and groups of people, on the other hand, this information is strictly targeted and encrypted and is sent only to the groups or individual users for whom it is intended. (Application for Patent PCT/AZ 2011/000011, "Method of receiving and transmitting information", authors: A.M. Abbasov, E.N. Khalilov, 18.08.2011, WPO, Geneva, 2011).

4. OUTLOOK

In the future, the **"SatPag"** information transfer system should become part of every person's everyday life, work and activity. Sat-pagers, as low-cost receivers may be built into private, public and service vehicles, computers, mobile and fixed telephone sets, in offices, private homes and apartments, business premises as well as be in personal use of government employees and individuals. The "SatPag" system can be used to remotely control particularly important strategic objects, if there is no access to them or their control systems are destroyed, for example, for automatic shut-off of emergency valves, to turn on emergency power supply, to enable emergency protection systems, etc.

Where SatPag System can be used

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REMOTE SENSING TECHNOLOGIES APPLIED TO DISASTERS MANAGEMENT IN ALGERIA

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Algeria is affected by fourteen major risks (earthquakes, landslides, floods, forest fires, oil spill, etc) and the means for the management of these disasters are limited and often inadequate. In recent years, Remote Sensing and Geographical Information System (GIS) technologies have been the object of considerable interest to all bodies concerned with space and in particular emergency services and disaster management in Algeria, in collaboration with all other bodies responsible for prevention and management of all major risks in Algeria.Among these risks we can mention the most preoccupying as being the forest fires that ravage thousands of hectares every year, earthquakes that have a devastating effect every time, the industrial risks that are real considering the numerous complex petrochemical and industrial existing in Algeria, coastal and marine pollution at present little recognised but very real considering the 1200 kilometre Algerian coast line, near which many ships empty their tanks offshore as well as the oil industry activity in many Algerian ports.

The use of remote sensing and GIS has become an integrated, well developed and successful tool in disaster management. For our part, we are interested in this communication to present our research work concerning the management of risks and we hope to contribute directly or indirectly to putting these new technologies in place in Algeria. This has been done in collaboration with bodies such as the forestry services for the management of the forest fires, the centre for astronomical, astrophysical and geophysical research for the monitoring of earthquakesand so on.For the first risk, a large earthquake (M_s> 6.8) occurred in May 2003 in the Algiers-Boumerdes area (Algeria). Remote sensing technologies and Synthetic Aperture Radar (SAR) Interferometry (InSAR) have been shown to be a valuable tool for monitoring relative surface displacement due to

various crustal movements and for creating accurate DEM's using pairs of SAR images.SAR data of ERS-1/2 and ENVISAT satellites are provided from European Space Agency and are used to create differential interferograms and DEM's of the earthquake area.

This research is under study in our laboratory and first results as interferograms are obtained and the work is go on.For the secondrisk of forests fires, every year, about30 000 hectares of forests are destroyed by fires in Algeria, fires also take a heavy toll in lives and property and our major preoccupation in to reduce forests fires in the country, thanks to inventory, prevention and management and follow-up. The goal of our work is to set up of a GIS integrating remote sensing data for the prevention and management of the fires. The principal factor of degradation of the Algerian forest is the fire which finds an environment physical and natural favourable to its blossoming and its propagation.

The structure and the component of the vegetable formations are as many factors facilitating fires of forests.In this communication, we present our contribution of the Algerian experience in the use of Space technologies for disaster management. Remote Sensing can provide useful information, and create disaster awareness with politicians, concerned decision makers and the public, so that on a national level decisions are taken to set up disaster management organisations.

MINGECHEVIR EMBANKMENT DAM COLLAPSE: CATASTROPHIC RISK ANALYSIS AND MANAGEMENT

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The paper deals with heavy rains, flash floods and dam collapse risk analysis and management in Kura river basin. There are 8,359 rivers in Azerbaijan Republic and 5,141 of those are in the Kura river basin. River Kura flows through regions in Turkey, Georgia, Azerbaijan and falls into Caspian Sea. Rivers of the Kura basin has extremely irregular discharge throughout a year. Last year spring flood became catastrophic, destroying river banks in many places simultaneously water flows have gone to urbanized areas.

By the quantity of large dams (height of a dam >60m and power of HPS >100MW) the Kura river basin with 8 dams, takes 14th place in the world. In Soviet period for hydropower, flood control, irrigation, etc. purposes have been built cascade of four dams on Kura river in Azerbaijan. The largest among them is Mingechevir embankment dam. It is one of the highest dams in Europe that was constructed through sprinkling. The height of dam is 80m, length 1,550m and total capacity of soil 15.6 million m^3. The length of the similar reservoir is 70km, total area 600km^2 and water storage >16km^3.

The large scale water management efforts have been undertaken in the Azerbaijan during the past 20 years of independence. However, the Soviet environmental legacy and military conflicts in Kura river basin led to unfortunate results. Practically right off after constructions of dam and fillings of reservoir (1953) the safety issues became actually: collected 16km^3 waters can break embankment dam and catastrophic flash flood will carry by Kura river valleys, destroying all on the way. Unfortunately, for the existence period the dam inspection and modifications was never spent.

There is a need for more adequate legal frameworks for dam operation. If to consider, that the flash flood hazards area of downstream valleys is 8000km^2 with about 3.5 million inhabitants, we can as certain that now, Mingechevir dam and similar reservoir are both a blessing and curse of Azerbaijan!

As already mentioned above, like all hydraulic structures also dams hold a potential risk of breaking. Heavy flooding and/or break one of dams in Turkey or Georgia is enough for catastrophic "domino" destruction of Mingechevir dam and all other downstream river banks. In the presented work the following risks have been considered: river valley population; Economy of coastal zone;

Environment of downstream coastal zone. Mingechevir dam collapse catastrophic risk analysis and management related to potential flash floods induced or amplified by manmade structures along Kura river, is a problem that calls for the definition of policy guidelines and new technical instruments.

A decision support system composed of an information system that will support flood modeling and prediction, dam collapse models, as well as operational safety guidelines under normal, training and emergency situations, may constitute an important instrument that will help decision makers to comply with the legal regulations.

This paper presents one of the components of this decision support system, namely the information system that includes elements of aero-space geodetic driven-in markers in the body of dam and digital water level recorder system with GSM/GPRS transmitter established on reservoir. The recommended risk management system is suitable for any transboundary rivers.

AN ANALYSIS OF IRAN'S CITIES DISTRIBUTIONS IN RELATED TO EARTHQUAKE HAZARD

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Natural disasters such as earthquakes often result in extensive casualties and damage. The location of Iran and many other developing countries in active tectonic regions of the world emphasizes the necessity to develop a comprehensive disaster management system. Iran is located in the Alpine-Himalayan seismic belt which is one of the most active tectonic regions of the world. Iran is a country with about 75 million people living and the history of the region indicates strong earthquakes. Population centralization in urban area and metropolitans with environmental disaster, especially in developing countries such as Iran increase metropolitan's vulnerability against earthquake hazard.Iran is a vulnerable against earthquake hazard, because of distribution of cities and population centralization in its metropolitan. But the amount of damage and injured in an earthquake in Iran's cities is different. Population growth with increase of cities number cause to sustain a loss of people and appurtenances. This research tries to help to planning for earthquake crisis. Type of research is applied and method of data collection is documentary and methods of analysis are; population analysis with urban system analysis and urban distribution system in related to earthquake hazard.In beginning the situation of urban system and locations of cities are studied, than the relationship between distribution of cities and earthquake hazard studied. This paper examines the spatial distribution of the population and focusing on urban system patterns.

Key words: Iran's Cities, Distributions of Cities, Earthquake Hazard, Urban System.

FLOOD FIGHTING METHODS IN THE KURA AND ARAZ RIVERS

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In the article the flood events occurred in the lower flows of the Kura and Araz rivers, the damages caused by them, the results of protection methods implemented against the floods in Azerbaijan and their efficiency are characterised and concrete constructive proposes are given.

Key words: flood events, lower flows, protection methods, concrete constructive proposal.

Azerbaijan surface, climatic conditions, the vast encircling by the Caspian Sea, the mountain formation processes, all the natural disasters except tornado, tsunamis existing in the world in the result of global climatic changes, anthropogenic factors, are met in Azerbaijan.

Floods causing mainly to economical damages and destructions, only being backward from flows are met in flat areas forming especially 40 percent of the republic territory, low currents of the Kura and Araz Rivers. Floods are mainly observed in distance of the areas 300 km from Mingachevir water dump to the Caspian Sea flowing area, in the Araz River in the distance of 140 km from Shahseven point to the Kura River flowing area, in the Kura-Araz plain, the biggest by territory not only of Azerbaijan but also Transcaucasia.

The inclination of this area from Mingachevir water dump up to the Caspian Sea is observed in the territories 0-27m from sea-level.

In the areas with flood risk there are 2 cities, 15 administrative districts, 300 settlements and 1.2mln of Azerbaijan population settle in such areas. The area where flood happens becomes the main industrial and agricultural district of Azerbaijan and each catastrophic flood damages 100ha plots of land, some thousands km of irrigation canals, collectors, drainages.

The drawing of subsoil waters near the ground surface cause to highly- mineralization and saltiness of arable lands. Each existing catastrophic flood in causes losses to Azerbaijan economy about one billion dollars. [1] Along with the shown damages, the floods causes to such infectious diseases as malaria, gastroenterostomy and other illnesses.

In order to prevent the destroying power of floods water dumps are constructed on overflow rivers. Even the thousands of water dumps were constructed and functioned for prevention the main floods in the world countries with flood risks, their functions are not still principally efficient.

In order to prevent the floods in 1953 the first capacious water dump Mingachevir with 625 square km and 16070 milllon cubic meter, in 1970 Araz water joint with 145 sq.km and 1350millon cubic meter, in 1980 Shamkir [2] water dump with 116 sq.km and 2677 cubic meter and other water dumps were constructed and given to exploitation. Since the fullness of these water dumps there weren't any floods in the low flow of the Kura and Araz rivers. But after the completion of fullness the floods became more intensive and as a result in 1967, 1969, 1979, 1982, 1987, 1993, 1997, 2002, 2003, 2010 the floods in the Kura and Araz rivers caused the great number of economical damages and destructions. The last devastating floods happened in 2010 proved the above-mentioned facts.

The water dumps existing in Azerbaijan as well as in the world are served not only for prevention the floods, but also to regulate the water quantity brought by rivers, to get electric power, for irrigation purposes, for provision of population with drink water, for fishery, for development of tourism and so on. New water dumps are constructed in Azerbaijan and the further new ones are planned. Some governmental bodies propose such ideas and thoughts as if new constructed water dumps will be able to fully prevent the floods in Azerbaijan. But this idea is absolutely wrong, as it's impossible to prevent the floods by this way. Generally, the water dumps depending on their area and capacity are intended to use for 100-300 years. During these periods owing to fullness of these dumps with flown thaning materials, the latters should be either cleaned or the exploitation of dumps have to be stopped. In the world practice it is still possible theoretically to clean such dumps as Mingachevir from thaning material, but practically it is highly-cost, and it'll be more expedient to stop the exploitation of these water dumps and to construct the new ones.

Now in Azerbaijan, such small water dumps as Pirsaat, Bolgarchay and others are completely filled and their exploitation period was over. So the further constructions of new water dumps in nearby propitious areas will be expedient. Taking into consideration the mentioned facts, the Kura and especially the Araz rivers being the most thaning materials brought [3] rivers gather the majority of these materials into the water dumps constructed on the Kura and Araz rivers, their depth and water capacity are incisively reduced and as a result such water dumps filled earlier than they were intended. This reduces the opportunities of such water dumps to prevent the floods.

Sometimes in order to get cheap electric power not taking into consideration the prognosis about the expected rainfalls, in less watery periods above the planned rate water was collected in water dumps. In the last decades, in Mingachevir water dumps Azerbaijan population confronted by this case 3 times, and the most critical situation in this water dump was observed in the flood periods in May-June of 2010.

Generalizing the facts we can conclude that, it isn't possible to prevent the floods in water dumps in the rivers of plain areas. In the world practice, still in the IV century in Egypt the ground

dams were constructed along prevention floods in overflow rivers. [4] Nowadays this method is successfully used as the main protection method in the countries with flood risks. However, in extreme periods such ground dams weren't able to prevent the river boundary territories from floods. Though the construction period of ground dams in Azerbaijan are concerned to XVI-XVII centuries, to our mind, the ground dams should have been concerned to the more ancient periods. As in the lower flows of the Kura river, in the territories nearby its mouth, it was impossible for its flown to the Caspian Sea which is below the ocean-level. So, the Kura river could only reach the Caspian Sea through the protection ground dams.

Historically constructed 650km long ground dams on the Kura and Araz rivers not always were able to prevent the Azerbaijani territories till the construction of Mingachevir water dump. The main reasons for floods were the construction of ground dams in limited areas, their not enough regular maintenance and reconstruction, the local indifferent attitude to dams, not admission of governmental laws and programs about ground dams and etc. [7]. Though the length of ground dams on the Kura and Araz rivers, they aren't effective in protection in Azerbaijan, as in the world practice.

The rivers in the ideal world plains flow by meanders. The meanders incisively reduce the flow speed and as a result regularly in such rivers the flood risks occur. The shipping navigation becomes impossible in such rivers. The Kura rivers reduces its length from 300km up to 650km by the meanders and there are still more than 50 uncorrected meanders in the river. [5] During the post soviet period such meanders were systematically corrected. As a result, the area of the Kura river up to the Caspian Sea in Yevlakh city was made useful for shipping navigation and ships regularly swam there. The correction of meanders will help partly to prevent the non-devastating floods and cause in reducing the flow speed of the rivers. In the world practice the rivers flown through plains are regularly deepened. Unfortunately, such works are mainly conducted in Azerbaijan during the flood period. Though the deepen works conducted in 2010 during the flood period in the Kura river after the flood finished such works were forgotten. In our opinion, such works must be conducted all year long in the Kura and Araz rivers, but especially, in the Kura mouth.

As the area where the Kura river flows into the Caspian Sea is 27 meter lower the world ocean-level and it can not reach its waters to the Caspian Sea, in this case, year by year the Kura river enlarges its delta towards the sea. As the regular works on deepening the delta of the Kura river in the area where it flows to the Caspian sea the depth of the river changes between 30-50 sm. In 2010 the deepening of the Kura river delta and construction of its new extra branch was started. As a result in a short period the waters of the Kura river started freely to flow into the Caspian sea. However, the prevention of floods was temporarily done, the neglecting of implementation of these works caused to the incisively shallowness of the delta of the Kura river and the happening of new floods at any time. Taking into consideration the above-mentioned we can note that, the severe north-western winds blow during 100 days in a year in the Kura river delta of the Caspian sea and as a result, the 5-8 meter high waves bring sands with seawaters to the Kura river delta and it causes the incisive reduction of river's depth, the flood risk in Neftchala and Salyan districts rises any moment. Such works must be done independently from flood events.

The Araz water joint given into exploitation in 1970 fills in some extreme periods and as a result it causes the floods. The last such situation happened in May-June of 2010 and it resulted with the destruction of some settlements, but further they were evicted to safer places. While the Khudafarin water joint constructed on the Araz river by the Iran Islamic Republic during the floods in May-June of 2010 according to the agreement between Iran and Azerbaijan, the flown of collected waters to the Araz river was temporarily stopped and in a result the full destruction of settlements in Imishly, Saatly, Sabirabad administrative regions and some settlements of city Shirvan was prevented.

In order to prevent the floods on the Araz river, the reconstruction of the river-bed existing in 1896 can play a positive role in prevention the flood in the Kura river. Owing to the exploitation of this new river-bed with length of 140 km in the Araz river can have great possibilities for flowing the waters of the Araz river directly into the Caspian Sea. Taking into consideration the great political, economical and even the military interests, independently of its high cost the construction of the new river-bed of the Araz river must be implemented before the new floods. Any

construction works in the areas of 500-1000 km between the constructed new river branch and river-bed must be strictly controlled by the government.

Many small lakes and ponds as Sarisu with 67km², Aggol with 56,2km² on the Kura and Araz rivers historically played an important role in regulation of floods. However, some of these lakes and ponds were drained and used cotton plantation. So the Kura river was deprived of such sources playing the natural water regulation roles and further such areas turned into "dead" zones. Though the associated administrative organs restored the function of such natural water regulators on the Kura river, it doesn't give the effectiveness as it was earlier. The floods on the Kura river happened in 2010 again proved that, during the floods the waters naturally flown into the lakes and ponds, and after the flood again into the Kura river could have been played the natural regulator roles. Nowadays, the large lakes on the Kura river banks were privatised and used for fishery. In other words, the connection of these lakes with the Kura river was cut and it doesn't allow to regulate the Kura river flood waters by the given method. We think that, the regulative roles of the lakes and ponds on the Kura river banks during the floods must be restored, and taking into consideration the economical, strategic importance of these lakes and ponds, they should not be allowed to be privatised.

In spite of implementation of all ways and methods in world practice against floods in lower flows of the Kura and Araz rivers, we can not say about the full prevention of floods in Azerbaijan.

Despite of the economical development no country in the world is able to fully prevent the floods. Nowadays talking about the flood problems, it is very useful in Azerbaijan not to fully prevent the floods but to use the methods implemented in the world practice in this sphere which can be principally reduce damages, destructions, human decease caused by this natural disaster. It is one of the main problems standing upon the world scholars busy with this sphere.

Unfortunately in the world countries the full prevention of floods don't happen. The positive solution of such global problem in a few years is also unreal for Azerbaijan.

In conclusion, in the Kura-Araz plain where the floods historically happened very often, but nowadays with intervals the flood prevention measures must be constantly done, the world practice on protection against them must be used, the development of industrial spheres, forming and settlement of the population and other works must be implemented in safer territories.

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THE MAP OF SOCIAL RISK OF RUSSIA FROM THE HAZARDOUS NATURAL PROCESSES AS THE TOOL OF CONSEQUENCES' REDUCTION FROM EMERGENCY SITUATIONS

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More than 20 hazardous natural processes of various genesis are observed in the territory of Russia. Under such conditions, it is necessary to have the information on the hazard degree of various territories of our country to provide safe development of territories and the population. The most convenient way of presenting such information is a map of possible population losses from natural hazards, or a risk map.We have the map of danger of 22 natural processes in the territory of Russia. This map permits us to estimate in degrees the hazard of each of processes for any taxon of territory. The degree estimation of hazard is determined by a complete set of factors, which describe volume, velocity, and other features of the process, the territory degree of exposure, the frequency of events. Besides, we have a database on the facts and consequences of events of natural hazards in the territory of Russia for last 20 years, which allows obtaining the statistical data about human losses in each negative event: those killed, wounded, and suffered material damage. These two sources have allowed us to create the map of social risk of Russia from 5 natural hazards, which are the most hazardous in their consequences: landslips, flooding, hurricanes, and avalanches. First, we define the number of inhabitants subject to influence of hazardous process of determined category of danger (N_H), all over the country. This is a sum of inhabitants of all taxons ($i = m_h$) the danger's degree map, with a process h the k category (h_k).

The database stores: quantity of died – n_h^d, injured – n_h^t, and had material loss – n_h^w in all events of process h_k. Thus we can obtain the average of casualties from natural hazards in a year $an_h^{(d,t,w)}$.

Further we define probability for a person to suffer from effect of process $h_k$we dividing the average of casualties for a year into total number of inhabitants in subject territory (N_H).

$$P_{hi}^{d(t,w)} = an_h^{(d,t,w)} / N_H \quad (1)$$

We accept that the individual risk to suffer from natural hazard

$$Ri_h = P_{hi} \cdot F_h, \quad (2)$$

where F_h– long-term repeatability of process h_k, p.un./year (data from map).

The collective or social risk – expected quantity of casualties on a certain site of territory as a result of hazardous natural processes for the certain period of time. The social risk (Rs) is calculated as product of individual risk and population of the taxon, expressed in peop./year

$$Rs = N_i \cdot Ri, \quad (3)$$

It is more convenient to use specific value of social risk for creation of a map of social risk which is calculated as

$$rs = Rs / S_i, \quad (4)$$

where S_i – territory of the taxon (sq. km).

The presented map can be used as a tool to reduce the negative impacts of natural hazards. For example, in accordance with the values of social risk can be carried out the spatial distribution of number of the personnel and material resources departments of the Ministry for Emergencies. This card can serve as a basis for addressing placement of protective structures, the adoption of measures on prevention of natural hazards or reduction of their consequences.

CONSIDERATION OF EXTREME HYDRO-GEOLOGICAL EVENTS IN NUMERICAL FORECASTS OF HYDRO-GEOLOGICAL CONDITIONS CHANGE IN THE TERRITORY OF IMPORTANT INFRASTRUCTURE OBJECTS

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According to the Russian standard documents at designing a possibility of change of hydro-geological conditions on the site in the course of construction and operation of buildings should be considered. One of principal causes of the given changes is natural seasonal and long-term fluctuations of ground water's level. Natural fluctuations are complicated by the time variability caused by factors of urbanization in city. The different time data about geological conditions and ground water's level position is used at construction of hydrodynamic models of ground water. It is incorrect to use this data without recalculation it by uniform time. It is also necessary to note an absence of good methodical base for manufacture of long-term hydro-geological forecasts of satisfactory accuracy. The most convenient and informative way of data presentation about hydro-geological conditions changes is the estimation of extreme maximum and minimum possible levels of ground water and also a position of the level received at researches in this range. Extreme levels are made by calculation in which the data of single observations in concrete wells is a necessary component. Maps of hydroisohypses for extreme positions of level in the given territory are constructed on the basis of the processed data. Use of this data as initial at hydro-geological models making allows to estimate influence of a projected construction on ground water in the greatest possible range. This method gives priority in comparison to the decision of a non-stationary filtrational task as complexities with an estimation of accuracy and reliability of the received forecasts are difficultly surmountable in this case. Especially it concerns the urbanized territories characterized by the broken ground water's regime. The range estimation allows to consider all possible changes of environment at various positions of ground water level. It also gives good base for the further construction of more exact forecasts in case of increased requirements to accuracy.

TECHNIQUE OF DRAWING UP OF NUMERICAL BAND FORECASTS WITH USE OF EXTREME GROUNDWATER LEVELS

The technique has been applied for the prediction of the hydrogeological conditions in the construction of the 3,5 km automobile tunnel in Moscow. Building of a tunnel site as a part of two tunnels (a direct and return direction of movement of motor transport) is provided in the underground and partially open way. The line of a projected tunnel crosses a river Chertanovka valley (Fig. 1, 2).

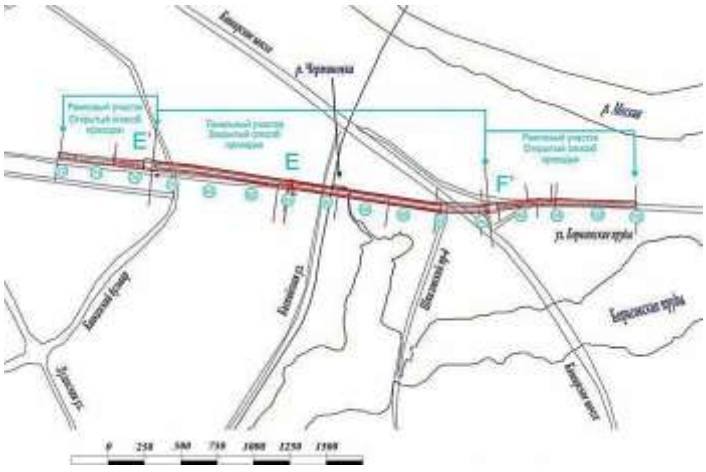

Fig. 1. The situation

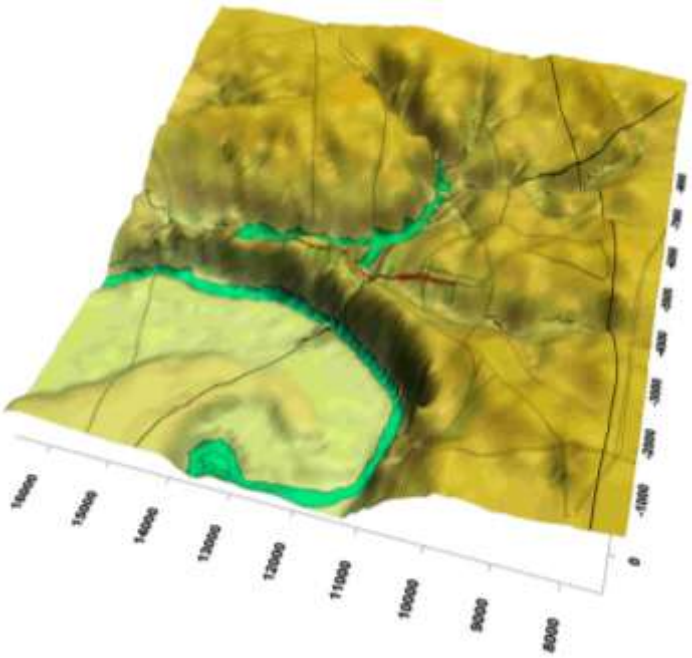

Fig. 2. The 3D relief

Prominent feature of the given project is that the geological and hydro-geological information is non-uniform and non-uniformly distributed on research territory. Drilling of wells was made by various organizations at the different periods of time. Not all materials of researches contain hydro-geological information (Fig. 3, 4).

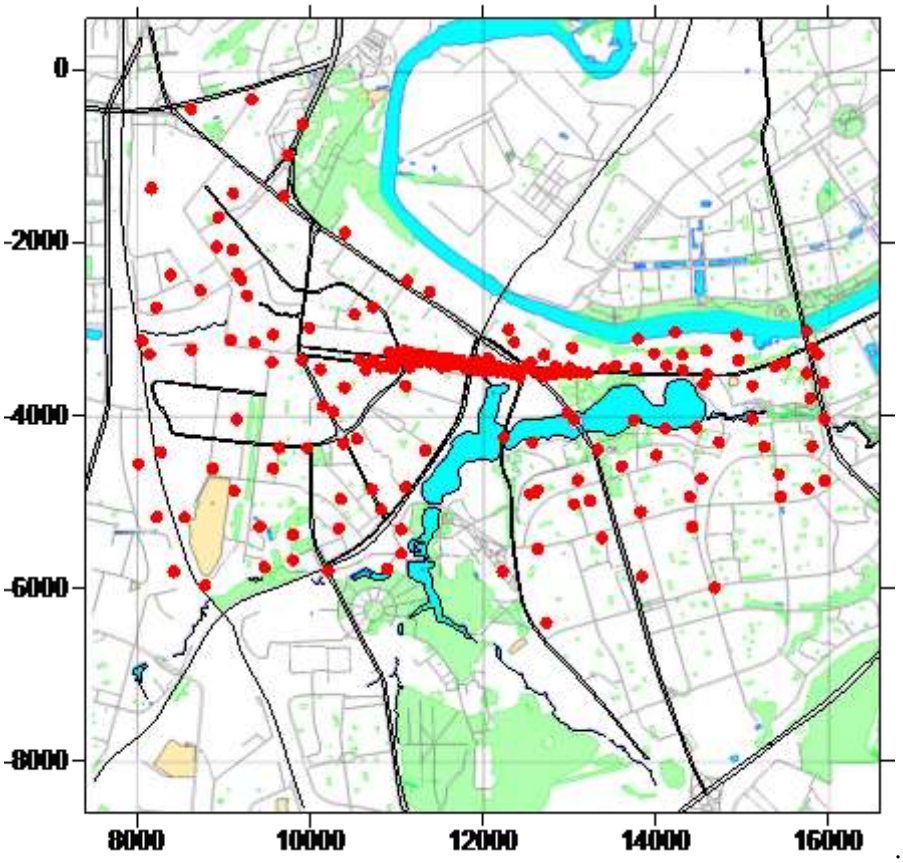

Fig. 3. The initial data distribution

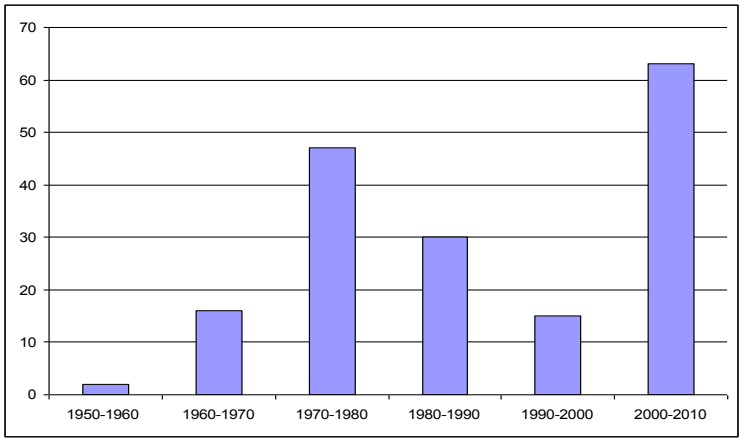

Fig. 4. The distribution of drilling time

Most detailed information is available along a building line in regular intervals (Fig. 5).

In adjoining territory share wells have been involved the part from which has been passed more 30-40 years ago. Wells are essentially non-uniformly distributed in time.

Hydro-geological forecasts for definition of ground-water levels are carried out on the basis of long-term data of groundwater regime on investigated catchment basin. In this case the interfluve of the rivers of Moscow and Gorodnya was used.

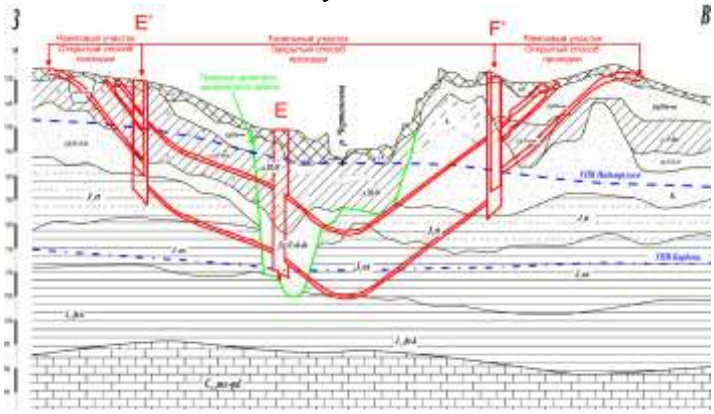

Fig. 5. The section along the tunnel

To consider the data of researches in calculations on the basis of regime supervision, it is necessary to spend lengthening of existing lines of supervision at least till the moment of carrying out of researches (Fig. 6).

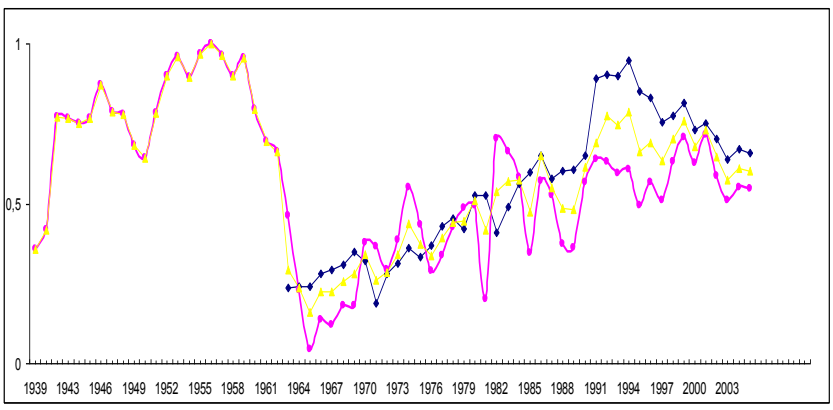

Fig. 6. Long term annual normalized groundwater regime

Daily measurements of precipitation and temperature in Moscow territory have been involved. These factors are the most informative concerning variability of ground water regime as characterize recharge and evaporation (Fig. 7).

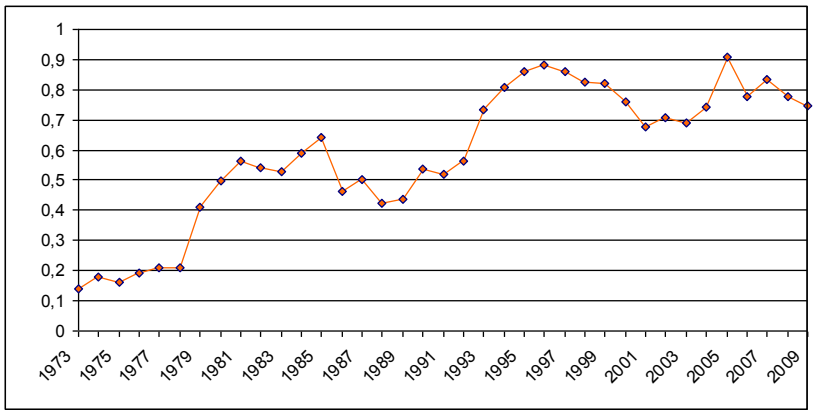

Fig. 7. Long term annual normalized groundwater regime prolonged with precipitation data

The technique is based on use of look-ahead-information nomograms which allow to define groundwater level position according to single measurements of last years. Prediction can be created for any date in a month. The authentic single measurement fixed in the course of drilling is sufficient (Fig. 8).

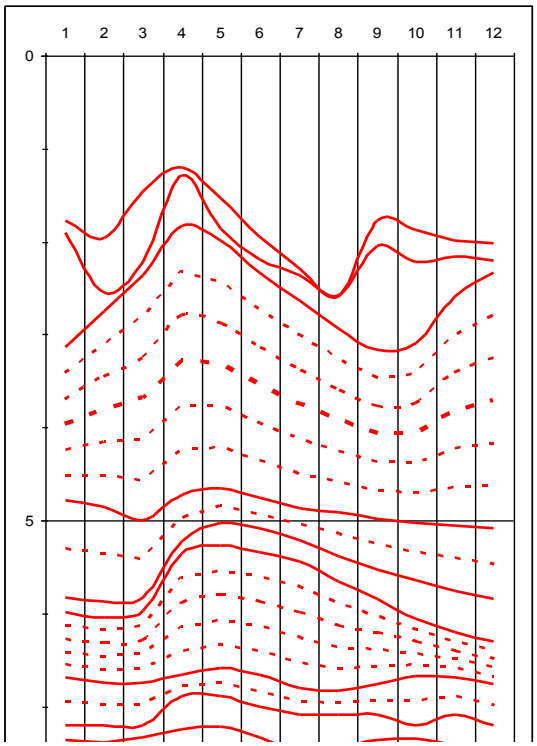

Fig. 8. Seasonal regime nomograms with depth (months, depth (m))

The information-look-ahead nomograms is a family of typical seasonal modes for all intervals of depths of ground waters, characteristic researches for area with reference to the most widespread geo-lithologic complexes. In a general view the nomogram can be considered as the original passport characteristic of seasonal natural regime of ground waters of certain region.

The most important stage of hydro-geological forecasting is entering into calculation of the amendments considering long-term amplitude of fluctuations (Fig. 9).

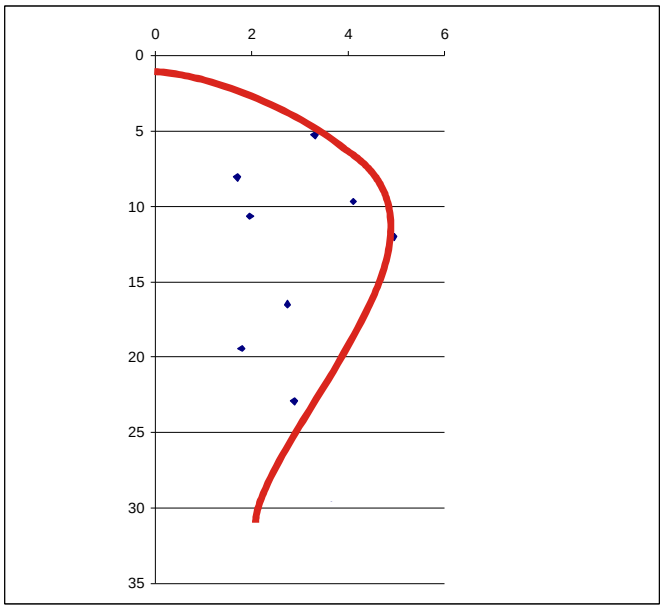

Fig. 9. Distribution of long-term amplitude of groundwater with depth, m

Long-term amplitudes bring rather essential contribution to the general scope of fluctuations. The form of the graphic genetic law showing how ground waters level depth corresponds this or that long-term amplitude was made. Look-ahead calculation is carried out for each prospecting well separately. The maps of maximum and minimum possible groundwater levels were constructed (Fig. 10, 11).

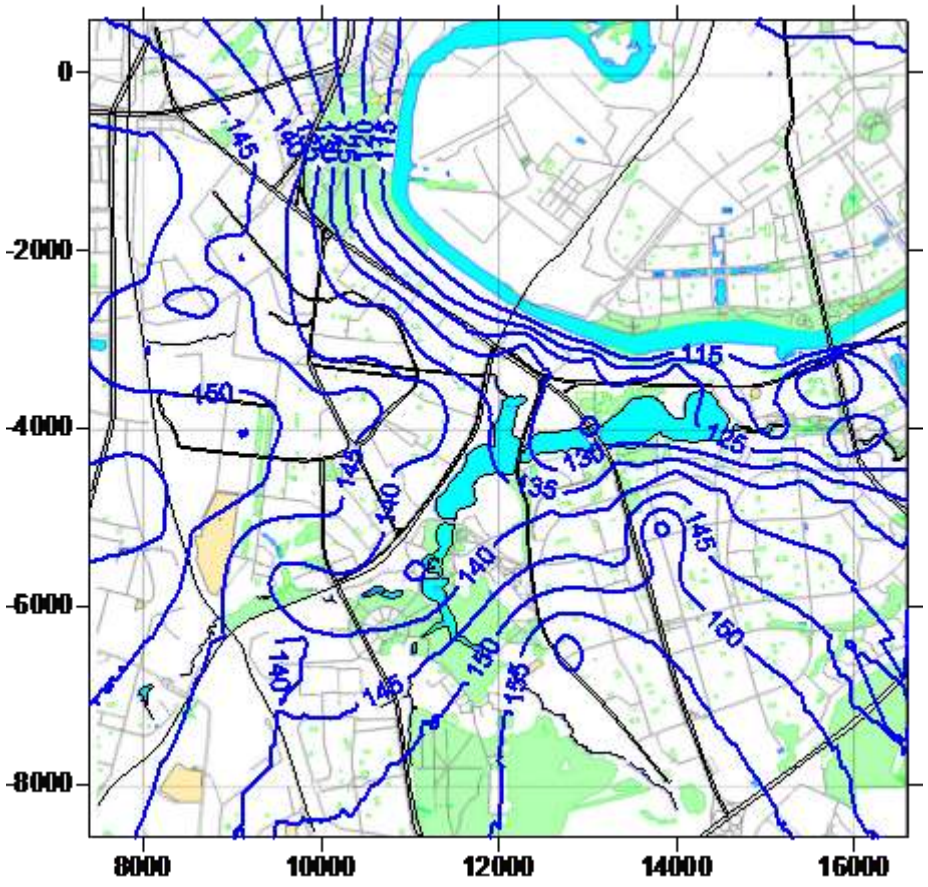

Fig. 10. Minimum possible groundwater level

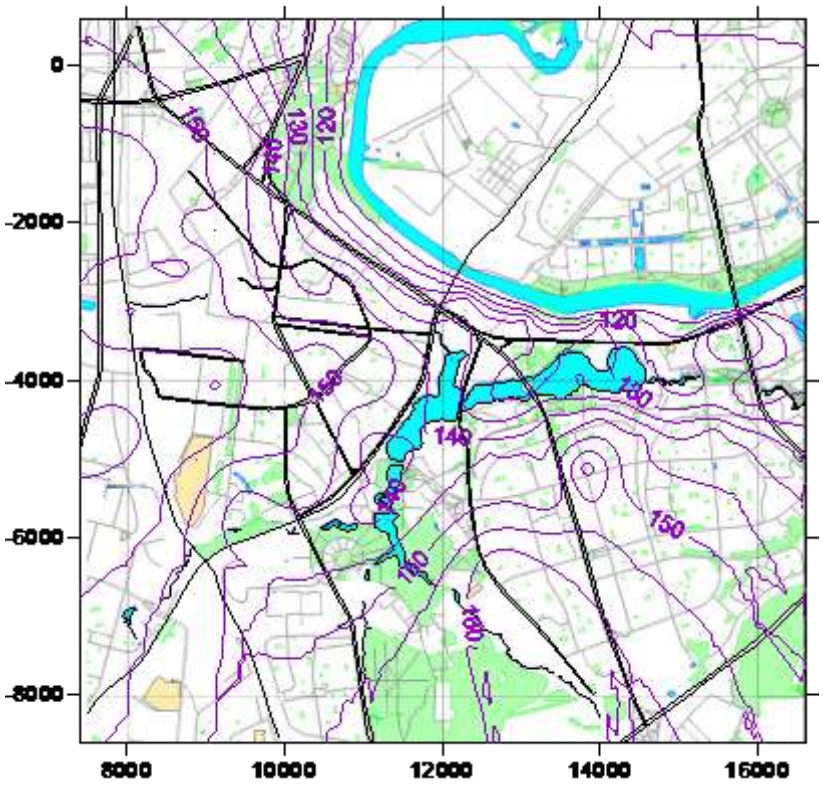

Fig. 11. Maximum possible groundwater level

Metodology of numerical simulation

The territory of a large megacity as Moscow is characterized by difficult hydro-geological conditions. On the one hand the Moscow region in the hydro-geological relation represents the river basin of the Moscow-River characterized rather good drainage features due to powerful layers of high permeable alluvial and glacial rocks. On the other hand presence of a clay cover in South and West together with low absolute marks and a rare erosive network in the East make possible conditions for flooding of 40 % of the city territory. Other important complicating moment is set of factors of the urbanization influencing a relief, filtration properties of environment, recharge and discharge conditions, hydrochemical regime and so on. Researches show that natural factors in the city territory dominates, however, artificial factors transform them strongly enough. In the geological relation the territory of Moscow is studied more than hundred years. Now the huge geological data – about one million wells, supervision on a network of more than three hundred hydro-geological regime observation posts, technical characteristics of many city objects influencing surrounding geological environment is accessible. At the same time to consider in prognostic model all set of versatile factors of influence it is difficult enough even when there is an exhaustive information on these factors. It becomes especially important at designing of large or extended object which gets at once to a zone of influence of variety of the natural and artificial factors non-uniformly distributed on the area and in time. Similar complexity of reproduction of hydro-geological conditions and factors of formation of ground waters regime in aggregate with high requirements to speed of performance of works and accuracy of result has made rather popular use of computer programs for the numerical decision of the differential equations used for calculation of a filtration and migration in porous environments, and also means of input and output of the information. In our calculations we use program MODFLOW 2000 developed by the American geological survey. For work with program MODFLOW 2000 the license program of input, preparation and a conclusion of results Visual Modflow by Waterloo Hydrogeologic [1] was used.

Use of similar optimized under the user, hi-tech software on the one hand yields the geologist the powerful tool for fulfillment of calculations, but on the other hand creates illusion

high poossibilities. In these conditions the competent schematization of hydro-geological conditions and verification of results become the major procedures. A question of graphic presentation of forecasting results which should be accessible to a wide range of experts, including architects, designers and experts also rises.

Features of hydro-geological conditions

Long-term experience of making up of numerical hydro-geological models in aggregate with acquaintance and examination of the models executed by other organizations of a geological profile, have allowed to reveal a number of characteristic rules of hydro-geological conditions schematization and the task for models of technogenic loading.

The following features of hydro-geological conditions which are necessary for considering at a geofiltrational schematization as a whole for the city territory of Moscow are the following:

- In an interval of depths in quaternary, cretaceous, jurassic, top - and middle coal horizons the four aquifers are allocated;

– Over moraine aquifer, as a rule, is sporadic and directly not always is set in the model.

– The over jurassic aquifer in most cases is the core on degree of rendering of influence on objects of a city infrastructure and is most subject to changes under the influence of these objects.

– The jurassic aquifer is presented more often low-power, but a layer of phosphorites possessing by very high filtrational properties of titon age. Aquifer is confined. Pressures are established on the same marks, as levels in over jurassic aquifer.

– On most parts of Moscow territory, excepting a part of rivers valleys of Moscow and Jauzy, over jurassic and titon aquifer are separated from coal aquifer by Jurassic clay.

– Characteristic feature of the Moscow river valley is ancient buried erosive valleys in which capacity of clays is essentially reduced up to their full absence. But even there, where capacity of clays remains enough big, erosive valleys carry out a role of linear ways of discharge of ground waters.

– The analysis of the data of deep drilling, and also the regional given absolute marks of levels of coal horizon in Moscow territory, has allowed to assume that on the most part of territory the levels of ground waters in over Jurassic aquifer are established above, than in coal, hence, there is a precondition of an overflowing of ground waters from top to down;

– The analysis of lines of ground waters equal pressure in over jurassic horizon has shown that regional movement of ground waters occurs in a direction from the basic areas of recharge which are situated in zones of high watersheds, to the basic drain – the river Moscow.

– Deformations of lines of an equal pressure are connected with local areas of a recharge and discharge. Besides, the stream of ground waters unloads in underlaying horizons as a result of an overflowing. On separate sites with superficial level, dated for channels of the rivers, unloading is carried out as a result of evaporation from a surface of ground waters.

Schematization of hydro-geological conditions

Basic elements of a geofiltrational schematization of hydro-geological conditions in Moscow are: a choice of a filtration regime in time, spatial structure of a stream, parameters of water-bearing system, boundary conditions.

1. Model borders in the plan

The sizes of settlement area of a filtration get out so that it should be possible to estimate influence of a construction on change of hydro-geological conditions on the territory adjoining to a site. Practice of hydro-geological calculations for territory of Moscow has shown that the size of a zone of influence of objects on ground waters can be approximately in 3-4 times more the than maximum size of a construction. Proceeding from it external borders of model also are accepted.

2. Model borders on depth are defined by characteristic depth of influence of construction on ground waters. As a rule, in case of absence of powerful sources of pollution the sole of that layer (aquifer or aquatard) into which the object directly takes root is accepted to the bottom border. More often the bottom border of model doesn't fall deeper than jurassic dividing layer.

Considering a parity of pressures of ground waters in over jurassic and coal aquafers on a roof (or a sole) of clays the overflowing of ground waters from over jurassic aquafer downwards is set.

3. Use and the analysis of the initial geological information.

In territory of Moscow a considerable quantity of the geological information received from researches of last years is accessible. It essentially facilitates creation of hydro-geological models as within the limits of engineering researches in the project of a concrete construction it is impossible to spend drilling on all area of model. The analysis of an actual material on the city territory has shown that the geological and hydro-geological information is non-uniform and non-uniformly distributed on research territory. Sites of woods and parks are most poorly characterized. Drilling of wells was spent by the various organizations to the different periods of time, not all materials of researches contain the hydro-geological information. As a rule, the building site is characterized also most in detail. In other territory the density of an arrangement of wells is much less. Quite often there is no data about drilling time. There are no data on hydro-geological parameters. The part of wells has been passed more 40-50 years ago, to a modern lay-out of territory. Nevertheless, spatial variability of lithological layers and depths of stratigraphic borders allows to describe adequately enough a geological structure of the top part of a section with accuracy, sufficient for the decision of tasks in view.

4. Filtrational parameters.

As initial values of factor of a filtration values which are in a range of the data received as a result of researches are accepted. In the absence of experiments by definition of filtrational parameters within the limits of the given researches, results of last years are used.

5. Criterion of calibration.

By the purposes or criteria of calibration of model divergences modelled and measured levels components about 10 % from the maximum difference of pressures in the field of a filtration, as a rule, are accepted. **Estimating quality of calibration of model it is necessary to note following objective reasons which can affect results:**

– There is a considerable quantity of archival levels of ground waters occurring at different times in wells both on a site of building and in adjoining territory;

– A part of archival wells was in territory which has undergone to building therefore the hydrological regime and absolute marks of a surface have been essentially changed that could affect change of pressures of ground waters;

– Not all researches were spent with identical quality – in some wells level was measured without waiting for its complete recovery.

Interference kinds in system "ground waters – technogenic object"

The joint analysis of technical decisions and environment of Moscow territory has shown that the basic possible negative consequences in building territories will be: (1) formation of depressions in ground-waters owing to water-extraction and (2) the barrier effect owing to settlement of a tunnel on the way of a stream of ground waters. Last is shown that in a face-to-face part of a stream there will be a lifting, and in rear – decrease in ground-water level.

Depressions can have various depths and the planned sizes. They are defined by depth and duration of water-extraction and also its area and filtrational properties of rocks.

The barrier effect usually leads to lifting of level a maximum on 1,0-1,5 m near to a construction (Fig. 12). Level decrease usually doesn't exceed one meter. For superficial constructions and the small planned sizes these values essentially are less.

Influence on a river drain take place mainly for the small rivers and, as a rule, it is insignificant. The damage to a drain of the river will take place only in immediate proximity from a building site and less in a current. After the termination of civil work the drain in the river is quickly restored, as high gradients of a stream and high filtrational properties promote active inflow of water.

Pollution of ground waters can occur basically as a result of receipt of polluting substances: 1) with the waters from territories of building sites and access roads, 2) with pulling up of river waters at carrying out water-extraction works.

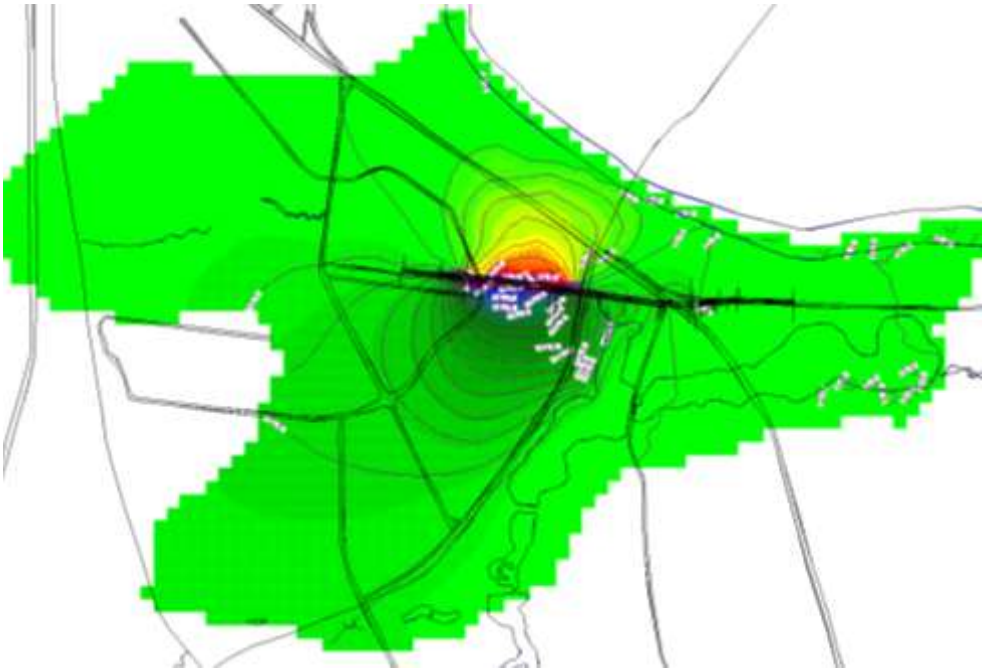

Fig. 12. Results of numerical simulation of barrier effect owing to a tunnel

The results of numerical simulation shows that effect of human activity (Fig. 12) is smaller then the losses of accuracy owing to ignoring of natural fluctuation amplitude (Fig. 13).

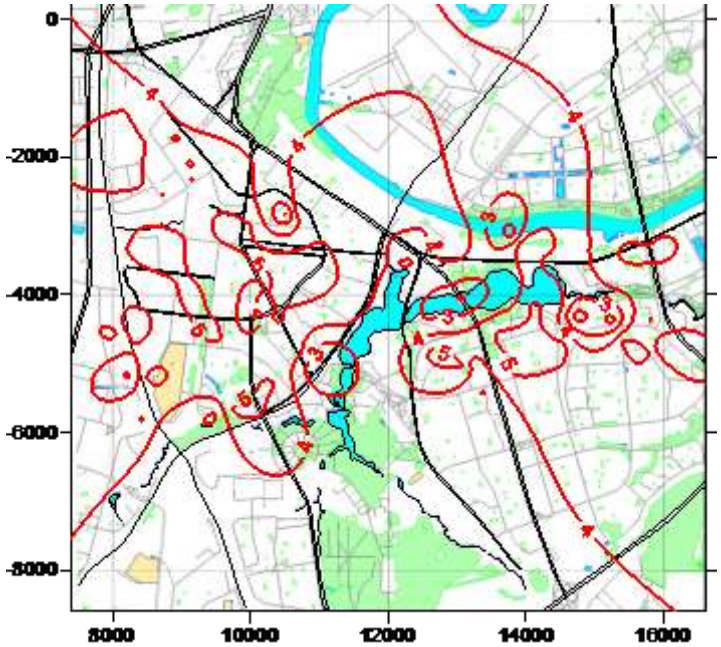

Fig. 13. Difference between maximum and minimum possible levels, m

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A SOCIAL NETWORK ANALYSIS OF RESILIENCE IN CHRONIC HAZARD SETTINGS

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BACKGROUND

More than half the world's population, 3.4 billion people, lives in disaster-prone areas, exposed to landslides, storms, floods, earthquakes, and volcanic eruptions and many reside in chronically hazardous conditions [1]. This presents challenges to policy-makers, planners, and researchers who seek to understand why people continue to live in areas when they know the risks. There are many explanations, it is their home; their economic well-being is dependent on the place; their history and family are close by; or they cannot leave [2, 3,]. How to mitigate the impacts of disasters, of course, is the focus of another set of questions. Any mitigation strategy, for instance, is inextricably linked not only with the geo-physical environment but also with socio-economic vulnerabilities and social support networks of the people concerned. Indeed, a comprehensive assessment is necessary to place the disaster within context of other geo-physical, social, economic and political forces. The situation is further complicated if chronic conditions prevail, such as with on-going volcanic eruptions, that continually threaten community resilience [4]. A central goal of this research, then, is to explore how exposure to chronic hazards has a cascading and cumulative effect on the recovery and coping ability of people who live in exposed (affected), evacuated, and resettled communities, and in this regard, to examine the extent to which social networks mitigate or exacerbate community resilience. Chronic exposure to an on-going hazard may influence social network structures, which in turn may shape individuals' abilities to adapt to the hazardous conditions. The Cascade of Impacts framework, as shown in Fig 1, identifies those variables (environment, economic, health, and social capital) that, while appearing individually, have cumulative and systemic impacts on mitigation or recovery from chronic disasters [5]. The research tackles a complex issue, therefore, how does social support vary in the separate settings of evacuation, resettlement, and exposure?

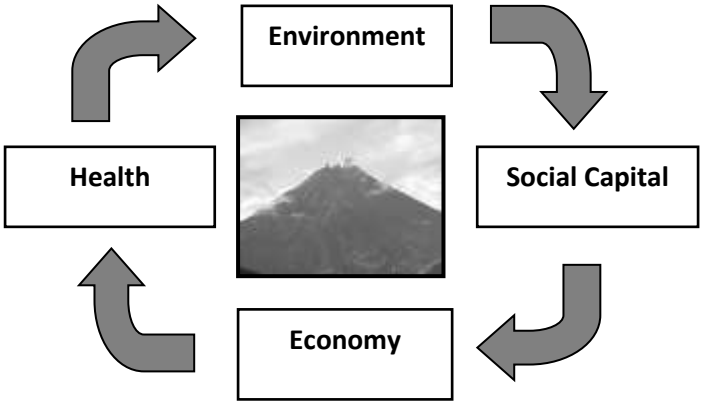

Fig.1. Cascade of Disaster Impacts

STUDY SITES

Research was conducted in Mexico and Ecuador in two volcanically active areas that have experienced ash-falls, lahars, and some pyroclastic activity over a number of years as well as a landslide/flood prone area.

Ecuador

The primary focus of this project in Ecuador was Tungurahua Province, about 120 kilometers south of Quito, an area that has been directly affected by ongoing eruptions of Mount Tungurahua since 1999. The continuing eruptions have had severe impacts on agricultural practices, on other economic and business activities, and on the health and well-being of many living in the shadow of the volcano [6]. There have been several evacuations of populations, some long-term, which have led to high levels of stress associated with leaving homes, possessions, livelihoods, friends and familiar surroundings. In many cases, individuals have experienced a decline in their health [7, 8]. These physical, economic and emotional losses have been exacerbated by a loss of faith in both the local and national political leadership and by a national economy in disarray [9]. The research has extended over the last eleven years, and has investigated concerns in number of communities situated around the volcano. These are:

Penipe Viejo

Penipe Viejo has been affected by the volcanic activity, notably through ash falls but has not been evacuated. It is a small community located 10km south-west of the volcano. It served as a base of emergency response operations during the major eruptions, such as August 2006, and several local buildings were converted to shelters for evacuees from the high risk zone to the north. The on-going disaster, however, has affected Penipe economically, politically, demographically, and in terms of health and well-being [10].

Penipe Nuevo

Penipe Nuevo is a resettlement community built adjacent to Penipe Viejo. It consists of 285 houses, constructed by the Ministry of Housing and Urban Development and a multinational, faith-based NGO, Samaritan's Purse. The resettlement is a landless, urban resettlement populated by smallholding rural agriculturalists displaced from the northern parroquias of Bilbao, Puela, and El Altar in the wake of the 2006 eruptions of Mt. Tungurahua.

La Victoria de Pusuca

Pusuca is a small rural resettlement community, built by Ecuadorian NGO, Fundaciun Esquel. The hilltop resettlement conprises 45 houses occupied by smallholding rural agriculturalists primarily displaced from the northern parroquia of Puela, and a few residents from Bilbao and El Altar. It is located 5 km south of Penipe.

Pillate and San Juan

Pillate and San Juan are two small communities that have been evacuated on occasions but the residents have always returned to their homes. The two villages lie just west of the northern extents of Parroquia Bilbao, Canton Penipe, across the Chambo River. The two communities of approximately 35 households each are situated just 3 km west of the volcano and well within the high risk zone. They were evacuated on several occasions and the villages have suffered extensive damages as a result of heavy ashfall, incandescent material, and tremor-induced landslides. In spite of this damage, approximately 70 percent of the former residents of these communities returned to live in and rebuild the villages after each eruption.

Mexico

Two study sites were selected in Mexico, one, San Pedro Benito Juarez, which has been directly affected by the volcano Popocatypetl, and Teziutlbn which has been impacted by a landslide and flood.

San Pedro Benito Juarez

San Pedro is a small community, population about 4,340, located approximately 11.5 km east of Popocatypetl. It has been subjected chronically to varying degrees of hazards from the volcano. The town is the closest population to the cone and is prone to ash fall, volcanic bombs and pyroclastic flows. The volcano has been relatively quiet over the last 100 years; however, it entered a new phase in 1994 when an eruption triggered the evacuation of 75,000 residents in the region. Eruptions have continued since then, and a large event in 2000 necessitated a second formal evacuation. The people rely primarily on agriculture, cultivating corn, beans and squash and raising livestock. Community members also engage in a variety of other pursuits such as producing and selling charcoal, commerce of agricultural and animal products, remunerated employment in nearby cities, and migration to the United States [11, 12].

Teziutlán

Teziutlbn a large community of 60,000 people, experienced a mudslide in 1999 that forced the evacuation and eventual relocation of many residents to a new community, Ayotzingo, a neighborhood within the municipality of Teziutlbn. In 1999, many communities in the Sierra Norte experienced a series of floods and landslides that took the lives of more than 400 people and destroyed the homes of 200,000 [13]. The neighborhoods that were most severely affected (La Aurora, Huehueymico, Colonia Juarez, Aire Libre, San Sebastian, Xoloco, Xoloateno, Mexcalcuautkam Atoluca, and La Gloria) were relocated to Lomas de Ayotzingo where the Instituto Poblano de la Vivienda (Puebla Housing Institute) purchased four hectares of land on which to build starter homes for relocated families. Currently, different measures are implemented by local and state government authorities to inform the population of possible risks and the actions that might be needed in the event of a future emergency such as emergency booklets and radio messages in Nahuatl, the language of many surrounding rural populations [14].

METHODS

Field work included questionnaire surveys, ethnographic studies, and interviews with government officials and political leaders in all nine communities. Three separate surveys were undertaken in each community: a socio-demographic survey; an impact and well being survey; and a network survey. In addition, in-depth interviews and focus groups were used to collect additional information about the adaptations to the volcanic eruptions. The socio-demographic survey was used to collect basic data on the community characteristics and this was followed by the in-depth network and well-being surveys (Table 1). The network and well-being surveys were administered to a random selection of participants from the socio-demographic survey. To determine networks, participants (ego) were asked to list 45 contacts (alters) from which a subset of 25 were randomly selected and classified according to sex, estimate of age, socioeconomic status relative to ego, ethnicity, number of household members, degree of emotional closeness to ego (higher, lower), whether affected by the volcano or not, and which of the individuals in the network know each other. In addition, respondents were asked for the estimated month of their last contact with each of the people in their network, and whether social, personal, financial or material support has been provided by anyone in the network. Previous experiences with surveys in Mexico, plus preliminary testing of personal network protocols by study team members, had shown that the solicitation of networks to be feasible and produces reliable data and sufficient variation in network structure [15].

Table 1.

Community Type and Survey Participants

Community	Hazard Type	Socio-Demographic	Impact and Well-Being/Network
Ecuador			
Penipe Viejo	Exposed - Ash	53	44
Penipe Nuevo	Resettlement	116	99
Pusuca	Resettlement	42	40
Pillate	Evacuated-Returned	54	48
San Juan	Evacuated-Returned	37	30

Mexico			
San Pedro	Evacuated-Returned	155	61
Teziutlán /Ayotzingo	Resettlement	139	139

Variables and Measures

Survey questions were arranged into nine variable groups, including demographic, evacuation data and beliefs toward the hazard (either volcano or flood/mudslide), household conditions, recent life changes, closeness to people, material possessions and resources, physical health traits, depression symptoms, and post traumatic stress. In terms of the dependent variables (risk perception and evacuation experiences), several questions were asked about past evacuation experience and likelihood of evacuating again; four risk perception questions were asked—concern about living near a hazard, perception that the hazard posed a risk to life during eruptions/landslides, whether the hazard continues to pose a risk to health, and whether they are generally attentive to or concerned about health.

Social Networks

The social network approach was used to examine how such traits affect hazard exposure, evacuation and resettlement outcomes. Four social network types were identified recognizing that in reality these are points along one or more continua:

- **a.** Tight/Closed Networks: nearly everybody interacts with everybody else forming a tight group likely with high cultural homogeneity;
- **b.** Extended Networks: relatively closed cores but with some ties or bridges to more loosely connected individuals;
- **c.** Subgroup Networks: at least two distinct groups or cores that are usually well-bridged or connected; and
- **d.** Sparse Networks: relatively few ties among individuals and few bridges.

It was hypothesized that participants with networks comprised of strong subgroups and relatively robust bridging would be more successful than those with closed or extremely sparse (disconnected) networks in accessing varied and appropriate information and resources.

RESULTS

Residents of all communities, whether exposed or resettled, continue to face considerable hardships. In Ecuador, for example, socio-economic conditions have progressively deteriorated in a cascade of impacts starting with the destruction of basic crops and livestock [16]. This has culminated in a changing agricultural landscape, affected economic circumstances, and compromised human health. Not surprisingly, levels of recovery following eruptions are varied. Residents who evacuated from their homes for long periods often experienced poorer health and faced greater economic challenges than those who remained in place. In Ecuador, those who evacuated frequently, and for short periods, had fewer health problems than those who either did not evacuate or stayed away from home for longer periods [17].

In Mexico, the conditions for residents in both the evacuated community and the resettlement community remain challenging and chronic conditions only serve to exacerbate the problems. Respondents in the evacuated site reported that harvests had declined and that fertilizer was needed to increase crop yields particularly for fruit trees such as avocadoes. Others stated that water and food is sometimes contaminated with ash, although the animals are fine and no one has become ill from it. Others reported losing stock animals and pets due to not being able to feed their animals after being evacuated [18]. At the same time, more respondents from the resettlement site, Teziutlbn, believed that it is dangerous to live close to the hazard (i.e., mudslides) and stated that they had been affected by a hazard/disaster, and believe that the hazard poses a health risk to them and their families, compared to San Pedro Benito Jubrez respondents. Significantly more problems were reported by Teziutlbn respondents, including issues with space, problems with heat, lack privacy, and fear of criminal activity--all possibly related to living in small high-density housing.

In this regard, social networks apparently have an effect on disaster recovery outcomes and hence may help explain community resilience more fully. For instance, Fig 2a shows the tight/closed network of a participant from San Pedro. This individual has few contacts outside the community, but all are of equal socio-economic status and constitute close ties or somewhat close relationships [19]. In contrast the extending network shown in Fig 2b illustrates a network with contacts that extend beyond the local community, although there is no connectivity among subgroups. This individual also has several contacts with relationships that are not considered close. This contrasts with the network in Fig 2c, where there is connectivity (bridging) among the different subgroups, all contacts are considered close or somewhat close and are of similar socio-economic standing. Finally, Fig 2d illustrates a sparse network. The participant in this case has few close contacts and most do not have connectivity. In considering disaster impacts, therefore, support mechanisms as provided through such networks may prove crucial. For example, if resources and materials are not available locally, then strong outside connections may be essential to support the local community. Similarly, close ties with those from different (higher) socio-economic levels may also be advantageous under such conditions.

Results show that disaster recovery in Ecuador and Mexico has been significantly impacted by social network type and that these play some different roles depending on the prevailing conditions in the community. Evacuated, exposed and resettlements present specific challenges and should not necessarily be considered as simply hazard prone. Preliminary findings are presented below.

Mexico Networks

1. Those networks with tight/close ties, such as found in types a and c, provide greater support mechanisms fostering reciprocal relationships amongst their contacts. Those participants within such networks reported more sharing, including that of materials, labor, tools, and food, than other networks. Indeed, 94 percent of respondents reported reciprocal labor activities. In this sense, close networks and those with highly connected subgroups predict higher levels of social support.
2. In addition, where there are differences in socio-economic status between the participant and the contacts, there often exists a patron-client relationship which permits less wealthy individuals to have access to the support provided by the richer ones. However, 67 percent of named contacts were of similar socio-economic status.
3. Networks that incorporate subgroups (type c) that extend beyond the local community can provide additional benefits. Tight networks generate multiple and often reciprocal benefits, but they do not offer a diversity of resources or information. This is apparent in the case of San Pedro where remittances sent by migrant workers in Mexico City or the USA played an important role in supporting the local economy. At a local scale, these remittances also have a significant impact in the sustainability of the community. While on the one hand, migrant workers are marginalized in the host countries due to the fact that they are perceived differently from the local population, on the other hand, they provide essential resources for many impoverished communities.
4. Age, gender, and perceived support moderately or lightly predict impact and emotional and material well-being. However, geographic distance is important affecting not only the frequency of contacts but also the strength of contact. In San Pedro this was especially important since all the community was impacted by the volcano and relies heavily on material support from outside.
5. Networks with sub-groups and networks with high levels linkages (termed betweeness centrality) predict many impact and well-being measures. Thus, participants whose networks comprised well-connected sub-groups (type c) demonstrate a moderate awareness of the hazards, but at the same time exhibit strong well-being and tend to participate in the evacuations. In contrast, those with dense networks have greater concern regarding the risk.
6. Participants with open/weak networks (type d) do not have enough social influence to act in emergency situations and hence are vulnerable and often show lower levels of well-being.
7. In general it was found that people with networks of medium density with some duplications in connectivity (type c) had a better adaptation to the demands of the disasters and evacuations, in comparison to those with dense networks and a high number of restrictions, for

whom the recovery was more difficult [20]. The type of social network, then, appears to influence impact and well-being and can have significant repercussions for communities prone to disasters.

Preliminary analysis of these social networks indicates that they can have a significant impact on community resilience in chronic disaster environments.

Ecuador Networks

It is clear that the chronic conditions associated with the eruptions of Mount Tungurahua have had a profound impact on all communities in the region [21].

The impacts appear to be cumulative with conditions for many getting significantly worse over time. Specific to this research on social networks, it was found that social networks can play an important role in support and recovery. In particular:

1. Social networks with strong ties and close relationships tend to be associated with greater levels of support and hence recovery, than those with looser networks.
   - Support in this instance includes material, such as food and supplies, emotional support, and information.
   - Close relationships in the exposed site that had received ash had lower levels of support than in the other communities.
2. Social networks with only a few key connections (type b) were especially important in the resettlement communities. Individuals with such networks received higher levels of support (material, emotional and informational) than those with more complex networks. It is possible that traditional support networks had broken down once individuals moved from their old communities and that new connections had not been established. Such relationships were not found in the exposed or evacuated communities.

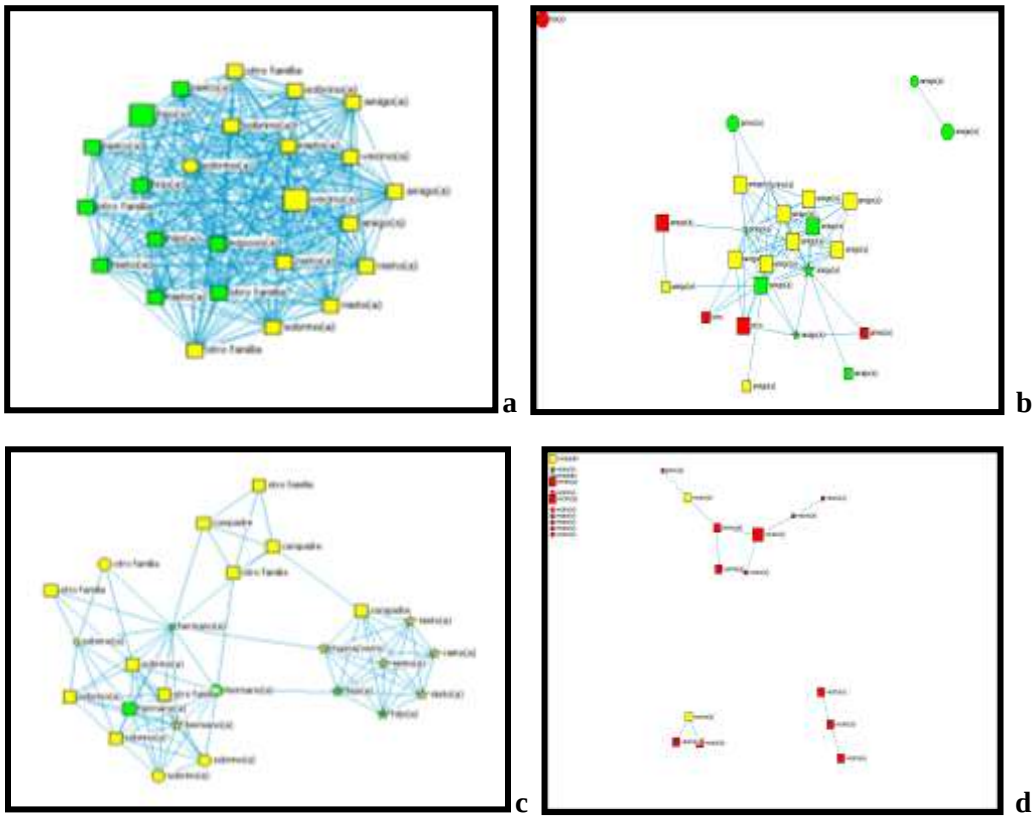

Fig. 2. Personal Networks: (a) Tight, (b) Extending, (c) Subgroup, (d) Sparse (from Mexico)

1. Support from families differed amongst the communities. Evacuated individuals cited the highest levels of family support, followed by those in the exposed community. The lowest levels were apparent in the resettlement communities. Again, it appears that social networks had been negatively impacted by the resettlement and it may take time before new relationships are made.
2. Support from spouse or friends did not vary by community type.
3. Males received more material and emotional support in the resettlement communities than females. There were no significant differences in the other communities between males and females.
4. Household conditions were worse in the resettlement and evacuated communities than in the exposed, non-evacuated community.
5. Physical health conditions were worse in the resettlement and evacuated communities than in the exposed community.
6. Stress levels were higher in the resettlement and evacuated communities than in the exposed community.
7. Depression levels were highest in the resettlement communities.

CONCLUSIONS

This research started with the hypothesis that residents with social networks comprised of strong subgroups and relatively robust bridging would be more successful than those with closed or extremely sparse (disconnected) networks in accessing varied and appropriate information and resources. The results from Mexico and Ecuador indicate that the structure of networks is indeed important in disaster recovery, but that its mechanism can depend on context. We must also consider the degree to which network structure is a product of the chronic hazards themselves. Overall, social networks serve important purposes in disaster environments and appear to influence levels of vulnerability and resilience. However, continued analysis and follow-up research will determine if differences among research sites is a result of the nature of the events or variations in cultural, historical, political and economic contexts in which the hazards occur. It is anticipated, therefore, that a full understanding of social networks will enhance hazard response and facilitate community resilience. For instance, when reflecting on the lasting outcomes of the eruptions, respondents often spoke of the displacement and dissolution of their communities. They reported that their communities were tight-knit and organized prior to 1999, but that since then, and especially after 2006, resettlement and migration have severely disarticulated their communities. Taking different social networks into account when responding to further eruptions, then, may assist the transformation of disaster survivors to safe environments.

ACKNOWLEDGMENTS

The research constitutes part of several larger projects focusing on vulnerability, sustainability and community resilience in disaster environments. The research has been funded through two collaborative National Science Foundation grants (0751264/0751265 and 0620213/0620264) and grants from the Center for Disaster Management and Humanitarian Action at the University of South Florida and the University of North Carolina at Greensboro. Additional support was provided by CUPREDER, Mexico and the Instituto Geofisico, Ecuador.

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ASSESSMENT OF HAZARD AND RISK, CAUSED BY GROUNDWATER CONTAMINATION IN THE URBAN TERRITORY IN THE EXTREME EMERGENCY

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The safeguarding of security has always been one of the major problems of individuals, society and state, but this problem became particularly topical in the second half of the twentieth century. The development of civilization led to natural and technonatural hazards increase, disruption of ecological balance, environmental degradation. Significant environmental degradation occurs not only at local and regional, but even at the global level. Ensuring the environmental safety is especially important for the population of cities (especially megalopolis) from the threats caused by environmental contamination. Analysis, evaluation and forecast of anthropogenic environmental changes and associated with them hazards and risks are important elements of sustainable development of urban territories, determining their optimal use and population safety. The probabilistic approach to forecasting of hydrogeochemical risk (risk caused by groundwater contamination or by aggressive groundwater formation) in the urban territories is considered in this paper. Hydrogeochemical risk includes the following factors: 1) probability of hydrogeochemical hazard formation and its realization; 2) damage caused by hydrogeochemical hazard realization. Hydrogeochemical risk assessment should take into account both risk of groundwater contamination or aggressivity (so called "the risk of exposure" and risk of contaminated or aggressive groundwater impact ("the risk after exposure"). The paper presents a generalized conceptual model of geochemical hazard and the risk occurring in the social and natural-technical system, developed on the basis of the scientific synthesis of various theoretical models and long-term research. The conceptual model allows us to represent: the main stages, the factors and processes of geochemical hazards and risks formation, interconnection in the system "DM (decision maker) – technogenic sources – groundwater – human". The developed conceptual representations are the basis of the methodology of forecasting and management of geochemical risk in urban areas. Forecast of risk is performed at the level of complexity, which depends on projection stage, intensity of potential technogenic source impacts, importance of the objects under consideration, receptivity of groundwater and the objects to external influence, degree of uncertainty and expected value of risk. According to it the method of hydrogeochemical risk forecast is selected. Different methods are used for probability estimation: from method of subjective estimate of probability, method of analogy and expert methods to complex statistical procedures and numerical stochastic modeling. In represented example risk forecast was evaluated with the use of numerical simulation.

Methodological principles

The main terms

Due to the scientific publications of Rowe W. D. [10], Petak W., Atkinson A. [6], Mark R. K. and Stuart-Alexander D. E. [5], Udias A. [12], Ayala F.J. [1] and others generally accepted interpretation of risk ultimately formed for natural and anthropogenic hazards as probabilistic measure of the losses, which can be defined by multiplication of probability of the adverse event (P) by the damage value (L): R = P L. So the necessity of "hazard" and "risk" differentiation was noted. Complexities of terminological base creating are connected with specific of the object of research and research technique, different genesis of hazards and risk (urban, natural, social and others), conversion from worldly and ordinary notions to scientific notions. At determination terms "hydrogeochemical hazard" and "hydrogeochemical risk" we assumed as a basis conventional notions of hazard and risk, founded on creation experience of the terminological base, which was universally recognized and satisfied the requirements of concrete fields of knowledge [16-19]. Hydrogeochemical hazard is a geochemical state of ground water (the hydrogeochemical situation), posing a threat for people and/or environment. We consider "hazard" as objective reality (state, material property, situation and others), existing in respect of society and nature. Hydrogeochemical hazard can be conditioned as both low and high chemical substance

concentrations in comparison with hygienic standard, as well as aggressive characteristic of ground water to different recipients. Hydrogeochemical hazard can be both natural and urban. We shall consider only coupled urbanonatural hydrogeochemical hazard and risk. Hydrogeochemical risk - the hydrogeochemical hazard measure. It includes the following quantitative factors: 1) probability of hydrogeochemical hazard formation and its realization; 2) damage caused by hydrogeochemical hazard realization; 3) uncertainties in the damage and probabilities values. It is important to emphasize that hydrogeochemical risk is considered as integral factor. Hydrogeochemical risk assessment should take into account both risk of groundwater contamination and risk of polluted groundwater impact on population and infrastructure objects.

Structure of hydrogeochemical hazard and risk

The approach suggested in this paper is founded on well-established conception about genesis of the geological and hydrogeological hazards and risks at urban territory [12-14]. Hydrogeochemical hazards were characterized by more various sources and factors of formation, that greatly complicates the model of hazard and risk. The model presented below was created on the base of our long-term experience in hydrogeochemical hazard research and also we took into account the experience of environmental contamination risk assessment [3, 9, 11]. There are the following essential elements in the structure of hazard and risk: Subject of the hazard, Environment and Object of the hazard (Fig.1). A decision maker is the first rank hazard Subject. Decision maker can be one person or group of persons, working out the collective decision. He brings about urban sources (the second rank subjects) – in other words the urban hazard. Urban hazard realization can bring to formation of hazardous hydrogeochemical situation. The first rank object of hazard in the city territory is a human. The second rank objects of the hazard are the objects of infrastructure, related to a human immediately. Term "environment" includes various environment components. In addition to these three components (Subject–Environment–Object) an external person (Positioner), estimating actual or potential hazard, is usually entered. In process of hydrogeochemical hazard formation and realization it is possible to change of the subjects and objects role functions. The first and second rank subjects can become the objects of hazardous "secondary" impacts, for instance: the factory, where leakages occurred, becomes underflooded by aggressive groundwater that brings about destruction of the foundation and sometimes the building collapse.

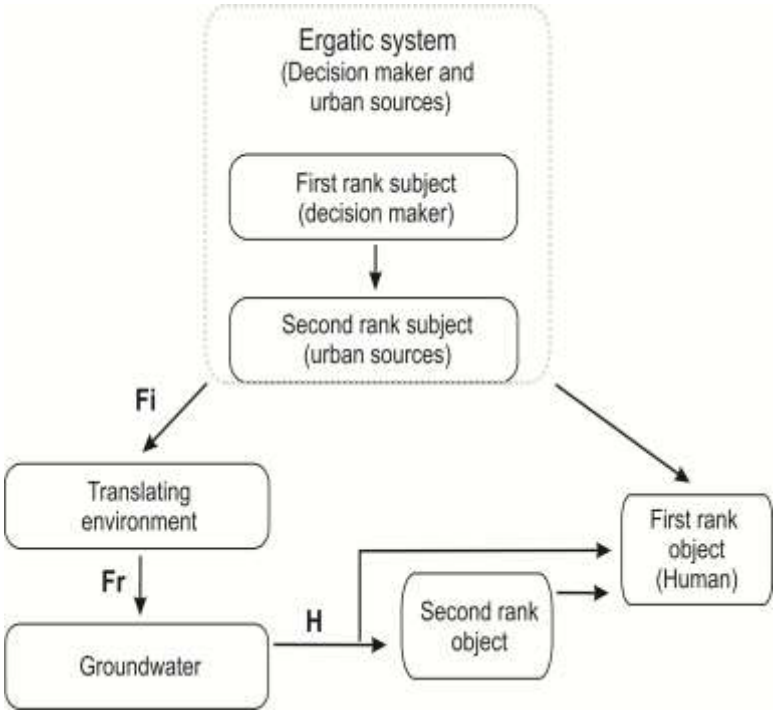


Fig. 1. Structure of hazard and risk

For investigation of hydrogeochemical hazard formation and realization it is reasonable to select two models: model 1 – "ergatic system (Decision maker and urban sources) – ground water" and model 2 – "ground water – human" (Fig. 2). In the first model the probability of hazardous hydrogeochemical situation occurrence is estimated. In the second model the hydrogeochemical risk for recipient is estimated.

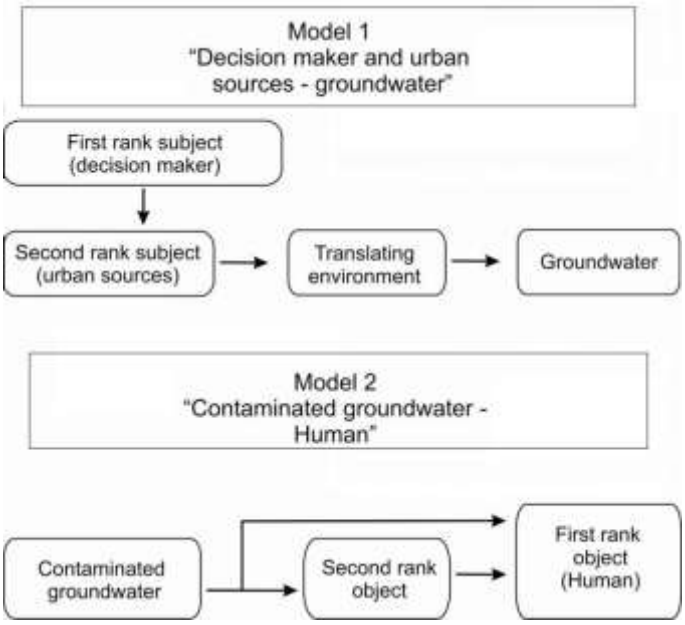


Fig. 2. Scheme of hydrogeochemical hazard formation (Model 1) and realization (Model 2)

The hydrogeochemical hazard formation and realization can be considered as a complex event, which forms because of more simple events. The probability of the complex event can be valued on the base of the probability of simpler events knowledge.

Model 1 – "ergatic system - groundwater"

Possibility of hazardous hydrogeochemical situation can appear already in the stage of idea. It depends on social, economic, political reasons, competence and professionalism of Decision maker, learning of situation, information influence on Decision maker and population. At a later date in the stage of project risk can change (increase or decrease), for instance, can increase as a result of mistake in designing, distribution of enterprises etc. The result of the Subject intellectual and organizational activity on the stages of idea and project is an urban sources creation in the stage of construction. Thereby, the technogenic impact with specific parameter (intensity, composition, periodicity etc.) appears in construction and operation stages. It is important to notice, that initial impacts are only potentially dangerous, since their real hazard from the position of the hazardous hydrogeochemic situation formation appears only in process of the interaction with environment.

Urban sources are characterized by different types of impacts, time of the action, composition and concentration of contaminants and so on. The hydrogeochemical hazard formation can be conditioned by different types of source impacts - direct (chemical) and indirect (physical, biological and others), different character of impacts - normal or emergency, different source actions - deterministic or probabilistic. Two types of urban sources stand out on a nature of the action: 1) the sources operation are destined the impact on ground water (for example water inlet, drain hole), 2) the source impact is conditioned by different failures. The first type impact is deterministic, the second is probabilistic (is defined by probability of the failure). In practice of risk analysis frequency of the hazardous event is often used for the urban sources. But for the

probabilistic estimation the hazardous impact occurrences is considered as Markov process, characterized by the simplest flow of the event appearance.

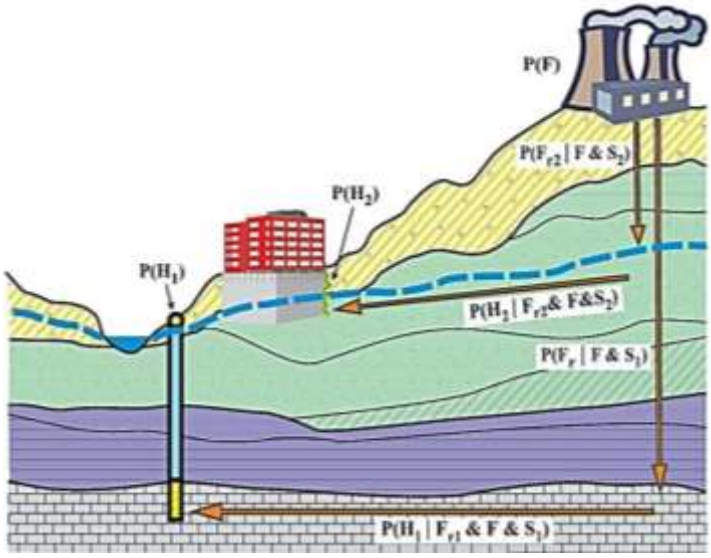


Fig.3. Scheme of hydrogeochemical hazard formation

Result impact formation (external factor). The result impact intensity and nature are essential factors of the risk of hazardous hydrogeochemical situation formation. It is important to assess probability of the resultant impact formation above maximum allowed value, i.e. capable to bring about hazardous hydrogeochemical situation occurrence. The Parameters of the resultant impact depend on type and intensities of the source impact and conditions on the way to its translations. For instance, in case of chemical influence resulting influence parameters depend on: initial amount of contaminants, chemical properties of elements and their compounds, forms of migration, redox potential, acid-base balance, water-rock interactions and microbiological factor on the translation way. It is possible to select two types of situation: hazard of resulting influences either increases, or decreases as compared with initial influence. The first type situation example is the increase of contaminant concentrations in drinking water in case of leakage from water-supply pipes and filtration through polluted unsaturated zone, the second type situation example – a reduction of sewage contamination as a result of polluting substances sorption during their filtration through soils and rocks, as well as their degradation or deposition.In many cases the resulting impact is defined as a contaminant concentration, arriving from the unsaturated zone. It is necessary to define: 1) probability of the contaminant concentration, arriving on water table, exceeds criterion level, or 2) probability of arriving time on water table, will be less than criterion time.

Groundwater stability (internal factor). The hazardous resulting impact on groundwater is not a sufficient condition for hydrogeochemical hazard formation, because groundwater can be stable to external impact. Probability of the hazardous situation occurrence depends on its internal characteristic and abilities to save, restore and (or) adjust its composition, characteristic and (or) execute the certain functions (for instance, as drinking water). Probability of the hazard formation is valued in failure fixation area (point), which depends on purposes of the study. In most cases it is the area, where groundwater impact on human and infrastructure objects is valued. It can space coincides with the area of the contaminant arrival to the ground water or be on a certain distance. When contaminants transport significant changes of hazard degree the issues of dispersion, physico-chemical interactions in water-rock system are possible. Groundwater stability depends on its receptivity, i.e. possibility of negative reaction on factor impact, and from state, characterized by remoteness from the critical point (for instance, maximum allowable concentration). Even small impacts on groundwater close to threshold of stability can bring about negative consequence. Groundwater stability is defined to specific contaminant; it also can be greatly changed at time. It is conditioned by hydrosphere change (for instance, rock sorptive capacity exhaust, approximation to critical point etc.). Stability assessment can be made with use of time value, during which system «groundwater-rock» saves the ability to resist the external influence, or with use of the losses value

(for instance, quality water deterioration). The particularity of hydrogeochemical hazard formation is its "latent" nature.

Hydrogeochemical hazard formation can result from synergetic effects. Besides, essential factors of hazard formation are simultaneous impacts on hydrosphere absolutely different loads (for instance, hydrodynamic, mechanical, heat or chemical), though separately each of them can not bring about hazard situation.

Thus in the first model the probability of hazardous hydrogeochemical situation occurrence is determined as a result of multiplying probabilities of several occurrences.

$$P(H) = P(F) \cdot P(S \mid F) \cdot P(Fr \mid F \,\&\, S) \cdot P(H \mid Fr \,\&\, F \,\&\, S), \quad (1)$$

where P(F) – probability of the source impact F on groundwater during the given period; P(S | F) – conditional probability of the object location in a zone of the source impact F; P(Fr | F & S) – conditional probability of the resultant cumulative impact formation above maximum allowed value Fr in the case of the source impact F and corresponding object location; P(V/Fr) – conditional probability of the groundwater instability occurrence V in the case of the resultant cumulative impact Fr.

Model 2. Contaminated groundwater – Human

The hydrogeochemical risk for recipient is estimated in the second model. Here the impact of contaminated or aggressive ground water on human (the first rank object) and objects of the material sphere (the second rank objects) is considered. The object choice depends on the purpose of investigation. Hydrogeochemical hazard realization is the cause of social and economic losses. The social losses from the contamination are determined as urban dwellers health worsening upon the direct impact of contaminants. The economic losses in this case are determined as the probability of indirect effect to a man, i.e., the aggressive ground water impact on the basements or other underground engineering structures in the underflooded areas leading to their destruction. As it was mentioned above in the "Model 1" Decision Maker "organizes" risk of hydrogeochemical hazard formation, creating urban sources. In the "Model 2" he also "organizes" risk of hydrogeochemical hazard realization, placing the buildings in a zone of aggressive ground water influence, allowing use insufficient water treatment, and so on.

Hydrogeochemical hazard is characterized by multiple furcated successions (chains) of interactions in technical and natural systems. For instance, leakages from water supply system or sewers can cause underflooding and change the chemical composition of groundwater. In one's turn these events can cause groundwater aggressivity growth, chemical and mineralogical rock transformations, filtration characteristic and deformation behavior changes. This generates new breakings of water supply system or sewers pipes, additional leakages, foundation deformations, which provoke other processes, manifestations which often turn out to be unexpected. Taken measures can break the dangerous synergetic chains, but herewith generate new.

For the "Model 2" probability of the damage to the object depends on: 1) probability of the hazardous hydrogeochemical state; 2) probability of the recipient contact under consideration with contaminated ground water; 3) probability of the vulnerability recipient occurrence. The contact of the object with contaminated ground water can be as deterministic (location of the building in territory, underflooding by aggressive ground water), and probabilistic (casual use of water from pit.). For pair II it is important to consider the result impact also, however it is defined by artificial protectability of recipients (water treatment, hydroisol foundation etc.).

Overall, taking into account the factors of the risk in the "Model 2", the integral hydrogeochemical risk is expressed by the following dependency:

$$R = P(H) \cdot P(S^* \mid H) \cdot P(L \mid H \,\&\, S^*) \cdot L \quad (2)$$

where P(H) – probability of hazardous hydrogeochemical state (refer to formula (1)); $P(S^* \mid H)$ – conditional probability of the contact S*of the underground engineering structures with

groundwater; $P(L \mid H \& S^*)$ – conditional probability of damage L in the case of contact with contaminated groundwater.

Forecast of risk is performed at the level of complexity, which depends on projection stage, intensity of potential technogenic source impacts, importance of the objects under consideration, receptivity of groundwater and the objects to external influence, degree of uncertainty and expected value of risk. According to it the method of hydrogeochemical risk forecast is selected. Different methods are used for probability estimation: from method of subjective estimate of probability, method of analogy and expert methods to complex statistical procedures and numerical stochastic modeling. At the initial stage (pre-investment) in connection with information deficit the analog method and expert methods are used. At the stage of investment feasibility the analytical method using simplified statistical distributions, such as triangular distribution is recommended. These methods usage based on the following proposition: the probability of "final" undesirable event can be valued on the base of the probability of simpler events estimation. The hydrogeochemical hazard formation and realization can be considered as a complex event, which forms because of more simple events. The ultimate probability of the complex event is defined as the product of the probability of primary (triggering) event by the conditional probabilities of all other events provided that the probability of each consequent event is calculated on the assumption that all other events have already happened. In this case calculation is spent by formula (1).

At the stage of project risk assessment procedure is complicated. Analytical solutions cannot give the correct result in the presence of irregularities in the environment system, therefore it is (quite) reasonable to use numerical stochastic modeling, when probabilistic blocks are included in the model, which describes the deterministic geofiltration and geomigration processes. Previously the analysis of all components of hydrogeochemical risk and marking of probabilistic and deterministic events are carried out. An approach mentioned above was used for risk assessment of groundwater contamination by oil products in the territory of large motor car complex in Moscow.

Risk assessment of groundwater contamination by oil products in extreme emergency in the territory of large motor car complex

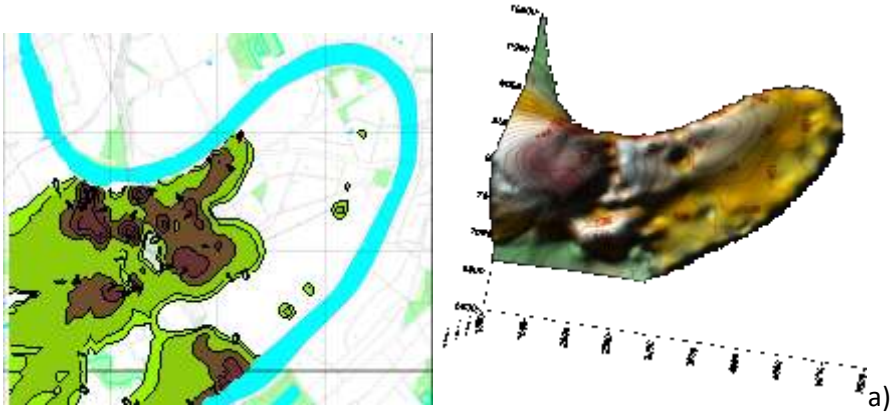
The study area is located in the valley of Moscow-river (Fig.4).Two different types of rocks: Precambrian crystalline basement rocks and Paleozoic, Mesozoic and Cenozoic sedimentary cover rocks take part in the geological structure. The geological section depth in accordance with the tasks to be solved was limited to Upper Carboniferous rocks. The investigated part of the geologic section is represented by clays and marls of Voskresenskyai subsuite (C_3vs), limestones of Ratmirovskay subsuite (C_3rt), clays with interlayers of marl of Neverovskya subsuite (C_3nv), limestones of Perhurovskya subsuite (C_3pr), and also unconformable overlaying Callovian – Oxford clays ($J_{2\text{-}3}$k-o), and the fluvioglacial and alluvial sands and sandy loams, as well as fill-up soils. The geological history of the study area identified a number of important features which is necessary to take into account when creating a geological model – the basis of geofiltration and geomigration models. Erosion and glaciation, often occured in the Pleistocene epoch, significantly influenced on the Jurassic sediments preservation. Within the ancient erosion valleys developed in the territory Jurassic sediments are absent or eroded. The sites of significant reduction of Jurassic sediments, or even their absence have been called "hydrogeological windows." It was assumed that hydrogeological windows could be a fast pathway for contaminants transport from the polluted upper aquifer to the lower aquifer with fresh water.The main aquifers in the study area are as follows: "over-Jurassic" aquifer in the alluvial and fluvioglacial sand and sandy loam and Kasimovskii aquifer in Upper Carboniferous limestones which lies below. Separation layer is represented by Callovian – Oxford clays. The main task was assessment the probability of oil products arrival to water intake wells and monetary risk.

General conceptual model for hydrogeochemical hazard and risk include the following concepts: the formation of hydrogeochemical hazard (model I); realization of hydrogeochemical hazard (model II); type of damage. The concept of Upper Carboniferous aquifer contamination (hydrogeochemical hazard) consists in the fact that in a result of filtration of oil products arrived in the "over-Jurassic" aquifer, and from it through weakly permeable Jurassic clays to Upper Carboniferous aquifer. Realization of hydrogeochemical hazard in this case can occur when using

of contaminated groundwater, resulting in correspondingly may be a damage to the health of the population. It is assumed that in this case the major cost of drinking groundwater contamination will be determined by the cost of treatment facilities constructing.

On the basis of situation analysis we concluded that certain events are: the source of contamination impact on groundwater P(Fi), the object location in a zone of the source impact P(S/Fi) because well captured zone (the object) is located in the way of contaminant migration, the groundwater instability occurrence P(V/Fr) because physico-chemical interaction the main contaminant – benzene with water – bearing limestone is negligible and dispersion (the main process in our case) is considered as deterministic process. So the only probabilistic event is the resultant impact formation P(Fr/Fi&S), because the contaminant concentration entering to aquifer depends on location of hydrogeological windows.

Fig.4. The study area



a) b)

Fig.5. a) The scheme of the Jurassic deposits spread (green and brown areas), b) the study area relief

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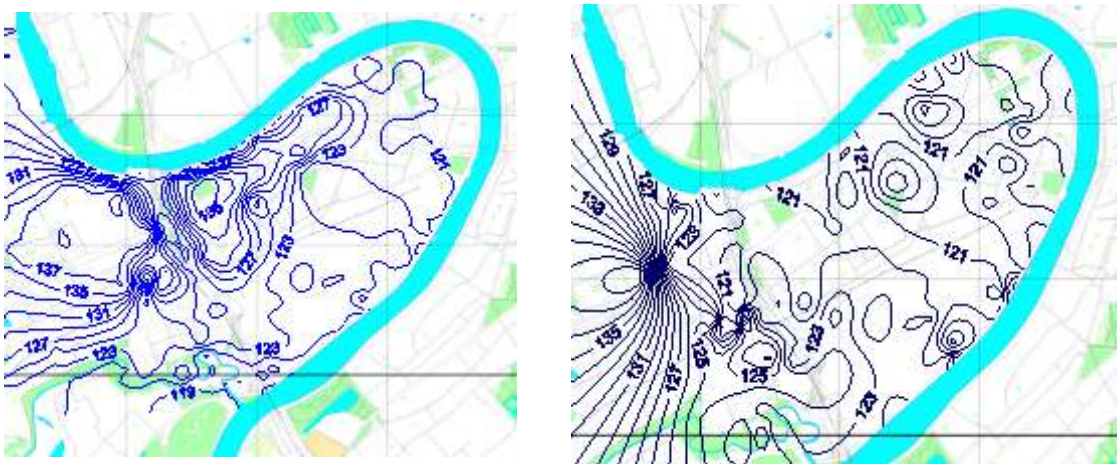
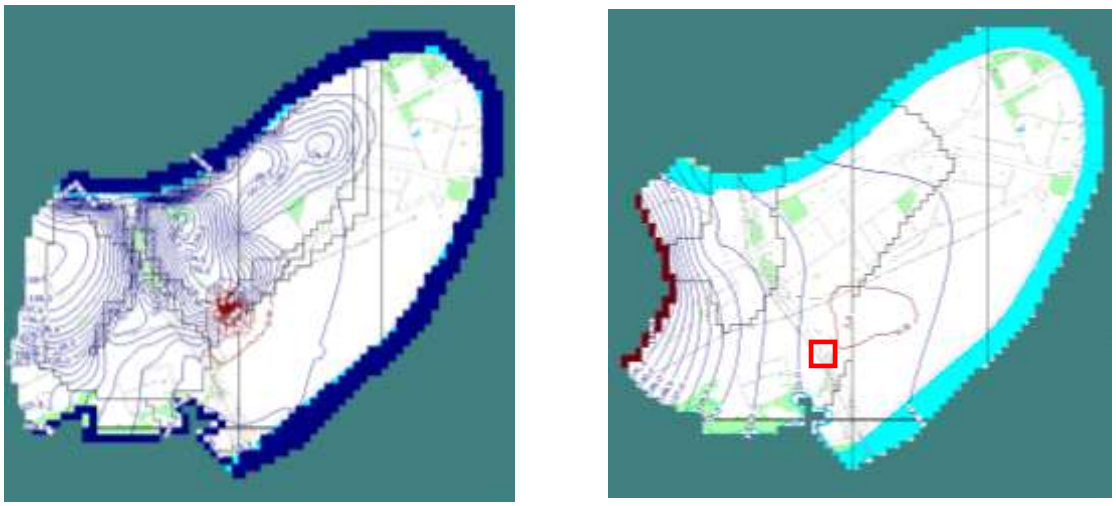


Above aquitard Below aquitard

Fig. 6. Distribution of heads above and below the aquitard



a) b)

Fig. 7. Distribution of benzene: a) in "over-Jurassic" aquifer, b) Upper Carboniferous aquifer

The steady-state hydrogeological model included 3 layers: the upper aquifer in alluvium and fluvioglacial sand and sandy loam; the aquitard in the Jurassic clays and the lower aquifer in the Upper Carboniferous limestones. The model domain was bounded by the Moscow river in the west, the north, the east, river Setun in the south-west and by hydraulic watershed in the east. The model had uniform grid. Each sell size was 50 m (x) Ç 5 m (y). For numerical 3-d groundwater flow modeling Processing Modflow Pro, v. 7.0.26 was used [2]. We performed simulation of benzene transport using MODFLOW/MT3DMS codes, because benzene is one of the most soluble oil components with low sorption ability. In model benzene concentration was specified equal 50 mg/l.

The suggested approach applied for modeling of probability of oil products arrival to water intake wells in lower aquifer includes the following steps:

– estimation of different variants of Jurassic clays boundary with the use of random-number generator;

– running MODFLOW/MT3DMS codes for the each variant and obtaining concentration fields;

– probability analysis of simulated concentration fields.

Results of probability analysis are shown that the probability of benzene arrival to water intake wells in lower aquifer is about 30%. The value of monetary risk with an allowance for risk of treatment facilities is 0.3* 100000 $ = 3000$.

Another approach we suggested in [4]. Applied approach of estimate of contaminated groundwater probability was based on stochastic simulation of hydrogeological windows in the aquitard. The model of indicator simulation was used for stochastic simulation of hydrogeological windows in the aquitard. We applied indicator function I(x):

$$I(\mathrm{x}) = \begin{cases} 1, if \ \ window \ exists \ in \ \mathrm{x} \ location \\ 0 \ otherwise \end{cases}$$

Statistical properties of I(x) were calculated using well data. Calculated expected mean E{I(x)} i.e. the probability of windows was 0.3 and spatial correlation of indicator function in the form of indicator variogramm was identified.

An approach applied for modeling of risk of lower aquifer includes the following steps:

stochastic conditional simulation of 50 realizations of aquitard windows locations using SISIM code of GSLIB library;

transferring the each simulation results into hydraulic conductivity field using the rule:

$$I(\mathrm{x}) = \begin{cases} 1 & \text{then } k(\mathrm{x}) = K_{sand} \\ 0 & \text{then } k(\mathrm{x}) = K_{clay} \end{cases}$$

running MODFLOW/MT3DMS codes for the each conductivity field and obtaining concentration fields; probability analysis of simulated concentration fields.

Results of probability analysis are shown in particular that the probability of contaminated groundwater formation in construction area is about 75% -80%. The value of monetary risk = 0.75* 100000 $ = 75000$.

Conclusion

Development of the theory and methodology of population safety ensuring when different type of natural and techninatural activating - one of the most important problems in modern times, whose decision shall be based on risk analysis and forecasting. The interdisciplinary nature of this problem has led to research in various knowledge domains that has defined different approaches to classification of risk, the methodology and methods of risk assessment. Results of analysis and synthesis of risk researches, associated with environment contamination, demonstrated the necessity of further development of the theory and methodology of analysis, prediction and management of these risks. Methodology of assessment and forecast of techno-natural risk is a relatively young research area, intensively developed in various fields of scientific knowledge, and therefore the search for new and improved ways analysis, forecasting and risk management as the foundation of population safety is quite legitimate. The main tasks for the future development of the theory of hydro geochemical risk include1) Improving the methodology for forecasting and management of hydrogeochemical risk on the basis of approaches integration developed by specialists of different fields of knowledge. 2) Development of methodology and techniques of large-scale hydrogeochemical hazard and risk mapping in the urban areas. 3) Development of documents governing the procedure of risk assessment and forecast at various stages of development in urban areas.

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GLOBALIZATION AND MODERN URBAN-PLANNING POLICY

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"People of the country…" – that is how usually starts constitution of many democratic states. Thus, a man is underlined as primary value of the state. At that, majority of the state problems is overcome in favor of a man – preservation of rights, welfare and life quality. Day by day the population of the World is increasing for a quarter of a million. Starting from of 50-ies and the beginning of 90-ies of XX century the population of the World has doubled. Rapid cities growth is observed. Situation today dictates a range of conditions for the further development of urban-planning policy, offering, thus, fundamentally new complex of problems that should be solved not only at local and regional levels, but with the help of the mutual efforts within frameworks of interregional and international programmes as well.

The paper offered below mostly investigates key administrative tools and conditions favourable for successful implementation of administrative regulations in the field of urban-planning policy. Alongside with competent policy, carrying out of respective reforms strengthens worked-out policy. In this long term and complicated process importance of cooperation at international/interregional level, both within local administrative units and as result of organizational interaction, positive feedbacks and mutual benefits are also stressed.

Considering benefits and returns one should not ignore all negative affects and primary concerns arising with rapid urbanization and growth of the cities, such as wastes, unrecoverable products, pollution, cost rising and others that are also reflected in the given paper. At the same time this paper separates role of state and private sector activities and their role in this factor as well as points out possible ways of their cooperation and how they both can profit.

Key words: administrative tools, urban-planning policy, initiatives, innovations, investments

1 SUSTAINABLE DEVELOPMENT URBAN–PLANNING POLICY

Nowadays, one of the key objectives for competent urban-planning policy is the solution of problems concerned with sustainable city development. It is worth pointing out that a city in long-term perspective may not rely upon prosperity if joint influence of urbanization on global recourses reaches a volume, when balance and normal functioning of ecosystems is affected. Introduction of the term "stability" into already existing development models will mean imposing restriction on rights of city enterprises and consumers to use of mean resources available and generation of the wastes unable to biologically decompose. Probably, nowadays most important is the problem of nonrecovarable products use and waste processing.

Sustainable development principles' conceptualization consolidated principles of rational resources use to maintain living social comfort and economic development advancement without causing any damages to life support systems of the planet.

In context of settlements, aspiration to provide sustainable development proposes outlining of new objectives in addition to those that are traditionally related to the filed of city government bodies' responsibility.

1.1 Sustainable development indicators

As far as economical as well as nature protection components are considered, sustainable development of settlements can be judged from a range of indicators reflecting:1 population quality of life, including affordability of housing, service systems and socio-political stability;2 expansion of recirculation methods and usage of renewable energy sources;3 effective functioning of engineering infrastructure systems and satisfaction of the needs for water, electrical energy, liquid wastes and rubbish removal; 4 settlements ecological footprint reduction;5 ensuring processing and recycling of wastes, produced as result of production and usage as well as methods for their removal, including degree of the influence of these wastes on human health, natural systems and domestic facilities.

1.2 State and private sector role separation/ecological approach

Government bodies are called upon creating all conditions for the development and maintenance of economical welfare, however, based on multiple examples, for the realization of resources available, one cannot ignore interests of private sector's commercial and industrial enterprises. Increase of investment opportunities in majority of countries is observed exactly in private sector after privatization of numerous public institutions and other works.

It is mentioned in many countries that private sector starts to analyze economical aspects of sustainable development. However, positioning of the private sector in many regions as a whole is not having a single meaning of fair and equal distribution of goods(both within framework of contemporary society, and related to future generations) as well as supplying population with infrastructure and services. Majority of commercial and industrial enterprises will have to analyze their direct interests in provision of sustainable development, as exhaustion and degradation of the environment make growth of costs for production and increase of risks number more possible. Thus, bringing modern ecological problems to private sector rises up new responsibility for government and municipal administration. Succeeding it this is impossible in terms of industrial structure of administration. Its frameworks should be limited by complex plan tasks of economy territorial organization at national, regional and local levels. Meanwhile, key direction of the private sector's activity in environment issues is mainly concentrated in reduction of negative affects to human health and environment at their enterprises and in adjacent regions.

1.3 Administrative tools and reforms

Methodological platform of the reforms, alongside with strengthening decision making institutions, should include new tools of territorial planning. This will demand development of feedback tools in territorial administrative system, consolidation of legislative base and improvement of common international and interregional urban-planning culture.

At the same time for the realization of sustainable development principles, forming of new alliances and bridging of new partnership ties between members of urban-planning process is necessary. Owing to rational administration the very frameworks of success in stimulation and support of innovative approach and forming of new partnership relations at all levels - from local small organization s to communities and union at city and region level- are founded.

Urban-planning policy administration reforms should stipulate success in sustainable development objectives. For this, exactly within the frameworks of city should be organized a wide scope of programmes, that, perhaps, will be of a little use, but anyway will play great role in the planet's climate preservation and its biological diversity due to change of human understanding towards ecological compatibility. In order to succeed in these goals it is very important to provide optimization of the spatial behaviour models and use of resources.

Rational administration means ability to cope with goals and demands collision, caused by interests' difference. It also means that city municipalities should control quality of environment and promote innovative initiatives.When reforms are carried out, one should consider importance of decentralization principle, supposing transfer of duties and responsibilities and function of resources control to the level, where their fulfillment will be most effective. At that it is especially pointed out that in order to succeed in sustainable development everywhere, respective institutes should be developed and partnership relations bridged between various subjects of activity.

Stimulation principle is a pivot of "incentive strategy". All its meaning is directed to activation and promotion of the whole scale of big and small initiatives, investments from private persons, communities, private enterprises and charity organizations. In contrast to previous settings, city municipalities and central administration should be initiators of city development within frameworks of the new approach. Their role changes, as a function of direct investment activity passed to the private sector.

Stimulation conception was based on understating of the fact that investment activity, as with many other arrangements made and as a whole having effect to the success in development and environment, is mainly realized out of "urban-planning policy administration". This activity is carried out without government bodies' direct control, and even in the case when they somehow or other control it.

Despite the fact that it has been accepted that without control measure and regulation and their close supervision, activity of some private persons and enterprises may have negative outcome on others. For this reason, all means to avoid it were considered as key objectives of policy administration. Consequently, one of the main questions and issues for city administration is necessary stimulation tool selection, which will successfully complete efforts of private persons, communities and voluntary organizations and provide close coordination of the efforts contributing to further improvement of the city.

2 INTERNATIONAL/INTERREGIONAL COOPERATION AT ORGANIZATIONS AND MUNICIPAL LEVEL

The analysis of municipal administration showed that cities development process in 90-ies had been affected by various civil unions and organization at lower level, non-governmental organizations, commercial and industrial enterprises. Since that time the number or urban-planning activity members has been increasing. Various civil unions have different names and are known as groups or organization at community level. All of them represent one or another form of initial organization of city inhabitants with the aim to expand their opportunities for struggle with unfavourable factors. Unions of this type are usually formed based on the place of residence or work

Non-governmental organizations have various forms and vary by scale and type of activity. They are differentiated with their scale, from big and well organized institutions functioning at

global and regional level, to small organizations functioning at micro district level with poor budget. According to their orientation they vary from organizations with wide scaled work with various groups and their organizations, to institutions and funds dealing with search of innovative approaches to urban-planning development problems.

As many other social organizations they have been assisting in development of partnership relations. Now we may see many examples of state and private sector partnership in realization of urban-planning projects. Within frameworks of 90-ies doctrine was mainly emphasized the fact that state sector deals with regulation of land tenure development and building up, working out infrastructure development programmes and investment activity coordination for its foundation. Private sector, in its turn, is dealing with mobilization of resources for realization of housing programmes and infrastructure it improves housing distribution tool and work of engineering and social service.

Joint work promises mutual benefits. Potential benefits of state sectors are: reconstruction of the decayed regions; renewal of economic activity and increase of taxes returns by growth of city territories adaptation; financial gains from collective land rents and joint development plans. One of the innovations is so called "infrastructural stimulation" of national development, providing maximal usage of state investments and growth of roads and utility which will stipulate national economy development and improve quality of urban-planning policy and strengthening private sector role in this policy.

Hereby, a task to control that social and ecological influence of macro economical and industrial policy held does not lead to aggravation of the problems at which policy if sustainable development is aimed arose in front of national governments. To succeed in the field of city progress, which is also aimed to promote stability, stipulation as well as regulation, is necessary.

Any city council can hardly operate alone. Coordination tools also stipulate joining of efforts in the solution of common problems. Problem of sustainable development is one of them. Here the key role is given to national governments, and for this they solve problems of changing the course of economical and territorial development into ecological sustainability with the help of normative legislative base progress and development of coordination tools with municipalities. In international terms they are responsible for reaching agreements on rational use of natural resources of the whole planet. At national level they should set frameworks determining conditions for harmonic spatial reclamation, without disturbing sustainability of development at national and global level.

IGMASS AS A TOOL FOR EVOLVING GLOBAL AND REGIONAL DISASTER SECURITY INFORMATION AREAS

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The capabilities of astronautics in the permanent global monitoring of all layers of the geo-sphere, geo-information technologies and space means of rescue in emergencies are well known. These achievements, now in use across the globe, are hard to overestimate. Those include satellite geodesy, navigation, meteorology, communication and television, satellite relaying information, Internet, distance learning and universal education. Without them it is hard to imagine today the daily life of "the planet of people". The combination of achievements in space and information technologies integrates the world community into "a global village" and promotes the steady development. However, in order to avoid unpleasant surprises in this area in the form of unpredictable consequences, it is necessary to look into the future, for which purpose the services of sociologists and political analysts are unavoidable. The space exploration today starts socialization of space. With the growth of applied use of space, new questions arise spontaneously and new aspects become obvious in the system of social and political priorities. The classical political and economic problems come to be regarded in a new light and the economy comes to

grips with new tasks. Thus we have not yet learned how to adequately measure and plan the funding of space exploration, how to assess the ecological damage sustained from this and how to handle such issues in terms of economy and engineering. Also, we need to learn how to forecast the pricing of space products and services and how to calculate the economic effect of each space launch.Contemporary multi-faceted space exploration rests on a single foundation whereas its components supplement one another. The ultimate goal of space exploration is to serve mankind in general and each individual in particular, primarily in the sphere of security. The better understanding of Nature by man helps to enhance both environmental and social security. That is why space exploration issues have become vital today. Addressing them adequately and quickly is a top priority task for understanding the social genesis of progress of science, technology and civilization in general. Without this it is impossible to map out the strategy and tactics of advance of science and technology, to improve forecasting, programming, planning, decision-making in any sphere of material and spiritual production, including applied astronautics, which from the theoretical point of view is today *a humanistic value that ensures global security and means much more than the conventional interpretations.* Thus, one of the urgently important tasks may become the formation of "the secure information space" as part of the above mentioned "information sphere" that thwarts global threats and reduces the risk of their emergence. It's common knowledge that mankind has always lived in zones of internal and external risks, which have become part of people's everyday life. As a source of tension and apprehension, such risks stimulate the progress of civilization. With the change of epochs and technologies some of them disappeared (softened), whereas others were handed down as "legacy" to the next generations. Such risks often turned into new, more formidable ones, which time and again materialized in the form of outer and inner threats to civilization.Outer threats are those coming from outer space. So, the cycles of anomalous solar activity were followed by cycles of global climatic changes with glaciations, floods, which led to global cataclysms. The inner threats are natural calamities and man-made disasters (accidents resulting from human activities). Dangerous natural phenomena are often triggered by man's actions whereas natural calamities, in their turn, often cause man-made catastrophes. In any case, such dangerous natural phenomena as the sinking and under-flooding of terrain, landslides, tropical hurricanes and even increased seismic activity may result from mankind's intensified attempts "to transform nature". At the turn of the century the risks from man's impacts came close to a crisis which may become a threat capable of irreversible processes with the most deleterious consequences for mankind. In the current conditions, the elaboration and realization of balanced decisions by authoritative international institutions (the UN being the main one), it is necessary to possess relevant information whose amount, the rate of delivery and update correspond to the dynamics of the global on-going processes. Such information could be obtained using the resources of space facilities belonging to national and transnational institutions. The latter, being territorially separated, could be united under the IGMASS project, which is being implemented under the auspices and supervision of the United Nations. The current globalization gives any user of communication facilities a convenient opportunity, on the one hand, to access an aggregate information resource (which in some cases may be anonymous), and on the other, to distribute information freely among a vast number of users. In this case, the transnational information traffic in science, technology, economics, education, culture, business, advertizing, etc, eliminates the historically established value system, and levels the mentality, thus turning political borders into artificial obstacles. If brought to the extreme, this process may lead to an information war. The trend can be prevented by further development of purely humanitarian aspects of IGMASS by uniting telecommunication resources for addressing mankind's issues of spreading education and preserving cultural and moral values.Thus, "the information space of global and regional security" may be converted from a philosophic and futuristic notion to a practical one. For this purpose, the rightly organized power, which ordinarily supports direct and indirect information links, must draw up a compromise that would ensure a steady advance. This can only be achieved if all the operators have an adequate access to information that can be placed in the global security space created with the help of modern and future space systems of all countries.

INTERNATIONAL GLOBAL MONITORING AEROSPACE SYSTEM IGMASS – NEW APPROACH TO THE DISASTER MANAGEMENT ISSUE

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The report is devoted to the Project of the International Global Monitoring Aerospace System (IGMASS) – an initiative of Russian scientific and public organizations, actively promoted during last two years at the interstate level, to create the system of systems for effective warning of the world community about global threats of natural disasters and man-made catastrophes, including risks of space origin. Scientific background of the Project is the concept of detecting (with the use of special space, aviation and land based equipment) so-called "premonitory signs" of natural disasters, which appear in the form of anomalies at lithosphere, hydrosphere, atmosphere and ionosphere and could be used for forecasting of coming catastrophic phenomena of geological or meteorological origin. Among advanced IGMASS missions are: early prevention about meteoric and asteroid threats, and also - about dangerous situations on the near-Earth orbits, caused by man-made objects (well-known phenomena of "space junk") with future farsighted formation of "informational spatio of global security". The project was actively supported by the Russian Academy of Cosmonautics named after K.E.Tsiolkovskiy, International Academy of Astronautics, some profile UN institutions, space agencies, well known scientists and authorities. According to common understanding the system is not an alternative to existing projects and programs of disaster management, but an attempt to unify efforts of the international community on so important issue mentioned above. However, the Project's implementation connected with a complex of scientific and technical, technological, organizational, political-legal and economic problems that should be solved in wide international cooperation. At the same time two international specialized symposiums in Cyprus and in Latvia, eighteen profile presentations of the IGMASS concept at international conferences and seminars, on the COPUOS and its technical-scientific subcommittee, and, at last – formation of "The International Committee on the IGMASS Project Implementation" as supervising body of the Project, which has signed more than fifty MOU about cooperation with various organizations worldwide, all that brought popularity to IGMASS ideas both in Russia, and abroad. That genuine interest to the IGMASS Project allows to start our R & D in practice, to overturn advanced ideas of Russian scientists into subject matter. Therefore, the IGMASS Project could became in the nearest future a large-scale international initiative in the field of peaceful outer space exploration, based on principles of multilateral, mutually advantageous cooperation.

SECTION 6
Construction

NEW TECHNOLOGY OF SEISMIC STABLE CONSTRICTION "DANCING BUILDING TECHNOLOGY"

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Historical traditions of civil engineering and technological simplicity have made 2-3 floored masonry buildings highly popular in many countries. Even now, they are a great commercial success in large cities' suburban construction and small towns and countryside alike due to their availability and universality of construction.

Majority of people residing in Azerbaijan, Turkey, Kazakhstan and other countries of the region which is located in earthquake-prone areas live in seismically unstable buildings. 90% of all buildings across Azerbaijan excluding urban areas of Baku, Gandja and Sumgayit are 2-3-storey masonry buildings. Plus, 15% of buildings in Baku, 35% in Gandja and 20% in Sumgayit are masonry buildings as well. They are built from bricks, natural stone or construction blocks made of clay and hay and are not earthquake-proof [1].

Assessment of the status of competition among earthquake-proof construction technologies for 1-to-3 storey buildings in Turkey has revealed that more than 95% of buildings are built without any seismic resistant technology applied but rather employing standard techniques: bricks, construction blocks or concrete masonry units. The remaining 5% can be regarded as earthquake-proof.

SRIPSE research has shown that about 85 % of buildings in small towns and rural areas of Ukraine, Czech Republic, Poland, Hungary, Romania, Greece, Italy and some other European countries have one to three storeys. More than 70 % of them are built of bricks. About 3 % of the construction in large European cities consists of 1-to-3 storey buildings; these are mainly suburban buildings: private country houses, social and cultural facilities.

However, despite their attractiveness for the population and building companies, brick buildings are the most dangerous in seismically active areas as they quickly collapse during earthquakes with intensity of 6-6.5 by MSK64 scale. Also, they are not proof against vibrations and shock wave from explosions caused by, for example, acts of terrorism.

Today, there are many different techniques of seismic resistant construction all over the world using metal carcasses, special pulling ropes, damping muffs, seismic isolation systems. One of them is a technology developed at the University of Stuttgart, which diminishes the impact of seismic waves on a building's foundation. Special damping system is fixed between lower parts of the bearings of the foundation, which support the building. During an earthquake, the building moves against the foundation and this distortion leads to less acceleration of the building's displacement and lower risk of its collapse.

Japanese engineers widely use the seismic isolation technique to increase seismic capacity of buildings. One of its main disadvantages is that it cannot be used in buildings made of bricks and concrete. Those technologies could only be employed in buildings which have a framework and

building-supporting bearings, which are rarely used in construction of 1-to-3 storey buildings. Another key disadvantage is that seismic isolation reduces the effect of seismic movements, especially in the lower part of the building connected with the foundation. At the same time building walls can undergo irregular intense acceleration which may cause the building to collapse.

The principle of LEGO construction [2] is that bricks are made with caps and hollows on opposite sides. The caps of bricks are closely interlocked with the hollows of others, due to which firm joint is secured and caps do not go out of hollows. Technologies employing the LEGO principle are well known in construction. They all use the method described above with addition of cement or glue. During weak earthquakes, the interlocking joints of LEGO type construction blocks stand firmer than those of regular bricks. However, during strong earthquakes LEGO walls are mechanically destroyed just as walls of regular bricks.

There are also other earthquake-proof construction technologies for low-rise buildings. For example, in Greece and Turkey some designs are used in which the skeleton is made of metal or wooden elements interconnected by means of mobile metal fastenings. External and internal walls of those buildings are made as multi-layered slabs of synthetic or natural materials. During earthquakes, the building's skeleton can bend in the joints where its elements are interlocked, without collapsing. The weak point of those buildings is that there is a bending limit by flexibility and durability of multi-layered slabs. During strong earthquakes, the skeleton and slabs are destroyed. Besides, those buildings are assembled from ready modules delivered by the manufacturing plant to the buyer. This is not always convenient as the manufacturing plant may be situated in another country or region thus requiring transportation of modules to the supplier and sending a construction team to the building site. This makes construction more expensive and also localizes it to the area where the manufacturer of the modular structures is located [3].

One of the techniques based on the use of steel framework is the Steelife technology [4]. It is quite expensive and, therefore, is not affordable for the poor and middle class. Another aspect of this technology is that construction can be carried out only by highly qualified specialists who have undergone special training.

Another seismic resistant technology is the Monoblock Containers Complex Systems [5]. This technology is based on the use of monoblocks – containers. By interlocking the monoblocks, it is possible to construct buildings of up to several floors. This technology is less expensive as compared to the buildings made with steel frameworks. Its disadvantage is that monoblock buildings are mainly used for offices and manufacturing facilities. The monoblock technology is not suitable for residential buildings because its architecture is limited in size; its design is rather specific and cannot be changed by the customer's desire.

Construction of buildings from cylindrical metal structures can be mentioned here as well. Those building are used mainly as warehouses and manufacturing facilities, not residential buildings.

As we see, there is a great need worldwide for a technology which could combine the positive features of the above-mentioned ones, being at the same time inexpensive and affordable. Such a new effective technology of seismic-resistant construction of 1 to 3-storey brick buildings has been developed within NATO SfP [6] 982167 Project [7], having its name commercially patented as "DANCING BUILDING TECHNOLOGY" or shortened DBT.

The main idea behind the Project was to develop and introduce a simple and affordable technique of designing and building brick houses as well as walls and other structures to prevent them from collapsing during high magnitude earthquakes and strong explosions of various nature, minimizing thereby the number of victims, with the ultimate goal to secure seismic safety of people all over the world, especially in least developed countries. This included developing and making several designs of seismic resistant blocks and damping substance (later – damping pads), know-how owned by SRIPSE, as well as the special method of interlocking the bricks. These blocks are of special shape which allows them to interlock without cement or glue being used, with some damping substance or damping pads applied in between the bricks. During strong earthquakes, the buildings are distorted rather than destroyed and the deformations remind of dancing movements (hence the name DBT) while standing still and nor resonating to weaker earthquakes.

The Project's objectives were in line with NATO policy for providing people's security and reducing human victims and damage caused by earthquakes and terrorist acts.

The scientific objective of the Project research was to investigate the feasibility of building low-cost masonry dwellings that are resistant against strong earthquakes. As mentioned above, the concept of interlocked load bearing walls for increased in- or out-of-plane resistance is not particularly new. The novelty contained in this Project is the enhanced damping capacity of these walls achieved through the application of affordable binding material used in the joints of the masonry elements. Thus, mechanical interlocking that prevents sliding or dislodgement of the units coupled with energy-absorbing layers is capable of increasing the earthquake resistance of the structure (Fig.1).

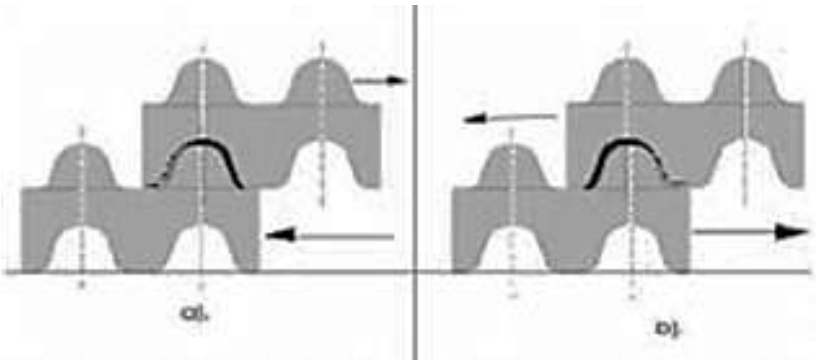

Fig. 1

The purpose was to provide maximum stability by evenly distributing the seismic energy during strong ground acceleration (energy dissipation) as a result of: 1. Absorption of the seismic energy by the damping pads between the blocks and softening of the mechanical shock in the area of their joint; 2. Redistribution of blocks' direction of movement from horizontal to vertical due to the hyperbolic shape of caps and hollows. These properties manifest themselves only at certain threshold level of shock intensity (starting from 7 points by MSK 64 scale) preventing thereby the deformation of buildings at low resonances. No cracks or splits occur in those structures.

The Project which started in September 2006 was carried out by two institutions: SRIPSE and METU (Middle East Technical University, Ankara, Turkey), in the Binagadi suburban area of Baku, Azerbaijan, at the SRIPSE-owned testing ground. The Project involved scientists and experts from Azerbaijan and Turkey. The entire Project has been accepted by the NATO SfP Programme Office.

The main results of the Project are:

- A new, simple and affordable technology which makes it possible to construct low-rise (1-3 storey) seismically stable houses capable of withstanding earthquakes with intensity of 9 by the MSK-64 scale as well as explosions has been created.
- A computer-operated seismic platform (shake table) to produce harmonic and random vibrations, unique for the region, with the area of over 10 (3.45m Ç 3m) sqm has been designed and its operation started to simulate vibrations similar to those of strong earthquakes.
- Model buildings have been constructed under the new technology and their seismic stability tested on the platform.
- Machine tools for production of seismic-resistant construction blocks and damping elements have been designed and made.
- Technical specifications (state standards) and several patents for the seismic-resistant construction blocks have been obtained.

The Project was realized in several stages.

At the first stage, the simulative seismic platform's (SSP) principal scheme was agreed upon, main units designed, its metal frame, metal surface, concrete foundation, rotation mechanism, compensatory module, hydraulic station with hydraulic engines produced/purchased and installed.

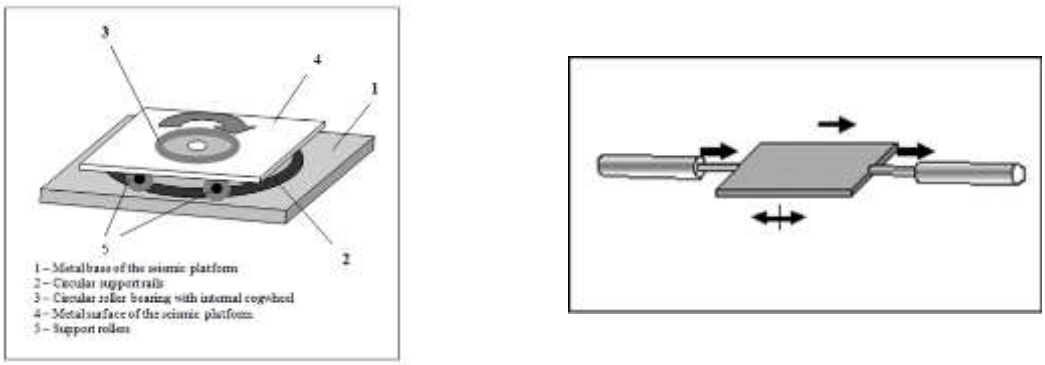

Fig. 2. Graphic outline of the working principle (left) and the model of synchronous movement of the hydraulic motors (right) of the simulative seismic platform built within the Project

To house the platform, a 14m x 9m x 10m protective hangar was built (Fig.3).

Fig. 3. Left, simulative seismic platform; Right, hangar

Simultaneously, development of new modifications of seismic resistant blocks (40cm x 20cm Ç 20cm, 25cm Ç 12,5cm Ç 12,5cm and 20cm Ç 10cm Ç 10cm with different protrusion height), new damping elements (movable pads) and making of equipment (machine tools) to fabricate them was started. Two vibrocompression-based machine tools for production of seismic-resistant blocks sized 40 cm Ç 20 cm Ç 20 cm and 25 cm Ç 12.5 cm Ç 12.5 cm respectively, with the size and shape of the blocks depending on the press-mold applied, and a machine tool for fabrication of damping pads were designed and made.

Fig. 4. Left, seismic resistant construction block (view from below); Center, seismic resistant construction blocks with damping pad applied; Right, machine for block production

According to the Technical Specifications for Seismic Resistant Construction Blocks (Azerbaijan State Standard, 2011), they have truncated cone-shaped projectures on one side and hollows on the reverse side, with holes along the projecture-hollow axis (Fig. 4). The bricks are layered one on top of another and damping pads are placed on the lateral surface of the projectures. Damping pads may be shaped as a cone or two damping circles. One circle sits below half-height of the cone-shaped projecture and the second one is placed above its half-height (See Fig.5).

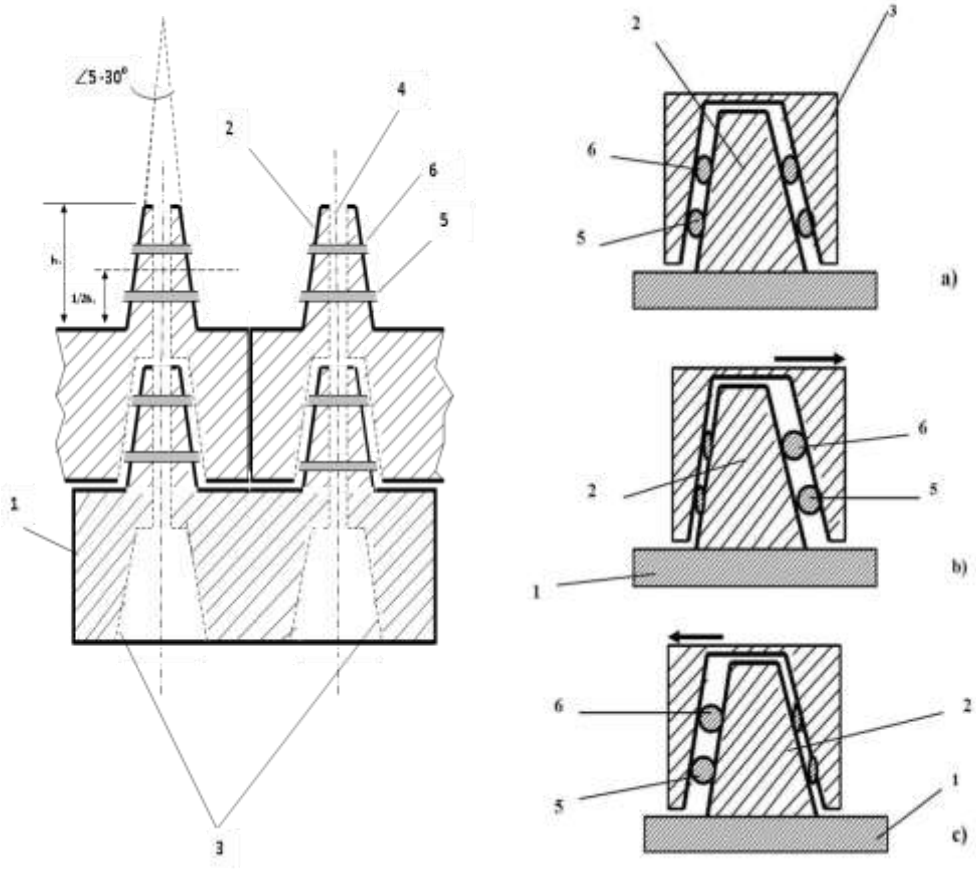

Fig. 5. Left, masonry of earthquake resistant blocks (schematic diagram); Right, relative movement of projectures and hollows during passing of a seismic wave and operating principle of damping rings

These technical specifications apply to seismic resistant construction blocks made from rock dust (chippings) and cement with or without various binding additions mixed with water, by pressing method (according to the patent PCT/AZ2004/ 000004, Geneva 2004). Damping elements are made of oil wastes and other available materials.

At the second stage, a computer-operated system to control SSP as well as a system of registration and control of test parameters (recording accelerations using three-component accelerometers placed in different parts of SSP and the building model) were also developed and created. For these purposes, a multi-channel digital seismic station was used.

At the third stage, following the completion of SSP, development of computer software to operate it and making of the required quantity of blocks and damping pads, it was possible to start construction of walls and a building model made of seismic resistant blocks and to test them.

The purpose of the tests was to study the reaction of the whole building and its individual parts (walls, roof, apertures, connection joints and bricks) to strong seismic vibrations reaching 9 points by the MSK-64 scale, and generally, to find and eliminate any shortcomings in the DBT technology.

A one-storey model building was constructed on SSP, sized as follows: total area: 9.40 sq.m; length: 3.30 m; width: 2.85 m; height: 2.05 m. For its construction, seismic resistant blocks were used sized as follows: length: 25 cm; width: 12.5 cm; weight: 6.5 kg; projection height: 6 cm. In

the course of construction, some damping elements (pads) made of mixture of bitumen and natural mineral filler were used between the blocks, with the following parameters: diameter 14 cm, thickness 2 mm. Breaking force at stretching: 275 kgf (N).

Fig. 6. Simulative seismic platform with test walls (left) and model building (right) on it

The total weight of the building's brickwork is 4,238 kg. The calculated weight of the ferroconcrete slab on top of the building is 4,277 kg. Thus, the weight of the ferroconcrete slab fully substitutes for the weight of the DBT brickwork to be used for construction of the second floor and the entire construction can be regarded as a two-storey masonry building.

The construction process was implemented in accordance with DBT (Dancing Building Technology). First, a metal frame was installed on the platform along the building's entire perimeter. 24 cm-high metal rods were mounted onto the frame's surface to enter the blocks' holes from below and go upwards through two brick layers. The door and window frames were made of metal channel bars with side parts of the bricks fitting into them. The lintels have a special design, as shown in Fig. 7. The top of the lintel is equipped with 24 cm high metal rods directed upwards. Also, the bottom parts of the lintel lying beyond the opening have some 24 cm long metal rods, too, directed downwards. When the lintel is installed, the metal rods penetrate the blocks adding to the building's stability.

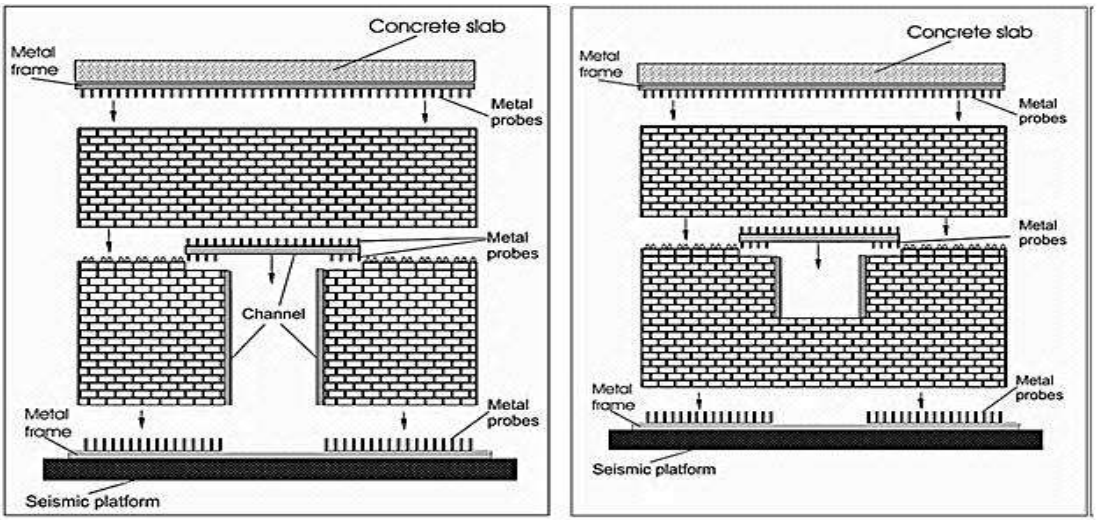

Fig. 7. Model building's design

The frame of the building's roof consists of metal channel bars running along its entire perimeter and of connective metal bars. Just like the lintels, the bottom of the channel bars is equipped with 24 cm long metal rods. When the roof is installed, the metal rods along the building's perimeter penetrate the holes inside the bricks which form the top layers. The top-layer bricks have no caps.

To record the testing process, a seismic station and 10 seismic sensors were used, attached to different parts of the building. The testing process was recorded on ten channels simultaneously.

Fig. 8. Model building moving perpendicularly (left) and at a 30 degree angle (right), simulating two different seismic waves

The first round of tests was carried out by placing the building perpendicular to the direction of SSP motion as shown on the left in Fig. 8. The SSP oscillation amplitude was 5 cm with frequency of 2 Hz. In total, during the first cycle, the model building was tested for 1 hour and 45 minutes. During the second round of tests, the surface of the seismic platform with the model building on it was turned to an angle of 30 degrees relative to the platform's axis of motion as shown on the right in Fig. 8. The oscillation frequency of the seismic platform was 2 Hz, amplitude 5 cm.

The tests showed that a model building made of DBT blocks on the seismic platform have high seismic resistance and do not collapse during earthquakes with intensity of 9 by the MSK64 scale (the intensity was limited due to the platform's capacity). More specifically, the tests have enabled us to draw several important conclusions:

1. If the building is located at a certain angle relative to the seismic wave's axis of motion, it is subjected to more complex mechanical loads and therefore has a greater risk of destruction compared with a building oriented perpendicular or parallel to the seismic wave's axis of motion.

2. When the model building was placed at an angle of 30 degrees to the axis of oscillation, seismogram records verified that the building's walls experienced complex deformations and non-synchronous oscillations; however, the model building was neither destroyed nor partially damaged.

3. While testing the model building on SSP at smaller amplitudes corresponding to an earthquake with intensity 6.5-7, it was established that the building's walls do not experience any deformation at low-intensity earthquakes. A building made of DBT blocks has a threshold after which deformation starts when the vibration intensity exceeds 6.5 points. Until then, the building remains still behaving as a rigid structure. When the 6.5 point threshold is reached, the deformation begins and the building's walls can change their shape. It was also established that the threshold value of vibration intensity after which wall deformation begins is conditioned by the mechanical properties of damping pads. By modifying these properties, the threshold of the building's sensitivity to earthquake intensity can be adjusted. This result is very important since if the building began to deform under low-intensity earthquakes, it would cause discomfort for the building's residents and make its use unattractive and non-effective.

The results of the tests were confirmed by the Resolution of the Expert Board comprised of representatives of the Azerbaijan State Committee for City Building and Architecture, Azerbaijan National Academy of Sciences and other government agencies of the Azerbaijan Republic.

At the final stage, the test results for seismic resistant blocks, damping pads, separate walls, model building and its individual units were summarized and their optimal parameters identified. The structures' reaction to vibrations was analyzed, shortcomings revealed and necessary amendments made to the seismic resistant construction technology.

To sum up, it can be stated that the NEW TECHNOLOGY FOR SEISMIC RESISTANT CONSTRUCTION developed within NATO SfP 982167 Project has fully accomplished its mission and objectives initially set and is recommended for application in construction of low-rise 1-3 storey seismic resistant buildings.

CONCLUSIONS

When compared with other earthquake-resistant construction techniques, we can see that DBT has a number of advantages, sharing at the same time their positive features.

- It is inexpensive and affordable, which creates favorable conditions for large-scale and mass use of this technology by all, not only rich people. Calculations have shown that the construction costs for buildings, walls and other structures under the Project were comparable with or even lower than those of the conventional building techniques. This is explained by the fact that to manufacture seismic-resistant blocks, we use wastes of stone quarries and a small amount of cement. Using other local natural materials such as sand, clay, stone and oil waste etc. for making blocks and damping elements is possible as well, which makes their production costs extremely low and their commercialization potential really immense.
- It is very simple in use and can be applied in any part of the world. There is no need for highly qualified and specially trained personnel to build those earthquake-proof structures. Any construction crew can easily master the new technology.
- DBT structures are stable not only against earthquakes, but also against shock wave from explosions that is very important for protection of people against terrorism.
- DBT structures can be disassembled and transported to another spot as the blocks are not connected by means of cement or another binding substance.

Earthquakes are not the only kind of natural disaster to occur in Azerbaijan and other countries of the region. In recent years, the territory of Azerbaijan has been subjected to numerous landslides, mudslides, floods which caused huge economic damage and made homeless great numbers of people. Also, there are over 1 million refugees in Azerbaijan. The authorities have to build temporary houses and even settlements to accommodate internally displaced persons, but the newly-built houses become abandoned and have to be demolished as soon as the danger is over and people return to their homes or leave for big cities. One of the best solutions in this situation is construction of demountable houses which can be built, then dismantled and reassembled at another spot. That is not possible under the conventional building techniques where bricks stick together with the use of mortar or other adhesive, but can be realized under the new DBT technology. When the building is no more needed, we can disassemble it, transport the materials and build it somewhere else for another group of people or simply store the bricks and damping pads for future use. The technique described above can save millions of public funds allocated to construction of temporary dwelling to be disposed after single use.

Taking into account the simplicity and low cost of construction, seismic and blast-resistance of buildings, walls and other structures matched with a huge demand for such kind of houses in Azerbaijan, this NEW TECHNOLOGY FOR SEISMIC RESISTANT CONSTRUCTION is going to have a significant nation-wide effect. The new state standard for seismic resistant bricks already confirmed by the Azerbaijani construction and emergency authorities, the European and many other patents, the positive conclusion of the expert commission comprised of governmental representatives and other factors are to contribute to the recognition and application of the new technology at the national and international level. The application prospects of the new technology appear to be very promising, considering the planned involvement of building materials manufacturers, construction companies, state agencies, municipalities, local authorities in the implementation of the Project's results.

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UNDERGROUND METALLIC EQUIPMENTS' CATHODIC PROTECTION FROM ELECTROCHEMICAL CORROSION BY SOLAR ENERGY

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At present, the majority of hardware accidents are operated in simultaneous influence of corrosive medium and great mechanical load, due to which, increase the demand to corrosion stability of metals, their wear and fatigue. Due to the high content of hydrogen sulfide and carbon dioxide, fail-safe protection from the corrosion of metallic equipments, applied in oil-gas sector of energy, perhaps only with the application of specially developed complex of safety measures of the whole equipment and communication.

Corrosion of metals damages the economy significantly. Corrosion loss in industrially developed countries is of ten percent of national income. Steel loss, caused by the corrosion, is of 30 percent of its annual production. The research shows that, only in the USA yearly damages from the corrosion of the metal consist in 70ç80 billion dollars, of which only 10ç45% appears as the recoverable loss. 40% of the total production of steel in the USA goes to the product exchange, disabled as a result of corrosion.

Besides that, there is also indirect loss due to the corrosion, to which belongs: 1) simples; 2) loss of ready production; 3) power loss; 4) contamination of products; 5) corrosion tolerance and etc. In developing countries due to the less development of technological and protective measures, including progressive anticorrosive system, damages, happening due to the corrosion of metallic equipments is much bigger [1-3].

In the majority of the accidents the metallic underground equipments, including trunk oil-gas pipelines break down due to the electrochemical corrosion, which appears as a result of redox process of thermodynamically unstable metals being in the soil, playing role of solid electrolyte.

Electrochemical corrosion of metals occurs on the below-mentioned mechanism.

The anodic dissolution process of gland in humid soil for the equation

$$Fe + mH_2O = Fe\cdot mH_2O + 2e, \quad (1)$$

Where the primary stage is the transition to the soil electrolyte of aquated ion of the gland.

In the very humid soils, having neutral or alkalinity, in the case of lack of oxygen, the ferrous hydroxide of white color is formed

$$Fe^{++} + 2H_2O = Fe\,(OH)_2, \quad (2)$$

Within the enough quantity of oxygen in anode section of metallic underground equipments (for example, trunk gas pipeline) the ferrous hydroxide can be oxidized till the formation of ferrous hydroxide of brown-red color, which is difficult to seperate from the surface of the equipment:

$$Fe(OH)_2 + 1/2\ O_2 + H_2O = 2Fe(OH)_3, \quad (3)$$

Cathode processes, occurring in the metal in soil, are presented by the following equation:

$$H^+ + e = H;\ H + H = H_2, \quad (4)$$

(hydrogen depolarization, characteristic for strong-acid soils) :

$$O_2 + 2H_2O + 4e = 4\ (OH)^+, \quad (5)$$

(oxygen depolarization – oxygen reactivation by its transfer to ion system – characteristic for weak-acid, neutral and alkaline soils). In the majority of humid soils the cathode process occurs on the equation (5).

It is seen from the analysis of chemical equation that (1-5), generally there are three main stages of corrosion process in electrochemical corrosion: 1) anode – transfer of metal ions to solution and hydration with the formation of uncompensated electrons in anode sections; 2) electro transfer – electron flow over the metal from anode sections to cathode ones and appropriate movement of cations and anions in the solution; 3) cathode – electron assimilation by any depolarizator – by ions and molecules, which are in the solution and are able to be reactivated in cathode sections.

The speed of electrochemical corrosion is given by the following correlation:

$$I = \frac{\varphi_{k_0} - \varphi_{a_0}}{R + P_k + P_a}, \quad (6)$$

Where I – the intensity of corrosion current; $\varphi_{k_0} - \varphi_{a_0}$ – difference of initial potentials of cathode and anode; R – ohmic resistance of corrosion element (protected object); P_k, P_a – polarized resistance of cathode and anode processes, accordingly (in linear polarization). But in current's nonlinear dependence on the potential

$$P_k^I = \frac{\Delta\varphi_k}{\Delta i_k},\ P_a^I = \frac{\Delta\varphi_a}{\Delta i_a}, \quad (7)$$

As it is seen from the above-mentioned, electrochemical corrosion of underground metallic equipments occur due to the percolation on the metal-electrolyte (salted soil) boundary of anode reaction of metal ionization (metal oxidation in electrolytes) and cathode reaction of metal reduction. In equilibrium state, the corrosive processes completely end. But the equilibrium break in any of the two directions, causes the oxidation or vice versa, reduction of the metal.

Scientifically proved that [4], in the electrochemical corrosion the corrosion elements are the more polarized, the less occurs the difference of their potentials and intensity of corrosion current. Taking into account these considerations and the formulas (6), such conclusion can be made that, in order to decrease the speed of electrochemical corrosion, it is necessary:

1) decrease of the level of thermodynamical instability – potential convergence of cathode and anode processes;

2) decrease of cathode polarizability P_k, causing the breakage of the cathode process;

3) increase of anode polarizability P_a, causing the breakage of the anode process;

4) increase of ohmic resistance R, which depends on the state of the soil, its humidity, aeraty, temperature and etc.

Besides the electrochemical corrosion, the underground metallic goods are subject to the other kinds of corrosion, which cause the significant material damage; it includes electro and biocorrosion. Electrocorrosion of the metal occurs by the influence of stray currents from some external electric installation, on the underground metallic equipments. In this case, the railway network of the electrified transport (tram, electrified railway, including underground railway,

grounding electrode in welding plants and substations and etc.) appears as the source of stray currents and corrosion or as the distribution network of direct current by partial or full return of operating current through the ground.

Biocorrosion of the metals occurs as a result of the influence of microorganisms or products of their life activity. The aerobic and anaerobic bacteria, which give rise to the localization of corrosion affection, participate in the biocorrosion. In the condition of the complicated oxygen access in laying of gas pipelines in swampy soil or at great depth of structure (underground gas well) location, the anaerobic sulfate-reducing bacterium can cause the corrosion, which recover sulfates till sulphides in the process of life activity, by using hydrogen, that provides the percolation of cathode processes on equation (4). The reason for the corrosion of underground metallic constructions can be as well as the sulphuroxidating bacterium, producing sulphur acid quite aggressive in respect to steel in its life activity, and also the bacterium, which use hydrocarbons and destroy the bituminous isolating coating and series of inhibitors.

Considering that, for the protection from the corrosion of steel constructions, operating under the ground or in water, for example, pipelines, well casing pipe, pile footing, bridges, piers, tank bottom, cables, railway and etc. is mainly used the electrochemical protection, in the given work we are studying just this type of protection of metals from the corrosion. Electrochemical methods of protection are of the active methods of struggle with the corrosion, which are based on the creation of electric field, decreasing or completely reducing the corrosive breakage. At present time, three types of electrochemical protection of metals from the corrosion are applied: tread, drainage and cathode protection. In the tread protection the protector, connected with the protected object for a while, serves as a short-circuited galvanic element, which is the source of direct current. In this case, the protected metal serves as a cathode, and the protector metal as a sacrificial anode. Generally, protectors make zinc, magnesium, aluminum and etc. from alloys, then from metals inexpensive and possessing more electronegative reversible potential in comparison with other technical metals. However due to the little magnitude of radius of the activity, tread protection is applied in special cases, for example for the protection of ditches, vessels, etc. Drainage protection is applied for the protection of underground metallic equipments from electric corrosion, occurring due to the stray currents. During this case, more unfavorable area, from the point view of the appearance on anode zone structure, is the area of its convergence with the elements of railway network of electrified transport (railway – suction points – negative tires of traction substation). The main point of the electric drainage consist in that, the structure, being connected with the railway network elements, gains negative potential in accordance with the surrounding soil, so comes to the cathode state. In this process the corrosion does not occur, through drainage device the stray current from the structure returns to the source, which makes this stray current.

From the shown methods of protection, the more optimal and widely used one is the cathode protection, giving an opportunity for 100% protection of underground metallic equipments. Such protection is subject to, as a rule, metal constructions of large-tonnage vessels, floating stationary constructions, pipeline systems, as well as main oil and gas pipelines, also series of other underground structures. The cathode protection is carried out by the external source of direct current. In this case, the protection is attained due to the cathode polarization of the protected object. In order to get it, the negative plus source of direct current is switched to the protected object, and the positive one – to the artificial anode – grounding. In the cathode protection the potential of the protected construction, being measured regarding the electrolyte (for the main pipelines – pipeline potential - soil), in which the current corrosion is practically equal to zero, is called protective potential. The minimal protective potential for the steel constructions, established in sandy and clay soil, is changed between- 0,72 V ç -1,1 V in the comparison with the copper-sulfate electrode. This indicator for the territory of the former USSR, including Azerbaijan, was accepted as $E_{prot.\,min} = - 0,85$ V.

In anaerobic biocorrosion the protective potential should be - 0,95 V. For the construction with the protective coating, for the maximal protective potential is accepted $E_{prot.\,max.} = - 1,1$ V.

However, the practice shows that, in the main pipelines along its whole length it is impossible to create the same value of the protective potential. Therefore, in exploitation of the pipelines in drainage points of cathode stations protective potential for bitumen coating can be

raised till -2,5 V, and for polymeric film and silicate till -3,5 V. Such raise of the protective potential provides the increase of the economical efficiency of the cathode protection of the main pipelines due to the reduction of the number of cathode stations for 3-4 times.

At present time network cathode stations (with rectifiers) were achieved for the cathode protection of wide spread occurrence. In the lack of electricity network cathode stations with internal combustion engine are applied in the regions with favorable wind – for the power supply of cathode station it is applied wind-driven generators. Thermoelectric generators and aggregates with turbines are applied only as a pilot plant. The single line laying of electric power transmission along the main pipeline, passing over the desert places, is economically disadvantageous and complicated, the individual power supply, operating on the base of different organic fuel, is unprofitable and disadvantageous from the ecological point, requires fuel transportation and daily qualified service.

Series of demands are made to the sacrificial anode: minimal transient resistance to the current spreading; minimum overall dimensions; the most durable and uncritical material; simplicity of installation; service duration in minimum recovery work; minimum cost. Earth electrodes gained the most spreading from the black metals, especially from steel. It is conditioned with that, practically it is always possible to find old pipes, rails, coal and etc. and to use them for anode grounding electrodes.

In the 80s of the last century in some countries it has been carried out scientific-research works on the application of solar photoelectric current source (SPhCS) for power supply of the cathode station. It is connected with that, in its work, SPhCS does not pollute the environment and does not violate the heat balance of near-earth atmosphere and the Earth itself. They are noiseless, don't require daily service, reliable in the work and durable (its durability is 30÷50 years). As off-line power supply, they are irreplaceable, especially for the application in hard-to-reach and distant from the centralized systems of power supply of the places, especially in military and other strategic objects, situated on islands, mountainous places, as well as in other places with hard geological structure. Other advantage of SPhCS is that, they work on the base of general solar radiation and therefore in its work doesn't require complicated system for automatic solar tracking. The further pace of development on the photoelectric showed that, the application of the solar photoelectric current source for the cathode protection from the corrosion of different metallic equipments is economically expedient.

Considering the above-mentioned, since 1971 of the last century in the laboratory "Photoelectric converter" of the Institute of Physics of Academy of Sciences of Azerbaijan SSR it has been conducted scientific-research works in the shown direction. This work has been conducted by Dr., prof. M.Y.Bakirov. In short time it has been established the experimental photoelectric cathode station for electrochemical protection of the main pipelines. Field observation of the solar photoelectric current source has been carried out in climate conditions of Baku, its load voltage-current characteristic (VCC) for various seasons of the year and ISR were taken, then it has been determined the change of the internal resistance of SPhCS, depending on the load change and ISR, the behavior of coefficient of VCC SPhCS filling in various variants of connecting individual modules between each other and etc. Then, on the base of this SPhCS it has been created cathode protection system (CPS), which was applied in the protection from electrochemical and electric corrosion of the main gas pipelines Sumgait-Garadagh with diameters 529 mm. A two-year field test has been carried out. During the testing, the cathode protection system provided average protective current 1,1 A, during this time significant changes of the parameters were not observed. The achieved scientific results were published in the works [5, 6].

It is necessary to mention that, Azerbaijan is one of the leading countries of the world in oil-gas producing in the sea, which for the further processing is transported by land. At present time for the direct transportation of Azerbaijani, and in the further transit transportation of Turkmen and Kazakh oil, to EU countries, it has been built and put on the exploitation the main oil pipelines "Baku-Tbilisi-Jeyhan" and "Baku-Supsa". For the delivery of Azerbaijani natural gas to EU countries, it has been put on the exploitation the main gas pipeline "Baku-Tbilisi-Erzurum" and has been prepared the project NABUCCO for transit delivery of Turkmen and Kazakh gas through the territory of Azerbaijan to EU countries. From the above-mentioned it is obvious that, the corrosion an issue problem for Azerbaijan. From the other hand, Azerbaijan is situated between 39^0 и 42^0

parallels and is rich with solar energy resources. As, the number of sunny days in a year in Azerbaijan is ~300 days, the number of shining hours is more than 3000 hours, the annual average value of ISR entering on 1 m^2 horizontal square about 200 Vt/m^2, the annual average power of ISR entering on 1 m^2 horizontal square ~2000 Vt/m^2, maximum value of ISR in the midday of the bright sunny day more than 950 Vt/m^2, the average number of working hours: for winter 6ç7 h., for spring and autumn 7ç9 h, and for summer more than 12 h.

Of course, such circumstance requires the development of more progressive and powerful cathode protection system with power supply from the alternative current sources, as well as from solar photoelectric current source. Taking into account this, we continued to carry out the scientific research works on the study of the possibilities of SPhCS application for CPS power supply of different power. Besides this, if in the previous works [5,6] CPS could work only in "cathode" mode, which limited its application possibilities, then in the current situation the whole authors' work is about the anticorrosive system with power supply from SPhCS with operating possibility in both "cathode" and "anode" modes.

In order to reach the given task, first of all, it has been carried out experiments on the model set and different power supply of the protected metal equipments (PME) has been realized, very close to the real mode of power supply from SPhCS. In this case except the work [7], in which the experiments were carried out in liquid electrolyte (in water), the protective current density, as well as the temperature and humidity of the soil, playing role as solid electrolyte, remained in the constant level. The experiments have been carried out within 50 days. As protective metal equipments (PME), it has been used 40 pieces of steel electrodes, playing role of cathodes. And as a sacrificial anode (SA) – 4 pieces of ferrous anode. All electrodes are of cylindricity. Below in the table it is given the constructive parameters of cathodes and anodes, being used in the experimental model set, where: W_k^0 and W_a^0 - initial weight, d_k and d_a - diameters, ℓ_k and ℓ_a - length, S_k and S_a - squares of cathodes and anodes, accordingly.

It has been taken vessels of cylindricity, which were filled with sandy-clay soil, taken from brackish ground area, on which, generally, the oil-gas pipelines of Azerbaijan pass. Soil mass in all vessels is 10 kg. Inside of each vessel is installed 10 pieces of protected metal equipment (PME), which is placed in the vertical position over the circle, and in the center with the same position is placed one sacrificial anode (SA). In order to create the same conditions (uniform current density and etc.), all electrodes were set in the same angular distance relatively to each other (36°), and for increasing the conductivity of the soil, and the anode parts of all sacrificial anode (SA) were filled with the common salt NaCl. Within the experiments in all vessels the humidity of soil changed between 15ç20%, and the temperature- between 20ç25°C.

Table

Constructive parameters of cathodes and anodes, being used in the experimental model set

Cathode parameters				Anode parameters			
W_k^0,g	d_k,sm	ℓ_k,sm	S_k,sm^2	W_a^0,g	d_a,sm	ℓ_a,sm	S_a,sm^2
250	20	101,2	6355	150	15,6	100	3821

As a reference electrode (RE) it was used the copper-sulfate half-cell $CuSO_4$, beforehand known with the standard equilibrium potential. The selection of this type RE is conditioned with also that, it does not participate in near-electrode process, occurring between PME and SA. As PME was made from well-bright-finished steel, then the potential difference between PME and SA changes between (-0,72ç -0,8) V. Considering this, it was chosen the proper value for bias voltage, impressed from the complimenting source of direct current to PME and RE, which is- 0,4 V, as in normal conditions the accumulative value of the protective potential shouldn't be more than 1,22 V. However, it has been established that, in those cases when complimentary chemical measures

(for example, inhibitor protection) are not applied, the magnitude of protective voltage can be increased twice and more. But in the current situation, the potential difference between PME and RE was kept in the established nominal level, for example in the interval (-1,1ç -1,2) V.

In order to carry out the experiments, it was taken four modes of electrode power supply. To the electrodes of the first vessel within the experiment were not delivered voltage. To the electrodes of the second vessel, the voltage was delivered periodically with the same time of connection and disconnection of the current source. To the electrodes of the third vessel, the voltage was delivered from the end of AB, switched to the end of the current source and operating in buffer mode, but the current source was connected to the impulse mode with different times of connection and disconnection. Sacrificial anode of the second and the third vessels are connected to the current source via voltage regulator.

After every 10 days, from the vessels it was withdrawn per two electrodes of protected metal equipments (PME), which after the purification from the corrosion products, it was weighed and determined mass loss due to the corrosion. For the possibility of keeping the set value of the protective potential and current density, each time after taking out PME from the vessels, by means of the voltage regulator, their value changed. In order to clean PME from the corrosion products, it has been used hydrochloric acid (HCl) and with the purpose of prevention of dissolution of the metal itself, 1ç2% solution of formaldehyde was added to HCl as an inhibitor. On the base of the achieved experimental data, it has been determined the corrosion speed by calculating, and for this the following equation was applied:

$$K = \frac{W_k^0 - W_k^I}{S_k \cdot \tau} \ , \tag{8}$$

Where W_k^I - weight of the sample (PME) after purification of products from the corrosion, g; W_k^0 - initial weight of the sample, g; S_k - square of the sample, m^2; τ - durability of the running time, hour.

It has been determined the levels of the protection activity analogically for the second, third and fourth modes in percents, for which, it has been applied the equation:

$$P = \frac{W_1 - W_2}{W_1} \ , \tag{9}$$

Where W_1, W_2 - mass loss of the sample in the running time, accordingly, without the application of protection and in the application of protection.

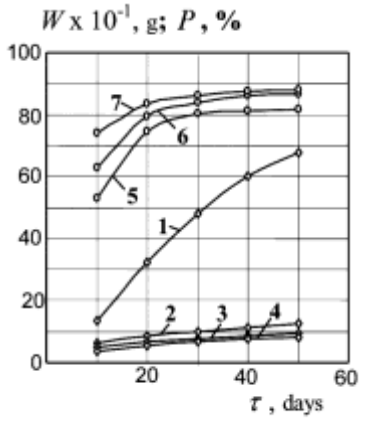

Fig.1 Graphic dependency of weight loss (curves 1, 2, 3 and 4) and rate of protective action (curves 5, 6 and 7) on running time (curve 1 concerns to mode 1, and the curves 2, 3, 4 and 5, 6, 7 – accordingly to the modes 2,3 and 4)

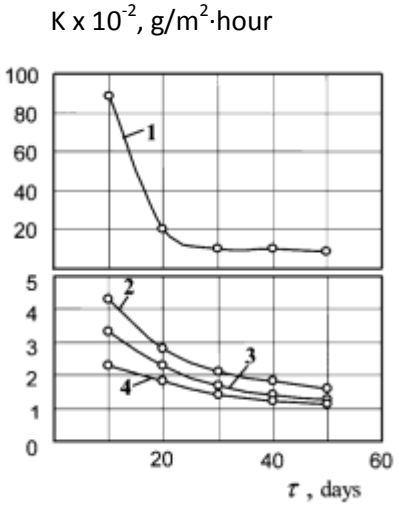

Fig.2. Graphic dependency of corrosion rate on running time: (curves 1, 2, 3 and 4 concern accordingly to modes 1, 2, 3 and 4).

On the base of the calculated data for all the four modes of the power supply, it has been drawn the graphic dependency of mass loss, the stages of protection activity and corrosion speed (K) on the running time. In fig.1, it is shown the graphic dependency of weight loss (curves 1,2,3 and 4) and the stages of protection activity (curves 5,6 and 7) on the running time (curve 1 concerns to mode 1, and the curves 2,3,4 and 5,6,7 – accordingly to modes 2,3 and 4), and in fig.2 – graphic dependency of the corrosion speed on the running time (the curves 1,2,3 and 4 concern accordingly to the modes 1,2,3 and 4). As it is seen from the curves, in much closer to the power supply mode from SPhCS second mode, in comparance with the fourth mode, the corrosion speed increases only 5ç10% and 2ç5%, accordingly, which shows the high level of protection of samples from the corrosion, and the level of the protection activity gradually increases due to the polarization of electrodes (PME and SA) and on the 50th day of the experiment they reach accordingly 81,5%, 86,8% and 88%.

For revealing the expedience of the cathode protection system power supply from SphCS on the model set has been carried out as well as the experiments on the study of polarization patterns of electrodes. For this accordingly [8] has been taken four modes of impulse power supply of electrodes with different connection periods τ_{con} and disconnection τ_{disc} of current source, which made it possible to predict the expediency of SPhCS application for CPS power supply in random modes of ISR hange, including night hours of the day. During this time, in the first mode τ_{con} = 8,0 h, τ_{disc} = 16,0 h; in the second mode - τ_{con} = 0,5 h, τ_{disc} = 2 h; in the third mode for the first two impulses τ_{con}^{1} = τ_{disc}^{1} = 2,0 h, and later every time the pause was prolonged for 0,5 h (in the current situation τ_{disc}^{2} = 2,5 h; τ_{disc}^{3} =3,0 h; … τ_{disc}^{n} = τ_{disc}^{n-1} + 0,5 h). In the fourth mode everything was done vice-versa, relative to the third mode, so the disconnection time of the current source was chosen constant, and the connection time gradually decreased. However, except the third mode, in the present situation if after the first impulse series, the finite value of the protective potential on the electrode is less than its permissible minimal value, then the whole process is again repeated. Thereby, in the current mode for the disconnection time it is chosen τ_{disc} = 4 h = Const, and for connection time: τ_{con}^{1} = 2 h; τ_{con}^{2} = 1 h 40 min; τ_{con}^{3} = 1 h 20 h and etc. When the energizing period was 20 min (τ_{con}^{6}), it is accepted as the minimal value for τ_{con} and such impulse mode (τ_{disc} = 4 h = Const; τ_{con}^{6} = 20 min = Const) is kept until the value of the protective potential is less than the established minimal level. As soon as the protective potential becomes less than the established minimal value, the electrode is again supplied with a series of impulses and energizing period. It is necessary to mention that, except the first and the second modes, in the third and fourth modes the electrode was supplied with the impulses with alternating current. In figure 3 a), b), c) and d) it is shown the graphics of the change of cathode polarization for the first, second, third and fourth modes of energizing, accordingly. As it seen from the given graphics, in all cases after a while, the protective potential gains the necessary value, but in the third and fourth modes, much closer to the mode of CPS power supply from SPhCS with uncontrolled output parameter, better results are achieved, which is one of the complementary facts of the assertion of expedience of SPhCS application for CPS power supply. Besides that, the comparance of different systems of discrete protection shows that, they all allow getting significant energy save and in periodic protection the state of chemical coating remains much better than in constant protection. It is known from the literature [7, 8] that, periodic protection is effective enough for steel in the sea water. It is of great significance, especially for such countries like Azerbaijan, where oil and gas are produced from the sea.

Considering the experiment results, we have worked out an automated CPS with power supply from SPhCS, meant for high power (for the protection from electrochemical, electrical and bacteriological corrosion of metallic pipelines with the length of 20 km and more). In this length the protected parts of pipelines by applying one package of CPS, can be enlarged by the way of establishing complimentary SA on pipelines, and suction points in immediate vicinity of SA [9, 10]. The main scheme, worked out by CPS with power supply from SPhCS, is given in figure 4. CPS consists of SPhCS 1, AB 2, operating in buffer mode, monitor unit 3 for regulating charging

and discharging processes AB 2, control unit 4, completed as an electron bridge, which serves for regulating the protective potential and switching the system to "cathode" "anode" modes, operational 5 and differential 6 intensifiers, copper-sulfate reference electrode (RE) 7, PME 8 and SA 9. In the given CPS, the discharge possibilities of AB 2 are removed through SPhCS 1 in weak ISR, including nighttime of the day. In CPS it is studied the gradual change of protective potential both in addition negative and positive direction, for achieving the one, for which is used the control unit 4, completed on double-crack electron bridge scheme.

CPS works in the following way.

In decreasing the potential difference between PME 8 and RE 7 till the fixed minimum (for RE from $CuSO_4$ and steel pipes are - 0,8 V), appropriate control signal enters the differential amplifier input 6, which after the amplification from the output of the last, voltage 5 enters the input of operational amplifier, which in the output signal with negative sign is achieved. Under the influence of this signal, the transistors of the second shoulder of control unit 4 (isn't shown in figure 4) are opened. As a result of this, PME 8 is attached with negative, and SA 9 is attached with positive potentials and with the lapse of time due to the polarization, the potential difference between the given electrodes (protective potential) will gradually increase and will reach the established value for standard protection of PME 8. As soon as the value of the protective potential reaches the established upper limit, transistors of the second shoulder of control unit 4 is closed, and voltage transmission to PME 8 ends. As a result, by time corrosive current linearly decreases, and protective current analogically increases and as these currents have opposite directions relatively to each other, then in equation of their absolute values, the public current in the chain equals zero, and it means that, 100% PME 8 protection from electrochemical and electric corrosion occurs. Bacteriological corrosion (biocorrosion) also ends in the value of protective potential more than 1,1 V.

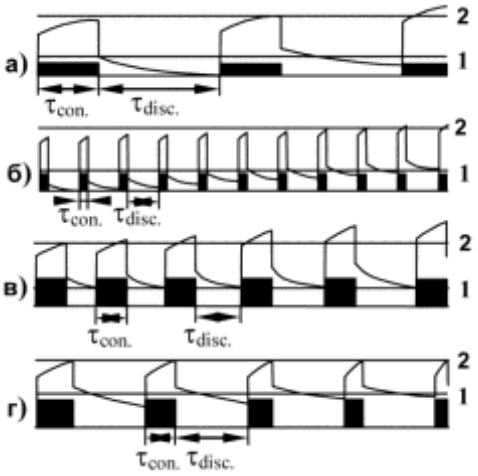

Fig.3. Graphics of the change of cathode polarization for different pulse modes of current source work (graphics a, b, c and d concern accordingly to 1-m, 2-m, 3-m and 4-m operating mode of current source)

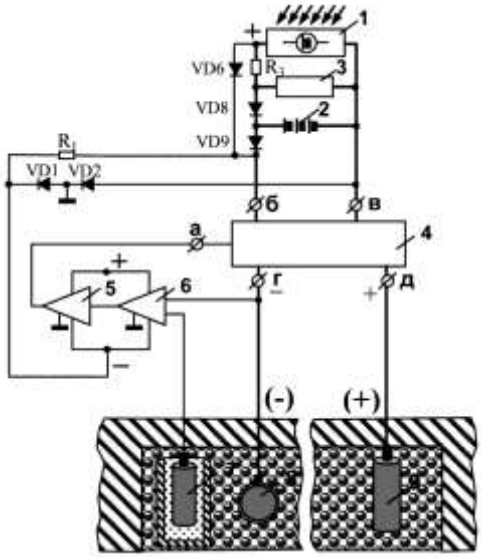

Fig.4. Basic diagram of CPS with power from SPhCS

Except the analogue CPS, in the studied anticorrosive system within the condition of much deeper displacement of potential PME 8 in the negative side (for example, due to the negative influence of the neighbor CPS and etc.) and the cutover of its value, set above in upper limit, voltage in the exit of differential amplifier 6, changes its polarity. As a result of this, all transistors of the first branch of electron bridge of the direction 4 are simultaneously opened and the system is switched to the "anode" mode of protection. In this condition, the positive potentials enter PME 8 and the negative ones - SA 9 and depolarization process starts. Due to this difference, the potentials between PME 8 and RE 7 are moved to the positive side, gradually decrease and reaches the given

value. Further, every time in the change of difference of the potentials between PME 8 and RE 7, on both sides, above-mentioned processes are analogically repeated, which conditions the guaranteed protection of PME 8 from electrochemical and electric corrosion.

Summary

1. For revealing the possibility of power supply of CPS, it was created model set from SPhCS, in which the experiments have been carried out within 50 days. In order to achieve reliable results, testing was carried out both in impulse and continuous regimes of current source connection. It's determined that, corrosion speed in the impulse regime on the 10^{th} day of the experiment is 12,6% more than in the continuous regime, but in the further stages this difference gradually decreases and on the 50^{th} day it becomes 4,3%. In the case of AB application, analogical parameters consist in 5,2% and 1,6%, which shows the enough high level of PME protection from corrosion.

2. In different impulse modes of current source connection, has been studied the polarization features of PME. Determined that, in the impulse mode the current source connection in the initial stage PME is polarized relatively slowly, in the comparison with the continuous mode of power supply, however after the series of impulse polarized PME voltage reaches the agreed value, necessary for the reliable PME protection from electrochemical corrosion. Established that, impulse modes allow obtaining significant energy saving, but the state of chemical coating remains much better than in the continuous mode of protection. The achieved results show that, the application of SPhCS for power supply of CPS is quite reasonable.

3. It has been worked out CPS with power supply of SPhCS, being able to work both in "cathode" and "anode" modes of the protection, which it can be widely applied as an autonomic anticorrosive system in the protection from the electrochemical and electric corrosion of metallic underground equipments, including main gas trunk pipelines, set in the out-of-the-way place, as well as in the sea, deserts and also islands.

4. The researches and literary analysis show that, the use of SPhCS for the power supply of CPS is not connected with the pollution of soil surface, water resources, as well as bottom layer. The application of SPhCS for the given task does not cause the break of the thermal balance of atmosphere and can not be the reason for different types of nature cataclysm (global warming and cooling, tsunami, mass fires, the formation of ozone hole in atmosphere, showery, as well as acid, muddy rains), and also junctures.

5. SPhCS is noiseless, doesn't require daily service, fail-safe in the work and durable (its durability is of 30ç50 years). Their work is not connected with the transport of different kinds of organic fuel, as well as line wiring of electric power transmission through the regions with complex geographical reliefs (desert, sea, mountainous places, etc.).

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GEOCHEMICAL EVALUATION OF ARSENIC IN EFFLUENTS, SURFACE AND GROUNDWATER IN IBADAN METROPOLIS AND POSSIBLE REMEDIATION METHODS

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Arsenic, a toxic metal, constitutes critical quality index regarding pollution of drinking water sources and attendant health problems, such as, skin and lung cancer. There is limited information about arsenic concentration in effluents, surface and groundwater in Ibadan metropolis. Hence, the need for geochemical evaluation of the water sources, to determine the level of arsenic concentration and to assess possible remediation methods.Geochemical analysis was carried out on six rock samples usingInductively Coupled Plasma - Mass Spectrometry (ICP-MS) method. Forty-four water samples from surface water (19), groundwater (11) and effluents (14) were subjected to hydro-chemical analyses to determine their metal contents using Inductively Coupled Plasma - Optical Emission Spectrometry (ICP-OES), with in-situ field measurements. Remediation studies using filtration and phytoremediation methods were carried out. Arsenic acid (100 ml) of 10.0 mg/l, 20.0 mg/l, 50.0 mg/l and 100.0 mg/l was passed through four different geo-materials (marble, activated charcoal, filtration carbon and clay) placed on layers of different grain sizes of sand in glass filtration tanks. Filtrates collected were analyzed for arsenic using ICP-OES. Phytoremediation was done by cultivation of matured water hyacinth (*Eichhorniacrassipes)* in 10.0 mg/l, 20.0 mg/l, 50.0 mg/l and 100.0 mg/l of arsenic acid. Sprouting, flowering and matured water hyacinth were grown in arsenic acid solution of equal concentration (100.0 mg/l) for different durations in hours (0, 2, 12, 24, 48 and 120). The plants were harvested, dried, pulverized and analysed for metal content using Inductively Coupled - Ion Chromatograph. Geochemical analyses of rocks revealed that quartzite has highest arsenic concentration (0.8 ppm) compared to banded and augen gneisses (0.01 ppm). Thus, areas underlain by quartzite are susceptible to arsenic contamination. Other metals in the rocks include Cu (0.3-6.4 ppm), Zn (11.0-9.0 ppm), Pb (4.1-19.6 ppm) and Ba (445-1188 ppm). Ruxton Ratio (6.8) shows medium – high rate of chemical weathering. The pH values of the different water sources ranged from 5.9 to 7.2 with the lowest value (5.9) observed in effluents. Electrical Conductivity and Total Dissolved Solid for the different water sources ranged from 0.2-124.0 (µS/cm) and 0.3-191.0 (mg/l), with the highest values in effluents. Hydro-chemical analyses indicated that As, Zn, Cu, Pb and Ba concentrations are within the stipulated limits for drinking water, however, high arsenic (0.02 mg/l) was recorded in effluents. Inter-elemental analysis in effluents revealed strong correlation between As and some of the metals Cu (0.7), Pb (0.9). High pollution index (6.57 mg/l) obtained for As confirmed high level of pollution. Arsenic concentration in filtrates showed no arsenic loss, indicating poor absorption capacity of the geo-materials. Highest uptake of arsenic was recorded in the roots of matured and leaves of sprouting water hyacinth, at period ranging from 12 to 120 hours, while low arsenic concentration was observed in the stems. Water hyacinths also bio-accumulate Cu, Ba, Zn, and Pb.Water sources in Ibadan metropolis are prone to arsenic contamination from leaching of weathered bedrocks and effluents. Phytoremediation with water hyacinth compared to filtration is a better remediation method for arsenic removal.

Keywords: Phytoremediation, Contamination, Arsenic, Filtration.

ASSESSMENT OF RISK CAUSED BY THE NATURAL HAZARDS AT THE SANATORIUM CONSTRUCTION SITE IN THE COASTAL ZONE OF THE BLACK SEA, THE PITSUNDA PENINSULA

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The Pitsunda Peninsula belongs to the Abkhazia territory. It is situated on the Black Sea coast of the Caucasus and represents an ancient accumulative landform resulted from the Holocene transgression of the Black Sea. The engineering geological conditions of the peninsula are controlled by the following specific features:

- a relatively even surface at -0.7–6.5 m a.s.l. with marine beach ridges, lagoon depressions, and ancient lagoon relic lakes;
- location within the seismically active zone with the initial seismicity 9 M and the earthquakes recurrence once in 1000 years;
- a thick massif of marine and alluvial–marine deposits of late Pleistocene and Holocene age composing the upper part of the geological cross-section, which consists of pebble, sand, silty clay and silt;
- groundwater level close to the surface, unfavorable conditions for surface- and subsurface-water runoff, development of waterlogging and bogging, and technogenic impact of drainage network involving more than half of peninsula territory.

The sanatorium is designed in the peninsula southwest, 300 m far from the Black Sea coast. This will be a building of variable number of storeys (maximally, 9 above-surface storeys) and deepened for 2 m. Hydraulic isolation and tubular ring drainage around the building are proposed as protective measures against waterlogging. Bearing structures are performed as a monolithic reinforced concrete carcass. To protect the building from seismic impact, the building will be subdivided into blocks of different size by seismic-control deformational seams.The natural marine, atmospheric, and geological processes and phenomena manifested in the Black Sea basin that exert considerable harm to the economy and ecology in the region have been analyzed.The study of natural hazards that may develop in the Pitsunda Peninsula brought us to the conclusion that the risk of waterlogging, seismicity and whirlwinds should be assessed at the construction site. This assessment was performed according to A.L. Ragozin procedure. As proceeds from our calculations, the designed measures for protection from natural hazards will provide the adequate operation of this engineering structure.

ESTIMATION OF SEISMIC TREATMENTS IN HIMALAY REGIONS OF INDIA USING THE STATISTIC OF THE EMPIRICAL DATA

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The Himalayan areas of India are ones of the most seismically active regions of the world. This paper represents the experience of using empirical data statistics first in India to a counterbalance to the accepted practice of the seismic hazard assessment for the specified territory. Using the world data together with the local data the pure empirical attenuation laws were developed for earthquakes of the Himalaya.

Keywords: Seismic hazard, peak ground acceleration, predominant period, duration, coefficient of dynamic amplification, logarithmic spectra bandwidth, synthetic accelerogram.

1. GROUND MOTION PARARMETERS DESCRIBING SEISMIC TREATMENTS

At the first instance it is necessary to select some parameters essential for the considered task with required accuracy. Several common criteria exist for the parameterization of any physical process [1]: 1) ***the parameters should reflect the main features of a studied process; and in this case it is important from the engineering point of view; 2) parameters should be independent in pairs in the sense that alteration of a value of one of the parameters at calculations should not cause significant alteration of other parameter values.***

There are three main independent parameters describing ground seismic motion [1]:

A – a parameter characterizing signal's *level (in time domain or in frequency domain)*;
d – duration, defined as time interval between the first and the last cases of the condition fulfillment $A_{env} \le 0.5A_{max}$. *It should be noted, that another definitions of duration are in contradiction with the principles of parameterization*! For example, duration of Arias's definition has the negative correlation with damage degree.

f_0 **– *predominant frequency*** of oscillation (or predominant period).

Peak ground acceleration

This parameter of ground motion is most important in the ensemble of parameters describing the seismic treatment. The basic source and site parameters for the peak ground acceleration (PGA) estimation are earthquake magnitude, source depth, faulting type, distance and ground type. Towards measurement of distance, different values are taken. Out of these the shortest distance R_F to the rupture surface gives the best results.

We use the pure empirical relations which are based on the empirical amplitude distribution according to source and site parameters. Preselected mathematical expressions are not used. Estimates were provided using median values on the columns and the rows for the narrow magnitude and log (distance) intervals. The final result can be approximated by any functions. Absence of the various assumptions and suppositions decreases the errors. To design the empirical equations more than 3000 records obtained in different countries are used.

The magnitude (M) range of the events is $2 \le M_S \le 8$. The distance range is $0.01 \le R_F$, km $\le$ 100. It is shown in [2, 3] that the amplitude can be matched with shifting along the distance axis (not along amplitude axis as usually!): $\partial(\log R)/\partial M = 0.33$. Last value is in good agreement with the equation for size of the rupture surface as obtanied by Wells and Coppersmith [4].

Three zones with different attenuation relations are defined: *source field*, *near field* and *far field* [5]. Within the *source zone* PGA = PGA_0 = const. This zone stretches out from the fault surface upto the distance R_0 (km), which is as follows:

$$\log(R_0, \text{km}) = 0.33\, M_S - 1.51 \tag{1}$$

As it is seen from the empirical data, value of PGA_0 depends on faulting type.
The *near-field zone* stretches out from R_0 upto R_1:

$$\lg R_1 = 0.33 M_S - 0.61 \tag{2}$$

where R_1 is the border between the near - and far-field zones [5].

It is empirically estimated that at this border:

a) the slope of PGA curve is chaging from -0.8 to -1.9;
b) the dependence on distance for predominant period and duration are changing;
c) PGA is 170 cm/sec^2 for the all the fault types and all the ground types.
PGA in the near-field zone is estimated using the empirical formula [5]:

$$\log (\text{PGA}) = C\,(0.33 M_S - 0.61 - \log R) + 2.23 \pm 0.16 \tag{3}$$

where 170 cm/sec^2 < PGA < PGA_0, $R_0 < R < R_1$, C is coefficient, depending on faulting type. Values of PGA_0 and C are given in Table 1.

Table 1

The coefficients of empirical attenuation relation

C	PGA_0, cm/sec^2	Fault type
0.800	900	thrust (T)
0.717	757	thrust – strike-slip (T-S)
0.633	637	strike-slip (S)
0.550	536	normal – strike-slip (N-S)
0.467	450	normal (N)

***No significant influence of ground type* is estimated within the source- and near-field zones.**

Within the far-field zone ($R > R_1$, PGA < 170 cm/sec^2) PGA is estimated using the following equation [5]:

$$log\ (PGA) = 0.634\ M_S - 1.92\ logR + 1.076 \pm 0.18 \quad (4)$$

This equation is obtained for intermediate ground conditions. For hard rock log(PGA) is reduced by 0.15 and for soft soil it is enlarged by 0.15.

All the estimation are related to the more intensive horizontal component.

Predominant period of ground oscillations

The average world relation of predominant period T to various factors has a form [5, 6] as follows:

$$log\ T = 0.15\ M_s + 0.25\ log\ R - v_p + C_1 + C_2 \pm 0.20 \quad (5)$$

where v_p – is velocity of P-wave propagation on the foci depth, C_1 = - 0.1 for the thrust, 0.0 – for the strike-slip, and +0.1 for normal faulting. C_2 depends on regional condition and it's mean value is equal to C_2 = - 1.11.

The constants in the first and second terms are relatively stable in different parts of world but the last coefficient is extremely variable even on short distances depending on local site conditions in a rather complicated way and may be defined with reliability by empirical way only [6, 7].

Pulse width (shaking duration)

Definition of pulse width d satisfy the parameterization requirements. Pulse width on the strong motion records varies under the effect of various factors from fractions of a second up to 30 sec or even more. The relation of the pulse width d to a type of ground and distance is stronger than for predominant periods. According to world-wide data [5]:

$$lg\ (d, sec) = 0.15\ M_S + 0.50\ lg\ (R, km) + C_1 + C_2 + C_3 \pm 0.3 \quad (6)$$

where R is the hypocentral distance for far-field zone; in the near-field and source zones value of d is constant and equal to one on the border between far- and near- field zones (see subsection 1.1), C_1 = - 0.1 for thrust, C_1 = 0.0 for strike-slip, and C_1 = + 0.1 for normal faulting, C_2 = - 0.15 for rock, C_2 = 0.0 for intermediate ground, and C_2 = + 0.40 for soft soil. Mean value of C_3 is equal to – 1.3.

Logarithmic spectral bandwidth

The best and most simple method of description of a frequency composition of seismic oscillations is estimation of a logarithmic width of the response spectrum S [1, 8]:

$$S = log\ f_{high} - log\ f_{low}\ . \quad (7)$$

A frequency band width is measured at the level of 0.5 SA_{max} (between the frequencies at which the response spectrum level reached a half of its maximum value) (Fig. 1). In accordance with such definition it is necessary to measure the bandwidth in octaves, not in Hertz. This value is dimensionless and according to theory of similarity and dimensions must not depend on magnitude. In practice it was demonstrated that the correlation coefficient with magnitude is about 0.13. The correlation coefficient with logarithm of distance closest to the rupture surface is about 0.13 also.

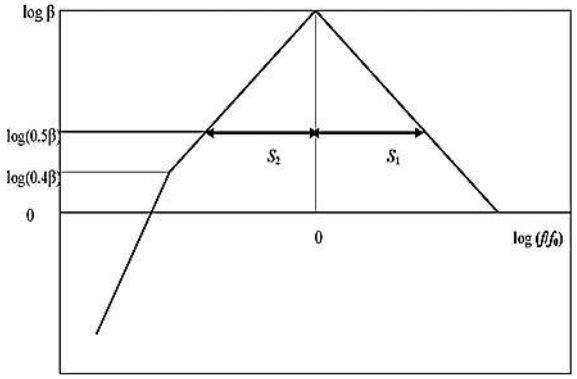

Fig. 1. The scheme of spectrum parameterization.
S_1 – the high-frequency part of spectrum; S_2 – the low-frequency part of spectrum; $S = S_1 + S_2$ – the logarithmic spectrum width, f_0 - predominant frequency, PGA – peak ground acceleration, SA –spectral acceleration, β – coefficient of dynamic amplification

The value of S is very stable: $S = 0.60 \pm 0.22$ disregard to earthquake magnitude, faulting type, distance and ground condition at the point of observation [9]. S depends on various factors [9]:

$$S = 0.6 + C_1 + C_2 \pm 0.20 \qquad (8)$$

where coefficient C_1 is equal to - 0.10 for the reverse (thrust) faulting, 0.00 for the strike-slip and 0.10 for the normal faulting; coefficient C_2 is equal to - 0.05 for a rock, 0.00 for intermediate ground and 0.2 for a soft soil.

Stability of S is helpful to design response spectra for a strong earthquake using records of weak local earthquakes [9]. In our calculations are used response spectra at 5% damping. In the subsequent process, the spectra are normalized by a SA_{max} and by the corresponding (predominant) frequency f_0 to characterize a spectrum shape. Separate consideration of a level, resonance frequency and spectra forms considerably increased accuracy of prognostic assessments.

In order to evaluate the spectrum asymmetry we may consider frequency intervals separately by both sides from a response frequency f_0 (see Fig. 1): $S_1 = \log f_{high} - \log f_0$; $S_2 = \log f_0 - \log f_{low}$; $S = S_1 + S_2$. It was shown that S_1 and S_2 are practically equal. The spectrum asymmetry is practically absent.

Coefficient β of dynamic amplification

The coefficient β_{max} characterizes the maximum spectral level. The averaged empirical coefficient β for ground acceleration (5% damping) using more than thousand records is [9] $\log \beta = 0.56 \pm 0.10$.

EMPIRICAL ESTIMATIONS OF STRONG GROUND MOTION PARAMETERS ON THE SHILLONG PLATEAU AND IN ADJOINING AREAS

The Shillong Plateau (latitude 25-27°N; longitude 89-94°E) is one of the most seismically active zones in the world. Several hundreds of earthquakes (M >4.0) are recorded during the past decade in the region.

Used data base

The strong ground motion records of two networks are used: the one maintained since 2005 by the Indian Institute of Technology, Guwahati, (IIT, Guwahati), and the other, Shillong array, maintained by the Department of Earthquake Engineering (DEQ), IIT - Roorkee. Presently, the strong ground motion accelerograph network of the IIT, Guwahati, consists of 12 digital accelerographs with SM recorder Etna. The analysis of ground conditions at the sites of seismic stations shows that the ground type is contiguous as soil. The Shillong array consists of 45 analog recorders SMA-1. The site conditions of the seismic stations are complicated [10]. The available database includes 86 three-component records of 24 earthquakes. Some of these events were recorded by several seismic stations simultaneously. The magnitude range of earthquakes used is $3.5 \le M_S \le 6.1$. The range of hypocentral distances is $40 \le R$, km ≤ 200. A lot of these events are weak without the confident estimation of the earthquake parameters. In some instances, it is difficult to estimate the P - wave arrival time. Some earthquakes are placed outside the Shillong Plateau. The records of some felt earthqukes were considered, including the North-East India earthquake of 10.09.1986 (M_S = 5.0) and of Bhutan earthquake 21.09.2009 (M_S = 6.1). Last earthquake was felt in Guwahati and Shillong with intensity I = 4 and I = 6 respectively. Records in near-field zone were not obtained.

The prognosis of the strong ground motion parameters

Logarithmic spectral width S

Distribution of S for local earthquakes is shown on Fig. 2.

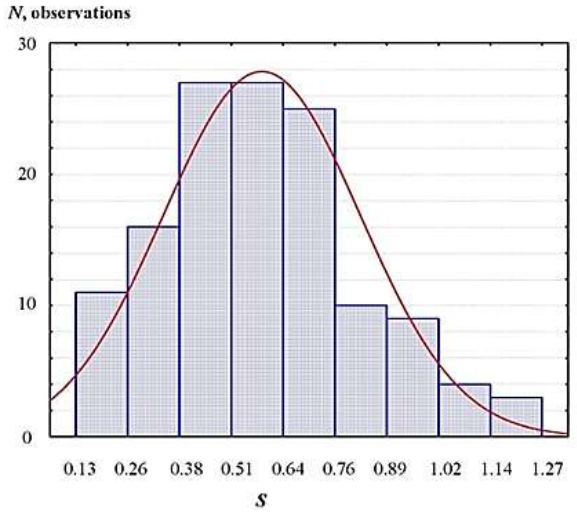

Fig. 2. Distribution of logarithmic frequency bandwidth S on the Shillong Plateau region

$$S = 0.58 \pm 0.24 \quad (9)$$

As it is seen, such results are very close to predicted one by the world-wide database. The spectrum asymmetry is shown on the Fig. 3:

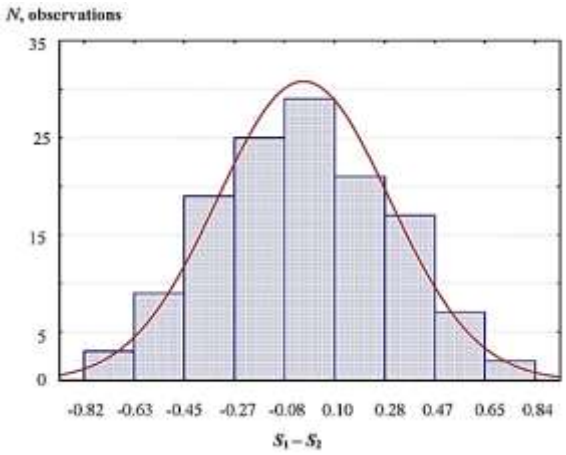

Fig. 3. Asymmetry of spectra of Shillong Plateau events

$$S_1 - S_2 = - 0.02 \pm 0.31 \quad (10)$$

This result is very close to world-wide one ($S_1 - S_2 = - 0.02 \pm 0.27$ [9]). Since the spectrum asymmetry is very small, for practical use it can be neglected.

Coefficient of dynamic amplification β

Distribution of β (5% damping) for local earthquakes is shown on Fig. 4:

$$\log \beta = 0.57 \pm 0.08 \quad (11)$$

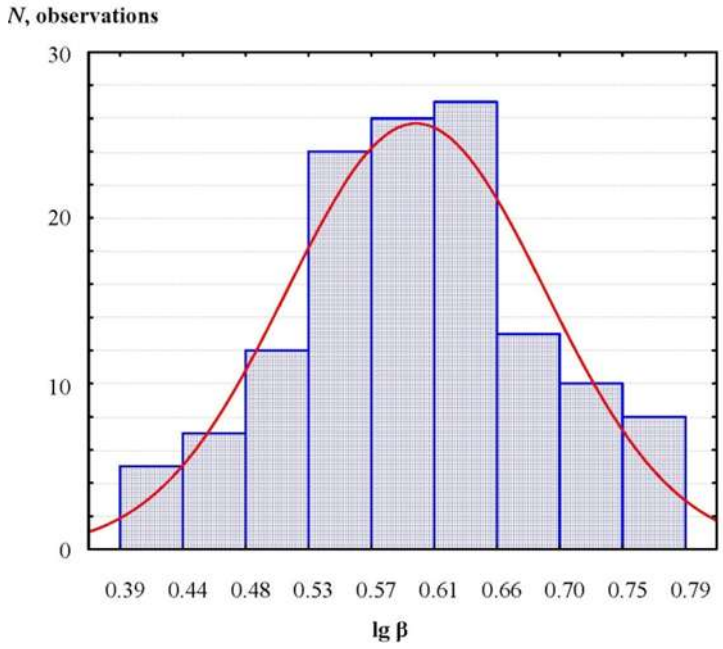

Fig. 4. Distribution of coefficient of dynamic amplification lg β on the Shillong Plateau region

It is seen, the calculated by the world-wide data and local data are practically the same.

Relation of predominant periods for the horizontal components

The relation between the predominant periods on the two horizontal components was obtained

$$\lg T(H_1) = \lg T(H_2) \pm 0.06 \quad (12)$$

This value is approximately the same as for the another regions [11]:

$$\lg T(H_1) = \lg T(H_2) \pm 0.13$$

PGA, predominant period T_0 and shaking duration d

To prove the applicability of world-wide relations [5] to the conditions of Shillong Plateau and its vicinity we have applied the method of comparison of observed ground motion parameters and calculated ones (using Eq. 4, 5 and 6). The records of 5 felt earthquakes with the evaluations of the epicentral parameters were used. The magnitude M_S range of these shocks is 4.4 – 6.1, the epicentral distance range is 10 - 157 km (Table 2). It is seen (Table 3) that the differences between observed and calculated values of the considered parameters are within standard deviation. The exceptions make the values of the predominant periods. As it is seen, the calculated predominant periods for area under consideration are larger than observed ones.

Table 2

The parameters of felt events used in the study of PGA, T_0 and d

№	Date	Origin time	Epicenter Lat. (°N) Long. (°E)	Depth, km	Magnitude M_S
1	23.02.2006	20:04:53	26.90 91.62	15	5.3
2	23.02.2006	20:07:26	26.90 91.62	18	5.0
3	25.04.2009	14:29:20	26.11 91.45	26	4.4
4	19.08.2009	10:45:14	26.56 92.47	10	5.1
5	21.09.2009	08:53:06	27.35 91.43	10	6.1

Table 3

The comparison of the observed and calculated ground motion parameters for the felt earthquakes at the points of observation

Event №	PGA, cm/sec^2		T_0, sec		d, sec	
	observed	calculated	observed	calculated	observed	calculated
1	10.0	9.8	0.09	0.17	18	12.5
2	6.6	6.3	0.10	0.15	15	10.5
3	22	15	0.05	0.10	1.4	1.4
4	3.8	4.4	0.09	0.18	0.8	3.0
5	6.0	3.8	0.33	0.29	5.5	2.1

Construction of ground motion parameters of Great Assam earthquake

As example the seismic effect due to the great 1897 earthquake at the Guwahati city area, the capital city of the state of Assam was evaluated. Location of this city near or on the Brahmaputra fault defines its seismic vulnerability and associated risk.

Estimation of Source Parameters

The region has already experienced about 22 large earthquakes (M > 7.0) including two great earthquakes (M> 8.0) [12]: the 1897 earthquake and the earthquake of 15.08.1950. Although no surface rupture was reported for the 1897 great earthquake [13], it has been now argued that the Oldham fault or the Brahmaputra fault was the causative fault for this earthquake of M_S 8.0 [14, 15]. We consider here the nearest Brahmaputra fault to the Guwahati city for our analysis. We assume the focal depth h = 25 km, half of the seismogenic depth beneath the Shillong plateau [16, 17]. A similar estimation of depth is given in [14, 15]. The shortest distance of the

Brahmaputra fault from the Guwahati city center is about 10 km, and the faulting type is thrust [13, 15, 17], and the ground condition is soil.

Estimation of Strong Ground Motion Parameters

Using the results of the previous sections, it is possible to estimate the strong ground motion parameters of the Great Assam Erathquake, 1897: PGA is 900 cm/sec^2 for more intensive horizontal component. The logarithmic pulse width S is 0.58. The predominant period T_0 is 0.41 sec. The shaking duration d is 9 sec. The estimated strong ground motion parameters and mentioned above methodics of the spectrum design [9] are used to construct the spectrum (Fig. 5) and the artificial accelerograms (Fig. 6) with 67% confidence level. It should be noted that the levels of the vertical and horizontal components for such very high accelerations are approximately equal [18]. Using the results of the works [5, 6, 9, 17, 18], the parameters of the seismic treatments for an expected earthquake Ms 8.0 (with the occurrence period 500 years) at the Guwahati city area can be estimated: the peak ground velocity PGV is 98 cm/sec, the velocity predominant period 0.8 sec, the velocity pulse width 50 sec; the peak ground displacement 70 cm and the pulse width of displacement ~ 2 min. The expected seismic intensity in Guwahati city is 9.8 for soft ground (liquation) and 9.3 for rock.

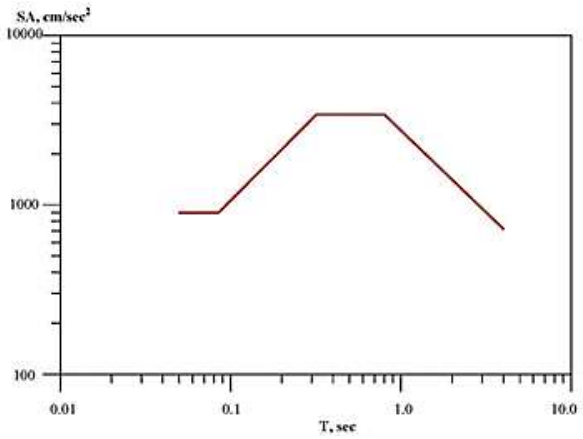

Fig. 5. Local design spectrum for an expected earthquake similar to Great Assam earthquake in the Guwahati city area

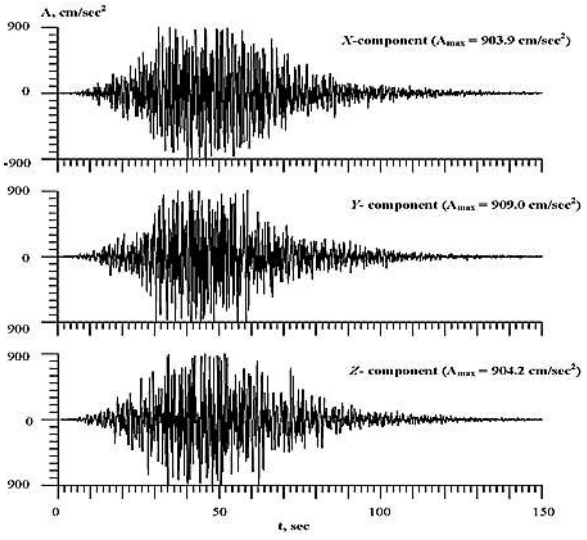

Fig. 6. Artificial accelerograms related to local design spectrum for an expected large earthquake similar to Great Assam earthquake at the Guwahati city area

PGA ATTENUATION LAW FOR THE STRONG EARTHQUAKES OF NW HIMALAYA, INDIA

Used database

Here are more local strong ground motion records including Dharmsala, April, 26, 1986, (M_S = 5.4), Uttarkashi, October, 20, 1991 (M_S = 6.8) and Chamoli, March, 28, 1999 (M_S = 6.7). Besides, 151 strong motion records obtained in this area since 2005 has been used to develop the empirical relations for the prognosis of the parameters of the strong ground motion. The used real database has limited within distance and magnitude ranges of 1.0< R < 100.0 km and 3.5 ≤ M_w ≤5.3, respectively. Three strong earthquakes of Dharm sala, April, 26, 1986, (M_S=5.4), Uttarkashi, October, 20, 1991 (M_S = 6.8) and Chamoli, March, 28, 1999 (M_S = 6.7) were recorded by the local seismic station network of strong ground motion in the NWR. All the earthquakes have the thrust mechanism. Empirical estimation data of PGA attenuation are badly fitted by known attenuation equations [19, 20].

Revision of strong earthquake sources parameters

Calculation of distances using the coordinates of the epicenter obtained by teleseismic stations is impossible [19]. For more reliable estimation coordinates of epicenter it is expedient to use records of strong movements. The hypocenter distance R_h can be estimated under the formula $R_h = 8\ (t_S - t_t + 0.2)$, where t_S – time of S–wave arrival, t_t – time of P-wave arrival on record, 0.2 sec – average time of the trigger device operation. Modern equipment allows recording without losses of record start.

Empirical value of const = 8 isn't too critical. Coordinates of epicenter of Uttarkashi earthquake are most strongly changed. New epicenter lies on a known fault. Then are calculated new epicentral distances for each station. Knowing epicenter and hypocenter distances the focal depth is calculated. New coordinates and depth of the epicenters and normalized distance R^* are shown in Table 4.

Table 4

New estimations of earthquake parameters in the northwest Himalaya, India

Earthquake	φ,°	λ,°	M_S	Faulting type	h, km
Dharmsala, 26.04.1986	32.17	76.34	5.4	thrust	5
Uttarkashi, 20.10.1991	30.70	78.63	6.8	thrust	14
Chamoli, 28.03.1999	30.53	79.35	6.7	thrust	8

PGA attenuation law

It was shown [2, 5, 21, 22] how it is possible to obtain single attenuation curve using the normalized distance. The normalized distance R^* is determined as $\lg R^* = \lg R - 0.33\ M_S$. We try to develop the empirical scaling law using normalized hypocentral distance $\lg R_h^* = \lg R_h - 0.33\ M_S$. Using axis R^* and PGA in double logarithmic scale one can obtain the empirical attenuation curve by the local strong ground motion records disregard to earthquake magnitudes. The shortest normalized distance is taken $R^* = 0.002$ (for the magnitude M = 5 it corresponds about 90 meters). Near the fault more important are the residual deformations and other non-linear effects. The relation between PGA and normalized distances for thrust faulting is shown on Fig. 7.

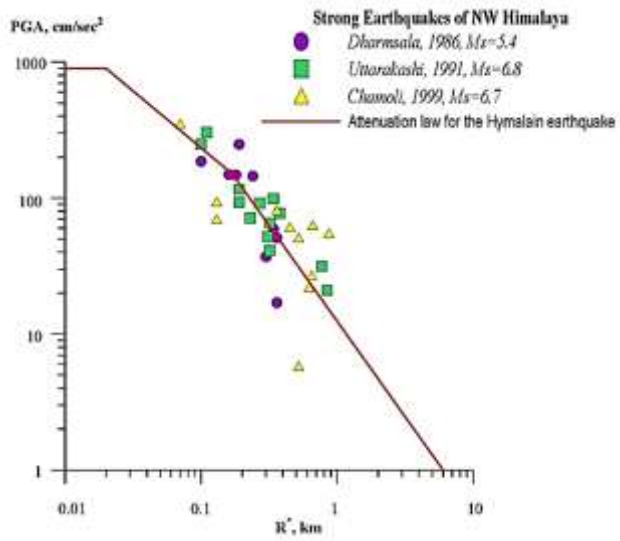

Fig. 7. PGA versus the normalized hypocentral distance R_h* for three Indian earthquakes with different magnitudes.

For the comparison the attenuation curve for thrust used by world-wide data [5] is shown. From the figure one can see the Indian earthquake have the same attenuation curve as in other regions of Earth. We haven't the records from the source zone, but the border between near- and far- zones is well visible (see Fig. 7). On the approximation line top is shown the acceleration limit (for the thrust, obtained from world - wide data [5, 23]. The correction for the ground type in far-field zone is not used. As it is posiible to see the size of a standard deviation has made 0.13 units dec. log., much less, than it is given by the best semi-empirical formulas. One can see follow features on attenuation curve: 1) the maximum of ground acceleration is observed on the normalized distance of $\boldsymbol{R^*} \leq 0.02$; 2) the maximal PGA (horizontal component) is constant: PGA_{max} = 900 cm/sec^2; 3) the border between near- and far-field zones is observed on normalized distance $\boldsymbol{R^*}$= 0.2; 4) the PGA on these border is equal to 170 cm/sec^2. In accordance with world-wide attenuation law this value is not depending on faulting- and ground type. Empirical PGA attenuation law (thrust) is: lg PGA, cm/sec^2 = 2.964 for the source zone; lg PGA, cm/sec^2 = 1.724 - 0.724 lg R^*, for the near-field zone; lg PGA = 1.000 – 1.755 lg R^*, for the far-field zone. In the far-field zone the influence of faulting type on PGA level is not observed but it is necessary to take into account the ground type for other parameters. The mentioned above relation was obtained for rock. For other type of ground it is necessary to estimate ground amplification. The mean amplification for intermediate ground is about 1.4, for soft soil about 2.0. It is very easy to mapping of expected ground acceleration using the calculated distances related to given acceleration (Table 5). To obtain the real distances, the normalized distance must be enlarged by factor $M_S^{0.33}$. It is necessary to add 0.5 intensity units for soft ground.

Table 5.

Expected accelerations and intensity at the fixed normalized distances (M = 8, thrust, rock)

PGA, cm/sec^2	900	700	450	280	175	110	70	45
Intensity	9.3	9.0	8.5	8.0	7.5	7.0	6.5	6.0
R*, km	0.020	0.048	0.052	0.100	0.119	0.200	0.330	0.424

RESULTS

In the area of Shillong –Assam it was possible to develop the regional empirical relations for the logarithmic spectral bandwidth and coefficient of dynamic amplification only. For the peak ground acceleration, predominant period and shaking duration is proved the application of the empirical relations obtained earlier using world-wide records. The reconstruction of strong ground

motion parameters due to Great Assam earthquake is provided. As example the seismic effect for an expected earthquake at the Guwahati city area, the capital city of the state of Assam was calculated. In Northwestern Region of India using the world data together with local data it was possible to develop the pure empirical attenuation law for earthquakes of NW Himalaya. Obtained results allow to predict seismic treatments due to expected strong earthquakes and very easy mapping of expected ground acceleration.

It was shown the possibility of use of statistics of the empirical data first in India for the seismic hazard assessment. This method can be applied to the seismic hazard assessments and especially for the seismic treatments evaluations in other regions of India.

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CONSTRUCTION SAFETY AND BUILDING CODES

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PARAMETERIZATION OF GROUND MOTION

Development of the earthquake resistant design techniques begins with selection of basic description of seismic ground motion. All the parameters used in this process should reflect the main features of the physical phenomena involved. As dictated by the principles of dimensional analysis the motion of any mechanical system is determined by three independent variables: distance, time and mass. Therefore the variables which describe -the seismic ground motion must include all these fundamental variables. This leads to some general criteria of processes parameterization [1, 2]:

- *parameters should reflect the main features of a studied process and must be relevant from the earthquake engineering point of view;*
- *parameters should be mutually independent, in the sense that changes of one of the parameters should not cause significant alteration of other parameters.*

There are three basic parameters which describe seismic ground motion:

A – an *amplitude*;

f_0 – *predominant frequency* (or *period* T_0);

d –*duration of shaking,* defined as time interval between the first and the last excursions of the amplitude of the envelope $A_{env} \geq 0.5A_{max}$.

Other parameters are combination of basic ones.

It is convinient to use dimensionless parameters, because of they are not depending on phenomenon scale. For example, coefficient of dynamic amplification β must be very stable; frequency content of ground motion can be described in octaves, not in Herz's. In [1, 2] logarithmic spectrum bandwidth S is defined as a logarithm of frequency relation where the spectrum level reached a half of its maximum value:

$$S_1 = \lg f_{\text{high}} - \lg f_0 \,;\; S_2 = \lg f_0 - \lg f_{\text{low}} \,;\; S = S_1 + S_2.$$

f_0 – the predominant frequency.

The main errors by seismic treatment estimation are connected with neglecting of the parameterization principles and wrong suppositions.

AMPLITUDE

Attenuation equations is based on assumptions that the definition of earthquake magnitude $M = \lg(A) + f(R)$ applies everywhere, in both teleseismic and epicentral areas. For example (Fig. 1), in [3] it is supposed that at a distance of 1 km, Pek ground acceleration (PGA) grows from 0.2 g up to 2.0 g in the magnitude range $5 \leq M \leq 7.5$. If attenuation curve is fitted for $M = 7.5$, the amplitudes for $M < 7.5$ became underestimated. This scaling model is in contradiction with empirical data for the near-field zone. Bureau [4] showed that PGA does not depend upon magnitude and distance when distances are less than 10 km from the fault. Hanks and Johnson [5] argued that PGA does not depend upon magnitude for a distance of about 10 km and for the

magnitude range $3.2 \le M_L \le 7.1$. Yamada, Olsern, Heaton [6] obtain that in magnitude range M = 6…8 near the source PGA not depend on magnitude and mean value is PGA ≈ 500 cm/sec^2.

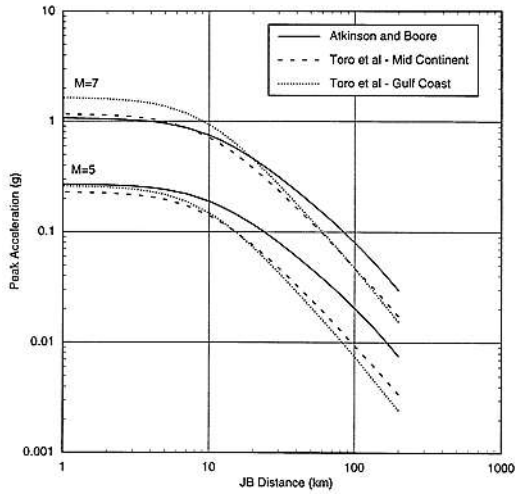

Fig. 1 - Model of PGA attenuation from [3]

A constant level of acceleration on the rupture surface is assumed in [7]. In [8–11], it was shown that lg(PGA) for earthquakes with different magnitudes are well scaled by fitting data along the distance axis and not along the amplitude, according to empirical law $\partial \lg(R)/\partial(M_S) \approx 0{,}35$. This value is in good agreement with the linear size of the rupture surface [12, 13].

Very often theoretical estimations of amplitude are provided using flat model of source. This model is in contradiction with empirical fact that PGA grow with distance near the fault [11, 14-17]. As a rule theoretical calculations underestimate the amplitude.

Three zones are defined using empirical data near fault: source-, near-, far-field zones [17].

The influence of ground conditions are different in near- and far-field zones. In the source- and near- field zones the acceleration is not dependent on ground conditions and may be even a little larger on rock. In far-field zone is absent influence of faulting type on amplitude level.

Some error is due to assumption that the relation between horizontal and vertical component is constant. The most important factor for relation between horizontal and vertical components is the vibration level. Using more than 3500 strong ground motion records it was obtained that when maximum horizontal acceleration A_{Hmax} is less than 250 cm/sec^2 the vertical component A_V is equal to $A_V = 0.5A_{Hmax}$ [18]. Then vertical component begun to overtake horizontal ones, and for 800 cm/sec^2 horizontal and vertical components are equal. The results are shown on Table 1. This relation not depends on magnitude, faulting type, distance and ground type [19].

Table 1

The relation between amplitudes for the vertical and horizontal components

A_{Hmax}, cm/sec^2	250	300	350	400	450	500	550	600
A_v, cm/sec^2	125	155	185	225	275	335	400	470
A_{Hmax}, cm/sec^2	650	700	750	800	850	900	950	1000
A_v, cm/sec^2	545	625	710	800	895	1000	1140	1200

DURATION OF SEISMIC OSCILLATION

The influence of this ground motion parameter on damage degree is considerable. We should dwell on a concept "oscillation duration" in more detail since oscillation duration in principal may be determined by different way and even to have a different physical sense [1, 2, 20], and the main

thing, do not meet the parameterization principles. American engineers, the first in the world who started systematic recording and processing of strong motions accepted a definition of duration D_B according to Bolt (by the terminology [20]): the end of a record is considered a moment of oscillation amplitude decrease up to some fixed threshold A_{thr}. For records on the ground it is accepted A_{thr}=0.05 *g*, for recording oscillations of buildings and structures A_{thr}=0.1 *g*. The value D_B appeared to be functionally correlated with an oscillation level and do not satisfy parameterization requirements. A substantial drawback of the definition of duration given above is also a fact that it can not be applied to oscillations with amplitudes lower than the threshold that makes impossible to compare durations at small and large ground motions. Abroad the value D_b is called "bracketed duration".

By Vanmarke and Lai (terminology from [21]) oscillation duration $\Delta t = D_{VL} = t_2 - t_1$ is a time interval during which a value

$$F(t) = \int_{t_1}^{t_2} A^2 dt \Big/ \int_0^{\infty} A^2 dt$$

increases from $F(t_1)$=0.05 up to $F(t_2)$=0.95.

Some researchers use other thresholds as well that do not change the meaning of definition. Experimentally it was established that a value D_{VL} under other equal conditions had a negative correlation with seismic intensity i.e. more continuous oscillations presented a smaller hazard. This paradox is explained by terminology errors. Factually the value $D_{V\text{-}L}$ is a measure of accumulation time for the given energy. The more the value $D_{V\text{-}L}$ is the more inert process takes place the less seismic intensity is. It is clear that this definition does not meet the parameterization requirements either. The duration *d* (pulse width) we determine as time interval between the first and the last time its envelope amplitude is equal to half of the maximum one. World-wide relation for pulse width *d* is described by empirical equation [9]

$$\lg d,\ sec = 0.15\ M_S + 0.50 \lg R,\ \text{km} + C_1 + C_2 + C_3 \pm 0.30,$$

R – hypocentral distance,

when $\lg R < \lg R_1 = 0.33\ M_S - 0.61$, value R_1 is used in calculations.

C_1 = - 0.25 for thrust, 0.00 for strike-slip, and 0.25 for normal faulting;
C_2 = - 0.15 for rock, 0.00 for intermediate ground conditions and 0.40 for soft ground;
C_3 = - 1.3.

The standard deviation reduces to 0.25 dec. log., when it is possible to use records of the local earthquakes. The total record duration is about 5*d*. The practice has shown that different definitions of duration are often mixed up with imprecise and not well defined terminology, and therefore it is proposed for *d* to use the term "pulse width" (as in radar technique).

The empirical relation between PGA and *d* for fixed seismic intensity is shown on Fig. 2.

Mean (for the record ensemble used) duration is about 4 sec.

It is easy to see that in duration interval 0.3 < *d*, sec < 30 the PGA/ PGA_{mean} alterates from 4.0 up to 0.4:

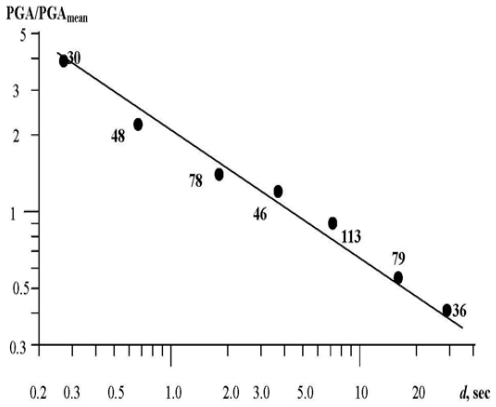

Fig. 2. Relation PGA – d for fixed seismic intensity. The number of records used is shown on the graph

$$\lg (PGA/PGA_{mean}) = 0.33 - 0.5 \lg d.$$
$$I = 2.5 \lg PGA, cm/sec^2 + 1.25 \lg d, sec + 1.05.$$

The duration values are different for acceleration A, velocity V and displacement D [18]:

$$\lg d(V) = \lg d(A) + 0.15 \pm 0.10,$$
$$\lg d(D) = \lg d(A) + 0.40 \pm 0.10.$$

As a rule there is no information about the duration in Building Codes.

PREDOMINANT PERIOD

Because of peak ground velocity (PGV) is well correlated with seismic intensity (Fig. 3), for fixed PGA. Some errors exist due to wrong mathematical data processing, for example, averaging spectra on fixed frequencies. Another error is due to supposition that the record ensemble is random.

SEISMIC INTENSITY SCALE

Often seismic hazard is estimated in units of seismic intensity scale. There are a lot different suppositions in converting intensity into PGA. For example often is believed that one unit of intensity corresponds to alteration of PGA by factor 2. There are a lot of mistakes in data processing. For example traditional least square method is used instead of orthogonal regression. Therefore in different countries the instrumental seismic intensity scale are different. For example to inensity I =9 corresponds PGA = 400 cm/sec^2 in Russia and Turkmenistan, 500 cm/sec^2 in China, 800 cm/sec^2 in USA [22]. The difference is too large.

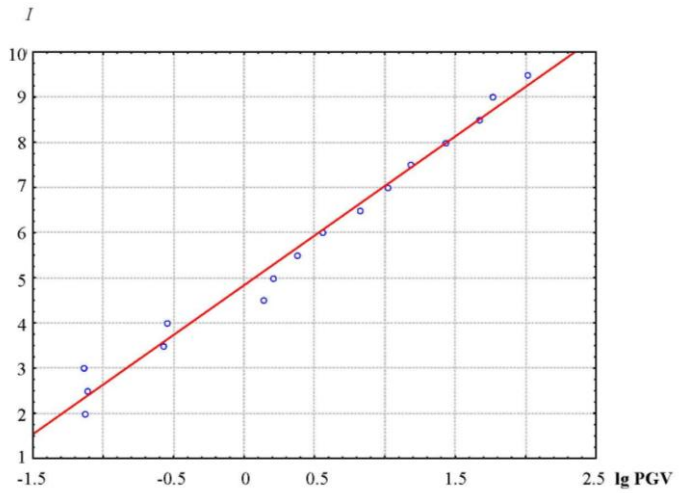

Fig. 3. Relation between seismic intensity I and center of logarithm PGV distribution the intensity depends on predominant period. The more the predominant period the higher the PGV is the higher seismic intensity is

Now in Russia is developed the project of new seismic intensity scale as National Standard. For every intensity estimated mean values of lg(PGA) and mean value of intensity. Then orthogonal regression is provided with correction according to Gutenberg-Richter law. The result is shown on Fig. 4.

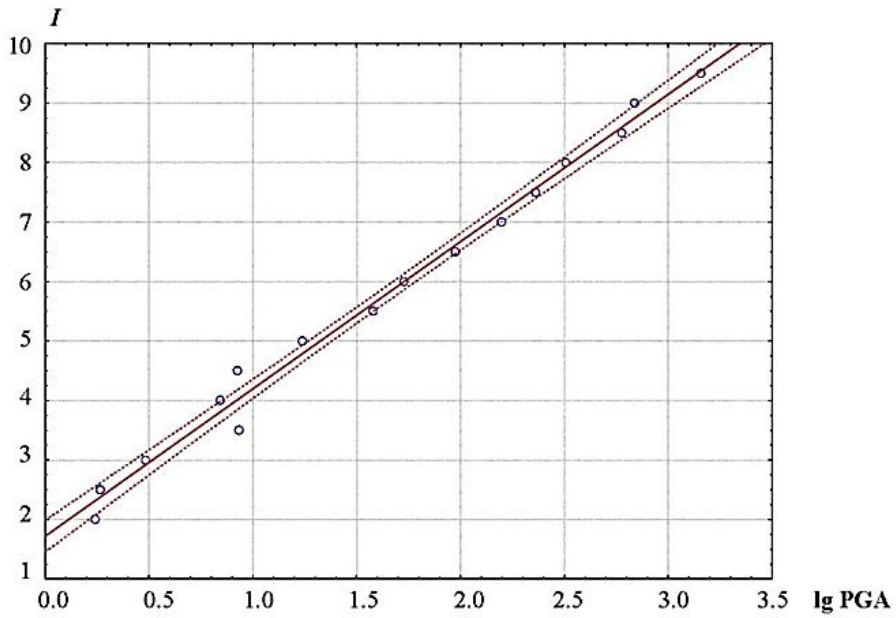

Fig. 4. Seismic intensity I vs. ground acceleration PGA. The circles are the centers of distributions. Dotted lines is 95% confidence level Correlation coefficient r = 0.82

The same procedure are made for peak ground velocity PGV, peak ground displacement PGD, Arias's energy $(PGA)^2 \cdot d$ (Fig. 5) and wave power W = (PGA) (PGV) (Fig. 6). Last parameter leads to the best result. Therefore for fixed PGA seismic intensity depends on predominant period, because larger periods lead to larger velocity. Main result: the energetic models of seismic treatment are better than inertial one:

$$I = 2.5 \lg \mathrm{PGA},\ \mathrm{cm/sec}^2 + 1.25 \lg d(A) + 1.05,$$

$I = 1.325 \lg (\mathrm{PGA}^*\mathrm{PGV}) + 2.83$. The results are shown in the Table 2.

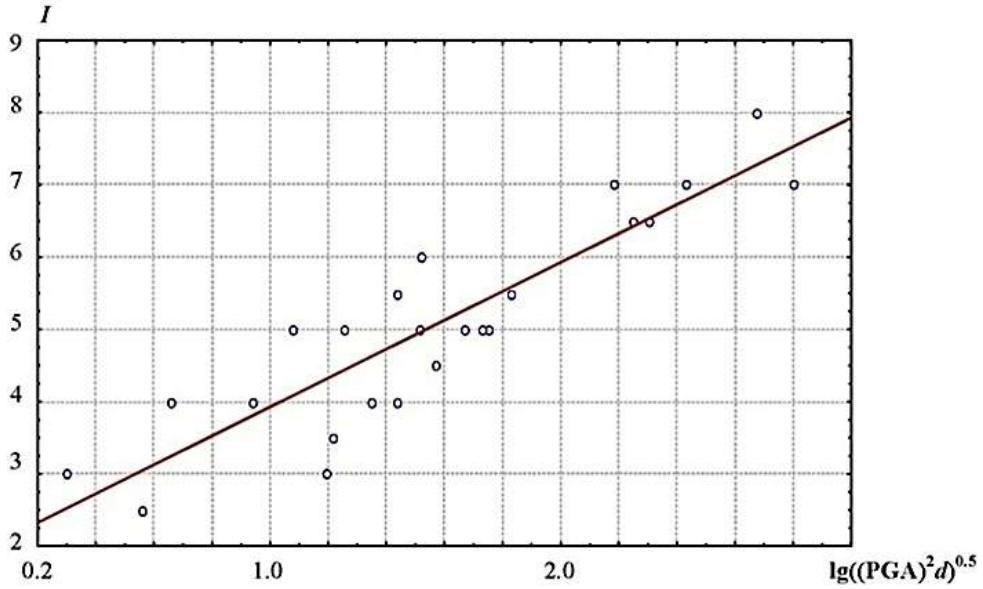

Fig. 5 - Seismic intensity I vs. Arias's energy. The circles are the centers of distributions. Correlation coefficient r = 0.90

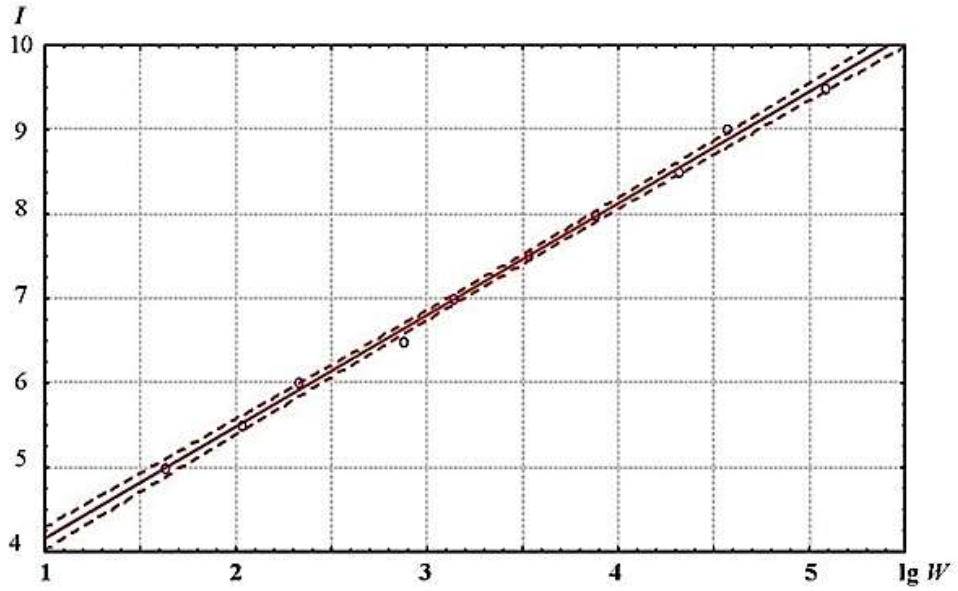

Fig. 6 - Seismic intensity I vs. seismic wave power W = PGA·PGV. The circles are the centers of distributions. Dotted lines are 95% confidence level. Correlation coefficient r = 0.999

Table 2.

Ground motion parameters related to different seismic intensity (Project of Russian Seismic Scale 2011)

Parameter	σ(*I*)	Seismic intensity *I*							
		6.0	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**	**9.5**
PGA, cm/sec²	**0.60**	44	70	110	180	280	440	700	1100
PGV, cm/sec	**0.55**	3.8	6.5	11	19	33	57	98	170

PGD, cm	**0.70**	0.66	1.4	3.2	7	15	33	72	160
PGA $d^{0.5}$, cm/sec$^{1.5}$	**0.35**	95	150	240	380	605	955	1515	2400
lg(PGA PGV, cm^2/sec^3)	**0.26**	2.4	2.8	3.2	3.5	3.9	4.3	4.7	5.0

Other Properties of Macroseismic Field in the Source Zone

Another component of seismic treatment is residual deformation. The constructions are totally destroyed when placed on line of rupture, but vibration recorded near the fault can't explain the damage degree. The seismic intensity along the fault is explained by such deformations. The error in the correlation between seismic intensity and parameters of ground shaking occurs when it is supposed that seismic intensity is determined by PGA only. But highest intensity is related not to vibrations but to residual deformations. That is why the scale INQUA and ESI 2007 overestimates the PGA-level. The PGA near the fault are relatively small and are growing with the distance. The largest ground accelerations are observed on some distance from fault depending on earthquake magnitude (Fig. 7).

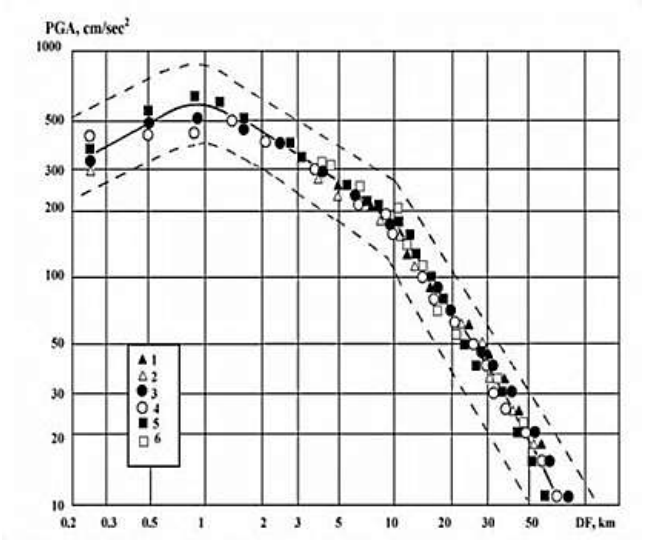

Fig. 7. Mean observed PGA scaled to M_S = 5.0 using empirical relation $\partial lgR/\partial M_S$ = 0.33

1 - M_S = 3.0; 2 - M_S = 4.0; 3 - M_S = 5.0; 4 - M_S = 6.0; 5 - M_S = 7.0; 6 - M_S = 8.0. The corrections for faulting type are provided also. Every sign for the PGA > 170 cm/s ^{2} is average value for at least 8 records. Dotted lines show the standard deviation (from [23]). Standing waves observed in epicentral area sometimes lead to dramatic differences in damage degrees in two places with equal ground conditions [24]. The classical examples are the Chinese earthquakes of 22 April 1974, M_S =5.5, I_{max} = 7.0, and of 9 July 1979, M_S =5.7, I_{max} = 8.0. The distance between epicenters is about 20 km. By both earthquakes were observed similar placement of zones. At the places of previous zones any effect of attenuation or amplification during the second earthquake was absent. The new zones of reduced effect were observed at 4.3 km, 3.8 km and 4.3 km (in different directions), and the next knot was observed at the distance of 11.8 km. Zone of amplification were observed at distances of 8 km 7.0 km and 6.5 km (Fig. 8). Special geophysical investigations can not explain the observed phenomena [25].

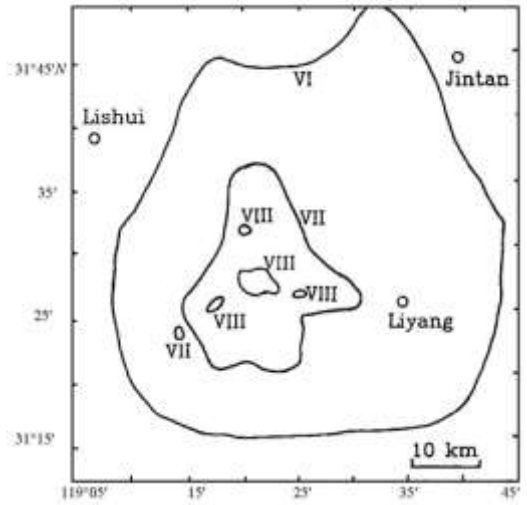

Fig. 8. The isoseismals of the Liyang, China, earthquake of 07 September 1979, M_S = 5.7. From [24]

CONCLUSIONS

It is shown the accuracy of energetic models of building damage is much higher than the inertial model. It is necessary to use more seismic treatment parameters in Building codes.

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MOVEMENT OF CYLINDRICAL INCLUSION IN THE VISCOELASTIC MEDIUM DESCRIBED MODEL FOIGHT

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A large number of works is devoted movement of cylindrical inclusion in the elastic medium [1-3]. The problem about cylinder movement in the viscoelastic medium is considered and dares in the given work. Decisions answering to the necessary boundary conditions are connected with analytical difficulties. Therefore at reception of originals of the problems solved to operational methods numerical decisions or the approached satisfaction boundary conditions are used. Received the solution in work [4] is limited in time. The solution not restricted on a time is created, however, the boundary conditions are dictated by possibility of reception of simple analytical forms.

Let's consider movement of a cylindrical rigid skew field in the medium of described by model Foight for a shift strain and elastic dilatations. Here instead of the generalized law of Hook will be:

$$\sigma_{ij} = \left(\lambda + \lambda' \frac{\partial}{\partial t} \right) \Delta \delta_{ij} + 2 \left(\mu + \mu' \frac{\partial}{\partial t} \right) \varepsilon_{ij} \tag{1}$$

$$\sigma = k\Delta \tag{2}$$

$$\varepsilon_{ij} = \frac{1}{2} \left(\frac{\partial U_i}{\partial x_i} + \frac{\partial U_j}{\partial x_j} \right) \tag{3}$$

Where σ_{ij} - components of tensor of voltage,

ε_{ij} - components of tensor of deformations,
σ - average hydrostatic pressure, Δ - volume deformation (dilatation),
λ, μ - constant Lames, λ', μ' - coefficients of viscosity, δ_{ij} - symbol of Khoroneker
K - coefficient of volume compression, U_i - projections of a vector displacement,
x_i - Parameter of Cartesian co-ordinates.

From the equations (1) it is possible to write,

$$\sigma_{11} + \sigma_{22} + \sigma_{33} = 3\sigma = \left[3\left(\lambda + \lambda' \frac{\partial}{\partial t} \right) 2\mu + 2\mu' \frac{\partial}{\partial t} \right] \Delta$$

Substituting in (2), we will gain

$$3\left(\lambda + \lambda' \frac{\partial}{\partial t} \right) + 2\mu + 2\mu' \frac{\partial}{\partial t} = 3k$$

whence

$$k = \lambda + \frac{2}{3}\mu; \qquad \lambda' = -\frac{2}{3}\mu'$$

Considering last in (1) we will have

$$\sigma_{ij} = \left(\lambda - \frac{2}{3}\mu' \frac{\partial}{\partial t} \right) \Delta\delta_{ij} + 2\left(\mu + \mu' \frac{\partial}{\partial t} \right) \varepsilon_{ij} \tag{4}$$

Further we observe the flat strained condition.
In this case the equations look like

$$\begin{aligned} \frac{\partial \sigma_{11}}{\partial x} + \frac{\partial \sigma_{1\varepsilon}}{\partial y} &= \rho \frac{\partial^2 U_x}{\partial t^2} \\ \frac{\partial \sigma_{12}}{\partial x} + \frac{\partial \sigma_{12}}{\partial y} &= \rho \frac{\partial^2 U}{\partial t^2} \end{aligned} \tag{5}$$

The law a straining (1) will become

$$\begin{aligned} \sigma_{11} &= \left(\lambda - \frac{2}{3}\mu' \frac{\partial}{\partial t} \right) (\varepsilon_{11} + \varepsilon_{22}) + 2\left(\mu + \beta\mu' \frac{\partial}{\partial t} \right) \varepsilon_{11} \\ \sigma_{22} &= \left(\lambda - \frac{2}{3}\mu' \frac{\partial}{\partial t} \right) (\varepsilon_{11} + \varepsilon_{22}) + 2\left(\mu + \mu' \frac{\partial}{\partial t} \right) \varepsilon_{22} \end{aligned} \tag{6}$$

$$\sigma_{12} = 2\left((\mu + \mu' \frac{\partial}{\partial t}) \varepsilon_{12} \right)$$

Having substituted (6) in (5) with used (3) also we will accept

$$U_x = \frac{\partial \varphi}{\partial x} - \frac{\partial \psi}{\partial y}; \qquad U_y = \frac{\partial \psi}{\partial x} - \frac{\partial \varphi}{\partial y};$$

we gain following equation

$$\left(\lambda + 2\mu + \frac{4}{3}\mu' \frac{\partial}{\partial t}\right)\left(\frac{\partial^2 \varphi}{\partial x^2} + \frac{\partial^2 \varphi}{\partial y^2}\right) = \rho \frac{\partial^2 \varphi}{\partial t^2}$$

$$\left(\mu + \mu' + \frac{4}{3}\mu' \frac{\partial}{\partial t}\right)\left(\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2}\right) = \rho \frac{\partial^2 \psi}{\partial t^2}$$

Or in polar system of co-ordinates

$$\left(\lambda + 2\mu + \frac{4}{3}\mu' \frac{\partial}{\partial t}\right)\left(\frac{\partial^2 \varphi}{\partial r^2} + \frac{1}{r}\frac{\partial \varphi}{\partial r} + \frac{\partial^2 \varphi}{\partial \theta^2}\right) = \rho \frac{\partial^2 \varphi}{\partial t^2} \tag{7}$$

$$\left(\mu + \mu' \frac{\partial}{\partial t}\right)\left(\frac{\partial^2 \psi}{\partial r^2} + \frac{1}{r}\frac{\partial \psi}{\partial r} + \frac{\partial^2 \psi}{\partial t^2}\right) \tag{8}$$

If dilatation and shift properties of a material are equal, then the law of a straining becomes

$$\sigma_{ij} = (1 + L)(\lambda \Delta \delta_{ij} + 2\mu \varepsilon_{ij}) \tag{9}$$

whence L – the linear operator on a time and the movement equations are gained by replacement a constant to the Llama on matching operators.

Displacement to the polar co-ordinate are expressed so

$$U = \frac{\partial \varphi}{\partial r} - \frac{1}{r}\frac{\partial \psi}{\partial \theta}; \qquad v = \frac{\partial \psi}{\partial r} - \frac{1}{r}\frac{\partial \varphi}{\partial \theta} \tag{10}$$

where U, υ – the radial and the peripheral components of a vector of moving, r - distance from a point, θ – a polar angle.

The solution of the equations (7) and (8) is searched in an aspect $\varphi = \varphi_1 \cos\theta$ and $\varphi = \varphi_1 \sin\theta$, and displacement $U = U_1 \cos\varepsilon$ and $\upsilon = \upsilon_1 \sin\theta$.

Having substituted them in (7), (8) and (10) we will gain

$$\left(\lambda + 2\mu + \nu_1 \frac{\partial}{\partial t}\right)\left(\frac{\partial^2 \varphi_1}{\partial r^2} + \frac{1}{r}\frac{\partial \varphi_1}{\partial r} - \varphi_1\right) = \rho \frac{\partial^2 \varphi_1}{\partial t^2} \tag{11}$$

$$\left(\mu + 2\nu_2 \frac{\partial}{\partial e}\right)\left(\frac{\partial^2 \varphi_1}{\partial r^2} + \frac{1}{r}\frac{\partial \varphi_1}{\partial r} - \varphi_2\right) = \rho \frac{\partial^2 \varphi_1}{\partial t^2} \tag{12}$$

$$U_1 = \frac{\partial \varphi_1}{\partial r} - \frac{\psi_1}{r}; \quad \upsilon_1 = \frac{\partial \psi_1}{\partial r} - \frac{\varphi_1}{r} \tag{13}$$

We solve the equations (11) and (12) at an initial state of space of medium and a condition of movement without brake-off from the cylinder.

Applying to (11) and (12) transformation of the Laplace-Carson, we have the following the solutions restricted on infinite

$$\overline{\varphi}_1 = CK_1\left(\frac{pr}{\sqrt{\alpha^2 - \nu_1 p}}\right); \quad \overline{\psi}_1 = DK_1\left(\frac{pr}{\sqrt{\alpha^2 - \nu_2 p}}\right) \tag{14}$$

Where p – transformation parameter

$$\alpha = \sqrt{\frac{1+2\mu}{\rho}}; \quad b = \sqrt{\frac{\mu}{\rho}}$$

At movement with adhesion in points of an adjunction of medium to a surface of the cylinder of transition of medium it will be equal to transition of the cylinder which moves in direction x:

$$U'\cos\theta - \upsilon\sin\theta = \left(\frac{\partial\varphi_1}{\partial r^2} - \frac{\psi_1}{r}\right)\cos^2\theta - \left(\frac{\partial\varphi_1}{\partial r} - \frac{\varphi_1}{r}\right)\sin^2\theta$$

At arriving driving of the rigid cylinder all its points have equal transition, i.e. do not depend from θ and therefore

$$\frac{\partial\varphi_1}{\partial r} - \frac{\psi_1}{r} = -\frac{\partial\psi_1}{\partial r} - \frac{\varphi_1}{r} \tag{15}$$

Having substituted solutions (14) in space of images in (15) we will gain

$$C\left[\frac{pK_0\left(\frac{pr_0}{\sqrt{a^2+\nu_1 p}}\right)}{\sqrt{a^2+\nu_1 p}} + 2\frac{K_1\left(\frac{pr_0}{\sqrt{a^2+\nu_1}}\right)}{r_0}\right] =$$

$$= -D\left[\frac{pK_0\left(\frac{pr_0}{\sqrt{b^2+\nu_2 p}}\right)}{\sqrt{b^2+\nu_2 p}} + 2\frac{K_1\left(\frac{pr_0}{\sqrt{b^2+\nu_2 p}}\right)}{r_0}\right]$$

or

$$C = -f(p)\left[\frac{pK_0\left(\frac{pr_0}{\sqrt{b^2+\nu_2 p}}\right)}{\sqrt{b^2+\nu_2 p}} + 2\frac{K_1\left(\frac{pr_0}{\sqrt{b^2+\nu_2 p}}\right)}{r_0}\right]$$

$$D = f(p)\left[\frac{pK_0\left(\frac{pr_0}{\sqrt{a^2+\nu_1 p}}\right)}{\sqrt{a^2+\nu_1 p}} + 2\frac{K_1\left(\frac{pr_0}{\sqrt{a^2+\nu_1 p}}\right)}{r_0}\right] \tag{16}$$

Where $f(p)$ - it is defined from boundary conditions
Having substituted solutions (14) in space of images in (13), we will gain

$$\bar{U}_1 = -C\left[\frac{pK_0\left(\frac{pr}{\sqrt{a^2+v_1p}}\right)}{\sqrt{a^2+v_1p}} + \frac{K_1\left(\frac{pr}{\sqrt{a^2+v_1p}}\right)}{r}\right] - D\frac{K_1\left(\frac{pr}{\sqrt{b^2+v_2p}}\right)}{r}$$

$$\bar{\upsilon}_1 = -D\left[\frac{pK_0\left(\frac{pr}{\sqrt{b^2+v_2p}}\right)}{\sqrt{b^2+v_2p}} + \frac{K_1\left(\frac{pr}{\sqrt{b^2+v_2p}}\right)}{r} - \frac{K_1\left(\frac{pr}{\sqrt{a^2+v_1p}}\right)}{r}\right]$$

Or having substituted expressions C from (16), we will gain

$$\bar{u}_1 = f(p)L \tag{17}$$

where $\bar{\upsilon}_1 = f(p)M$

$$L = \frac{p^2}{\sqrt{a^2+v_1p}\sqrt{b^2+v_2p}}K_0\left(\frac{pr_0}{\sqrt{b^2+v_2p}}\right) +$$

$$+\frac{1}{r}\frac{p}{\sqrt{b^2+v_2p}}K_0\left(\frac{pr_0}{\sqrt{b^2+v_2p}}\right)K_1\left(\frac{pr_0}{\sqrt{a^2+v_1p}}\right) +$$

$$+\frac{2p}{r_0\sqrt{a^2+v_1p}}K_1\left(\frac{pr_0}{\sqrt{b^2+v_2p}}\right)K_0\left(\frac{pr_0}{\sqrt{a^2+v_1p}}\right) +$$

$$+\frac{2}{r_0r}K_1\left(\frac{pr_0}{\sqrt{b^2+v_2p}}\right)K_1\left(\frac{pr_0}{\sqrt{a^2+v_1p}}\right) -$$

$$-\frac{p}{r\sqrt{a^2+v_1p}}K_0\left(\frac{pr_0}{\sqrt{a^2+v_1p}}\right)K_1\left(\frac{pr}{\sqrt{b^2+v_2p}}\right) -$$

$$-\frac{2}{r_0r}K_1\left(\frac{pr_0}{\sqrt{a^2+v_1p}}\right)\cdot K_1\left(\frac{pr}{\sqrt{b^2+v_2p}}\right)$$

$$M = -\frac{p^2}{\sqrt{a^2+v_1p}\sqrt{b^2+v_2p}}K_0\left(\frac{pr_0}{\sqrt{a^2+v_1p}}\right)K_0\left(\frac{pr}{\sqrt{b^2+v_2p}}\right) -$$

$$-\frac{1}{r}\frac{p}{\sqrt{a^2+v_1p}}K_0\left(\frac{pr_0}{\sqrt{a^2+v_1p}}\right)K_1\left(\frac{pr}{\sqrt{b^2+v_2p}}\right)-$$

$$-\frac{2p}{r_0\sqrt{b^2+v_2p}}K_1\left(\frac{pr_0}{\sqrt{a^2+v_1p}}\right)K_0\left(\frac{pr}{\sqrt{b^2+v_2p}}\right)-$$

$$-\frac{2}{r_0r}K_1\left(\frac{pr}{\sqrt{a^2+v_1p}}\right)K_1\left(\frac{pr}{\sqrt{b^2+v_2p}}\right)+$$

$$+\frac{p}{r\sqrt{b^2+v_2p}}K_0\left(\frac{pr_0}{\sqrt{b^2+v_2p}}\right)K_1\left(\frac{pr}{\sqrt{a^2+v_1p}}\right)+$$

$$+\frac{2}{r_0r}K_1\left(\frac{pr_0}{\sqrt{b^2+v_2p}}\right)K_1\left(\frac{pr}{\sqrt{a^2+v_1p}}\right)$$

Boundary conditions execution, at which turning on from a rest is set in motion with a fixed velocity for the purpose of application of a principle of Duhamel leads to analytical difficulties as McDonald's functions appear in we will sweep. Even more complicatedly matter is at security on boundary line of fixed force. Therefore, for the purpose of solution simplification, it is necessary to soften boundary a condition. From our point of view, the following boundary conditions in space of images would be practically useful

$$\bar{U}_{1t}\Big|_{r=r_0}=\frac{V_0}{\sqrt{a^2+v_1p\sqrt{b^2+v_2p}}} \tag{18}$$

In space of originals the modification of a velocity of turning on a time would be represented in a graph aspect (Fig. 1).

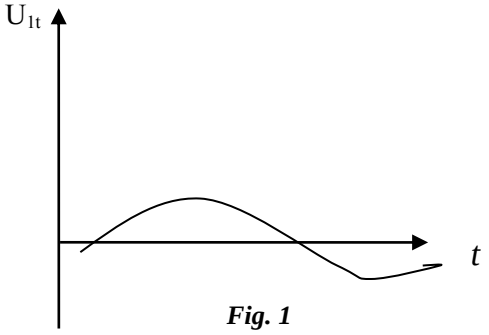

Fig. 1

Besides, fulfilling a condition (18) for small times i.e. R e p>> 1 and using asymptotic formulas

$$K_0\approx\sqrt{\frac{\pi}{2z}e^{-z}}\quad\text{and}\quad K_1\approx\sqrt{\frac{\pi}{2z}e^{-z}}$$

From (17) and (18) it is received

$$\bar{U}_{1t} = \frac{p^2 f(p)}{\sqrt{(a^2+v_1 p)\cdot(b^2+v_2 p)}} \cdot \frac{\pi}{2r_0} e^{-pr_0\left(\frac{1}{\sqrt{a^2+v_1 p}}+\frac{1}{\sqrt{b^2+v_2 p}}\right)} = \frac{V_0}{\sqrt{(a^2+v_1 p)\cdot(b^2+v_2 p)}}$$

whence

$$f = \frac{2r_0}{\pi p^2} V_0 e^{pr_0\left(\frac{1}{\sqrt{a^2+v_1 p}}+\frac{1}{\sqrt{b^2+v_2 p}}\right)} \tag{19}$$

Substituting (19) in (17), we will gain

$$\begin{aligned}
\bar{U}_1 = \frac{2r_0}{\pi} V_0 e^{pr_0\left(\frac{1}{\sqrt{a^2+v_1 p}}+\frac{1}{\sqrt{b^2+v_2 p}}\right)} \Bigg[& \frac{K_0\left(\frac{pr_0}{\sqrt{b^2+v_2 p}}\right)}{\sqrt{b^2+v_2 p}} \cdot \frac{K_0\left(\frac{pr_0}{\sqrt{a^2+v_1 p}}\right)}{\sqrt{a^2+v_1 p}} + \\
& + \frac{1}{pr} \frac{K_0\left(\frac{pr_0}{\sqrt{b^2+v_2 p}}\right)}{\sqrt{B^2+v_2 p}} K_1\left(\frac{pr_0}{\sqrt{a^2+v_1 p}}\right) + \\
& + \frac{2}{pr_0} K_1\left(\frac{pr_0}{\sqrt{b^2+v_2 p}}\right) \frac{K_0\left(\frac{pr}{\sqrt{a^2+v_1 p}}\right)}{\sqrt{a^2+v_1 p}} + \\
& + \frac{2}{p^2 r_0 r} K_1\left(\frac{pr_0}{\sqrt{b^2+v_2 p}}\right) K_1\left(\frac{pr_0}{\sqrt{a^2+v_1 p}}\right) - \\
& - \frac{1}{pr} \frac{K_0\left(\frac{pr}{\sqrt{a^2+v_1 p}}\right)}{\sqrt{a^2+v_1 p}} K_1\left(\frac{pr_0}{\sqrt{b^2+v_2 p}}\right) - \\
& - \frac{2}{r_0 r p^2} K_1\left(\frac{pr_0}{\sqrt{a^2+v_1 p}}\right) K_1\left(\frac{pr_0}{\sqrt{b^2+v_2 p}}\right) \Bigg]
\end{aligned} \tag{20}$$

Further we define originals of following magnitudes which allow finding transition U_1 from (20). We will take advantage of the expression original

$$pe^{gp} K_0(p) \frac{1}{\sqrt{(t+g)^2-1}} \qquad \text{at } t+g > 1$$

Or on similarity theorem

$$pe^{g\alpha p}K_0(\alpha p)\frac{1}{\sqrt{(t+\alpha g)^2-1}} \qquad \text{at } t>\alpha-g\alpha$$

Using an operational relationship at passage from p to $p-\frac{1}{p}$ which is gained from the generalized theorem of a contraction of Efros, last it is possible to lead to an aspect

$$e^{g\alpha\left(p-\frac{1}{p}\right)}\frac{K_0\left[\alpha\left(p-\frac{1}{p}\right)\right]}{p^n}\int\limits_{2(1-g)}^{t}\left(\frac{t-\tau}{\tau}\right)^n\frac{I_n\left[2\sqrt{(t-\tau)\tau}\right]}{\sqrt{(\tau+\alpha g)^2-\alpha^2}}d\tau$$

Using a relationship

$$\overline{f}(\sqrt{p})\to\frac{1}{\sqrt{\pi}}\int\limits_0^\infty\exp\left(-\frac{\eta^2}{4t}\right)f(\eta)d\eta$$

From the previous relationship follows

$$p^{-\frac{n}{2}}e^{g\alpha\left(\sqrt{p-\frac{1}{\sqrt{p}}}\right)}K_0\left[\alpha\sqrt{p}-\frac{1}{\sqrt{p}}\right]\to\frac{1}{\sqrt{\pi-l}}\int\limits_0^\infty\exp\left(-\frac{\eta r}{\eta t}\right)\times$$

$$\times\int\limits_{\alpha(1-g)}^{\eta}\left(\frac{\eta-\tau}{\tau}\right)\frac{I_n\left[2\sqrt{(\eta-\tau)\tau}\right]}{\sqrt{(\tau+\alpha g)^2-\alpha^\tau}}d\tau d\eta$$

Passing from p to p+1

$$(p+1)^{-\frac{n}{2}}e^{\frac{g\alpha p}{\sqrt{p+1}}}K_0\left(\frac{\alpha p}{\sqrt{p+1}}\right)\to\frac{e^{-t}}{\sqrt{\pi t}}\int\limits_0^\infty\exp\left(-\frac{\eta r}{\eta t}\right)\int\limits_{2(1-g)}^{\eta}\left(\frac{\eta-\tau}{\tau}\right)^n\frac{I_n\left[2\sqrt{\eta-\tau)\tau}\right]}{(\tau+\alpha g)^2-\alpha^2}d\tau d\eta$$

Further passing from p to γp

$$(\gamma p+1)^{-\frac{n}{2}}e^{\frac{g\alpha\gamma p}{\sqrt{\gamma p+1}}}K_0\left(\frac{\alpha\gamma p}{\sqrt{\gamma p+1}}\right)\to e^{-\frac{t}{\gamma}}\sqrt{\frac{\gamma}{\pi t}}\int\limits_0^\infty\exp\left(-\frac{\gamma\eta^2}{\eta t}\right)\times$$

$$\times\int\limits_{2(1-g)}^{\eta}\left(\frac{\eta-\tau}{\tau}\right)\frac{I_n\left[2\sqrt{(\eta+\tau)\tau}\right]}{\sqrt{(\tau+\alpha g)^2-\alpha^2}}d\tau d\eta$$

$\tau_1=\gamma\tau$ we have

$$(\gamma p+1)^{-\frac{n}{2}} e^{\frac{g\alpha\gamma p}{\sqrt{\gamma p+1}}} K_0\left(\frac{\alpha\gamma p}{\sqrt{\lambda p+1}}\right) \to e^{-\frac{t}{\gamma}} \sqrt{\frac{\gamma}{\pi t}} \int_0^\infty \exp\left(-\frac{\gamma\eta^2}{\eta t}\right) \times$$

$$\times \int_{\gamma\alpha(1-g)}^{\gamma\eta} \left(\frac{\gamma\eta-\tau}{\tau_1}\right)^n \frac{I_n\left[\frac{2}{\gamma}\sqrt{(\gamma\eta-\tau_1)\tau_1}\right]}{\sqrt{(\tau_1+\gamma\alpha g)^2-\gamma^2\alpha^2}} d\tau_1 d\eta_1$$

Having made substitution $\eta_1 = \gamma\eta$ (limit ∞ does not vary)

$$(\gamma p+1)^{-\frac{n}{2}} e^{\frac{g\alpha\gamma p}{\sqrt{\gamma p+1}}} K_0\left(\frac{\alpha\gamma p}{\sqrt{\lambda p+1}}\right) \to \frac{e^{-\frac{t}{\gamma}}}{\sqrt{\pi\gamma t}} \int_0^\infty \exp\left(-\frac{\eta_1^2}{\eta\gamma t}\right) \times$$

$$\times \int_{\gamma\alpha(1-g)}^{\eta_1} \left(\frac{\eta_1-\tau_1}{\tau_1}\right)^n \frac{I_n\left[\frac{2}{\gamma}\sqrt{(\eta_1-\tau_1)\tau_1}\right]}{\sqrt{(\tau_1+\gamma\alpha g)^2-\gamma^2\alpha^2}} d\tau_1 d\eta_1$$

Having injected physical constants

$$\gamma = \frac{v_1}{a^2}; \qquad \alpha = \frac{ra}{v_1}; \qquad g = \frac{r_0}{r}$$

Let's gain

$$\left(\frac{a^2}{a^2+vp}\right)^{\frac{n}{2}} e^{\frac{pr_0}{\sqrt{a^2+v_1 p}}} K_0 \frac{pr}{\sqrt{a^2+v_1 p}} \to \frac{ae^{-\frac{a^2 t}{v_1}}}{\sqrt{\pi v_1 t}} \int_0^\infty \exp\left(-\frac{a^2\eta^2}{4v_1 t}\right) \times$$

$$\times \int_{\frac{r-r_0}{a}}^{\eta} \left(\frac{\eta-\tau}{\tau}\right)^n \frac{I_n\left[\frac{2a^2}{v_1}\sqrt{(\eta-\tau)\tau}\right]}{\sqrt{\left(\tau+\frac{r_0}{a}\right)^2-\frac{r^2}{a^2}}} d\tau d\eta$$

at n=1

$$e^{\frac{pr_0}{\sqrt{a^2+v_1 p}}} \frac{K_0 \frac{pr}{\sqrt{a^2+v_1 p}}}{\sqrt{a^2+v_1 p}} \to \frac{a^2 e^{-\frac{a^2 t}{v_1}}}{\sqrt{\pi v_1 t}} \int_0^\infty \exp\left(\frac{a^2\eta^2}{4v_1 t}\right) \times$$

$$\times \int_{\frac{r-r_0}{a}}^{\eta} \frac{(\eta-\tau) I_n\left[\frac{2a^2}{v_1}\sqrt{(\eta-\tau)\tau}\right]}{\tau\sqrt{\left(\tau+\frac{\eta_1}{a}\right)^2-\frac{\tau^2}{a^2}}} d\tau d\eta \qquad (21)$$

For determination of other original in (20) will take advantage of the formula

$$e^{gp}K_1(bp) \to \frac{1}{b}\sqrt{(t+g)^2 - b^2}; \qquad t > b-g$$

Using as well as in the previous case passage from p to $p - \frac{1}{p}$,

Let's gain

$$e^{g\left(p-\frac{1}{p}\right)} \frac{K_1\left[b\left(p-\frac{1}{p}\right)\right]}{p^n\left(p-\frac{1}{p}\right)} \to \frac{1}{b}\int_{b-g}^{t}\left(\frac{t-\tau}{\tau}\right)^n In\left[2\sqrt{(t-\tau)\tau}\right]\sqrt{(\tau+g)^2 b^2}\,d\tau$$

Passing from p to $\sqrt{p}$, we have

$$e^{g\left(\sqrt{p}-\frac{1}{\sqrt{p}}\right)} \frac{K_1\left[b\left(\sqrt{p}-\frac{1}{\sqrt{p}}\right)\right]}{p^{\frac{n}{2}}\left(\sqrt{p}-\frac{1}{\sqrt{p}}\right)} \to \frac{1}{\sqrt{p}}\int_0^{\infty}\exp\left(\frac{\eta^2}{4t}\right)\times$$

$$\times\int_{b-g}^{\eta}\left(\frac{\eta-\tau}{\tau}\right)^2\sqrt{(\tau+g)^2-b^2}\,In\left[2\sqrt{(\eta-\tau)\tau}\right]d\tau d\eta$$

Passing from p to p+1, we will gain

$$e^{\frac{gp}{\sqrt{p+1}}} \frac{K_1\left(\frac{bp}{\sqrt{p+1}}\right)}{(p+1)^{\frac{n}{2}}\frac{p}{\sqrt{p+1}}} \to \frac{e^{-t}}{b\sqrt{\pi t}}\int_0^{\infty}\exp\left(\frac{\eta^2}{4t}\right)\int_{b-g}^{\eta}\left(\frac{\eta-\tau}{\tau}\right)^2\sqrt{(\tau+g)^2-b^2}\,In\left[2\sqrt{\eta-\tau)\tau}\right]d\tau d\eta$$

Passing from p to γp

$$\frac{(\gamma p+1)^{\frac{1-n}{2}}}{\gamma p}e^{\frac{\gamma p}{\gamma p+1}}K_1\left(\frac{b\gamma p}{\sqrt{\gamma p+1}}\right) \to e^{-\frac{t}{\gamma}}\frac{1}{b}\sqrt{\frac{\gamma}{\pi t}}\times$$

$$\times\int_0^{\infty}\exp\left(\frac{-\eta^2}{4t}\right)\int_{b-g}^{\infty}\left(\frac{\eta-\tau}{\tau}\right)^2\sqrt{(\tau+g)^2-b^2}\,In\left[(\eta-\tau)\tau\right]d\tau d\eta$$

It is made substitution of variable of integration $\tau_1 = \gamma\tau$.

$$\frac{(p+1)^{\frac{1-n}{2}}}{\gamma p} e^{\frac{g\gamma p}{\sqrt{\gamma p+1}}} K_1\left(\frac{b\gamma p}{\sqrt{\gamma p+1}}\right) \to \frac{e^{-\frac{t}{\gamma}}}{b\sqrt{\pi\gamma t}} \times \int_0^{\infty} \exp\left(-\frac{\gamma\eta^2}{4t}\right) \times$$

$$\times \int_{\gamma(b-g)}^{\gamma\eta} \left(\frac{\gamma\eta-\tau_1}{\tau_1}\right)^n \sqrt{\left(\frac{\tau_1}{\gamma}+g\right)^2 - b^2} In\left[\frac{2}{\gamma}\sqrt{(\gamma\eta-\tau_1)\tau}\right] d\tau_1 d\eta_1$$

Having injected $\eta_1 = \gamma\eta$ (limits 0 and ∞ do not vary)

$$\frac{(\gamma p+1)^{\frac{1-n}{2}}}{\gamma p} e^{\frac{g\gamma p}{\sqrt{\gamma p+1}}} K_1\left(\frac{b\gamma p}{\sqrt{\gamma p+1}}\right) \to \frac{e^{-\frac{t}{\gamma}}}{b\gamma\sqrt{\pi\gamma t}} \times$$

$$\times \int_0^{\infty} \exp\left(-\frac{\eta^2}{4\gamma t}\right) \int_{\gamma(b-g)}^{\eta_1} \left(\frac{\eta_1-\tau_1}{\tau_1}\right)^n \sqrt{\left(\frac{\tau_1}{\gamma}+g\right)^2 - b^2} In\left[\frac{2}{\gamma}\sqrt{(\eta_1-\tau_1)\tau_1}\right] d\tau_1 d\eta_1$$

Having injected physical constants $\gamma = \frac{\nu}{a^2}; \quad b = \frac{ra}{\nu}; \quad g = \frac{r_0 a}{\nu}$,

$$\frac{\left(\frac{\nu p}{a^2}+1\right)^{\frac{1-n}{2}}}{p} e^{\frac{pr_0}{\sqrt{a^2+\nu p}}} K_1 \frac{pr}{\sqrt{a^2+\nu p}} \to \frac{a^2 e^{-\frac{a^2 t}{\nu}}}{r\sqrt{\pi\nu t}} \int_0^{\infty} \exp\left(-\frac{a^2\eta^2}{4\nu b}\right) \times$$

$$\times \int_{\frac{r-r_0}{a}}^{\eta} \left(\frac{\eta-\tau}{\tau}\right)^n \sqrt{\left(\tau+\frac{r_0}{a}\right)^2 - \frac{r^2}{a^2}} In\left[\frac{2a^2}{\nu}\sqrt{(\eta-\tau)\tau}\right] d\tau d\eta$$

In that specific case, at n=1

$$e^{\frac{pr_0}{\sqrt{a^2+\nu p}}} \frac{K_1 \frac{pr}{\sqrt{a^2+\nu p}}}{p} \to \frac{a^2 e^{-\frac{a^2 t}{\nu}}}{r\sqrt{\pi\nu t}} \int_0^{\infty} \exp\left(-\frac{a^2\eta^2}{\eta\nu t}\right) \times$$

$$\times \int_{\frac{r-r_0}{a}}^{\eta} \frac{(\eta-\tau)\sqrt{\left(t+\frac{r_0}{a}\right)^2 - \frac{r^2}{a^2}} I_1\left[\frac{2a^2}{\nu_0}\sqrt{(\eta-\tau)\tau}\right] d\tau d\eta}{\tau} \qquad (22)$$

Let's display on instances that growth of function $\int_0^t e^{f(t,\tau)} d\tau$ matches to growth of function $e^{\alpha t}$ where $\alpha t - \sup f[0,t]$. At first we will observe $f(t,\tau) = \alpha(t-\tau)$ the graphic is presented on Fig. 2.

$$\sup f = \alpha t$$

$$\int_0^t e^{\alpha(t-\tau)} = \frac{1}{\alpha}(e^{\alpha t} - 1)$$

f

f=α t

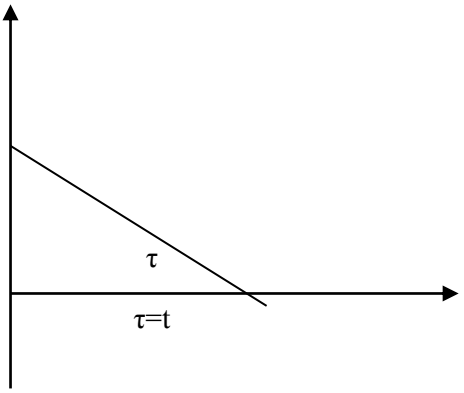

Fig. 2

In other case we will observe $f(t,\tau) = \alpha t$, the graphic on Fig.3

$$\int_0^t e^{\alpha t} d\tau = te^{\alpha\tau}$$

f

τ

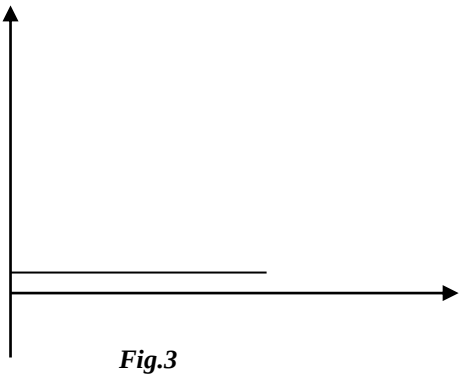

Fig.3

Now we will observe function the graphic Fig. 4

$$\sup f = \frac{a^2}{\nu} t$$

$$f = \frac{2a^2}{\nu}\sqrt{(t-\tau)\tau}$$

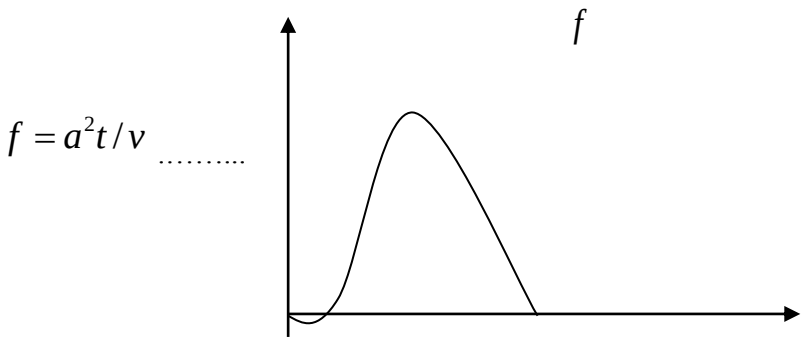

Fig.4.

Hence, integral growth will respond function $e^{\frac{\alpha t}{\nu}}$ and an integral of the Laplace will exist at Rep> 0. Having marked out originals of functions in (21) and (22) accordingly through A (a, r, t) and B (a, r, t), it is possible to express the original of function U_1 in (20) as follows

$$U_1 = \frac{2r_0 v_0}{\tau}\frac{d}{dt}\int\limits_{\frac{r-r_0}{b}} \Big[\ A(b,r_0,t)\cdot A(a,r,t-\tau) + \frac{1}{r}A(b,r_0,\tau)\cdot B(a,r,t-\tau) +$$

$$+\frac{2}{r_0}B(b,r_0,\tau)\cdot B(a,r,t-\tau) - \frac{1}{r}A(a,r_0,\tau)\cdot B(b,r,t-\tau) -$$

$$-\frac{2}{r_0 r}B(a,r_0,\tau)\cdot B(b,r,t-\tau\ \Big]d\tau$$

On boundary line $r = r_0$

$$U_1 = \frac{2r_0 V_0}{\tau}\frac{d}{dt}\int_0^t \Big[A(b,r_0,\tau)\cdot A(a,r,t-\tau) + \frac{1}{r}A(b,r_0,\tau)\cdot B(a,r_0,t-\tau) +$$

$$+\frac{1}{r}B(b,r_0,\tau)\cdot A(a,r_0,t-\tau)\Big]d\tau$$

Research of problems about extending of waves on the basis of model Foigot is less desirable, than on the basis of model of Maxwell as there can be infinite voltage or infinite velocities of extending of perturbations, that actually cannot have a place. However, practical data about properties of materials, including soils, are based on models Foight and conversion on model of Maxwell, naturally, can lead to essential lapses. Similar any modeling of the medium, which mechanical behavior depends on a time, is applied very widely, and models are called rheological models; some authors give them extremely great value and consider a problem of exposition of properties of this or that medium solved when discovered adequate rheological model is. Actually any model such is only analogy, but not means of an explanation of an appearance. In material structure it is impossible to specify real carrying agents of properties of an ideal elasticity or ideal viscosity; if sometimes also it is possible to gate out structural elements which elastic or viscous properties can be assigned.

From our point of view the interest outcomes of problems both on the basis of model of Maxwell, and on the basis of model Foight.

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DYNAMIC PARAMETERS OF HIGH-RISE FRAME BUILDINGS AT VIBRATING SEISMIC LOADINGS

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Research of dynamic properties of various materials and elements of structures at shock affecting and on the waves so many scientific works of the Azerbaijani scientists are devoted [1-10]. However, experimental definition of dynamic parameters of fluctuations of constructions and buildings while carries estimated character.

The purpose of the present experimental researches is definition of parameters of fluctuations of installation of observations, in this case, a mockup of four floor buildings and sixteen floor skeleton-type buildings built in the Baku with the stiffening diaphragm at natural vibrating seismic affectings. The block-diagramme of the given experiment for a mockup is resulted on fig. 1.

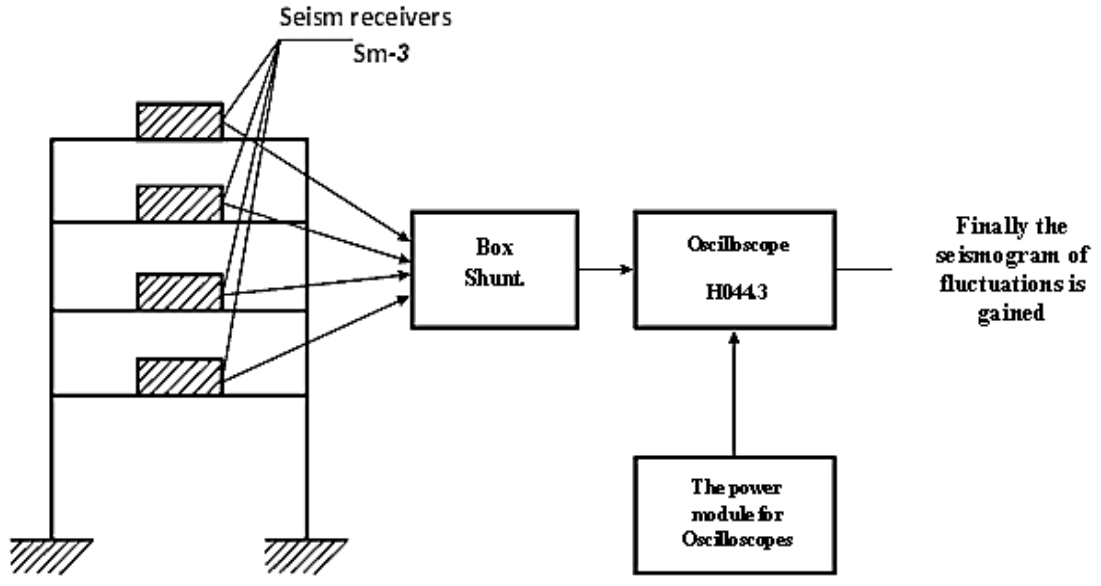

Fig. 1

In the given experiments have been used seism receivers Sm-3 for record of fluctuations of a mockup and 16 floor skeleton-type buildings. Device Sm-3 is universal and can be used for registration both vertical, and horizontal fluctuations. The period of natural fluctuations T=2 sec. Maximum amplitude of oscillation A_{max}=5мм. Seism receivers display mechanical fluctuations which convert in electric and transfer them in the oscilloscope, but through so-called shunt box Sc.-2. Box Sc.-2 is intended for turning on seismic channels between sensing transducers-seismoreceivers and galvanometres of the oscilloscope for step decrease in magnitude of an electric signal in 1, 2, 5, 10, 20, 50 and 100 times on each of six channels.

Shining oscilloscopes HO44.3 are intended for registration by a light ray on special photographic «oscillograph» to a paper of electric processes changing in a time, and also the various physical processes converted to the electric. The principle of their act is based on transformation of displayed electric magnitude by an oscillograph mirror-image galvanometre of a deviation of a light stain. At fluctuations of a framework of a galvanometre the reflexion angle in a horizontal plane also varies. The reflected ray of light moves, the investigated process developed in a time (fig. 2) further registers. In fig. 2 records of vibratory movement of a mockup are presented

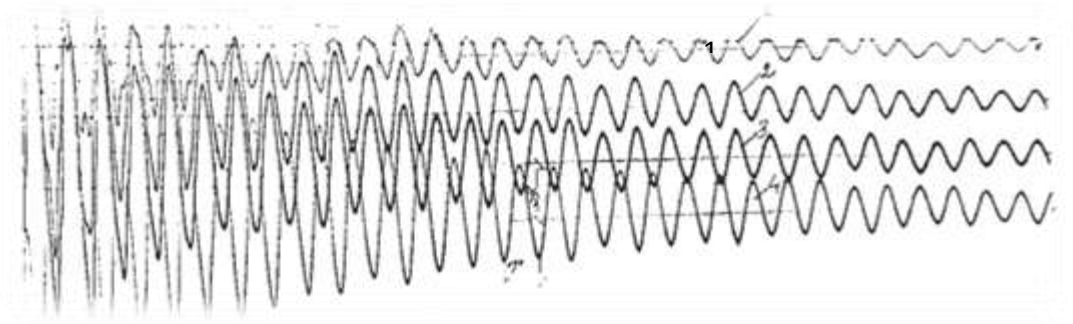

Fig.2

There: 1 – records at level of 1st floor,
2 – records at level of 2nd floor,
3 – records at level of 3rd floor,
4 – records at level of 4th floor,

Processing the received seismograms, we define following parametres of fluctuations of investigated object: duration of all record and a site of the most intensive fluctuations, the maximum amplitude of fluctuations, the visible period of fluctuations to corresponding maximum amplitude and the prevailing period of fluctuations, logarithmic decrement of attenuations. For recalculation of amplitudes in dimension of physical sizes characteristics and results degree devices, which is definition of factor of increase in seismoreceivers Sm-3 are used. True size amplitude in our case

$$A_{true}=\frac{A_{record}(мм)}{y}=\frac{A}{1250}$$

Periods of fluctuations are defined as time intervals, conclusions between extremes. The visible period matching to the maximum amplitude is defined by an interval between extremes. The predominating periods are as average arithmetical value in group samples of the characteristic periods discriminated among themselves more than on 20 %. Amplitudes of fluctuation read off from a zero line. On oscillogramm the zero line is absent and it also define as follows: in the beginning and in the end of amplitude record are close to zero, therefore having connected these sections of record, it is possible to gain good approach to a zero line. The logarithmic decrement of fluctuations is defined under the following formula

$$\lambda=\ell n\frac{A_1}{A_2}=\ell n\frac{An}{An+1}$$

In the scheme set forth above dynamic experiments have been made on test of a mockup of four floor buildings and sixteen floor skeleton-type buildings built in a city of Baku. The mockup for trial has been used for check and degree gears, and also in scientifically exploratory purposes.

The essence of test of dynamic characteristics of buildings on this way is reduced to that on certain distance from the examinee of installation from certain altitude from land depending on magnitude of a demanded impulse the metal load is dumped, in the form of the cylinder is power 3,5 ton which calls ground shaking. Thus tested installation is inferred from the balance condition, passing then in a phase of free fluctuations. Both forced with imposed own, and free fluctuation of the building, fluctuation of a ground from the shaking called by falling of a load are fixed matching by vibro-measuring equipment.

For data acquisition about disturbing forces, that is about seismic effect of fluctuations, interference between the base and the basis, and also about forced and natural fluctuations 16 floor buildings, clearer representation about the form and magnitude of moving seismometers are installed at foundation level, on the first, fourth, eighth, twelfth and sixteenth floors. The gained oscillogram of lateral fluctuations is presented on fig. 3

1 second

1 ground

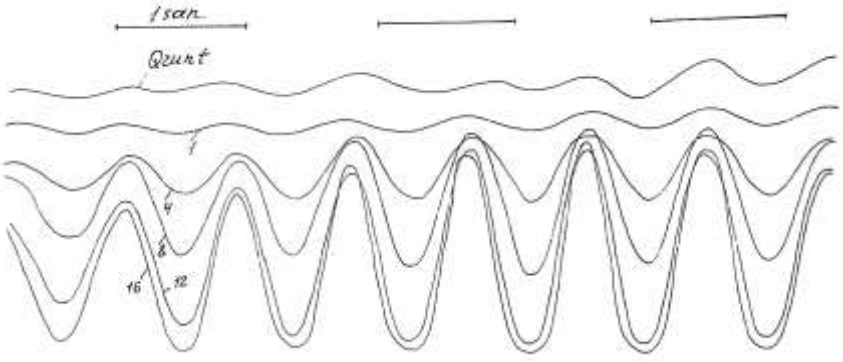

Fig.3

Changing arrangement directions of vibro-measuring equipment, the oscillogram of the longitudinal natural fluctuations of the building also is gained. Processing the gained seismogram and defining parameters of fluctuations of a building it is possible to draw following leading-outs:

1. Dynamic tests are spent for the purpose of definition dynamic and rigidity of the characteristics, bearing ability of constructive elements of a building, revealing of latent defects.
2. Speed of extending of longitudinal waves in a ground on which the building has, makes a=850 m/sec:
3. By results of calculations standard values of the periods of natural fluctuations $T_{calc.}$=1,4 sec., factor of dynamism $\beta = 0{,}714$. By results of tests in the transverse direction the period of natural fluctuations Tex=0,8 sec, logarithmic decrement of fluctuations λ=0,18, damping factor $\varepsilon = 0{,}23$.. In the longitudinal direction Tex. = 0,7-0,75 sec; $\lambda = 0{,}25$; $\varepsilon = 0{,}33$, the predominating period of natural fluctuations of ground T=0,12 sec. Coefficient of dynamism for transverse fluctuations $\beta = 1{,}023$, of longitudinal fluctuations $\beta = 1{,}03$, rated $\beta = 0{,}64$. Depending on a modification of actual phase of natural fluctuations of a building in comparison with the standard it is installed, that a building damage rate the moderated.
4. Phases of natural fluctuations on floors of building do not vary as well as in the longitudinal direction, and in the cross direction. It means that strength of concrete on all floors is equal, does not vary and matches to class of B25.
5. By means of specially made program on an algorithmic language of TURBO PASKAL 7.0. specters of acceleration of a ground depending on phase are formed and the analysis of gained these and frequency specters is carried out.

6. Outcomes of the spent trials have shown that, strength of concrete matches to class B25 and a seismic resistant building, is formed on norms SniP-82 "Construction in seismic regions"

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NONLINEAR THEORY OF THE INTERACTION BETWEEN UNDERGROUND CONSTRUCTIONS AND GROUND MASSIVE AT VARIOUS EMERGENCY SITUATIONS

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In this article we attempt to analyze the statement of the underground spherical vesicles created by a nuclear explosion, and a cylindrical vertical production [1] well using the mathematical methods. Purpose of this analysis is to determine stressed and strained condition, the cause of the vesicles failure and changes of geometrical parameters over time. Such task have to decide taking into account materials heterogeneity, physical and geometrical nonlinear statement, cracks and rock creep. It should be noted that creep deformation and breaking up of material are resulted because of high flexural stress. Also change in geometrical shape of sphere vesicle; loss of stability are reduced due to geometrical changes; aging of material are taking place. Decreasing of the carrying capacity of the cavity walls is possible under the influence of random processes, the effects of radiation, leaching of salts in any construction. After all, it might to initiate full crush causing by great environmental hazards focus.

The main idea of construction of the mathematical model for researching the object consists in following. Massive of heterogeneous rocks is considered as single solid heterogeneous body with variable heterogeneous properties in the cracking process. These properties are characterized by any parameters smoothing of stressed and strained condition in the crack vicinity and will considered integrally in the end.

Massive operation comes to the operation of the physically nonlinear heterogeneous material taking into account cracking in conditions of the flat strained statement.

We can to determine heterogeneity functions specifying the field of distribution of the relevant factor by analytical functions or based on the numerical solution, or by using the experimental data.

Micro cracks in material are resulted with decrease of carrying capacity of rocks. In our case elastic module also will decrease forming the massive heterogeneity with increasing of the cracking percent in heterogeneous rock massive according to this parameter.

The main idea of equivalent model is in replacement of such material by homogeneous isotropic material with equivalent (integral) physical and mechanical properties giving such deformational characteristics as well as cracked rocks.

We can to solve such problem on the base of equivalent characteristics of material using any software like «Lira» or SCAD, or to get certain calculations of solution using different engine methods.

Thus, computational model is shared into 2 elements. It is necessary to solve tasks of long-term creep of vertical half-flatness with a cylindrical hole and spherical cavity of a great depth for analysis of present condition.

First task. Vertical 10 m in diameter cylindrical vesicle is stated in the half-space consisting of different slices of material (from up to down: topsoil, loam, sand, mine salt, etc.). Walls of this vesicle are cemented with M400 brand cement on the depth of 20 sm. It is considered that wells influence is not considerable on certain R distance and stressed condition is considered to be equal to the natural stressed condition of half-space (hydrostatic pressure by Dinnik). Thus, task is reduced to the solution of thick-walled cylinder under the influence of natural and stressed condition of half-space. Problem is solved in one-dimensional statement. Analytical solution is working out in cylindrical coordinates for the accuracy estimation of the resulted numerical solution.

Second problem. Underground vesicle of sphere shape with D diameter generated by the nuclear explosion is examined. Walls with radially heterogeneous properties are formed by simultaneous influence of internal pressure and high temperature. Internal part of this vesicle is caked that caused by high temperature forming very strength rock. It is impossible to research properties of internal wall. Let it be as the most solid natural rock - granite, and the material property will be equal to the property untouched massive, i.e. property of mine salt in some removal of the R radius. Thus, model of second problem will be following. It is considered the sphere vesicle with internal radius *a,* external – *в* pressured even assigned mine pressure (hydrostatic pressure by Dinnik). Salt rock has temperature of 100^0C on the depth of 1 km and changes its property. Further solution is shown according to this property and temperature stress of vesicle. Problem is solved in linear one-dimensional statement. Analytical solution is working out in sphere coordinates for the accuracy estimation of the resulted numerical solution. Heterogeneity can significantly change view of the stressed and strained condition of hollow cylinder. And these changes can favorably affect on its strength (for example, to decrease the concentration factor) or can be cause of destruction. Anyway, research of these phenomena makes it possible to carry out grounded calculations. Thereby, estimation problem for hollow cylinder from earlier times attractive for researches taking into account its heterogeneity. At present, researches in this direction created rather new and independent branch of mechanics of solid strained body – theory of solid deformable body - the theory of elasticity of inhomogeneous bodies. Various aspects of the calculation theory for inhomogeneous bodies studied by Andreyev V.I., Burger I.A., Kolchin G.B., Lomakin V.A., Lekhnicki S.G., Mikhlin S.G., Rostovcev N.A., Olyshak V., Rykhlevski Ya., Urbanovski V. and other authors. It should pay special attention to the work of Lomakin V.A., Bezukhov N.I., Alexandrov A.V., Yerzhanov Zh.S., Darkov A.V., Shaposhnikov N.N., Zenkevich

O., Rozin L.A. and others' works have great importance in the sphere of numerical calculation methods by computer.

We consider a continuous heterogeneity when mechanical characteristics are continuous functions of coordinates. Choice of certain dependences between mechanical characteristics and coordinates are determined, firstly, on the base of experimental data according to the influence of various physical factors (material structure, temperature and radiation influences, etc.) on mechanical properties. On the other hand, it is desirable to select similar dependences that they will give an opportunity to get relatively simple solutions to problems. These two factors are sometimes very conflictive and determine the choice of functions of mechanical characteristics. For example, in the problem of radiation stresses in thick-walled cylinder constructed on the base of experimental data, Young's modulus dependence on the intensity of radioactive irradiation is so complex that it is not possible to obtain an analytical solution even in the one-dimensional statement. Solution becomes easier with approximating this dependence by more simple functions. But, obtained results essentially differ from accurate ones quantitatively as well as qualitatively. Same situation is in the temperature problems. It should be noted that approximation problems exist as in choice of functions for change of mechanical characteristics as in account of outside influences. Replacing the actual distribution of temperature by more simple dependence leads to incorrect results. For example, in the problem with internal heat sources.

The creation of underground vesicles using explosion and taking into account grounds structure conduces to soil consolidation or loosening, and ground cracking formation with certain decreasing of enumerated characteristics in the closest zone. Soil consolidations resulted with increasing of density, strength, deformation characteristics in the massive zone around the vesicle. Modulus of ground elasticity changing is well approximating with moving away from the vesicle in both cases as it is shown in [2, 7, 8]

$$E(r) = E_0\left[1 + m_E\left(\frac{a}{r}\right)^{n_E}\right], \tag{1}$$

when E_0 – modulus of undisturbed massive elasticity, $m_E = \dfrac{E_a - E_0}{E_0}$

E_a – modulus of elasticity on the outline of vesicle with $r = a$,

$n_E > 0$ – empirical coefficient.

Ratio (1) well describes experimental curves in spite of comparative simplicity. Moreover, modulus of elasticity tends to E_0 for large value of radius. Choosing certain n_E, we can to approximate the wide choice of dependences both as with slow as high speed of E quantity changing that meets the more or less zone of the massive with changed properties. If parameter $m_E > 0$ then ratio (1) satisfies to the soil consolidation, and $m_E < 0$ – to the soil loosening (fig. 1). It should be noted that the dependence (1) can be used in calculation of the strain and stressed condition of the massive with sphere vesicle and in sufficiently long cylinder vesicle in the blast-hole drilling method of tunneling.

Absence or insufficient quantity of experimental data of mechanical characteristics (Poisson's ratio ν, yield limit σ_T) changing doesn't make it possible to choose certain functions in the problems about explosive influence. However, ratio (1) can be well used for describing such dependences. In the problems of stress concentration in close of underground vesicles formed by explosion we can use following functions

$$\nu = \nu_0 \left[1 + m_\nu \left(\frac{a}{r} \right)^{n_\nu} \right]; \tag{2}$$

$$\sigma_T = \sigma_{r0} \left[1 + m_r \left(\frac{a}{r} \right)^{n_r} \right]; \tag{3}$$

when $n_\nu,\ \ n_r > 0$.

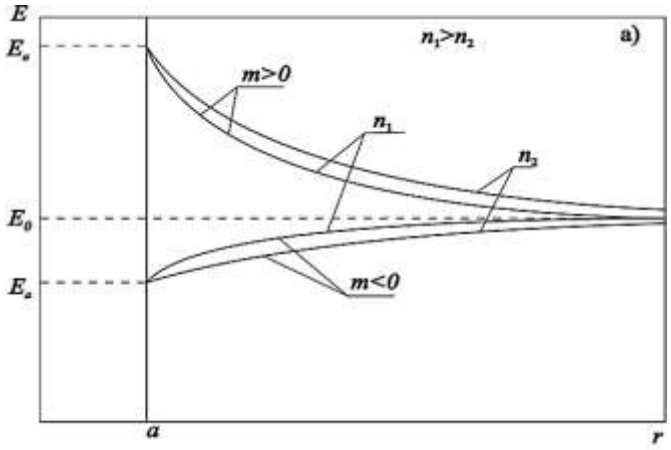

Fig. 1. Changing of modulus of elasticity in infinite massive with cylindrical or sphere vesicle

Also we can use types of ratio (1) – (3) to describe heterogeneity in calculations of the thick-walled cylinders or balls. And *n* coefficients can be negative but physical meaning of constants included in these ratios will be rather different. For example, if we know modulus meanings on inside (E_a) and outside outline ($E_{â}$) of the cylinder or sphere, and any its interim meaning, e.g. in the center of the wall – E_{cp} then m_E и n_E constants can be estimated from the following ratios

$$m_E = \frac{E_a - E_0}{E_0}; \qquad n_E = \frac{\ln\left(\dfrac{E_{â} - Å_0}{Å_{à} - Å_0} \right)}{\ln \dfrac{a}{b}} \tag{4}$$

a and *b* are the inside and outside radiuses of the cylinder or ball space, respectively. And E_0 is estimated in following transcendental ratio.

$$\frac{E_в - E_0}{E_a - E_0} = \left(\frac{E_{cp} - E_0}{E_a - E_0} \right)^{\alpha} \tag{5}$$

when

$$\alpha = l\,n\left(\frac{в + a}{2a} \right) \Big/ \ln\left(\frac{в}{a} \right).$$

It should be noted that dependences (1) – (3) don't exhaust all possible mode of approximation and we just can't use mostly in such problems.

Making of the dependence between mechanical characteristics and coordinates consist of two stages during solving the problems with indirect heterogeneity. We can to show the actions succession using the example of problem of the radioactive irradiation in concrete constructions at such operation. For example, concrete modulus of elasticity depends on irradiation intensity Φ (neutron fluence) like this [5]

$$E = E_0\left[\gamma - \alpha_1 \lg(\beta_1 \Phi)\right], \tag{6}$$

when γ, α_1 и β_1 – empirical coefficients depending on concrete brand and neutron energy spectrum.

Irradiation intensity is equal to

$$\Phi = \Phi_0 \frac{a}{r} e^{-\frac{r-a}{\lambda}}, \tag{7}$$

when Φ_0 – values on the inside space ($r=a$); λ - relax length. Thus, ratio $E(r)$ is shown as $E = E[\Phi(r)]$ in this example taking into account ratios (6) and (7). Functions of mechanical characteristics are drawn in like manner in thermomechanics problems.

We can to approximate experimental dependences of changing of the stone salt modulus of elasticity caused temperature influence by expression [5]:

$$E(r) = E_0 e^{-\gamma T(r)}, \tag{8}$$

when E_0 – modulus of elasticity of the not heated massive;

$T(r)$ – heating temperature;

γ – empirical coefficient, $\gamma > 0$.

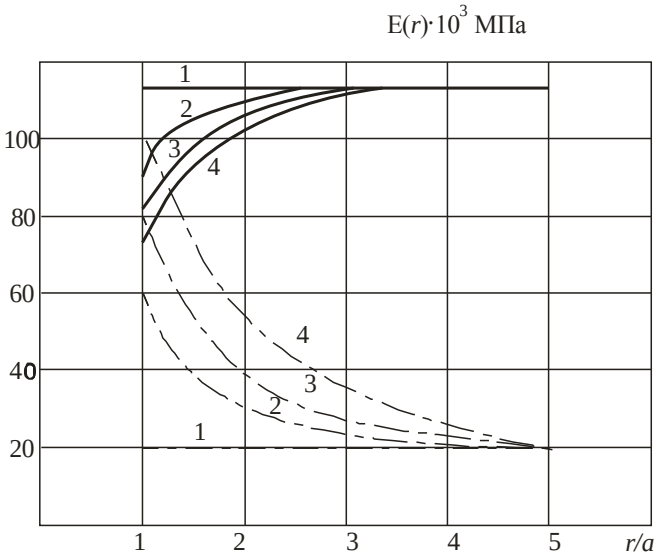

Fig. 2. ___ _ ___ - Temperature changing according to the sphere radius _____ - Changing of the modulus of elasticity depending on temperature [8]. 1 - T_0 = 20°C; 2 – T_0 = 60°C; 3 – T_0 = 80°C; 4 – T_0=100^{0}C.

Here we have questions of approximation of the temperature field. Real temperature distribution substitutes by more simple dependence leads to incorrect results.

Changing of modulus of elasticity for the massive with sphere vesicle is shown on the figure. It caused by the temperature influence and temperature dependence on radius.

If it needs account of temperature and cracking then dependence of the modulus of elasticity becomes more complex and have following view:

$$E(r) = E_0[1 + m_E(a/r)^{n_E}]\exp[-\gamma T(r)] \tag{9}$$

Majority of problems considered below and solutions methods are not determining concrete type of heterogeneity functions. In considered examples and practical attachments we used functions which are the closest ones satisfied to real properties and based on experimental data. Some of them are below.

Following problems were considered. Axes symmetrical flat deformation condition of the thick-walled cylinder, polar- (or central) symmetrical problem for thick-walled ball.

Vertical cylindrical plane is stayed in the half-space consisted from various layers of materials (from up to down: vegetable layer, loam, sand, stone salt, etc.) with diameter 10 m. Walls of plane are cemented by M400 brand cement on the depth of 20 sm. It is considered that in this problem hole influence is not significant on certain R distance and stressed condition on this surface is considered equal to the natural stressed condition of half-space (hydrostatic pressure by Dinnik). Thus, solution of the problem will be the solution of thick-walled cylinder influenced by outside natural stressed condition of half-space, and on the inside usual atmosphere pressure $p_a=0$.

Ambient massive heterogeneity for the shaft of cylindrical cavity can be considered quasiheterogeneity, i.e. with constant value for any cross section. In this case we can to solve the problem considering stressed condition in any horizontal cross section. We should to consider the most dangerous cross section lied on the hole bottom caused increasing of the rock pressure along the increasing depth. Considering depth is accepted equal to depth of the nuclear explosive device location neglecting the sphere radius in the case of probable decreasing of rock strength in connection point with sphere.

Temperature field outside of cylinder is more then 100°C (geothermal). Material formed by B25 concrete is considered isotropic and ideal. To make analytical solution easier pipe is considered as loaded outside by constant pressure for this depth and material is considered incompressible [9].

Temperature field for cylinder is described by formula:

$$T = A_t + B_t Lnr, \tag{10}$$

for sphere -

$$T = A_t + \frac{B_t}{r}, \tag{11}$$

when A_t и B_t - arbitrary constants determined from border conditions.

In the common case the cross section of the thick-walled cylinder or ball with outside radius r_1 and inside - r_2 is under the outside pressure p_1 and inside - p_2 along with temperature pressures.

Problem of estimation of the stressed and strained condition of the thick-walled heterogeneous cylinder comes to the heterogeneous resolving differential equation of the second degree [7,8]

$$\sigma_r'' + \varphi(r)\sigma_r' + \psi(r)\sigma_r = f(r), \tag{12}$$

when

$$\varphi(r)=\frac{3}{r}-\frac{E'}{E}-\frac{2\nu\nu'}{1-\nu^2};\qquad \psi(r)=-\frac{1}{r}\left[\frac{1-2\nu}{1-\nu}\frac{E'}{E}+\frac{(1+4\nu)\nu'}{1-\nu^2}\right]$$

$$f(r)=R\left[\frac{E'}{E}+\frac{2\nu\nu'}{1-\nu^2}-\frac{2-\nu}{r(1-\nu)}\right]-\frac{E}{r(1-\nu^2)}\left[\varepsilon'_B(1+\nu)+\nu'\varepsilon_B\right]-R'$$

We can see from (12) that the most simple solutions for $\varphi(r)$ и $\psi(r)$ we can get with ν = const = 0;5. Following equations are come out respectively:

$$\begin{aligned}\varphi(r)&=\frac{3}{r}-\frac{E'}{E};\\ \psi(r)&=0\end{aligned}\qquad(13)$$

Analogous solution we can get for ball

$$\begin{aligned}\varphi(r)&=\frac{4}{r}-\frac{E'}{E};\\ \psi(r)&=0\end{aligned}\qquad(14)$$

Then with $f(r)=0$ (12) equation makes it possible to reduce the degree and its solution becomes simple:

for cylinder

$$\sigma_r=C_2+C_1\int\frac{E(r)dr}{r^3};\qquad(15)$$

for ball

$$\sigma_r=C_2+C_1\int\frac{E(r)dr}{r^4}\qquad(16)$$

Then stresses σ_θ are estimated from following ratios:

for cylinder

$$\sigma_\theta=C_2+C_1\left[\frac{E(r)}{r^2}+\int\frac{E(r)}{r^3}dr\right];\qquad(17)$$

for ball

$$\sigma_\theta=C_2+C_1\left[\frac{E(r)}{r^3}+\int\frac{E(r)}{r^4}dr\right]\qquad(18)$$

Resulted equations make it possible to work out qualitative analysis of the dependence of stressed and strained condition of constructions on material heterogeneity and, in particular, to answer on question of approximation method influence of heterogeneity functions on estimation results.

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THE POSSIBILITY OF FORMATION OF ALKALI-MINERAL BINDER MATERIALS BASED ON MIXTURE OF ALUMINUM HIGHER OXIDE WASTE, LIQUID GLASS, SODIUM HYDROXIDE, CLAY AND PORTLANCEMENT

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Studies are devoted to the processes of hardening and structure formation of alkali-mineral binders and concretes with application of anthropogenic industrial waste (production of alumina) and alkaline compositions. In the following paper the possibility of formation of alkali-mineral binder materials based on mixture of contents was aluminum higher oxide waste, NaOH, portlancement, clay. Was studied and strengthening structurization process of prepared samples of result adhesive materials was researched. It was defined that adhesive material prepared on this mixture strengthens both at hydrothermal and process conditions. At warm regime 140-150°C temperatures and at 9 atm in autoclave with 174.5°C conditions, and durability limit during pressing of 45,2 and 76,8 MPa was defined accordingly for this alkali-mineral adhesive material. Strengthening of this binder material is based on its structurization process and is generated from creation of hydro silicates. Because after being processed at 140-150°C warm-dry conditions Ca - hydroaluminate $Ca_2Al_2(OH)_{10}\cdot 3H_2O$, Ca – hydroalumosilicate $Ca_2Al_2CиO_7\cdot 8H_2O$ and hydroconcrente $Na_8(Al, Si)_{12}O_{24}(OH)_2\cdot 3H_2O$ when strengthened in autoclave conditions additional xenotlite $Ca_4[Ca(Si_6O_{17})(OH)_2$ (3,06; 4,24; 3,89), Ca –$[Ca_2(HSiO_4)(OH)]$ (4,22; 3,90; 3,54), adularia $K(AlSi_3O_8)$ (3,313; 3,227; 1,792) and hydroxysodalite $Na_2OAl_2O_3SiO_2\cdot 2{,}1H_2O$ is formed which showed to add more strength. Developed, the compositions of alkali-mineral binders of maximum strength with compression of 22,0-70,7 MPa; grained concrete with an average density of 1410-2246 kg/m^3.

Key Words: alkali-mineral binder material, aluminum higher oxide waste, sodium hydroxide, portlancement, clay, liquid glass.

Introduction

One of the most actual problems of modern industry enterprises of construction materials is obtainment of effective composition materials on the basis of local raw materials and anthropogenic waste. It is well-known that on their basis cindery alkali binds and concrete are considered high-strength, frost proof and other improved exploitation properties materials. Cindery alkali cement is differs from famous compositions as it can produced on the basis of various anthropogenic waste and alkali compositions (Krivenko P.V., 1992., Voronin K.M., Qolishnikov M.S., 2006, Buchwald A., Schulz M., 2005, Raximova N.R. 2007).

It will be more reasonable to produce concrete on the basis of alkali-mineral bind using local raw materials and anthropogenic waste, under the stipulation in the capacity of alkali-mineral bind is used mix of liquid glass and flint component. Taking into the consideration that local conditions and development of industry fields in Azerbaijan is quite actual to use waste of different productions which are closer by chemical and mineralogical properties to domestic slag.

It is important to research structurization process of materials with distinct difference in strengthening condition, for both scientific and practical reasons. Research which has been done in this area shows that several scientists and researchers thoroughly learned formation of mineral process of alkali-mineral compositional materials in different conditions.

V.D. Qluxovski, V.Y. Timkovich researched the structurization process of Na liquid glass and alkali-soda alloy, based on alkali-dross cement stones, using physical-chemical methods. It was shown that the basic capacity of dross affects the process of mineral creation. On the first stage of strengthening firstly low CSH (B) typed based hydro silicate and alkali, alkali-land aluminum silicate gel contented minerals are formed not depending on lowness of dross component. Higher durability will be achieved with intensive hydro silicate phase crystallization during first stages of based dross. During the later strengthening period (90-180 days) analcime, leftover Na, Ca mixed hydro silicates and other alkali based products of hydration are received [V.D. Qluxovski, V.Y. Timkovich 1989].

For the first time V.D. Qluxovski, R.F. Runova, A.S. Popolov and others have observed crystallization of zeolite mineral in adhesive solution based on nephelin strengthening in warm-wet conditions. They have mentioned crystallization of zeolite like natrolite and zeolite typed nepheline hydroxide [V.D. Qluxovski, R.F. Runova 1971; V.D. Qluxovski, Rostovscaja Q.S., Raksha V.A., Kurena R.N. 1973, Ziremnikov A.D., Qluxovski V.D., Runova R.F. 1990].

Q.V. Rumin has determined formation of constant compositional kamphelit and analcime along with zeolite natured phenacite like minerals both in autoclave and steam processing conditions in hydromica K_2CO_3 systems, in natural clay materials and Na, K based carbonates, carbonate-sodalite structured sodalite in kaolin- Na_2CO_3 systems, also nepheline-hydroxide, montmorillonite, and new creations close to hydromic and analcime [Rumın Q.V., 1979].

Methods

Following technical processes were carried out as following for acquiring adhesive alkali-mineral effected heat-isolation material. Natural and artificial mineral components which have been used for this were fine graded to 3500-3500 sm²/q. Fine graded mineral is additionally mixed with slack lime dozed and mixed in mixer till uniform mixture. Then dozed amounts of liquid glass is added on to sodium hydroxide and mixed for 2-3 minutes to acquire solution. Moulds are lubricated with special lubricants for alkali-dross concrete prepared beforehand. Lubrication of moulds is made by lubricant oil with specific composition of (% per mass) clay 30-35, Na_2CO_3 3-8, elite-silicate 3-5, rest being water, especially considered for alkali-dross concrete. Casted samples are processed with accordance to strengthening regime selected beforehand. To assure fine grading of mineral components, materials are brought to constant mass at 105-110°C temperatures in CNOL 2.5; 2.5; 2.5/2M typed laboratory drying boxes and checked using ПСХ-2/4. Preparation of concrete mixture, testing, diffusion of mixture is carried out with accordance to construction

standards and rules. Fluidity of mixtures researched was accepted as for construction norms and diffusion of mixture was determined by Stewards viskozimeter. Stewards viskozimeter consists of planes showing different diameters, copper and bronze cylinders with internal diameter of 50 mm and height of 100mm. According to standards diffusion radius of mixture solution for foamy concrete is within 15-25 cm. Diffusion of mixture solution was determined as follows. Firstly 300 q of mineral is added to sphere shaped pottery which is cleaned with humid fabric. Then during 2-5 seconds liquid is added according to taken correlation and is mixed till uniform mixture is achieved during 30 seconds. Prepared mixture is poured into cylinder placed on Stewards viskozimeters pedestal. Surface of solution is leveled and soon viskozimeterical cylinder is freed from solution after rising 15-20 cm. Cylinder is placed aside. Solution is returning to level under force of its own mass. Diameter of spread solution is measured by a ruler and acquired median data is taken as result of the experiment. Samples prepared from mixture of alkali-mineral compositional materials with size of 1x1x3 cm are strengthened in different conditions, such as in normal, drying pit, under dry air and autoclave conditions. Strengthening limit of samples during pressing is defined after being kept in normal conditions for 28 days. Strengthening limit of samples is measured in P-5 typed electronically press and ПСУ-5 typed hydraulic press. Physical-mechanical properties of concrete are defined with accordance to ГОСТ 10180-89. Optimal composition of alkali-mineral systems is chosen using practical mathematical planning method. Analysis of fine graded materials and researched alkali-mineral systems were carried out using modern techniques for measuring phase changes x-rays (RFA) analysis with DRON-3.0 difractiometer (Anode Cu, Kkα1=1.5405E) at "Structure Chemistry" laboratory in Azerbaijan National Sciences Academy's Chemical Problems Institute, and taking derevatoqraphs using differential-thermal analysis Derivatofoqraph (Q-1500) apparatus at "Sorption Processes" laboratory, x-ray analysis method (RSM-8.0) at "Analysis of mineral materials using hysical-chemical methods" laboratory of Geology Institution.

Materials

Natural mineral rocks were used during research aluminum higher oxide waste were used as fine graded cilium 4 oxide mineral component. Liquid glass, NaOH clay and portlancement additions were used like alkali component.

Analysis of fine graded cilium 4 oxide component's chemical composition was carried out using x-ray and acquired results are shown in table 1.

Table 1.

Chemical composition of mineral components

Name	components, %											
	SiO_2	Al_2O_3	Fe_2O_3	K_2O	Na_2O	MgO	CaO	MnO	P_2O_5	TiO_2	i.l	Total
Aluminum higher oxide waste	65,18	18,71	7,56	0,72	0,60	1,06	1,70	0,07	0,13	0,21	4,76	100.7

Hydraulic activity of cilium oxide was defined using following indicators and results are show in table 2.

Modulus of baseness:
$$M_b = \frac{CaO + MgO}{SiO_2 + Al_2O_3}$$

Modulus of activity:
$$M = \frac{Al_2O_3}{SiO_2}$$

Quality coefficient:
$$K_{q.c.} = \frac{CaO + MgO + Al_2O_3}{SiO_2 + MnO}$$

Table 2.

Hydraulic activity indicator of mineral components

Name of Mineral	M_b	M_a	$K_{q.c.}$
Aluminum higher oxide waste	0,02	0,28	0,31

Comparison of used minerals and freezing dross's chemical composition shows that amount of base oxides in the minerals is noticeably low. Mineral is accounted to be base if Ma ≥ 1, acid it Ma < 1, highly active when Kq.o.> 1.9, active when 1.6< Kq.o.<1.9, less active when Kq.o.< 1.6 according to classification.

$Na_2O{\cdot}nSinO_2$ liquid glass was used as alkali component in this research. Special mass of liquid glass used in this research was 1215 kq/m^3, modulus was 2,9. Composition of liquid glass depending on modulus is given in table 3.

Table 3.

Composition of Liquid glass

Modul	**Special Mass kq/m³**	**Composition, % per mass**			
		$Na_2O+nSiO_2$	**SiO_2**	**Na_2O**	**H_2O**
2.9	1215	22.5	16.87	5.63	77.5

Sodium and calcium hydroxides were added to ensure the baseness of alkali-mineral systems.

Implementation and solution procedure

Based on physical-mechanical properties, exploitation quality composition and strengthening condition, researched alkali-mineral adhesive materials are in close relationship with new production.

The mass percentage of liquid glass in experiments with optimized contents was: aluminum higher oxide waste: NaOH: portlancement: clay. This mixture was tested parallel at warm regime 140-150°C temperatures and at 0,9 MPa in autoclave with 174.5°C conditions, and durability limit during pressing of 45,2 and 76,8 MPa was defined accordingly. Chemical components of materials were analyzed with x-ray. Results are show in table 4.

Table 4.

Chemical composition of materials

Name	**components, %**										
	SiO_2	**Al_2O_3**	**Fe_2O_3**	**K_2O**	**Na_2O**	**MgO**	**CaO**	**MnO**	**TiO_2**	**i.l**	**Total**
Alkali-mineral adhesive	36,34	8,63	9,29	0,48	12,42	0,44	7,73	0,025	0,106	29,79	100,8

To study the mineral composition of fine graded mineral components X-ray were taken (Anode Cu, $K_{k\alpha 1}$=1.5405E) woth DRON-3.0 difractiometer. Mineral composition of early mineral is mainly quartz SiO_2 $(3.34_x, 4.26_2, 1.82_1)$, kaolinite-smectite Si-Al-O-OH-H_2O (7,24; 4,44; 3,62 E), aluminum hydroxide $Al(OH)_3$ (4,82; 2,37; 2,45 E),
illite $Al_2(Si_2AlO_2)$ $(3.34_x, 10.0_9, 5.02_6)$, montmorillonite $Na_{0.3}(AlMg)_2Si_4O_{10}OH_2H_2O$ $(4.054_x, 2.294_9, 1.616_8)$ (fig. 1).

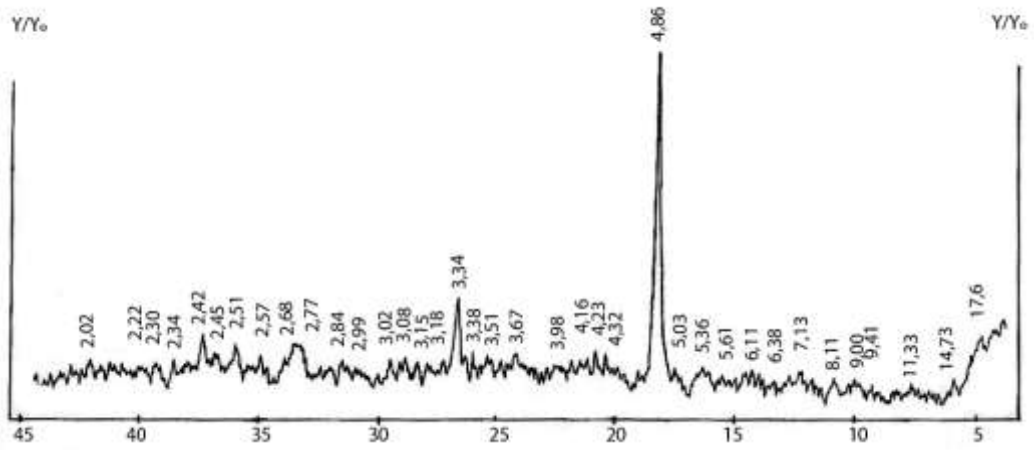

Fig. 1. X-ray of aluminum higheroxide waste based on volcano ashes:

X-ray analysis were carried out to research the phase changes of early and alkali-mineral compositional natural materials, structurization process during strengthening of adhesive materials based on aluminum higher oxide waste.

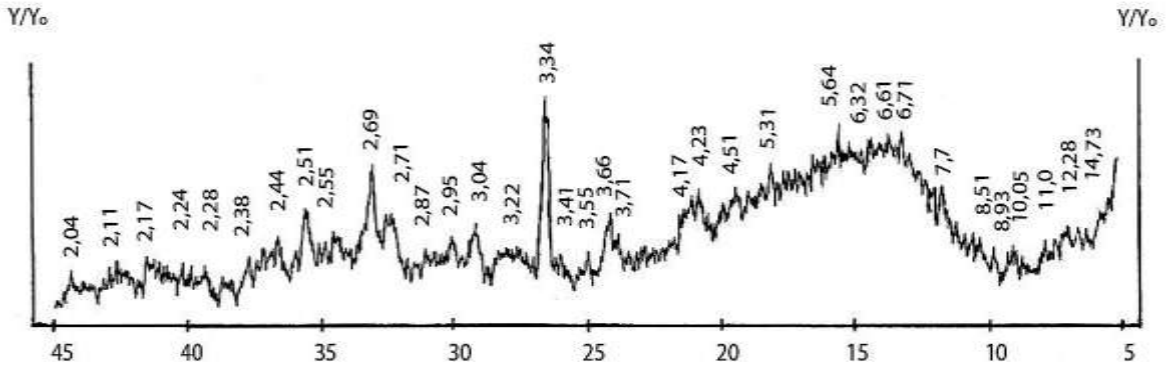

Fig. 2. X-ray of alkali-mineral binder materials based on volcano ashes at 140-150°C

Even though anorthite, quartz, kokcholong are partially dissolved in materials strengthened at temperature of 140-150°C, they remain like the base mineral. Mineral composition of this material is as follows: mainly quartz, kaolinite-smectite, aluminum hydroxide, illite, montmorillonite besides being a clay mineral Ca - hydroaluminate $Ca_2Al_2(OH)_{10}\cdot 3H_2O$ (10,7; 2,87; 2,55), Ca - hydroalumosilicate $Ca_2Al_2SiO_7\cdot 8H_2O$ (12,50; 4,18; 6,27) and hydrocancrinit $Na_8(Al, Si)_{12}O_{24}(OH)_2\cdot 3H_2O$ (3,25; 4,76; 3,71; 2,42) minerals are formed (fig. 2).

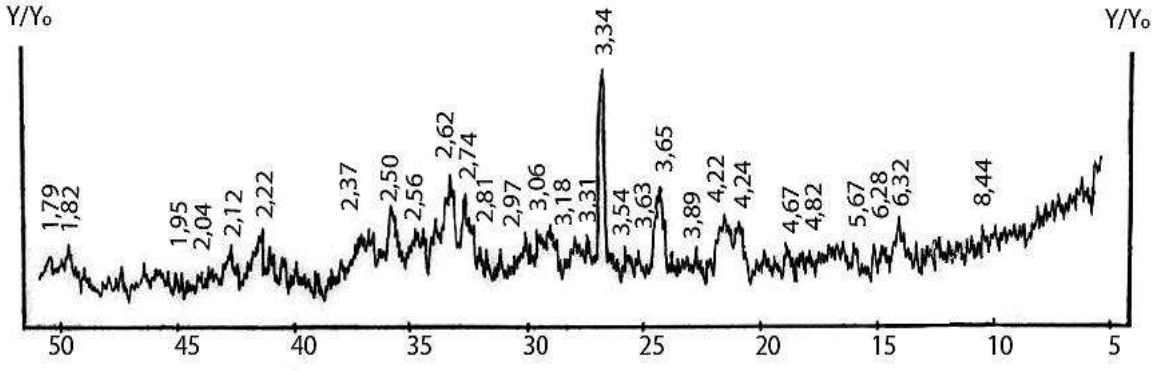

Fig.3. X-ray of alkali-mineral adhesive based on volcano ashes: alkali-mineral at autoclave after 18 hours

In autoclave conditions, quartz, kaolinite-smectite, aluminum hydroxide, illite, montmorillonite which are components of initial material are dissolved more; amount of xenotlite $Ca_4[Ca(Si_6O_{17})(OH)_2$ (3,06; 4,24; 3,89), Ca –$[Ca_2(HSiO_4)(OH)]$ (4,22; 3,90; 3,54), adularia $K(AlSi_3O_8)$ (3,313; 3,227; 1,792) and hydroxysodalite $Na_2OAl_2O_3SiO_2 \cdot 2{,}1H_2O$ (6,28; 3,63; 2,81; 2,56) minerals are formed (fig.3).

Result

Alkali-mineral adhesive based on contents was, aluminum higher oxide waste, sodium hidorxide, portlancement, and clay (% per mass) 22,1 : 57,96 : 7,94 : 4,74: 7,26 was received.

This mixture was tested parallel at warm regime 140-150°C temperatures and at 0,9 MPa in autoclave with 174.5°C conditions, and durability limit during pressing of 45,2 and 76,8 MPa was defined accordingly. Analysis of alkali-mineral material based aluminum higher oxide waste using modern physical-chemical methods shows that durability limit increases appropriately. Because after being processed at 140-150°C warm-dry conditions Ca – hydroaluminate and Ca – hydroalumosilicate is formed which showed to add more strength.

If strengthened in autoclave conditions durability limit will increase even more due to acceleration of melting process of main minerals and increase of xenotlite, Ca – щидросиликат, adularia and hydroxysodalite mineral. By increasing process time of researched system it is possible to normalize the mineral formation process and to increase the durability limit of material at pressing. Investigated system is part of binding hydro-condensation group type with new compositions: Developed, the compositions of alkali-mineral binders of maximum strength with compression of 22,0-70,7 MPa; grained concrete with an average density of 1410-2246 kg/m^3, maximum strength with compression of 12,6-42,2 MPa; insulating cellular concrete with average density of 350-500 kg/m^3, thermal conductivity of 0,077-0,084 W/(m·°C); constructional and heat-insulating cellular concrete with an average density of 500-800 kg/m^3, thermal conductivity of 0,084-0,156 W/(m·°C) maximum strength with compression of 4,5-8,9 MPa. It is established that such concretes have greater insulating ability compared to traditional foam concrete. Technic-economic calculations revealed that the cost of producing 1m^3 alkali-mineral fine-grained concretes is 8,97-22,8% less compared with the known hollow pottery; 24,7-30,11% less than clay tiles; 3,78-10,65% less - concrete tile and alkaline-mineral cellular concrete and 6,2-8,6 % less than known cellular concrete products.

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INVESTIGASTION OF SDOF IDEALISATION FOR STRUCTURES WITH OPTIMUM TUNED MASS DAMPERS

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The tuned mass damper (TMD) is a passive control system consisting of mechanical components such as mass, spring and viscous dampers. This device implemented to major civil engineering buildings in order to reduce structural vibrations.

The basic of TMDs were proposed by Frahm [1] but it is only effective under the excitations with the similar frequency of the device because it only contains mass and springs. Ormondroyd and Den Hartog [2] added inherent damping to the device for reducing vibrations immediately. Several expressions for optimum tuned mass damper parameters were given in documented researches [3-5]. In these methods, the main structure was idealised as a single degree of freedom system while obtaining the expressions.

Numerical optimization methods have been used for tuning structures with TMD [6-9]. In addition to that, several metaheuristic methods have been used for optimization of TMDs. Genetic algorithm (GA) [10-13], particle swarm optimization (PSO) [14-15] and harmony search (HS) [16] are the metaheuristic methods used for estimating optimum TMD parameters for structures.

In this research, single degree of freedom (SDOF) and multiple degrees of freedom (MDOF) idealization of superstructures were compared for optimization of tuned mass damper (TMD) implemented on top of superstructures. A metaheuristic optimization algorithm, harmony search (HS) was used for optimization process.

Methodology

There are two cases in this study. Case 1 is the SDOF idealization. Only the first mode at the horizontal direction of the structure is considered at the optimization process. Case 2 is the MDOF idealization. Number of the mode as many as storey number was considered. If the number of the storey is **n**, Case 2 is **n** times longer than Case 1 for optimization. In Case 2, **n** number of modes are considered so a more realistic idealization of the structure is done. After the optimization, multiple degrees of freedom model was tested for two cases.

The harmony search algorithm is based on musical performance process in which a musician searches for a better state of harmony. The HS method was proposed by Geem et al. [17] for solving problems optimally.

A program for optimization and dynamic analyses of the structure was developed by using Matlab and Simulink. For the time history analysis, Runge Kutta method with 10^{-3} seconds step was used. First, the program reads earthquake and structural data and calculates the major responses for the structure without TMD. Then, harmony vectors are generalized with random parameters of mass, period and damping ratio of TMD. Program searches mass between 1%-5% of the superstructure mass, period between 0.8-1.2 times of the superstructure period and damping ratio between 5%-40%. After the calculation of the dynamic responses for the structure with TMD, the stopping criteria are checked. For the stopping criteria, first storey acceleration transfer function (TF) must be smaller than uncontrolled one and the ratio between the first storey displacements of the controlled and uncontrolled structure (RFSD) must be smaller than a pre-selected value. If the criteria are not satisfied, new harmony vectors are generalised.

The worst vector is eliminated after each iterations until the satisfaction of the criteria. The best and worst vectors are chosen according to the RFSD. If the pre-selected value is smaller than the possible value, the program iteratively increases this value after several trials.

In Table 1, the records used at this study can be seen. Six different excitations were used for a more general optimization results.

Table 1.

Earthquake records used in the HS optimization

Earthquake	Date	Station	Component
Loma Prieta	1989	16 LGPC	LGP000
Gazli	1976	KARAKYR	GAZ090
Erzincan	1992	95 Erzincan	ERZ-NS
Imperial Valley	1940	EL CENTRO ARRAY #9	ELC180
Northridge	1994	24514 Sylmar- Olive View Med FF	SYL360
Kobe	1995	0 KJMA	KJM000

Note: Earthquake records were taken from PEER NGA DATABASE (http://peer.berkeley.edu/nga/)

Results

Numerical Example 1

The cases were compared with two examples. The first example is a seven storey building with same storey properties. The mass, rigidity and damping coefficient for each storey are 180 tons, 400MN/m and 3MNs/m, respectively.

The critical period of the first mode is 0.64 seconds. The natural frequencies of the building are 1.57 Hz, 4.64 Hz, 7.5 Hz, 10.04 Hz, 12.14 Hz, 13.71 Hz and 14.68 Hz respectively.

In Table 2, the optimum tuned mass damper parameters for the example 1 can be seen for both cases. The period and damping ratio are near to each other for different cases.

Table 2.

Optimum tuned mass damper parameters for Ex.1

Optimization Results	Case 1	Case 2
TMD mass (t)	25.85	29.5
TMD period (s)	0.661	0.666
TMD damping ratio	0.396	0.398

In Table 3, the maximum average displacements for all excitations for the example 1 can be seen. Average displacement is the average of the displacements of the first and top storey. All cases seem feasible.

Table 3.

Average Displacement (cm) for Ex.1

Earthquake	Uncontrolled	Case 1	Case 2
Gazli	6.38	4.62	4.60
Kobe	14.66	8.46	8.48
Erzincan	5.91	4.58	4.58
Imperial Valley	4.87	2.83	2.81
Northridge	10.58	6.69	6.65
Loma Prieta	20.45	5.83	5.75

In Fig. 1, the first storey displacement of the first example under Northridge Slymar record can be seen for the comprasions of the uncontrolled and the vibration controlled cases.

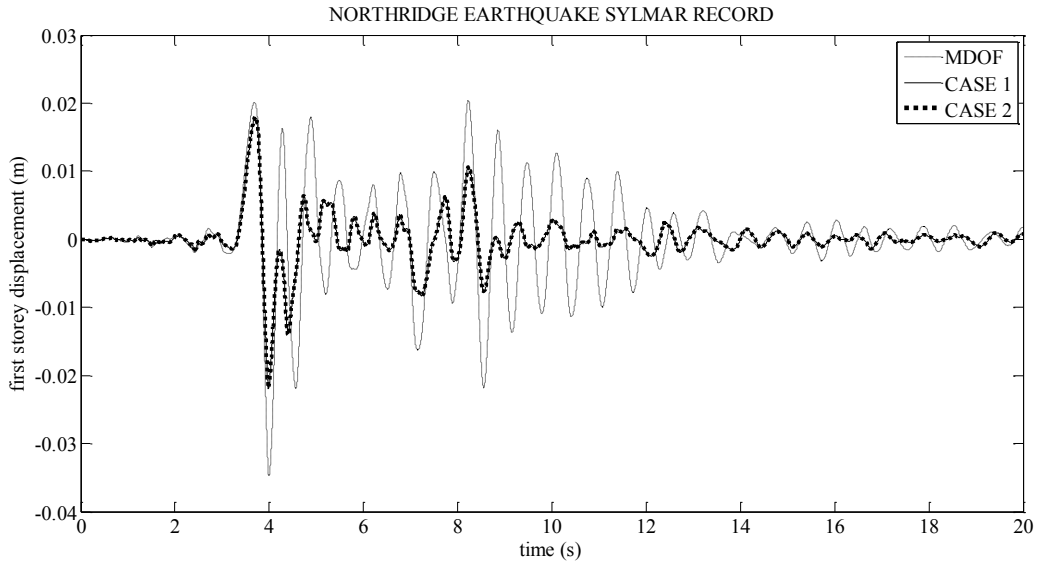

Fig. 1. First storey displacement under Northridge earthquake Slymar record for Ex.1

Numerical Example 2

The second example is also a seven storey building but it has different storey properties. The properties of the structure can be seen in Table 4.

Table 4.

The properties of building of Ex. 2

Storey	Mass (t)	Rigidity (MN/m)	Damping Coefficient (MNs/m)
1	180	400	3
2	170	380	2.80
3	160	360	2.60
4	150	340	2.40
5	140	320	2.20
6	130	300	2.00
7	120	280	1.80

The critical period of the first mode is 0.58 seconds. The natural frequencies of the building are 1.71 Hz, 4.67 Hz, 7.49 Hz, 10 Hz, 12.09 Hz, 13.64 Hz and 14.60 Hz respectively. These frequencies are closer to each other than the first example.

Table 5.

Optimum tuned mass damper parameters for Ex.2

Optimization Results	Case 1	Case 2
TMD mass (t)	18.4	15.6
TMD period (s)	0.598	0.612
TMD damping ratio	0.391	0.4

In Table 5, the optimum tuned mass damper parameters for the example 2 can be seen for both cases. A small difference can be seen in the optimum parameters for the cases.

In Table 6, the maximum average displacements for all excitations for the example 2 can be seen. In Fig. 2, the first storey displacement of the second example under Northridge Slymar record can be seen.

Table 6.

Average Displacement (cm) for Ex.2

Earthquake	Uncontrolled	Case 1	Case 2
Gazli	8.50	4.47	4.59
Kobe	10.66	7.36	7.28
Erzincan	4.84	4.03	3.97
Imperial Valley	4.67	2.72	2.71
Northridge	9.44	6.37	6.31
Loma Prieta	12.66	5.16	4.92

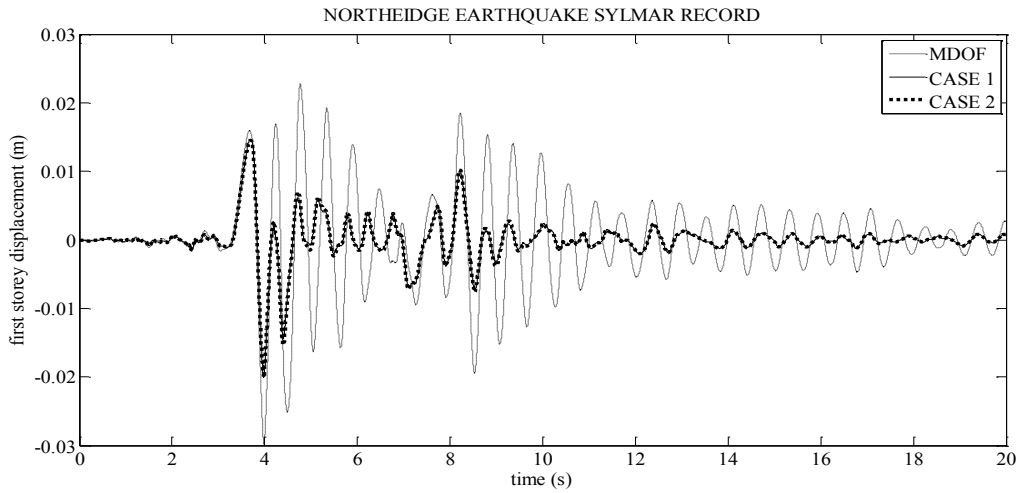

Fig. 2. First storey displacement under Northridge earthquake Slymar record for Ex.2

Conclusion

As a result of the study, the SDOF idealization seems feasible for optimization of TMDs. The structural responces for both cases are near to each other. SDOF idealization can shorten the optimization time. For a more precise optimum result, structure must be modelled as multiple degrees of freedom system at the optimization process. But in that case, the optimization process time will be n times longer than the SDOF idealization. For the structure with close frequencies, the MDOF idealization seems more important. The TMD optimization with idealized SDOF model is more suitable if the structure with multiple degrees of freedom has distant frequencies for structural modes. SDOF idealization can be used as a primary analysis in order to see the feasibility of the approach and the problem.

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NEW METHOD OF STUDYING LARGE LAND SLIDING PROCESSES

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Land slides are one of the most spread exogenous geological processes in the area of the Azerbaijan Republic. They often cause considerable economical damage in both the district and state scale. Contemporary dynamics of the slopes expressed as the total mobilizm of the lithosphere, interaction of the main shells of the Earth influenced by cosmic platen a notary, regional and local factors is an actual scientific and practical problem. Slope gravitational processes are the most active part of the chain of denutative and accumulative processes, influencing man′s life and activity. At the same time man's activity nowadays causes considerable changes in the evolution of geological environment and in the character of occurring slope gravitational processes. Nowadays they have gathered a great experience of studying slope gravitational processes and using the areas subject to the negative influence of those processes.

The development of methods of prediction of landslide processes sets new demands referring to increase of quantitive information of the mode of land slide processes within a vast area under its intensive usage, increase of accuracy u details of studying mechanism and dynamics of slopes of various types. The development of land slide processes in Bail slope in the city of Baku cause problems of not only engineering-geological nature but also gynecological ones of big social potential.

Landslide processes in Bail slop in Baku have a long history. The ancient Azerbaijan town Sabail of which ruins are now on the bottom of the Caspian Sea "was drowned" because of not only the change of the level of the sea, but also a large landslide. The trages of ancient landslides have been seen as stall walls and circuses. The strengthening of ground movements has been noticed since the XIX century-the time of building and oil activity in the area. Up-to date anthropogenic

man-made usage of the mentioned area hassled to the intensification of landslide processes. The first marked landslide took place in 1929 u occupied the area of 250 m length. Because of the ground displacement the tram ways and some other constructions were destroyed. In 1936-1939 there was a landslide in the area of Bail slope where Bail bridge and a shole making factory were located. The following land slide displacements were marked in 1939-1942 in the area where the zoo and the factory were located, the latter one was completely destroyed. The landslides in Bail slope took place in 1152, 1953, 1957 and 1960. Basing on the study of the landslide in 1960 the main reasons of landslide processes were revealed. Those are intensive leakage in water and sewage pipe system from which the liquid got just into the slope ground, unregulated watering plants in the surface of the slope, water leakage in the pool in the area of the zoo, lack of protective drainage in the slope, pruning the slope while building roads or constructions, the erosion of the slope. In Febiuary of 1974 there was a landslide which caused the damage of underground communication systems, deformation of buildings and constructions destruction of highways. Since 1992 in Bail slope the have been conducting stationary observations of the development of landslides by means geodesic methods.

In 1996 the leakage in water pipe line in T.Bagirov street in the upper part of the slope which caused prolong running out water and the leakages in the underground reservoirs caused the start of the development of a mighty landslide. The showers which took place in July of the year of 1996 played an important role in the process as well. The edge of the pruning coincided with that of the landslide which took place in 1974. To fix the base points to observe landslide check point they chose the places easy to be reached and seen, located in steady grounds, in the edges and inter land slide tops. After setting the net of base points they start to fix landslide cheek points the choice of landslide check points was done so that the rays going from the base points to landslide check points were short and intercrossed with angles close to direct ones. Tool observing the displacements of the landslide was found by means of the method of direct geodetically nicks, representing the change of the direction of formed by visible rays from several immobile points to the given movable one. When the nicks are of direct angles in every base point they chose original orientational direction from which they measured the directions to all the check points observed. According to even those not complete datum they were able to predict the following landslide in Bail slope on march 6-7, 2000. As a result 17 houses were destroyed, 26 became impossible to live in, and more than 100 buildings were deformed. Business and administrative buildings "Lukoil" filling station and located in Neftchiler avenue were destroyed. The part of the highway 200 m long was out of order because of the plastic went soil there appeared cracks in the different parts of the slope and the rarest buildings and constructions. Because of the side displacements there appeared numerous stall walls and crushed blocks of mountain soil of different measures. At the edge of the slope abutting to "Shehids memorial" there appeared a stall wall 35-40 meters high. The measures of the area of the landslide was from east to west 550-600 meters, from north to south 350-400 m. The approximate volume of the landslide is 10.000.000 m^3.

The main reason of the disaster was extreme man-made wetting slope soil with the leakages of old communication and the reservoirs of water located in the area of the TV-centre after the landslide of the year 2000 they set marks in the cracks in the area of "Shehids memorial". The measures were done from December of 2000 till the end of June of 2001. The biggest development of cracks was equal to 4,6 mm and was stable at that time. Because of the lack of exact organization and purposeful financing even such a simple monitoring of Bail slope was not conducted. In 2011 because of new building and other man-made factors in landsliding part of Bail slope the deformations such as cracks started to appear in the slope again. Basing on multiyear study we worked out the method of studying dynamics of developments of a landslide at different stages. This method is especially actual for the areas where landslides periodically take place. The main attention is paid to the study of the development of deformations, tensions and other parameters of landslides (fall down of the slope) to predict them, and very little attention – to after landsliding changes of the state of the slope and areas cloes to it. We suggest to study Beth before and after landsliding processes. Similarly to the methods of study earthquakes (forshocks, aftershocks) me suggest to call before landsliding deformations "forslides", and after landsliding ones - "afterslides".

The study of Bail slope carried out by us showed that forslides and afterslides have their own specifitics and special characters. Special kinds of their display are observed.

When syclic developments of landsliding processes take plase on slopes of a special interest.

The process has not been studied and demands systematic analysis.

In order to describe complex process of development of cyclic landslides we offer method based on the mathematical apparatus of development of energo-entropy of soil at different stages.

We enter the definition of resource of stableness (strength), accumulation of defects and so on to the theory of stableness of soil slopes.

Our investigations showed that the offered method let solve the problems of prediction of landslides, regulating the state of the slopes with danger of landslides, timely preventive actions of protection and choice of optimal methods of engineering and constructions subject to landslides.

NATURAL CALAMITIES IN THE TERRITORY OF IRAN

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There are 40 kinds of natural calamities in the world and 31 out of them happen in Iran. Iran is among top 10 countries which have the most number of calamities. Earthquake is holding the first place among other natural calamities. During last century over 1000 catastrophic earthquakes hit the world claiming 1.53 million lives and causing huge material damage. 80% of earthquakes happened in the territory of 6 countries (China, Iran, Peru, Turkey, Japan, Guatemala). 17.6% of recorded earthquakes took place in Iran, 15.7% in China and 7.1% in Japan. It is worth noting that on average every 6 years earthquake measuring not less than 7 points on Richter scale hits Iran. 98 % places in the territory of Iran are seismoactive. Gilan-Zandjan, Ardabil, Bam and Loristan earthquakes might be taken as examples of catastrophic earthquakes. Gilan-Zandjan earthquake happened at 00:30, 20 June, 1990. The earthquake measured 7.3 on Richter scale and hypocenter located at the depth of 11 km. Magnitude of the earthquake covered 600 thousands km^2. Shaking continued in the course of a minute. 34 aftershocks measuring 4 to 6 on Richter scale were recorded following the earthquake, the strongest measured 6 and struck 12 hours after the main earthquake. This earthquake caused shaking and panic in Tehran and Tabriz.

Earthquake totally ruined Abbar, Rutbar, Gilvan and Mandjil towns. Bakte, Djiranda, Deylaman, Rustamabad and Loshan towns were 80-90% destroyed. 1600 villages were completely devastated or 80-90% devastated. 15 thousand human lives, 101 thousand animals and over 88 thousand household birds were lost. 214 thousand residential houses, 2 hospitals, 200 medical establishments, 1329 schools, 6 plants and factories, including a great number of shopping centers and other establishments were destroyed. In earthquake zone there were the following faults: Pakte, Arzevil, Mandjil, Northern Pakte, Southern Barbon, Northern Parqasar and Northern Rutbar. Impact of these faults on the earthquake is undefined. Earthquake caused huge landslides in the mountains and landslips of the slopes. As a result of landslips, Fetelek village was completely buried under the soil together with its population. Several courses of rivers were blocked. In many places level of underground waters rose, sandy slime inundated the wells, dilution and thixotropy of soil masses were observed. In the mass of soil and rocks landslips there were 8-10 m wide stones weighing more than 1000 tones. 3 km long, 400 m wide and 20-50 m deep landslip occurred between 4 villages Daldere, Razaqul, Qoldiyan and Gulyashtar. Volume of landslip material averaged 20 million m^3 of soil. The dam on the river Sefitrut, which was designed for 0.25 э accelaration and was tested for 0.4 э and received acceleration of 0.75 э and got slightly damaged. Water reservoir of Rasht town which had reinforced concrete hydraulic structures was completely destroyed. This earthquake was the most destructive in 25 years. 2.5 people (500 thousand families) inhabited the earthquake zone. The damage was calculated at 1640 billion rials in 1991 (which currently makes 45280 billion rials or 4193 million USD). 75% of these means go to households, 25% to the property of the population, industrial installations, roads, communications and agricultural objects. These losses are direct damages, indirect damages were not calculated but according to preliminary calculations it exceeded direct damages. On average damage per capita came to 51 thousand USD. For Iran the damage constituted 3.4% of annual revenue. Ardabil

earthquake struck on 28 February, 1997. The earthquake measured 6.1 on Richter scale, hypocenter located at the depth of 10 km. The earthquake claimed 965 lives, over 2000 people got injured. First tremor caused cracks in many buildings, then aftershocks destroyed these buildings. This earthquake damaged 3 towns and 135 villages. Jorab, Gulistan and Shiran were completely destroyed. According to calculations of 1997, direct damages stood at 227.33 billion rials (which currently makes 1650 billion rials or 152 million USD). 68% of damage was done to private property, 31% to state property. Bam earthquake struck 1t 17:27, 26 December, 2003. Earthquake measured 6.7 on Richter scale and hypocenter located at the depth of 7 km. The earthquake claimed 31 thousand lives, 25 thousand got injured, 120 thousand were left homeless. Historical city Bam was 80% destroyed, Baravat town was 70% destroyed, 250 villages got considerably damaged. 57663 buildings and installations were destroyed or injured (33321 of them in town, 24332 in villages). 80% of these buildings were constructed of raw clay and were completely destroyed. 90% of the victims were in these houses. The mains reasons of the deadliness of this earthquake were: 1) hypocenter of the earthquake located very near to the surface. 2) earthquake struck at night time, when people were sleeping; 3) thick walls and ceiling of clay houses caused considerable striking and compression force when collapsing, created obstructions and people died immediately or the injured could not get out. Ancient Arg complex in Bam was 70% destroyed. The complex was very beautiful and popular with tourists. In earthquake zone there is a fault named Bam, which stretches 50 km from Bam to Barvat. This fault comes to the surface and is 2 km long. Before the main earthquake there was two foreshocks, one of them had acceleration of 0.017 э and was registered by apparatus, but there was a slight tremor the day before the earthquake which as not registered by the apparatus, as it was only geared to register acceleration not less than 0.01 э. The strongest tremor that as registered in accelerogram has 0.988 acceleration which is a sign of igh destructive capacity of the earthquake. After the earthquake 3 aftershocks were registered in 2 minutes. Researches showed that buildings constructed on the rock soils and hard soils got less damaged or demonstrated strong firmness, but buildings constructed on soft soils or silt river sediments got considerably damaged (got completely ruined or got considerably damaged). There were numerous landslips on the slopes. The sides of the trenches collapsed, dilution and thixotropy appeared in the zone of wells located in sandy and slime soils which was evident in dislodging of the soil and formation of erosive funnels. Loristan earthquake struck at 16:47, 31 March, 2006. Earthquake measured 6.1 on Richter scale, hypocenter located at the depth of 10-14 km. Epicenter located 5 km away from Burdjert town, 335 km from Tehran. The earthquake claimed 64 lives, and injured 1780 people. Before the main earthquake there were 2 foreshocks measuring 4.5 and 5.1 on Richter scale. These foreshocks contributed to that people left their homes and spent the night on the streets. Though over 40 thousands houses got completely ruined and got damaged, the casualties were comparatively less. During 3 days after the earthquake 60 aftershocks were registered. Sill is the second largest natural disaster occurring in Iran. Three sills that occurred in the late last century should be especially marked. Sill which occurred in Siestan region in 1991 devastated 15 thousand homes. In 1932 occurred another sill which swept a large area and destroyed 170 thousand homes. In 1999 a sill in Northern Iranian town of Nika destroyed 4 thousand homes, about 1000 ha of sown area and 200 units of big construction equipment. According to data of 2005, 4 earthquakes hit Iran claiming 625 lives (17.4% of all disasters), 4 sills claiming 109 lives (17.4% of all disasters) and 1 urricane (4.3% of all disasters). Special committee on construction in emergency situations is in charge of rehabilitation works after the natural disasters. This committee has strict management structure and deals with the set targets effectively. All the territory of Iran is divided into 7 zones. Regional representation is functioning in each of the zones. If resources of the regional representation are not enough, committee representations of the neighboring zones come to help.

Experience of committee on construction in emergency situations is very exemplary and international bodies should study and make use of the acquired experience of effective work, especially the states with Muslim population.

ACTIVE BRACE CONTROL OF FRAME STRUCTURES UNDER EARTHQUAKE EXCITATION

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Structural vibrations resulting from earthquakes cause serious damages on civil buildings. Also, valuable devices and non-structural elements can be damaged during big unstable vibration. Thus, structural control concept may be implemented to important structures in order to prevent structural and non-structural damages. There are various types of structural control, such as active, passive, hybrid and semi-active. Passive control devices are more economical according to active control. Passive control helps to damping of vibration with mechanical materials. Especially, passive tuned mass dampers was placed to several important structures under wind excitation and several studies showed that optimum passive tuned mass damper are effective on reducing earthquake indicated structural vibration [1-3]. Active control devices apply time varying forces to structures in order to protect them from unstable excitations like earthquakes. But, active control systems may be expensive and may need big control forces and big power supplies. Semi-active systems, which may be accepted as active system with lower efficacy, consume less power than active ones. Hybrid systems, which are the combination of active and passive systems, may be more effective on force and power reduction. In that case, when tuning active control devices, control force value must be considered in order to keep it at a minimum level. The time delay is also a problem for active control systems. In the tuning process, a realistic time delay must be considered. Otherwise, the system may be unstable under random vibrations and this situation will be the failure of the protection system. In this paper, an active brace controlled single storey frame structure was investigated under earthquake loadings. At the end of the analysis, time and frequency domain results were compared for the uncontrolled and the controlled structure. Several studies about active control of structure were mentioned here. Wong and Hart investigated the controlled response of inelastic structures and presented an active tendon controlled frame structure as a sample [4]. Lu and Skelton proposed a method for integrated design of passive and active elements including active braces [5]. Arfiadi and Hadi controlled three-dimensional buildings with passive and active systems such as active tunes mass dampers, passive tunes mass dampers and active braces by using genetic algorithm as a function optimizer [6]. In order to demonstrate the practical applicability of active control, experimental tests using a full scale three storey building equipped with active braces were conducted on the shake table at the National Center of Research on Earthquake Engineering (NCREE), Taiwan [7]. Lu and Zhao investigated active brace controlled structures with controllers extended by introducing the saturated control method [8]. Gluck and Ribakov developed an active controlled viscous damping device with amplifying braces [9]. Arfiadi and Hadi used a continuous bounded controller for active brace controlled structures and proved their study by applying different earthquake excitations with various intensities [10]. Han and Tsopelas developed a passive/active brace system (PAB) which is the combination of a piezoelectric stack actuator and a viscoelastic damper [11]. Pnevmatikos and Gantes investigated structures with diagonal braces combined with active variable stiffness devices that have an ability to activate or deactivate the braces [12]. Nigdeli and Boduroğlu investigated active tendon controlled structures with PID controller in order to prevent earthquake indicated big vibrations [13]. Torsionally irregular single storey structures with active tendon control were investigated by Nigdeli and Boduroğlu under earthquake excitations [14]. In this study, a single storey frame structure equipped with a diagonal active brace was analyzed under earthquake excitations. The Proportional Integration Derivative (PID) type controller was used for obtaining the control signal. The time delay effect was also considered in order to obtain realistic results. For more economical and practical results, the amount of the control force was held at a minimum level. The controlled and the uncontrolled structure results were compared including the rotations and moments at the conjunction of the beam and the columns.

Frame structure model and equations of motion

Model of the frame structure with active brace control is shown in Fig. 1. In Fig. 1, m_c, L_c and EI_c represent the unit mass per length, the length and the rigidity of the columns, respectively. Also, m_b, L_b and EI_b represent the unit mass per length (including storey mass), the length and the rigidity of the beam, respectively. The frame structure has three degrees of freedom. These freedoms are the lateral displacement of structure respect to the ground (x) and the rotations at the beam column conjunctions (θ_1 and θ_2). The equations of motion of an uncontrolled single-span single storey linear frame structure subjected to earthquake loading can be written as

$$M\ddot{x}(t) + C\dot{x}(t) + Kx(t) = -\begin{Bmatrix} m_t \\ 0 \\ 0 \end{Bmatrix} \ddot{x}_g(t) \tag{1}$$

where M, C, K are mass, damping and stiffness matrices, respectively. Total mass of the building and ground motion acceleration are shown as $\ddot{x}_g(t)$ and m_t ,respectively. $x(t)$ is the vector of the freedoms. $\ddot{x}(t)$ and $\dot{x}(t)$ are the derivatives of $x(t)$. The M, K, C matrices and x(t) vector for three degrees of freedom system are given in Eqs. (2), (3), (4) and (5), respectively.

$$M = \begin{bmatrix} \frac{156}{210} m_c L_c + m_b L_b & \frac{11}{210} m_c L_c^2 & \frac{11}{210} m_c L_c^2 \\ \frac{11}{210} m_c L_c^2 & \frac{1}{105}(m_c L_c^3 + m_b L_b^3) & \frac{-3}{420} m_b L_b^3 \\ \frac{11}{210} m_c L_c^2 & \frac{-3}{420} m_b L_b^3 & \frac{1}{105}(m_c L_c^3 + m_b L_b^3) \end{bmatrix} \tag{2}$$

$$K = \begin{bmatrix} \frac{24EI_c}{L_c^3} & \frac{6EI_c}{L_c^2} & \frac{6EI_c}{L_c^2} \\ \frac{6EI_c}{L_c^2} & \frac{4EI_c}{L_c} + \frac{4EI_b}{L_b} & \frac{2EI_b}{L_b^2} \\ \frac{6EI_c}{L_c^2} & \frac{2EI_b}{L_b^2} & \frac{4EI_c}{L_c} + \frac{4EI_b}{L_b} \end{bmatrix} \tag{3}$$

The damping matrix was generated by using the Rayleigh damping proportional to the mass and stiffness matrix. In Eq. (3), α and β are the coefficients of the Rayleigh damping [15, 16, 17].

$$C = \alpha M + \beta K \tag{4}$$

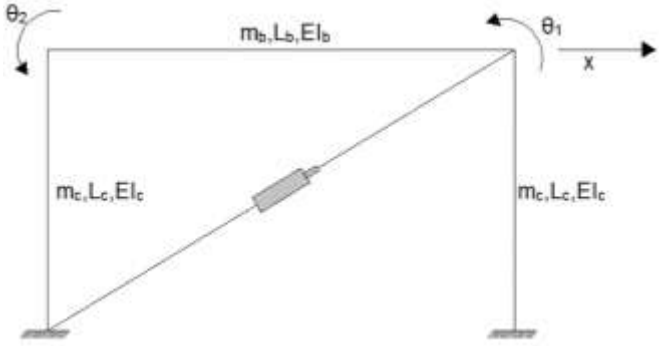

Fig. 1. The Frame Structure with Active Brace Control

$$x(t) = [x \qquad \theta_1 \qquad \theta_2]^T \tag{5}$$

The equations of motion of an active brace controlled single-span single storey linear frame structure subjected to earthquake loading can be written as seen in Eq. (6). In this equation, u and α_0 are the control signal and the angle of active brace with respect to ground, respectively.

$$M\ddot{x}(t) + C\dot{x}(t) + Kx(t) = -\begin{Bmatrix} m_t \\ 0 \\ 0 \end{Bmatrix} \ddot{x}_g(t) - \begin{Bmatrix} u \\ 0 \\ 0 \end{Bmatrix} (Cos\alpha_0) \tag{6}$$

The control signal is the force applied from active braces and the multiplication of the control signal with the cosine of the angle between ground and the brace is the control force. In order obtain the control signal, PID type controller was used. The equation of the PID controller can be seen in Eq. (7). In this equation, K_p(Proportional gain), T_i (Integral time) and T_d(Derivation time) are controller coefficients. By using the control algorithm, the error signal (e(t)) can be transformed into control signal. The error signal is taken as the velocity of the lateral motion. The controller coefficients were tuned by using a trial method by considering the maximum control force value.

$$u(t) = K_p \left(e(t) + \frac{1}{T_i} \int e(t)dt + T_d \frac{de(t)}{dt} \right) \tag{7}$$

In order to obtain realistic and trusted results, a 20 ms time delay of the control system was assumed. The block diagrams of the controlled and uncontrolled structure were developed by using Matlab Simulink. Runge-Kutta method with 1e-3 step size was used for the numerical analysis.

Numerical example

The frame structure was analyzed under various earthquake excitations. The damping of the structure was assumed as 5% for the first two modes. The properties of the structure and the PID controller can be seen in Table 1. In Table 2, the maximum responses such as the lateral displacement (x), the rotations at the joints (θ_1,θ_2), the total acceleration ($\ddot{x} + \ddot{x}_g$), the shear force at the columns (V), the moments at the joints (M_1, M_2) and the control force (F_c) can be seen under different earthquake excitation for the uncontrolled and the active brace controlled cases. The earthquake records were downloaded by NGA database of Pacific Earthquake Engineering Research Center (PEER) [18].

Table 1.

Properties of the structure and the PID controller

Symbol	DEFINITIONS	Numerical Value
m_t	Total mass of the structure	5250 kg
m_c	Mass of the columns per length	250 kg/m
m_b	Mass of the beam per length(including storey mass)	750 kg/m
L_c	Length of the columns	3 m
L_b	Length of the beam	5 m
EI_c	Rigidity of the columns	15000000 Nm^2
EI_b	Rigidity of the beam	15000000 Nm^2
α_0	Angle of the active brace respect to the ground	31 º
T	Period of the structure	0.15 s
α	Coefficient of the Rayleigh damping	3.1961
β	Coefficient of the Rayleigh damping	$5.5795x10^{-4}$
K_p	Proportional gain	-47200 Ns/m
T_i	Integral time	15 s
T_d	Derivative time	0.01 s

Table 2.

Maximum responses of the frame structure

Earthquake records		x (cm)	θ_1,θ_2 (rad)	$\ddot{x}+\ddot{x}_g$ (g)	V (kN)	M_1,M_2 (Nm)	F_c (kN)
Duzce (1999) BOL090	Uncontrolled	0.8427	0.0025	1.3623	61.7522	323.4508	-
	Controlled	0.7190	0.0022	1.1887	52.6511	229.1013	9.6200
El Centro (1940) ELC180	Uncontrolled	0.4372	0.0013	0.7555	32.0814	270.8723	-
	Controlled	0.3227	0.0010	0.6333	23.6787	160.0795	5.4415
Erzincan (1992) ERZ-NS	Uncontrolled	0.4906	0.0015	0.7447	35.9052	113.3049	-
	Controlled	0.4488	0.0013	0.7124	32.8373	69.6165	3.0420
Landers (1992) LCN000	Uncontrolled	1.1734	0.0035	2.0915	86.1456	785.5621	-
	Controlled	0.6227	0.0019	1.3842	45.7781	549.1632	13.6792
Loma Prieta (1989) LGP000	Uncontrolled	1.1221	0.0034	1.9046	82.3054	480.2536	-
	Controlled	0.6108	0.0018	1.1334	44.7806	295.4865	10.3414
Kobe (1995) KJM000	Uncontrolled	1.3290	0.0040	2.2160	97.4460	510.1252	-
	Controlled	0.8105	0.0024	1.4427	59.3987	350.3847	12.5385
Northridge (1994) SYL360	Uncontrolled	0.9209	0.0028	1.5310	67.5206	346.9131	-
	Controlled	0.7304	0.0022	1.3307	53.5471	275.2702	10.2412

In Fig. 2, the time history of the lateral displacement of the structure under Loma Prieta earthquake is given with the comparison of the controlled and the uncontrolled cases. Under Loma Prieta excitation, the maximum displacement is reduced from 1.1221 cm to 0.6108 cm (45.6% reduction).

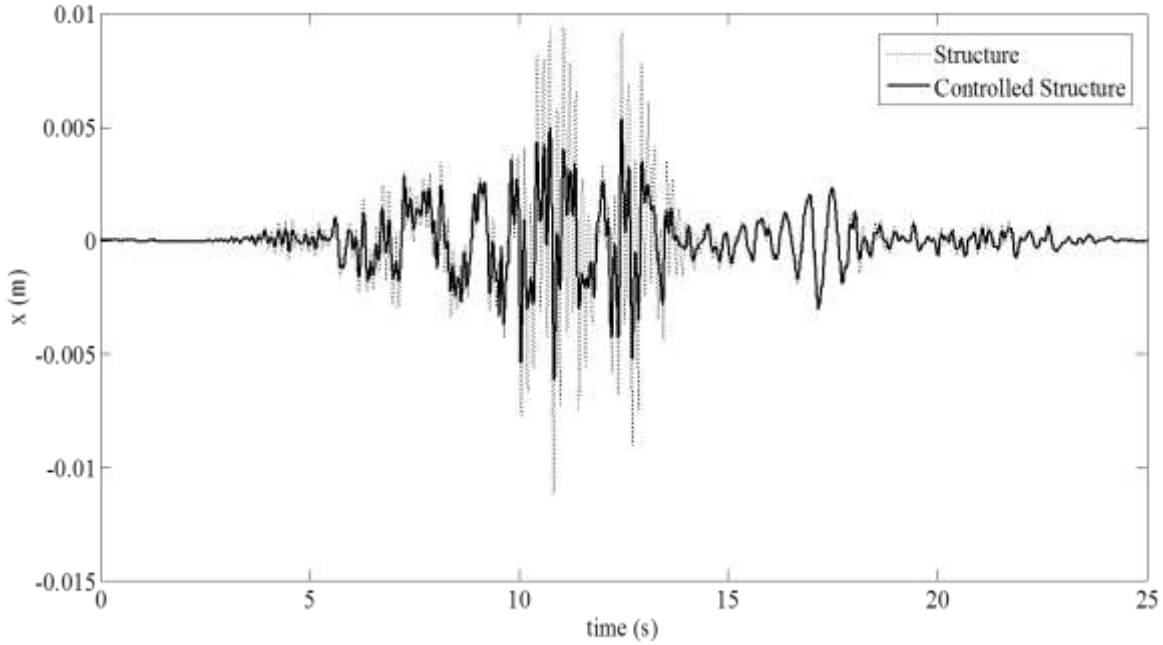

Fig. 2. The lateral displacement of the frame structure under Loma Prieta earthquake

In Fig. 3, the time history of the rotations at the joints under Loma Prieta earthquake is seen. The maximum rotation is reduced from 0.0034 rad to 0.0018 rad (47% reduction).

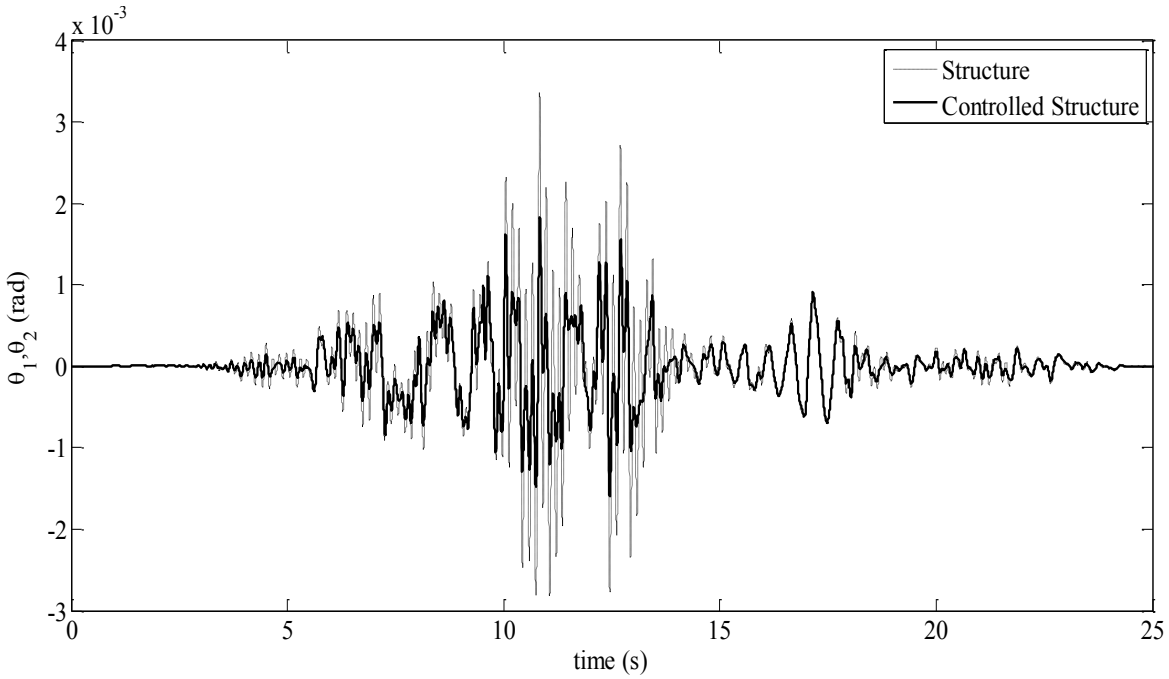

Fig. 3. The rotations at the joints under Loma Prieta earthquake

The shear force of the columns can be seen in Fig. 4 under Loma Prieta loading. The maximum shear force is reduced from 82.3054 kN to 44.7806 kN (45.6% reduction). In Fig. 5, the time history of the moments at the joints can be seen under Loma Prieta earthquake. The maximum moments are reduced from 480.2536 Nm to 295.4865 Nm (38.5 % reduction).

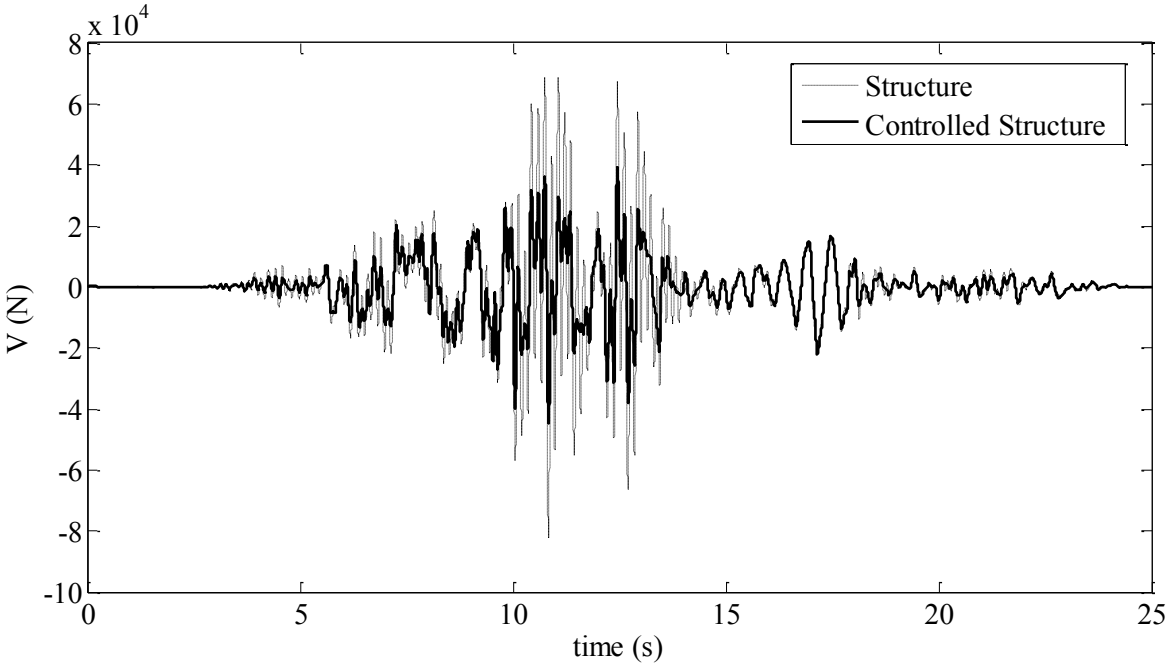

Fig. 4. The shear force under Loma Prieta earthquake

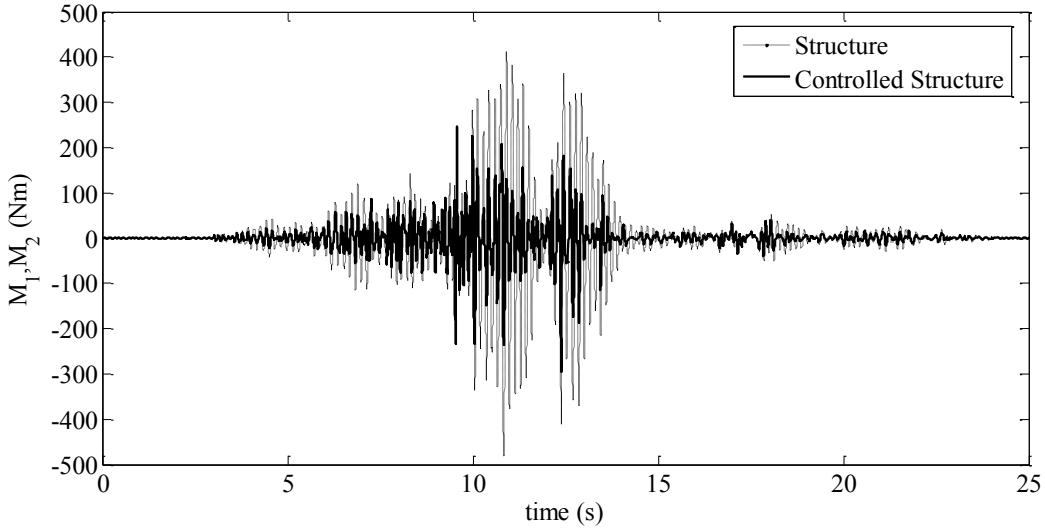

Fig. 5. The moments at the joints under Loma Prieta earthquake

The transfer functions of the frame structure can be seen in Fig. 6 for the lateral motion (TF_x) and the rotations at the joints (TF_θ), respectively. These transfer functions represent the ratio between Laplace Transforms of the accelerations of the frame structure and the ground excitation. The values of the first peaks representing the resonance state of the structure are reduced with the help of the active control.

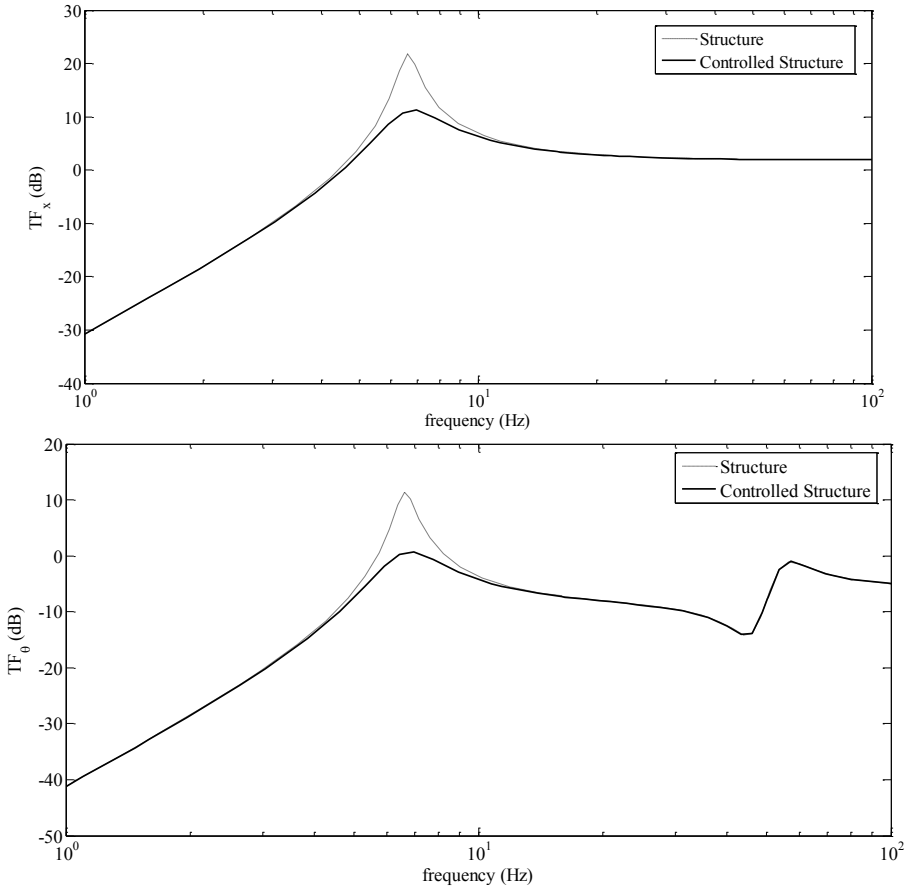

Fig. 6. The transfer functions of the frame structure for the uncontrolled and the controlled cases

Conclusion

The PID controlled active braces for the frame structures are effective on reducing earthquake indicating structural vibrations. The analysis results under different earthquakes prove that the control system is secure and effective for various conditions even a 20 ms time delay is considered. Also, frequency domain analyses show that the structure can be trustable for different random excitations. With the reduction of the lateral displacements, second order effects are reduced. Also, the active control concept is successful on reducing total acceleration of the frame structure. For the feasibility of the method, the control force must be in an applicable range. The results of maximum control force are well enough to maintain. The maximum control force is 13.6792 kN for Lander earthquake excitation. The actuator must apply this force with 100% efficiency in order to minimize time delay value.

Damages at frame structures may be prevented with active braces because of the reduction at the shear force and moments under different earthquakes. Also, the reaching of moments to plasticity capacity may be prevented.

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OPTIMIZATION OF TUNED MASS DAMPER PARAMETERS FOR STRUCTURES SUBJECTED TO EARTHQUAKES WITH FORWARD DIRECTIVITY

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The tuned mass damper (TMD), which was basically proposed by Frahm [1], is a device in order to reduce mechanical vibrations under disturbing excitations. This device implemented to major civil engineering buildings in order to protect them from wind indicated vibrations. This device can also reduce vibrations resulting from earthquakes. For the best reduction, the properties of the TMD components must be tuned.

The device proposed by Frahm [1] is only effective under the excitations with the similar frequency of the absorber because it only contains mass and springs. Ormondroyd and Den Hartog [2] added dampers to the device in order to improve the system against changing excitations. In several studies, expressions for optimum tuned mass damper parameters were given [3-5]. Researchers used numerical optimization techniques for tuning structures with TMD. Rana and Soong [6] controlled a single structural mode with the help of a numerical optimization. Lee et al. [7] developed a numerical optimization algorithm in order to decrease performance index values. Bakre and Jangid [8] used the numerical searching technique and obtained explicit mathematic expressions for optimum TMD. Marano et al. [9] investigated optimum parameters of tuned mass dampers including the mass.

Also, several metaheuristic methods have been used for optimization of TMDs. Genetic algorithm (GA) was widely used for TMD optimization [10-13]. Particle swarm optimization (PSO) was also used for estimating TMD parameters [14-15]. Bekdaş and Nigdeli [16] estimated optimum TMD parameters for structures by using harmony search (HS) optimization method. They developed a program for optimization of TMD parameters and none of the TMD parameters were preselected in order to obtain an economical result. TMD parameters are mass, stiffness and damping coefficient. Criterion of the optimization procedure was the maximum first storey acceleration transfer function (TF) and the displacement of the first storey (x_1) under a sine wave loading with 1g amplitude.

Near fault ground motions contain long pulse-like motions. These motions are directivity pulses at fault normal direction and flint step at fault parallel direction. Pulse-like motions with large amplitude and long period cause undesired structural vibrations, especially when forward directivity is occurred. Forward directivity occurs because of the close velocities of the fault rupture and the shear wave velocity of the ground near the source. In addition to this, the rupture propagation and the direction of slip must be toward a site. In this paper, optimum TMD parameters were estimated for structures near to the fault by using HS algorithm. In the optimization process, several earthquake data with forward directivity effect was used as external excitation.

Methodology

The harmony search algorithm is based on musical performance process in which a musician searches for a better state of harmony. The HS method was proposed by Geem et al. [17] for solving engineering problems optimally.

In this study, the dynamic response of structure was analyzed by using Matlab R2009b. The flowchart of the method can be seen in Fig. 1.

In the first step, the storey parameters of structure and six different earthquake data are loaded to program workspace. Earthquake records were taken from near fault regions and contain forward directivity effect. The records used at this study can be seen in Table 1.

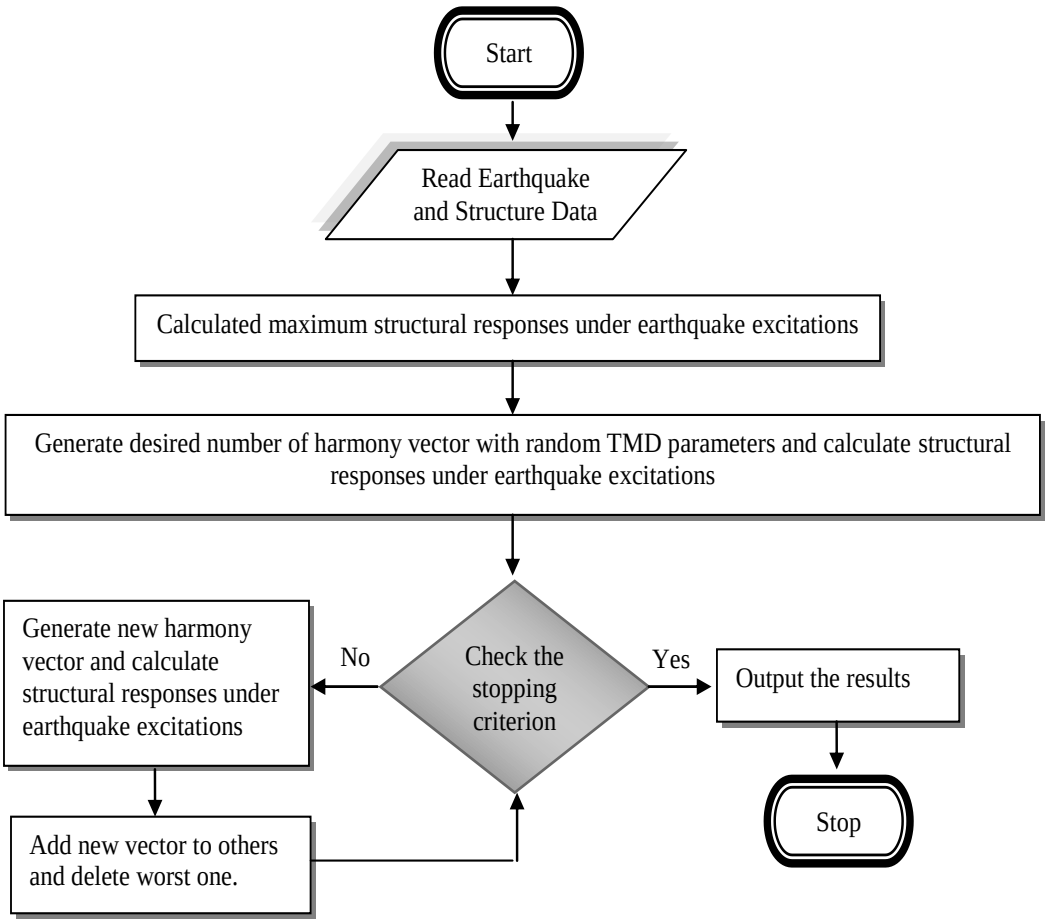

Fig. 1. Flowchart of the program

Table 1.

Earthquake records used in the HS optimization

Earthquake	Date	Station	Component	PGA (g)	PGV (cm/s)	PGD (cm)
Loma Prieta	1989	16 LGPC	LGP000	0.563	94.8	41.18
Cape Mendocino	1992	89156 Petrolia	PET090	0.662	89.7	29.55
Erzincan	1992	95 Erzincan	ERZ-NS	0.515	83.9	27.35
Northridge	1994	77 Rinaldi Receving Sta	RRS228	0.838	166.1	28.78
Northridge	1994	24514 Sylmar- Olive View Med FF	SYL360	0.843	129.6	32.68
Kobe	1995	0 KJMA	KJM000	0.821	81.3	17.68
Note: Earthquake records were taken from PEER NGA DATABASE (http://peer.berkeley.edu/nga/)						

Then, the structure without TMD is analyzed for comparison with the controlled structure. After that state, desired number of harmony vector is generalized with random parameters of mass, period and damping ratio of TMD. Program searches mass between 1%-5% of the superstructure mass, period between 0.8-1.2 times of the superstructure period and damping ratio between 5%-40%. This range values can be changed by users according to their demand. After the generation of the initial harmony vectors, the structure is analyzed for all sets of vectors. All results are checked for stopping criteria and if the criteria are not satisfied, a new vector must be formed. According to the special properties of HS, a new vector can be formed around the exciting harmony vectors or

from the whole range. The best vector has more chance to be chosen in this procedure. After the generation of each new vectors, the worst vector must be deleted. The best and worst vectors are chosen according to the ratio between the first storey displacements of the controlled and uncontrolled structure (RFSD). The loop must continue until the stopping criteria are satisfied. For the stopping criteria, TF must be smaller than uncontrolled one and RFSD must be smaller than a pre-selected value. If the pre-selected value is smaller than possible value, the program iteratively increases this value after several trials. If this value selected zero by users, program will increase that value to smallest possible value.

Results

An eight storey shear building was investigated in order to present the effects of optimum TMD. Each storey has same properties. Mass (m), stiffness (k) and damping coefficient (c) of a storey are 500 t, 600 MN/m and 5 MNs/m, respectively. The period of the building is 0.98 s.
In the optimization process, five harmony vector were chosen. The RFSD value is 0.61 at the end of the optimization. The TF is reduced from 12.83 dB to 2.43 dB. Optimum TMD parameters; mass (m_d), period (T_d) and damping ratio (ξ_d) are 199 t, 1.086 s and 0.385, respectively.

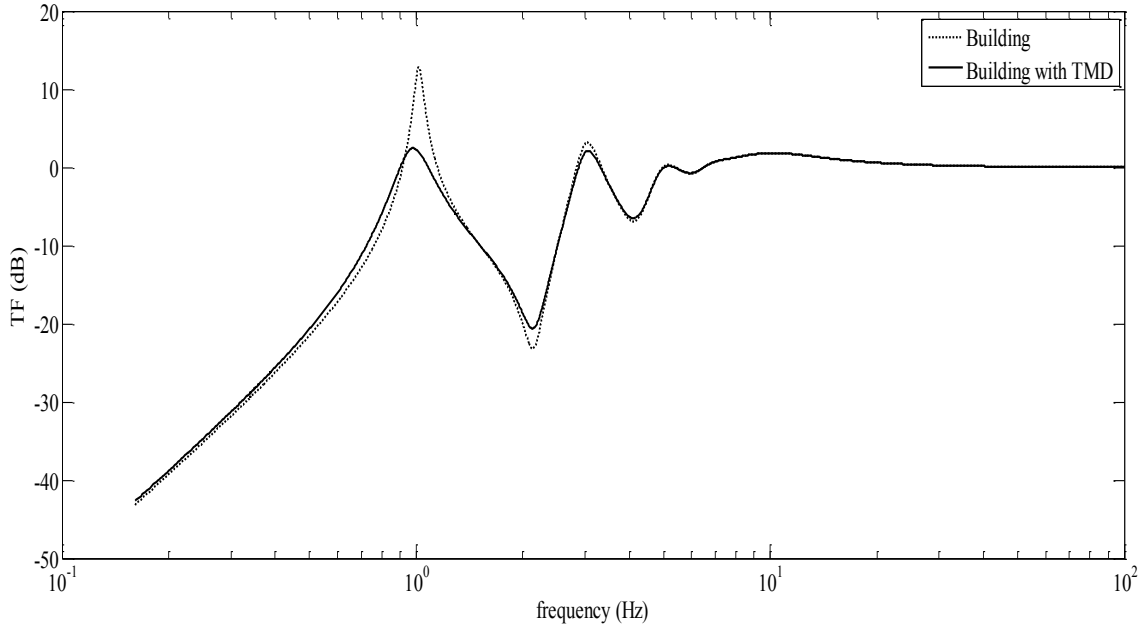

Fig. 2. First storey acceleration transfer function

In Fig. 2, comparison of the TF for the building with and without TMD can be seen. At the first resonance peak, the TF value is reduced excellently. The second peak that represents the second mode of the building is also reduced with a small amount. This reduction at the second peak shows the advantage of taking all modes into account in the optimization process.

Time history of the first storey displacement under the Erzincan earthquake can be seen in Fig. 3. The maximum first storey displacement is reduced from 5.53 to 3.19 cm (42.3% reduction) and the maximum eighth storey displacement is reduced from 28.40 to 16.43 cm (42.15% reduction). Under the Kobe earthquake, the maximum first storey displacement is reduced from 9.00 to 4.20 cm (53.33% reduction) as seen in Fig. 4. For the eighth storey, the maximum displacement is 52.53 and 25.02 cm for the building without and with TMD, respectively (52.3% reduction).

The displacement response of the building for the first storey under Loma Prieta earthquake is seen in Fig. 5. The maximum first storey displacement is reduced from 6.45 to 3.39 cm (47.44% reduction) and the maximum eighth storey displacement is reduced from 33.68 to 17.07 cm (49.32% reduction).

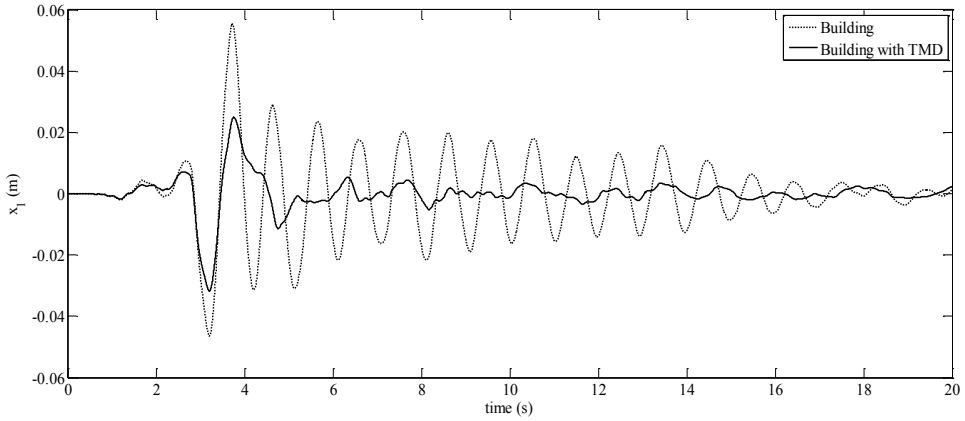

Fig. 3. The first storey displacement of building under the Erzincan earthquake

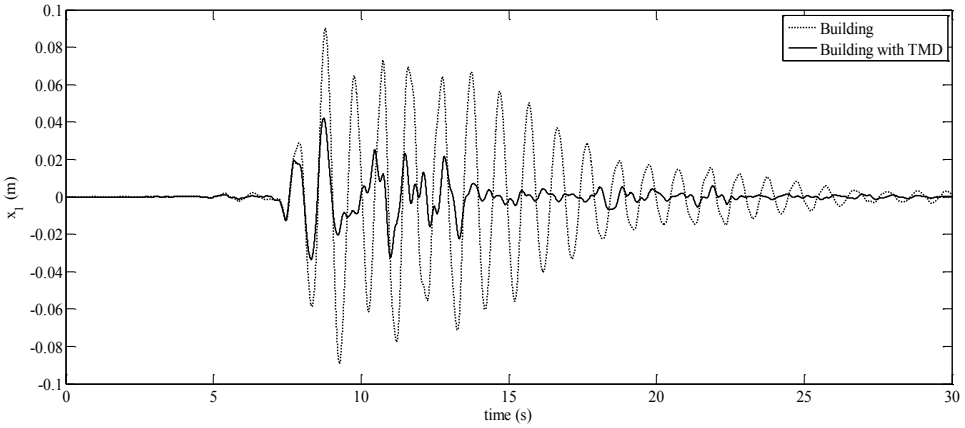

Fig. 4. The first storey displacement of building under the Kobe earthquake

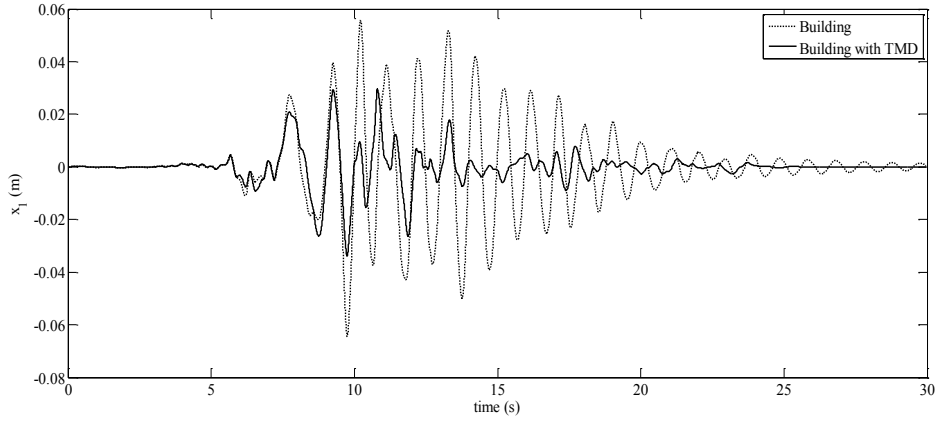

Fig. 5. The First storey displacement of building under the Loma Prieta earthquake

Under the Rinaldi record of the Northridge earthquake, the maximum first storey displacement is reduced from 12.06 to 6.63 cm (45.02% reduction) as seen in Fig. 6. For the eighth storey, the maximum displacement is 65.46 and 33.81 cm for the building without and with TMD, respectively (48.35% reduction).

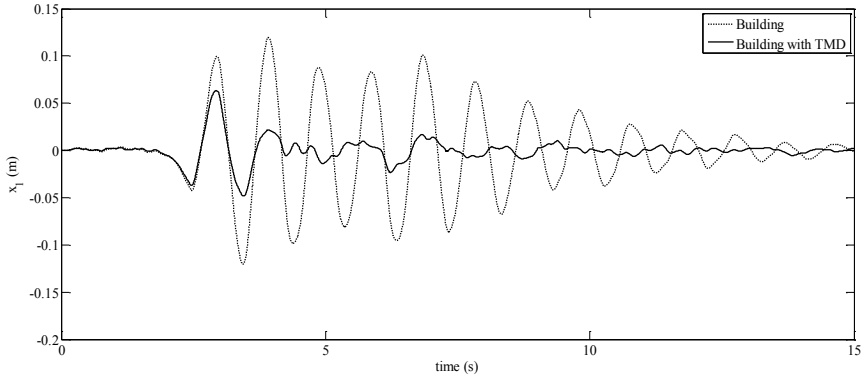

Fig. 6. The first storey displacement of building under the Northridge (Rinaldi) earthquake

The displacement response of the building for the first storey under the Sylmar record of the Northridge earthquake is seen in Fig. 7. The maximum first storey displacement is reduced from 6.78 to 4.13 cm (39.09% reduction) and the maximum eighth storey displacement is reduced from 26.78 to 18.97 cm (29.16% reduction).

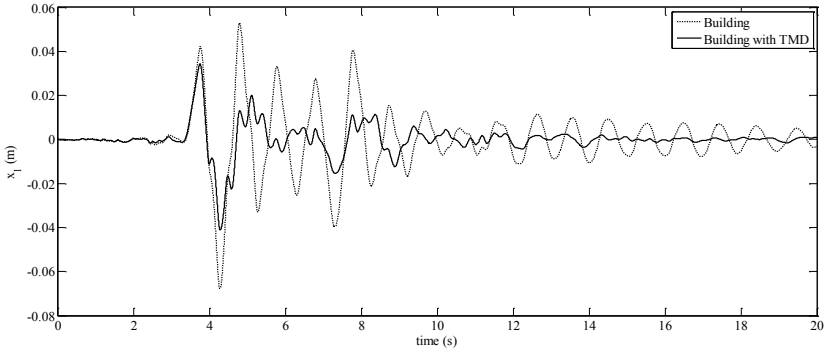

Fig. 7. The first storey displacement of building under the Northridge (Sylmar) earthquake

Under the Cape Mendocino earthquake, the maximum first storey displacement is reduced from 6.04 to 3.03 cm (49.83% reduction) as seen in Fig. 8. For the eighth storey, the maximum displacement is 33.86 and 18.15 cm for the building without and with TMD, respectively (46.40% reduction).

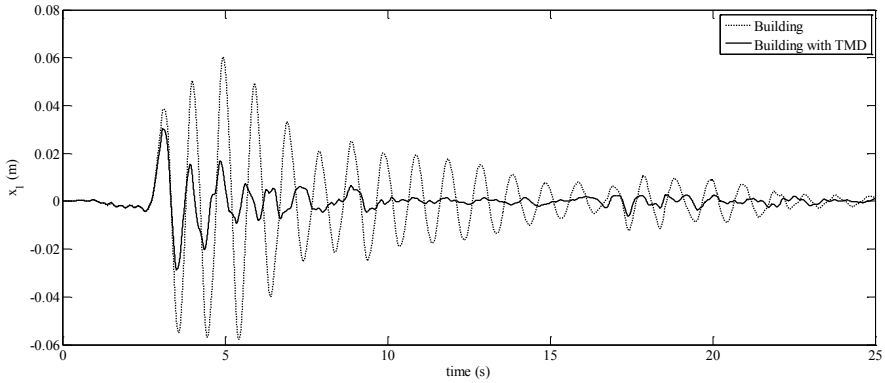

Fig. 8. The first storey displacement of building under the Cape Mendocino earthquake

Conclusion

At this study, the structural vibrations resulting from different earthquakes with forward directivity effect were reduced with the help of the optimum TMD. The results seem feasible for all six record used in the optimization process. The displacement reduction percentages for the first storey are between 39.09%-53.33%. The most critical record is the Sylmar according to the reduction percentage. This critical earthquake can be change according to building properties. Because, as we see from the analysis results, the reduction percentages are close to each other for all different excitations. The displacement reduction percentages for all stories are close to each other, so the TMD is effective for all whole of the building.

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NATURAL STRUCTURAL PROTECTION OF STRUCTURES IN NATURAL CATACLYSM: STRUCTURAL RESISTIVITY SECRET OF "WALLED OBELISK" MONUMENT AGAINST STRONG EARTHQUAKE ACTIONS FOR TEN CENTURIES AND ITS MATHEMATICAL MODEL FOR APPLICATION

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"Örme Dikilitaş" – "Walled Obelisk" (Column of Constantine Porphyrogenetus) is a monument, whose height is 32.77 m., and which roughly may be considered in two parts: a) bottom part with a height of 3.44m is formed from the three step marble stone and massive marble stone (enablement) with Horasan mortar between it; b) upper part is formed from the rough-cut limestone (with Horasan mortar between it) getting thinner to the four-sided hill with mean area of 2x2m. This monument is placed in one of the very sensitive seismic regions of the world-Istanbul -and from the construction date (approximately tenth century) until now it has been withstanding against all the strong earthquake actions. For discovering the secret of structural resistivity during its lifetime (1000 years), the system is modeled by the finite element method in nonlinear-contact studies under strong earthquake action in time and frequency domain respectively. The mathematical model of the monument has been obtained and investigated. It has been shown that, in the obtained model ,support of the structure undertake a NFRNSI (Nonlinear Frictional Responsive Natural Seismic Isolator) and show "similar" behaviour to that of the current LRB (Lead Rubber Bearings or lead-core rubber bearings isolator).

The total height of the NFRNSI is 3.44 m. The upper part of the structure which acts as an NFRNSI consists of three step marble stone and massive marble stone (enablement) that form four friction/sliding surfaces and Horasan mortar in it is taken into consideration by the nonlinear contact finite elements. NFRNSI appears as a "similar" function with LRB combined with layers of steel plates and hard rubber. Massive marble stone appears as a "similar" function with LRB lead cylinder core. NFRNSI shows fully frictional/sliding behaviour different than the LRB and keeps the upper part of the monument around the equilibrium (balance) state by the earthquake excitation which also varies around zero- equilibrium (balance) state.

During the comparison of the mentioned isolators "similar" expression is used mainly in this meaning. For the comparison, the used fixed base model of the monument cannot reciprocate the recovered earthquake actions during its lifetime (1000 years). That has been shown comparatively. The devised and presented model, by the authors, of the NFRNSI (Nonlinear Frictional Responsive Natural Seismic Isolator) proved, itself through historical experience (in this monument's example 1000 years). It is easy to construct, moreover does not requireany special maintenance, and can be usable also in today's structures in seismic regions.

Key words: Seismic isolation-structure interaction, base isolation, nonlinear- finite element contact analysis, dynamic response to seismic excitation in time and frequency domain, LRB (lead-core rubber bearing) isolator, NFRNSI (Nonlinear Frictional Responsive Natural Seismic Isolator).

INTEGRATED APPROACHES FOR THE EVALUATION OF THE DAMAGES AND RETRAINING OF HISTORICAL CENTRES: THE CASE OF PAGANICA (AQUILA)

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The traditional topic of the retraining, as perception tool of the urban context, becomes more complex in urban centres damaged by an earthquake.

Usually, the survey activity follows different approaches on depending by buildings peculiarities, for instance.The dimension, the form, but also the state of degrade and conservation, could suggest different survey approaches, graphic design and data management. The survey of the historical centre of Paganica made by the Task Group of Reggio Calabria, is included in the PRO.PAGA Project "Paganica Project – Propose of a Historical centre plan" promoted by ReLUIS (The Laboratories University Network of seismic engineering). During the Aquila earthquake (2009), the cultural heritage of the historical centre of Paganica, of medieval origin and hamlet of Aquila city, suffered the most structural damage.The survey involved task forces coming from different Italian Universities, among them the Faculty of Architecture and Engineering of Reggio Calabria. The survey followed innovative proceedings by means of particular conditions post-earthquake of the historical heritage. The known approach was directed to identify an integrated methodology with different experiences: conservation and architectural restoration, Aseismic adjustment and social retraining.

THE PARAMETERS THAT CAUSE TORSIONAL IRREGULARITY IN RC BUILDINGS UNDER EARTHQUAKE EFFECT

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The message given by the earthquakes that took place in the provinces of Kocaeli and Dğzce in 1999 which caused thousands of deaths must be scrutinized concerning the people living in this country and especially the scientists working on this field. Judging from the extent that the earthquakes in question have shifted the economic and social chemistry of the country as a whole, the government officers and institutions authorized on this issue were united upon the absolute necessity for taking certain precautions. However, after more than 10 years past the catastrophe, it remains clear that the required level of commitment was not displayed with respect to realizing the planned projects. Nevertheless, it is expected in light of the ongoing studies and projects in progress that the nation demonstrates a satisfactory performance in case of a potential earthquake. A classification of the existing building stock in Turkey shows that a significant portion of it consists of RC buildings. The preference towards RC buildings mainly arises from the ease of supplying the construction materials as well as favorable construction costs relative to other structural systems and acceptable construction periods. In this context, it is reasonable to expect that all buildings must comply with the related regulations. However, the increasingly sophisticated and changed needs and the ensuing architectural demands make it impossible to maintain the symmetry of structures. Generally in Turkey and especially in Marmara Region, prediction of what will happen to the residential buildings in case of a potential Earthquake is a not an unfamiliar topic. Regarding this issue, it is a generally accepted opinion that neither the local administrations nor the government institutions display adequate endeavor. This situation might be attributed to the fact it is not possible to achieve quick results to resolve this problem, in addition to a great deal of insufficiency in vision and technical savvy. On the other hand, the initiative in this issue should not be confined to the limits of local/national administrations. The public at large should also be informed about the steps that must be taken and make its influence felt. In case of a potential earthquake, evaluating risk exposure of the building stock, the expectation is that the buildings must at least avoid collapsing in the wake of an earthquake. Surely, this is not a topic that can be tied to wishful thinking without conducting any forecasts and taking some measures. Primarily, the complete profile of risks must be determined. An investigation of existing buildings exposes that various buildings were not constructed in compliance with the project, the project was not prepared pursuant to current regulations or certain modifications were made on the building that interfere with the characteristics of the load bearing system of the building. One of the risks the buildings are exposed to is the torsional effect. Concordantly, it is understood that the torsional behavior of the

structure was not properly reflected on the project or the knowledge level is not sophisticated enough to handle the parameters that must be taken into account. Hence, these concerns in question necessitated the analysis of torsional behavior of buildings. Torsional effect generally arises from the rotational motion at the structure's foundation. The foremost reason behind torsion could be shown as the asymmetrical distribution of load bearing elements in the building plan such that would induce an eccentricity between the centers of mass and rigidity. This situation is generally referred as eccentricity in rigidity. However, torsion may take place even if the structure is symmetrical due to the irregularly spread out ground vibrations or torsion components in ground vibrations. Additionally, malfunctions and asymmetry can exist even in seemingly symmetrical buildings as a result of faulty workmanship that is a part of the nature of all construction projects, which might consequently culminate in torsional effect.

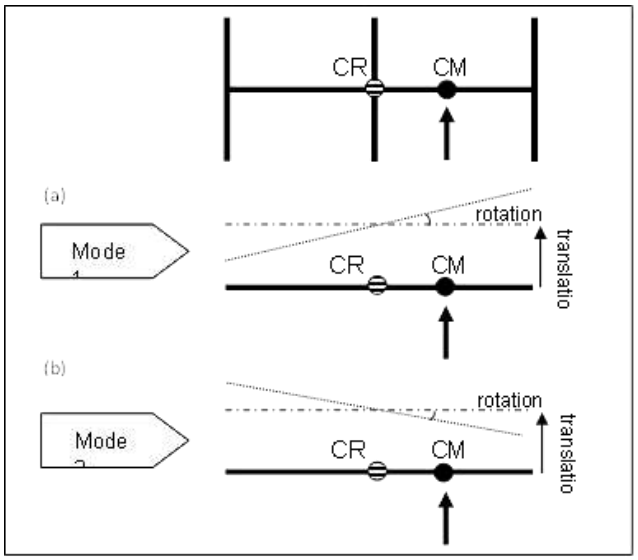

Fig.1. First two mode shape of an asymetric building (a) Mode 1 (b) Mode 2 [1]

As shown in Fig. 1, the asymmetry in the plan leads to torsion in the building, because the centers of mass (CM) and rigidity (CR) do not coincide. The existence of a gap between these two centers is referred as structural asymmetry and the magnitude of this effect can be determined. Accompanying increases in torsion due to other factors also complicate the estimation of torsion magnitude, which can be exemplified by sudden torsion. Sudden torsion emerges from the angular components of ground movements, inconvenient distribution of live loads and finally differences between the calculated and actual rigidity/load/yield strengths of the structural elements. All these factors arise from the dynamics between the horizontal and torsion movements in the building and this situation results in irregularly distributed in-plane floor displacements.

If the building plan is asymmetrical or the vertical rigid elements are in the vicinity of the structure's center, the torsional effects must be taken into consideration. Various earthquake specifications mandated that the structures are designed in a capacity that can withstand a certain level of torsional strength even if the applied lateral load cannot sufficiently cause torsion [2].

Within the scope of this study, references to torsional behavior in earthquake regulations were investigated and then results of the studies in the literature concerning this issue were presented. In the numeric section of this study, three building model were created by using ETABS three dimensional finite elements analysis software and numerous analyses were conducted by varying the storey, load bearing elements and axis configurations of the structure in order to allow comparisons and finally, a comprehensive demonstration of torsional effect was intended.

Torsional behavior in rc buildings

Torsional Behavior in the Regulations

Torsional effect can be defined as the rotational motion emerging from the distance between the center of mass and center of rigidity of the structure. Under the influence of an earthquake, the

torsional effects become dominant through the formation and rise of eccentricity between the centers of mass and rigidity in the stories [3]. According to the current earthquake regulations, the most frequently considered type of irregularity is "Torsion in Plan". Among the mentioned regulations, 39 of them included measures and penalties against this irregularity. Among these, eleven regulations outright ruled out this irregularity, where 6 of them mandated the use of dilatation joints. Three regulations prescribed the application of additional eccentricity, while 13 regulations required the use of "Dynamic Calculation" technique. 10 regulations stipulated the enhancement of additional eccentricity in case a set of conditions were not met as well requiring the use of dynamic calculation in extreme scenarios [4]. The generally accepted criteria is to increase the additional eccentricities when the parameters related to torsion exceed certain thresholds and repeat the lateral load analyses, and resort to "Dynamic Calculation" in case these values grow further. In the Turkish Earthquake Code entitled "Specification for Buildings to be Built in Earthquake Areas" (TEC, 2007), no clear and definite limitation exists concerning irregularities. Nonetheless, various precautions against these irregularities are recommended. For instance, a torsional irregularity coefficient η_b is defined in TEC 2007, which is calculated from the ratio of maximum relative story displacement to the mean story displacement at each direction for both of the perpendicular earthquake directions and a limitation was introduced for the value of this coefficient. As such, it is required that the eccentricity taken as 5% is multiplied by the parameter $D=(\eta_b /1.2)^2$ and the earthquake calculation is repeated, whereas the design stage should be modified by reducing the degree of eccentricity for structures with $\eta_b > 2.0$. In the Earthquake Regulation, limitations were imposed on the application of equivalent earthquake methodology on structures possessing torsion irregularity. In general, dynamic analysis is recommended as the safest method and the application of equivalent earthquake methodology on structures possessing torsional irregularity is held to a limited level [5].

2.2 Torsional Behavior in the Literature

In recent years, several research studies were conducted regarding the types of irregularity. However, investigation of torsional irregularity was confined to single-story buildings in most of those studies. In the studies conducted in Turkey, the issue was mostly handled with respect to shear-wall framed structures with multiple stories and thus the results for only a limited number of shear-wall framed structures were obtained [6-8]. An overview of torsional behavior shows that the main topics of interest are the assessment of torsional condition in earthquake regulations, investigation of irregular structural systems, analysis of seismic torsional behavior in asymmetrical single story or multistory structures, demonstration of torsion behavior via elastic or inelastic analyses and finally the issues incorporating inelastic torsion behavior in symmetrical structures. El Faro building in 1985 Chilean earthquake might set an example underlining the importance of inelastic torsion concerning the collapse of buildings due to earthquake shocks [9]. Treating all torsional effects as elastic behavior during design stage leads to a shortcoming in their assessment. In several regulations, since sustaining a certain level of safety against earthquakes appears as a key method, the emergence of a significant inelastic torsion effect that was not accounted for at this stage is possible. In several studies, the seismic behavior of structures that were assumed to exhibit only elastic behavior was taken into consideration, and elastically modeled torsional response was frequently employed in the estimation models as the association of lateral load-torsion effect is widespread in such systems. In recent years, obtaining the analysis results for inelastic systems regarding the seismic behavior of structures became more practical and the results became more applicable [10]. Torsional effect in buildings with high torsion resistance generally induces a larger displacement effect in inelastic systems in comparison to linear-elastic systems [11]. The conducted studies displayed the need for controlling the formation of torsional mechanism at the instance of structure's response to the earthquake in order to control the inelastic torsion effects [12]. It was observed countless time during earthquakes that the presence of structural asymmetry in the plan results in higher vulnerability against seismic damages. Great damages in buildings arise from asymmetry based extreme torsional behavior such as Managua earthquake in 1972, Michanocan earthquake in 1985 and Loma Prieta earthquake in 1989 [13-15]. Gülay and Çalım [16] parametrically studied a ten-story shear-wall framed building exhibiting a high level of

torsional behavior. The internal element strengths were calculated in accordance with Turkish Earthquake Code under seismic loads at 5% eccentricity. The torsional factors were incorporated into the calculations along the height of the building. Among the numerical solutions for the analyzed building, the highest increase was determined for the bending moments of most critical beams and columns at 10%. In terms of the torsional irregularity coefficients of the model building, Uniform Building Code [17] coefficients were higher than that required by TEC 97. In the study, both the absolute and relative displacements were compared in accordance with both regulations. The history of analytical and experimental studies on the nonlinear seismic behavior of multistory buildings does not date back to old times. According to De La Llera and Chopra, the reason is the reluctance of most researchers towards studying multistory buildings since even the single-story asymmetrical structures display a complicated enough behavior [18]. Sedarat et. al. [19] studied on the torsional behavior characteristics of 3 buildings with proper geometries in California. During the last three earthquakes (1989 Loma Prieta earthquake, 1986 Mt. Lewis earthquake and 1984 Morgan Hill earthquake), the recorded strong motions in these buildings were analyzed. Then, seismic behaviors of the buildings were compared for the models design as per the 1988 UBC specification. As a result of these studies, the specification being used to estimate the torsional behavior of buildings was deemed as inappropriate. A few scaled experimental models also took place in the literature. Bourahla and Blakeborough [20] designed a building model at a scale of 1/20 using an earthquake shaking table and investigated the cross link performance of asymmetrical framed buildings by conducting experimental studies. The building used in the experiment is a four-story framed structure with three spans in both directions. Variations in the seismic behavior caused by the symmetrical and asymmetrical sections of the frame were tested and the strength was investigated. Furthermore, the energy dissipation capacity of the frame was studied. According to the experimental results, it was determined that the magnitude of eccentricity was insignificant on a standalone basis but it nevertheless played a critical role in determination of the structure's torsional strength. Cruz and Cometti, used a five-story building model in their studies and thereby determined that the ductility of the building as a whole as well as its fundamental period are the primary parameters influencing the building behavior [21]. In their studies, De La Llera and Chopra determined that torsional capacity of the buildings which exhibit resistance in the orthogonal direction increases, in addition to recording that the modified rigidity and strength distributions are the most accurate measurements of local creep in the chosen planes [22]. A handful of studies were conducted in the literature concerning the design of multistory buildings and the evaluation of building specifications. Bertero and Bertero [23] developed a formula that takes into account the elastic and inelastic torsion at the preliminary design stage of high buildings. Bertero [12] utilized the classical analysis theorems to determine the drop in strength for special classes of buildings. De la Llera ve Chopra [24] proposed a methodology that incorporates the effect of sudden torsion in the seismic design of buildings. Ozaki et. al. [25] proposed a seismic design technique for multistory asymmetrical structures. Azuhata and Ozaki [26] suggested a safety assessment method for multistory shear type buildings. In both studies, the damage potential induced by torsion was evaluated by taking into consideration the shear and torsion capacity and the shear strength/torsional moment design at each story of the building. In their studies, Duan and Chandler [27] concluded that the application of static torsion conditions required by certain building specifications is not viable for the asymmetrical multistory framed building model due to the high ductility requirement, especially for those structures with large rigidity eccentricities. In another study [28], the same researchers proposed an approach that suggests revisions in the specification in order to make it accurately reflect the actual behavior of asymmetrical multistory framed structures.

3. NUMERICAL ANALYSES

The main objective of the prepared computer models in this study was to emphasize the effects of torsional on the parameters of the RC buildings. The buildings were modeled and analyzed in ETABS [29] and story forces/response for lateral loads were obtained. The analyses are performed according to irregularity in plan geometry, shear wall positions and the infill walls conditions.

3.1 Description of Building Models

It is prepared three different models with ETABS in order to reflect the effect of the parameters that cause the torsional irregularity in RC buildings. Three sample buildings were modeled: a) Model1, the effect of plan geometry, b) Model 2, the effect of shear wall positions, c) Model 3, the effect of infill wall positions. Then the three models were analyzed with ETABS. In the models, C25 concrete class and S420 type steel materials were selected and dynamic analysis was made by using Turkish Earthquake Code 2007 [5]. Springs are used in terms of soil in order to provide soil – structure interaction. Equivalent earthquake load method and response spectrum method were used during the dynamic analysis. From inside of the analysis results, earthquake effect in x-direction was taken into consideration.

3.1.1 Effects of the plan geometry with respect to lateral loads

In the Model 1, there are two different plan geometry buildings and each has three storeys. Each column, beam and slab is the same size 35/35, 30/40 and 12 cm, respectively. Model 1A and Model 1B can be seen in Fig. 2.

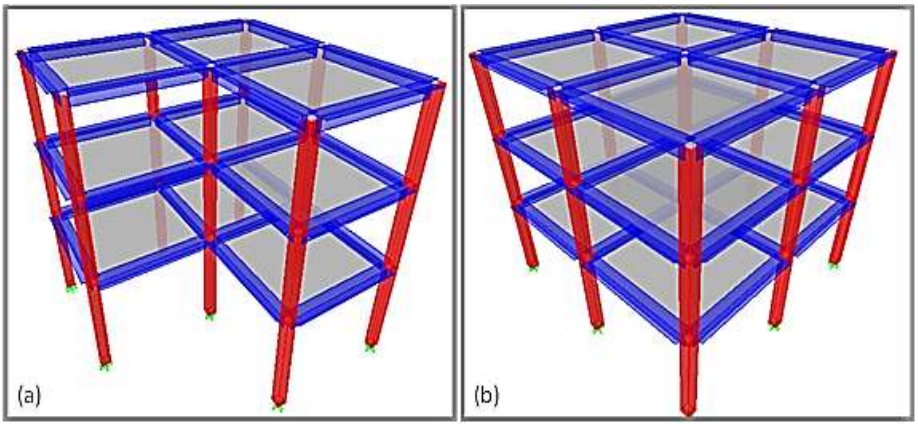

Fig. 2. Two different plan geometry (a) Model 1A (b) Model 1B

Dynamic analysis of Model 1A and Model 1B is made by using equivalent earthquake load method and response spectrum method. The analysis's results of the models are given in Table 1.

Table 1.

Model 1: Story forces/response for lateral loads

	Model 1A		Model 1B	
	Equivalent	**Response s.**	**Equivalent**	**Response**
Natural Building Period (Mode	0.36	0.36	0.37	0.37
Coefficient of torsional	1.15	1.036	1.06	1.034
Lateral load to story (Story 3, kN)	87.3	no data	104.66	no data
Story torsional moment, kNm	1149	1057	1207	1102
Maximum Story disp. (Story 3,	0.0092	0.0083	0.0095	0.0086
Story shear force (quake, kN)	190.5	172.5	228.6	207.4
Story overturning moments	1452.0	1269.7	1690.7	1522.3

When analysis results are examined, it is seen that the value of story torsional moments, maximum story displacements, lateral loads and story overturning moments that obtained from equivalent earthquake method is greater than that response spectrum method for both models. It is

observed that story torsional moment of the Model 1B (symmetrical plan) is greater than Model 1A (asymmetrical plan). In contrast, natural frequencies for both models is approximately the same. The proximity of the frequencies is majorly due to the fact that the small number of the axis and the storey.

3.1.2 Effects of the shear wall positions in plan with respect to lateral loads

In the Model 2, there are two seven storey building models that have different shear wall position in each (Fig. 3). The column size is selected 30/50, 30/40 and 50/30. Each beam, shear wall thickness and slab is the same size 25/60, 30 and 15 cm, respectively. The analysis's results of the models are given in Table 2.

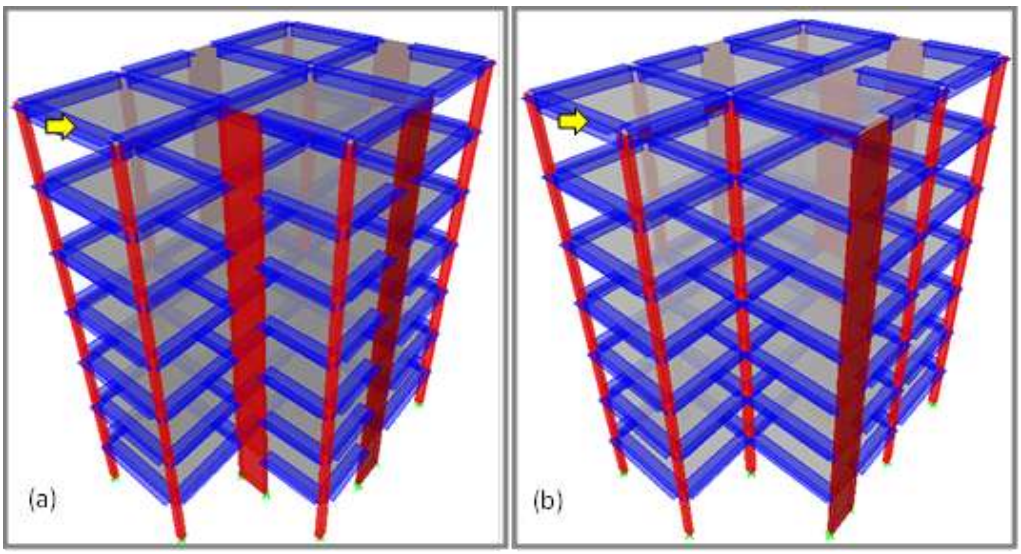

Fig. 3. Different shear wall positions (a) Model 2A (b) Model 2B

Table 2.

Model 2: Story forces/response for lateral loads

	Model 2A			**Model 2B**		
	linear		**pushover**	**linear**		**pushover**
CM /CR (Story 7)	7.49	6.48	Base reaction /displacement.: 21923/0.847 Performance point (V/Disp.) 8153/0.314 Performance point (Teff/βeff) 0.506/0.05	7.60	4.72	Base reaction /displacement.: 55300/0.832 Performance point (V/Disp.) 5270/0.079 Performance point (Teff/βeff) 0.400/0.05
Period (Mode 3), sec.	0.41			0.44		
Story torsional moment, kNm	22297			21370		
Maximum story disp. (Story 7), sec.	0.0529			0.0618		
Story shear force (quake), kN	3278			3477		
Story overturning moments, kNm	47380			49905		
Coefficient of torsional irregularity	1.361			1.421		

It is seen that the distance between center of mass and the rigidity eccentricity and the value of story shear force, story overturning moments, story displacements and torsional period that obtained from Model 2B is greater than Model 2A. However, the value of story torsional moments Model 2A's is greater than Model 2B's. The tortional moment value of the columns and beams of the Model 2B's is greater than the Model 2A's. For example, tortional moment value of the beams

that indicated by the yellow arrox in the Fig.3 is obtained 17.86 and 19.87 kNm, respectively. When nonlinear analysis results are examined, performance demand level of the Model 2A's is greater than Model 2B. However, Model 2B has more capacity in terms of story shear force and story displacement. The value torsional irregularity coefficients, which are used to determine irregularity of the plan, are examined, it is seen that both buildings have torsional irregularity due to exceeding limit value 1.2. Also, there is a difference between these coefficients. According to the analysis results, shear walls should be symmetrical as possible as in x and y directions and they should be positioned in corner axes.

3.1.3 Effects of the infill walls with respect to lateral loads

In the Model 3, there are two eight storey building. It is aimed to show the effects of the infill walls on the tortional behavior of the structure on these models (Fig. 4). The column size is selected 40/40, 45/45 and 50/50. Each beam slab is the same size 25/60 and 14 cm, respectively. The shear wall thickness is selected between 25-35 cm. Diagonal strut widths and axial rigidities are calculated by using Turkish Earthquake Code [5]. The analysis's results of the models are given in Table 3.

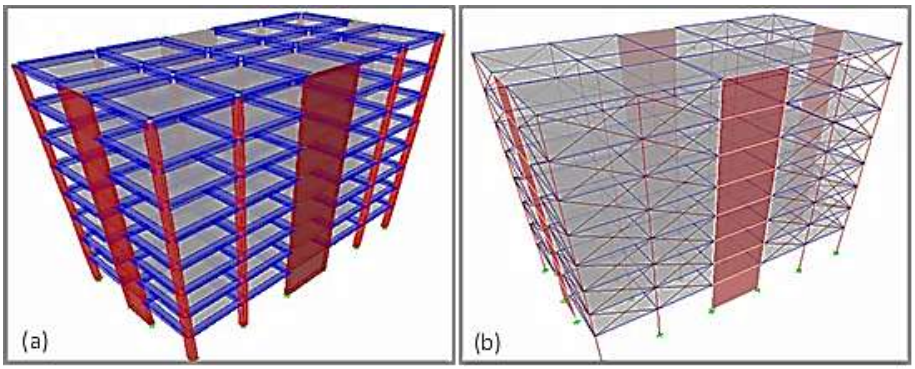

Fig.4. Effect of infill wall (a) Model 3A (b) Model 3B

Table 3.

Model 3: Story forces/response for lateral loads

	Model 3A		Model 3B	
	linear		linear	
CM /CR (Story 8)	12.50	12.49	12.50	12.50
Period (Mode 3), sec.	0.49		0.44	
Story torsional moment, kNm	26808		28300	
Maximum story disp. (Story 8),	0.0176		0.014	
Story shear force (quake), kN	3728		3933	
Story overturning moments,	50915		53771	

The infill walls in Model 3B were modeled as equivalent diagonal strut with hinged ends. Their diagonal strut width and axial rigidities were calculated according to Turkish Earthquake Code. In the Model 3A the effect of infill walls are considered by applying the wall loads to the system, whereas, in the Model 3B the walls defined as a structural member in the structural model. Mass and rigidity center is roughly the same for both models. The values of building natural frequency and maximum storey displacement that obtained from Model 3A is greater than Model 3B. On the contrary, Model 3B is exposed to higher effects in terms of story torsional moment and seismic forces. The tortional moment value of the columns and beams of the Model 3A's is lower than the Model 3A's.

4. CONCLUSIONS AND RECOMMENDATIONS

In this study, the current earthquake regulations as well as the studies in the literature related to the topic were investigated and the results were obtained through performing numeric analyses. The particular conclusions derived from this study could be summarized as follows:

- Asymmetric plan geometry increases torsional irregularity coefficient and thus may cause torsional irregularity.
- Position of shear walls in the building substantially effects eccentricity. This situation may cause torsional irregularity. In addition, position of shear walls also effects torsional moments of structural elements. Symmetric positioning of shear walls positively affects torsional behavior.
- In analysis of infill walls, considering only their effect on weight, limits the realistic determination of design and torsional behavior. Infill wall modeled as an equivalent diagonal strut decreases the period of the building.

Torsional rigidity is a factor that significantly determines the seismic torsional behavior of multistory buildings. A fall in the torsional rigidity of the load bearing system increases the torsional effect throughout the system, which then leads to a sizeable behavioral shift between the flexible and rigid facades of the building. Static torsional specifications ignore this shift as this situation possesses a dynamic character. Concordantly, it could be recommended that a lower value of torsional rigidity is employed in the design of buildings based on static torsional specifications. Torsional behavior constitutes a great danger with respect to the structural and nonstructural elements of multistory buildings under the influence of earthquake. Torsional behavior varies depending on the torsion rigidity of buildings; however torsional specification treats the seismic displacements and the effects of translational motions of stories at a minimum level. Such an assumption escalated the damage occurring in nonstructural elements in asymmetrical buildings. Designs based on static balance reduce ductility of buildings with high torsional rigidity while increasing it for buildings with more flexible torsional characteristics. Conducting experimental studies to investigate the inelastic behavior of structures is not easy, as a realistic and accurate determination of the behavior requires the preparation of a full-scale prototypical building and the performance of related tests on the prototype. Surely, this methodology is not practical for most structures. Nevertheless, the recorded motions in certain buildings equipped with seismic tools provided valuable information regarding the seismic performance of buildings. The number of required parameters to mathematically determine the elastic and inelastic characteristics of a model used for an asymmetrical multistory building is numerous. This situation necessitates the usage of simplistic models for the buildings in all studies in the literature and the obtained results are published based on the limited number of earthquake records utilized as the inputs for ground motions. In modern, multistory and high buildings, the architectural design and earthquake safety are closely related. Building height and plan geometry, distribution of infill walls, selection of the structural system, and mass / rigidity distribution of the building all significantly contribute towards the earthquake safety. Consequently, it is especially recommended that architects design regular and symmetrical structures. An investigation of collapsed or damaged buildings demonstrates that the damage either directly or indirectly arises from irregularities introduced at the architectural design stage. This interesting observation underscores that irregularities are not restricted by earthquake regulations although being known to be the primary cause of heavy damages.

Regarding the seismic torsional behavior of multistory structures, it is necessary to conduct generally accepted studies that would display the torsional effects with all dimensions and also become useful in seismic design, in addition to introducing such its findings into the specifications.

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THE ROLE OF PR IN EMERGENCY SITUATIONS

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In the modern condition of globalization, PR takes its worthy place among the system of sciences. PR, public relations - it is the interaction and integration, harmony of organization's interests (including government agencies) with the external environment, the community. Any organization is interested in the PR-service to build an effective communication.

PR is particularly actual in crisis (emergency) situations. Here, the primary aim of PR is to make the right decision and to work with the community continually. Emergency situation – it is always a new situation has arisen suddenly. "Men, in principle, can not make the right decisions in new situations. The surveys have shown that in stressful situations, ancient parts of the people's brains begin to work and it brings us to the animals. Therefore, it is more difficult to develop qualitative solutions. Other surveys have shown that in these situations the person has different blood biochemistry, and it also affect on developing the correct decision. Therefore, you should remember the rule: you must have a prepared plan of action to succeed in a crisis situation. Then this situation is no longer new and unexpected " /1/.

Crisis situations are divided into "known unknowns" and "unknown unknowns" by the classification of S. Black, the British scientist. In the first case we know *what* will happen, but do not know *when* it will happen (in the chemical industry, nuclear energy, pipelines, aircraft, etc.). So there is an opportunity to prepare a security measures. In the second case it is unknown *what* will happen and *when* it will happen /2/. Natural disasters can not be predicted. But we must be ready for them to get out of them unscathed.

PR-activities in the emergency situations can be divided into two stages:

1. The complex of preventive measures, undertaken before happening of the emergency situation, are dedicated to avoid or minimize loss of lives, to reduce the damage of the environment and material losses in the case of its occurrence.

2. Communication works carried out after the accident and emergency situations. Communications are directed to the community for saving lives and preserve human health, providing psychological support to them.

One of the examples of the lack of PR is an occasion, that took place in Almaty on May 1, 2011. This situation has shown the inability of the relevant authorities to conduct communications in a crisis situation, to apply effective PR-technologies.

Almaty is one of the most beautiful cities of Kazakhstan, located at the foot of the emerald ridges of the Tien Shan. Some sources claim that trade settlement Almaty was located on the famous caravan route - the Silk Way Road. In the XIII century it was destroyed by a horde of Genghis Khan /3/. Verny city was built, near the ruins of the ancient town in 1854. Then, in Soviet times the city was renamed Alma-Ata, and Alma-Ata was the capital of Kazakhstan from 1929 to 1997. With the adoption of the Constitution of the independence of the country in 1993, former Verny, then Alma-Ata was renamed Almaty. Almaty is located in a broad valley, closed on three sides by powerful mountains, and protected by green areas. The city covers an area more than 170 square kilometers. The city is located on the removal of old and young sediments of the Bolshaya

and Malaya Almatinka rivers and their tributaries. Almaty with the population of 1.5 million is the largest metropolis in Kazakhstan. The city is located in a seismic zone with magnitude of 9 point. The city suffered three devastating earthquakes in 1887, 1889 and 1911. A. Nurmagambetov, well-known Kazakhstani geophysicist and seismologist, with reference to international experience points out that "the large earthquakes with a magnitude of 9 points must be repeated in the same place with intervals from 80 to 200 years" /4/.

The last strongest earthquake destroyed Verny in 1911. This earthquake was attributed to the 10 strongest earthquakes of the last century, and the probability of recurrence of the devastating earthquake in that area, is large enough, because the last earthquake took place 100 years ago. The tension greatly accumulated in the area so that as a result it could run into the strongest natural phenomenon. An earthquake happened in Almaty on May 1, 2011 at 8.31by local time. Followed aftershocks continued until May 2. According to the Ministry of Emergency Situations, eight aftershocks were recorded in the period from 1 to 2 May, 2011 on the territory of Almaty city and Almaty region. The Ministry also clarifies, that in particular, there were four earthquakes on May 1, the epicenter of which was located 73-75 km north-east of Almaty. The first earth shock happened at 08.31, the second - at 13.41, the third - in 15.13, the fourth - at 17.37. The earth shocks with a magnitude of 4 points were felt in Almaty, and in Taldykorgan they comprised 3-4 points by MSK-64 scale. Four earthquakes occurred on May 2. The first earth shock happened at 02.29. The earth shocks comprised 4 points by MSK-64 scale were felt in Almaty. The second earth shock happened at 05.27, the third - at 05.52, the fourth - at 08.31. The earth shocks comprised 2-3 points by MSK-64 scale were felt in Almaty /5/.

Meanwhile, according to the European-Mediterranean Seismological Centre ten earthquakes took place in the south-east of Kazakhstan with a magnitude of 3.2-5.5 on May 1-2, 2011 /5/.

The duration of series of earth shocks never there before coupled with a complete lack of any information from the authorities, created a panic among residents of the city. Unwarned people fled their homes, many have left the city. By the evening, the situation had been completely out of control. The rumors about the city was expecting a devastating earthquake spread with lightning speed. As you know, the rumors in crisis situation attain particular color. Some public figures, trying to calm people, published what to do in the case of earthquake on their blogs. But others, less responsible well-known personalities, scared their fans telling them that they had left the city. Panic arose for two reasons. At first, the city authorities reacted too late, not tried to warn and reassure the public. At second, on Twitter, the microblogging network, and through modern tools of communication the citizens of Almaty tried to clarify the situation, but found much information about the disaster coming. The rumors, that the emergency services predict a devastating earthquake in the next few hours, begun actively spread on social networks.

After the first earth shocks, people left more than 600 messages on the popular Kazakhstani forum for 10 minutes, and about 10,000 people visited the forum during that time and all they were interested in the earthquake. The official site of the Department of Emergency Situations of Almaty could not support the load, and their server crashed from the visitors influx. Later the department reported that there would not predicted a devastating earthquake in the near future in the country.

During the XX century, especially in the last 20 years, intensified urbanization has occurred in Kazakhstan. It led to augmentation increase in the number of residents in urban areas, where now the vast majority of the population lives. For example, the officially population of Almaty city is 1.5 million people, but the real number is about 2 millions /5/.

Despite of the fact that modern seismology has advanced far ahead and can predict earthquakes with high probability, to calculate the date and even the year of the accident is very difficult. Therefore, warning people about the threat of earthquakes is difficult too. However, the competent authorities had to use the PR-instruments to prevent the panic in that crisis situation. There were opportunities to use modern tools of communication: social networks, Twitter, blogs, forums, sending SMS-messages on mobile phones. The same evening, the Ministry of Emergency Situations developed the official account on Twitter, but instead of encouraging people, they claimed the starting of a press conference at 12 o'clock at night. Many people stayed up all night with their young children on the street. Only the official press conference of the city authorities,

which was organized in 15 hours after the first earth chock, reassured residents. As the situation showed, modern tools of communication such as cell phones, social networks, forums, blogs, short messaging servers, may throw a million-strong city in panic and chaos in a few hours, but at the same time, their effect can be used to prevent similar situations, such as early warning, education and issue instructions how to behave and what to do. They can help save lives and prevent critical situations.

After a panic among the population, Vladimir Bozhko, the Minister of Emergency Situations of Kazakhstan said: "Lighting past earthquakes in Almaty all possible prospects for rumors, fears of citizens have not been evaluated. Complete information on the development of the situation was not given to the media and citizens." He explained that it was connected with the lack of information on the nature of the earthquake from the Institute of Seismology of the Ministry of Education and Science: if the first earth shock is harbinger of an earthquake or is it an earthquake itself. He also noted that "the Institute of Seismology at that time also collected and analyzed the information on the earth shocks" /5/.

"There were about 1,500 vibrations during two days," - said the minister on the press conference. And he assured to inform people more quickly the next time. He complained that residents did not apply to official sources, but took information from other less reliable sources. Some citizens appealed to the security departments, where relevant explanations were given /5/.

After that situation the Ministry of Emergency Situations apply with proper attention to PR. They have developed a detailed mechanism of interaction during the earthquakes, created a system of civic education activities during the earthquakes. Also the pool of media, who will quickly, almost automatically receive information about emergencies occurring in the country was formed, and the pool of persons of ministries and agencies, who will provide current information on the media's request, was also identified. Vladimir Bozhko, the Minister of the Ministry of Emergency Situations will notify Kazakhstani people on the emergency situations within the country through Twitter, the social network. A special website, "where operational information will be exhibited" is created. SMS-sending will be used also. PR-service of the Ministry of Emergency Situations and the Ministry of Information should show a constant readiness for immediate use of the republican system of public notification and use the most modern informational tools at risk situations, and in case of earthquakes. There are great possibilities of catastrophic seismic events in a time of global activation of seismic processes all around the world. We must not forget that Almaty is one of the most dangerous regions of Central Asia. On the press conference, devoted to the medium-term prognosis on earthquakes for 2011 in Almaty (16.03.11), the participants unanimously declared that a state of readiness for a serious earthquake at a low level in Almaty, because the key issues are unsolved. T. Abakanova, the Director of the Institute of Seismology: "Ensuring of Seismic Safety consists of a number of issues need to be solved: first is the assessment of seismic hazard, the second is the prognosis of the earthquakes and third is the risk assessment and reducing the impact of possible earthquakes by quakeproof construction " /6/.

The density of new building territory of Almaty, in comparison with the density of buildings in earthquake zones of Japan, China, USA, Turkey and other countries are much higher. In the case of a strong, destructive earthquake Kazakhstan will not be able to provide effective help for a very long time. Moreover, not all high-rise buildings of Almaty are in accordance with "the requirements of international practice of choosing the optimal solutions in terms of resonance phenomenon development in the system" soil-content ", because that does not take into account the spectral characteristics of soils at each specific site construction" /7/. The issue on the preparation of the place of population collection, left without shelter, is also not fully resolved. At the epicenter of earthquakes rescue units will not be able to help every person who is in the zone of an emergency the first few hours or even days. Because, as a rule, it is impossible to calculate on the amount of the forces (local rescue services) and resources which are in the epicenter of earthquakes in the first hours or even days, connected with the same losses that professional-and-rescue units will have, as well as it connected with the moral atmosphere which develops within the territory where the accident happens /7/.

Thus, the role of PR in emergencies, of course, is high, and it is necessary to carry out anti-crisis communication. These events can occur in a limited period of time. In such a short time periods the media makes attention on the negatively developed events, which are broadcasted to the public. Crises are constant such as humanity itself. Therefore, you should treat them not as something extraordinary, but rather as an event, which could be controlled. How earlier the first person of a structure (company) is able to understand the help of crisis professionals, there are more chances to correct the situation. Of course, the lack of resources (material, financial, intellectual, and human) will inevitably affect on the work efficiency, and the obtained results. American PR specialists offer to consider the following positions in a similar situation /1/.

- The phrase "without comments" will only increase hostility;
- Always try to help;
- It is necessary to know about the issuance of television news and newspapers, do not collect a press conference, when this period is over;
- Meet with reporters in advance, it will help you learn about the technology in their work and they will know about you and your company.

The rapid flow of information stops the appearance of rumors, that will not have to fight and that otherwise would be another PR program /1/.

The data on the emergency situations of recent years indicate that despite the efforts in most countries, the number of emergencies tends to a significant increase.

As it was mentioned above, during emergencies PR-work aims to minimize losses due to effective preventive actions. The process will be effective only if people know what to do during a disaster and what to expect from it. Therefore, training of the population is an essential part of the work plan of PR-service of the Ministry of Emergency Situations:

- Education for children and youth in schools with an emphasis on what actions should be done in the case of disaster (for example, during the earthquake);
- Special courses for adults;
- Training Programs of the rural population, intended to instruct employees on the work places, providing with necessary information and training them to doing those tasks that they have to take on themselves during emergency situations;
- Informing the public through the media, whether television, radio or print organ can not be compared with the strength of the direct communication with the instructor. At a reasonable presentation the media can be a useful addition to the learning process, covering the broad masses of the population.

Just as the military exercises can not represent the reality of battle, repetitions of readiness to disaster can not represent operations of providing first aid in all their dynamics and show the chaos that would prevail in reality. Nevertheless, this fact can not be excuse for such exercises should not be provided.

PR-service of the Ministry of Emergency Situations under the threat of disasters should:

- To establish contact and exchange of information with the public.
- To establish contact with other government agencies;
- Be in direct contact with the government authorities responsible for the management with operational departments, donors and nongovernmental organizations (NGOs);
- Collect and analyze information and report on international aid (need and use);
- Cooperate in the mobilization of other necessary resources;
-Regularly inform all concerned government agencies, donors and NGOs (nongovernmental organizations);
- To direct the attention of NGOs to the areas and activities where they can be most benefit (which may or may not be the most affected areas).

A striking example of effective organization and communication technologies is the earthquake in north-eastern Japan on March 11, 2011. Despite the strong earthquake there were no panic and looting among the public. Japanese coolness and lack of panic can be explained by the country's readiness for the earthquake in the country a special gathering place, regular exercise, emergency reserve, which is stored in the house of every Japanese. Every day at 17.00 special

melody sounds, which, in essence, is a test alert services in an emergency on the streets across all the country. Positive results of the organizational PR-activities must be spread, so people can see the results of taken decisions, and proof that PR works. Regardless of the nature and complexity of the crisis on the communicative level, they can be managed, and contribute to achieve the most effective results, and exit from the crisis with minimal losses.

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SECTION 7
Ecology and Environment

USE OF NEW TECHNOLOGIES IN SOLUTION OF ENVIRONMENTAL PROBLEMS IN AZERBAIIJAN

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Environmental protection and rational using of its resources under conditions of the rapid growth of industrial production has become one of the actually problems today. The results of human impact on nature must be seen not only in the light of technical progress and population growth, but also depending on social conditions in which they occur.

Changing dynamics of the environment are global and irreversible, stop or influence to them is almost impossible, not now, not in the future even with a very high level of science and technology. The problem is aggregated by the fact that for the last 1.5 century mankind's by irresponsible actions caused significant changes.

The rapid transformation of the environment and the load on the soil in the social production is growing in relation to the development and introduction of new intensive technologies. Construction and operation of industrial manufacturers, mining operations have resulted in serious destruction of the natural landscape, pollution of soil, water and air a variety of waste. Factors creates emergencies can be divided into anthropogenic and spontaneous, not dependent on the will of man. Accordingly, an environmental emergency may arise as a result of accident or natural disaster. Of course, apart from human exposure to these destructive processes can influence by the impact of nature itself. It is clear that natural cataclysms have a devastating effect on the stable development of world economy, causing enormous economic damage to countries in which occur. Not every country is able to cope with economic losses from natural catastrophes. But if we imagine that natural cataclysm will gain a wide spread character in many countries, the global financial system may not be able to cover the resulting deficit of funds, which undoubtedly will lead to the need to introduce into circulation new money and will result in a global inflation and the subsequent global economic crisis. But the crisis began may prove to be deeper and more extensive than usual, since large-scale natural cataclysms can cause financial problems for many countries simultaneously. Two types of ecological trouble zones have been investigated in the article: zones of ecological disaster and emergency zones (5, 8).

Environmental disaster zone - these are parts of the territory, where as a result of economic or other activities irreversible environmental changes have taken place to such extent that it led to a significant deterioration in population's health, the violation of natural equilibrium, the destruction of natural ecosystems, the degradation of flora and fauna. Under the emergency zone sometimes understood not so much environmental as extraordinary natural and man-made disasters associated with the explosions of gas pipelines, trains, fires, earthquakes, droughts, etc., in the elimination of which involved the Ministry of Emergency Situations (MES). It is necessary to differentiate clearly similarities and differences between the emergencies, the jurisdiction of MES and the emergency situation, entailing the creation of a zone of ecological disaster, which reflect the different spheres of social relations. The similarity between these emergencies is that in both cases there is a violation of the stability of natural areas, to eliminate which is impossible without the

implementation of stringent administrative measures that may lead to restrictions on the rights and freedoms of citizens (for example, land use). In addition, in both cases take place negative environmental changes, so result of the influence of certain factors on ecosystems the same. However, the fundamental difference between them is a description of the process that led to this result. The Caucasus region and Southern shores of the Caspian Sea from the geological point of view are among the most active and dangerous zones. There exists constantly increasing geodynamic activity and therefore the processes of active crustal deformation are observed. This is mainly reflected in the intensity of earthquakes, volcanic eruptions, landslides and other natural phenomena. Deformation is also the reason for the destruction of roads, areas and pipelines. In recent years, in Azerbaijan has been observed a large number of natural disasters of all sorts: floods, storms, landslides, mudflows (9). More detail in the context of solving common problems, some of them can be specified. As a result of heavy precipitation on the territory of Azerbaijan, within a few days their number exceeded the average monthly rate, the level of water in many areas has increased, in results the inhabitants of many regions of the country faced serious problems. 6 and 4 meters height coastal dikes were broken, and a powerful stream of water poured into the village's direction. After strong rain there was a landslide. The landslide that engulfed the area 300 meters long, 150 meters wide severely damaged houses. A large land area was became useless for agriculture (17, 18).

Geodynamic processes, the deformation occurring in the Caucasus and the coast of the Caspian Sea are the main objects of research not only for scientists of the region, but also for Europe and America. So far numerous scientific projects have been conducted in this field. International project entitled "Deciphering the dynamics of continental deformation Arabian-Eurasian collision zone" is carried out with grant support of the American National Science Foundation. In the first step will studied the nature of the deformation along the western coast of the Caspian Sea, while the second - an assessment of the nature of the deformation energy of the Small Caucasus and the Kur Hollow to more accurately assess the threat of earthquakes. In connection with this project is planned to establish GPS (Global Position Systems) station at the Institute of Geology of ANAS, the creation of new research points along the west coast of the Caspian Sea, the integration of other geological and geophysical data and GPS results, the development of improved models for the active deformation Arabian-Eurasian continental collision zone and etc. The third participant country is Turkmenistan. It is expected the installation of two GPS stations to the east of the southern coast of the Caspian Sea and a lot of research stations on the Kopet Dagh. Scientists of America and Azerbaijan earlier conducted researches on the crustal deformation in the Caucasus region. At that time, our scientists represented Azerbaijan as a country which was executing the project, but in this project, the first time our country stands as an equal partner-country with the United States. This project has importance to the security of oil and gas terminals and pipelines in the region.

In addressing these challenges using advanced information technology plays a huge role.

For example, aerospace (remote) methods for environmental monitoring include monitoring system using aircraft, balloon tools, satellites and satellite systems, as well as data processing system remote sensing. Satellite remote sensing data allow us to solve the following problem of control of the environment (1-4, 6-8):

- Identify of meteorological characteristics: vertical profiles of temperature, humidity integral characteristics, the nature of clouds, etc.);
- Monitoring of the dynamics of atmospheric fronts, hurricanes, obtaining maps of major natural disasters;
- Determination of the underlying surface, operational control and classification of soil and water surface;
- Detection of large or regular emissions of industrial enterprises;
- Monitoring of technogenic influence on the state forest-parks;
- Detection and isolation of large fires fire zones in forests;
- Identification of thermal anomalies and the thermal emission of large factories and cogeneration station in megacity;
- Establishment of Smoke plumes from pipes;
- Monitoring and forecast of seasonal floods and river floods;

• Detection and assessment of the extent of zones of large floods;

• Monitoring the dynamics of snow cover and pollution of snow cover in the zones of influence of industrial enterprises (10, 12, 14-16).

The newest information technologies also include the permanent positioning system - AZPOS (Azerbaijan Continually Operating Reference Stations), orthophotoplan, aero photography, etc. (19). In today's dynamic world of high technology as development key are global positioning systems - GPS. Base stations are ideal for infrastructure projects and are intended for autonomous organization of the basic GPS-station or a network of continuously operating stations for the problems of geodesy, geodynamics and monitoring of engineering structures.

Orthophotoplan - photographic location plan on the basis of precise geodetic obtained by aero photography.

Orthophotoplan objectively and in near real-time image of the terrain and betrays a fundamental base material to create and update maps and photo plans. Widespread use of orthophotos received during the conduct of hostilities and are now used in topographical, geological as well as in construction and reclamation works. Also photo plans are used in the formulation and updating of digital maps and rapid assessment of soil, green vegetation, processing and quality of arable land and of course in construction, especially in the cottage building. At present the most accurate method of determining the size of the Earth's surface with objects located on it, as well as the formation of planimetry for further use, for example, the point is achieved by building surveying, however, this type of work is fairly labor intensive and prolonged period of time. In July 2007 the Government of Azerbaijan and the World Bank signed an agreement on a loan of $ 30 million for the project "Registering of Real Estate" at a total cost of its 38.57 million. Of these, 15 million were allocated to the State Land and Cartography Committee of Azerbaijan for the needs of geodesy, cartography, orthophototopography and training land cadastres. Unified cadastre system will boost the property market, building an appropriate system of management and use of state property, as well as proper management of real estate registration. The project was approved by the Board of Directors of the World Bank March 21, 2007. Currently, within the framework of the Project financed by the World Bank and the Government of Azerbaijan Republic orthophotos with 1:1000 scale have been composed for all regional centers, cities, and of course for the Baku city and the surrounding area (about 5000 km^2). Most recently aero photography of survey of the rest of the republic's territory has been completed in order to obtain orthophotoplan by 1: 5000scale. Completed imagery throughout the border zone and alpine areas for orthophotoplan by 1: 10000 scale. The State Land and Cartography Committee of Azerbaijan in the framework of the World Bank Project "Registration of Real estate in Azerbaijan" has developed orthophotos of 65 000 km^2 of the country. Orthophotoplan by 1:1000, 1:1500 and 1:10000 scale are developed (11) based on aero photo- and space photography.

Orthophotoplan plays an important role in environmental monitoring. It is used to update the cadastre system, maps of irrigated soil, land of urban and rural types of production planning area of digital images with the imposition of large-scale grid of any size (always the most accurate and recent data on the site) + GPS reference. With Orthophotomap we have the opportunity to explore difficult terrain and also used for inventory of land-property complex, aero photography of urban development for forest management and land administration.

Also using Orthophotoplan possible to detect soil contaminated by petroleum and petroleum products, and other wastes. When using aero photo- and space photography and Orthophoplan are possible to carry out monitoring of emergencies, estimate the scale of disaster areas and provide timely assistance to the population, an opportunity to aerial disaster zones. All these materials will be used in the future for specific goals, as well as to update topographic maps and plans of the Azerbaijan Republic.

GPS - one of the most accurate global positioning systems of coordinates. But its accuracy degrades a number of factors arising from the influence of atmospheric conditions and solar radiation on the parameters of satellite signals, the satellite clock care, etc. Such errors can be greatly reduced by applying a differential correction using a stationary GPS receiver mounted at a pre-determined coordinates. Such a receiver is called the base. With this receiver can calculate the correction value of error in the ranging of satellite signals. There are two methods of differential correction of coordinates, which is achieved by means of the positioning accuracy of 2-5 meters to

several millimeters. The method of differential correction of real time to determine the refined on-site measurements. To do this, the mobile GPS receiver must signal from the satellites but also take corrective data from the base GPS receiver. This method is good because it allows for precise navigation on site positioning. Its disadvantages is the decrease in reliability of the system because of the additional equipment and narrowing of scope, because of the limited range of radio stations. The cost of this equipment is quite high. Post processing method is based on the accumulation of data for subsequent differential correction base station. Mobile GPS receiver also stores data in its own memory or in memory of a mobile computer in an amount sufficient for subsequent correction. Upon completion of the work the data base and mobile GPS receiver (the raw measurement data) is processed together with the help of special software. This method is more reliable than the method of real time, on his area of influence only limitation of the method of differential correction. For the operation of the differential operation of GPS ground there is a basic network of GPS stations constant. Each station has an up to date high-precision peg. Station accumulates data that is available to users through the Internet. The most advanced such system in the U.S. (CORS) and Europe (EUREF).

GPS is a reflection of the general trend of the binding of environmental data for spatial objects. According to some experts, the further integration of GIS and environmental monitoring will lead to the creation of powerful EIS (environmental information systems) with dense spatial binding. In addition to the now completed construction work and summarizing the points of communication to a permanent satellite geodetic network and recently started installing the equipment. By World Bank project in Azerbaijan built 37 permanent geodetic satellite networks, as well as developed land registry maps covering the territory of 4 million hectares of land. The main station to control AZPOS under the jurisdiction of and controlled by the State Land and Cartography Committee of Azerbaijan Republic. These stations are located within a radius of 65-70 kilometers from each other. This makes it possible to determine the coordinates of the desired objects or points up to 1-2 cm network covers about 70% of the country. Potential users of this service are the organizations conducting any surveying the definitions in the range of the station: surveyors, land surveyors, cadastral organization, the creators of GIS (Geographic Information System), construction management, design and survey companies, municipal utilities, etc. To receive data from the base station Internet. Data from these stations can be used in all sectors of the economy. In this case, natural cataclysms and emergency stations make it possible to quickly determine the coordinates of the terrain and create maps of disaster zones. State Land and Cartography Committee of Azerbaijan jointly with the grant of the Government of South Korea is carrying out the respective work on the cadastral project. In parallel prepares relevant documents and construction documents for another grant for the project "Land Resource Management", also selected by the Republic of Korea to create a Geographic Information System of Baku city and surrounding area. In addition, in conjunction with Korean experts put into practice the project "Intelligent management of transport" in 2000 km^2 area. Made some steps to comprehensively address these global environmental problems, because there is a lot of overlapping issues. The country has implemented global projects of the World Bank. In these circumstances, only by persuasion, informing, educating a wide range of people can save Azerbaijan heritage and a wide variety of differing species composition and rich fauna and flora of the country. The introduction of new communications and information technology in disaster areas to address related problems is one of the biggest challenges of our state.

Prevent these problems is difficult, but taking the necessary steps possible to ensure timely response to this situation and prevent the emergence of civilian casualties.

Policies to improve the environment will be more efficient and effective only in case if more reliable information about its condition is collected.

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ECOLOGICAL PROBLEMS OF PETROLEUM INDUSTRY AT MODERN STAGE

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With the increasing of oil-producing, oil transportation, storing and processing the ever-increasing share of ground areas and water space becomes an object of oil pollution in the process of oil outflows. The existing various international programs on decreasing of ecological tension not always can stop the impending anthropogenic catastrophe. The main task is that for the solve of this problem it is necessary the consolidation of scientists efforts on adoption of innovation technologies both in the field of oil-producing and in the direction of development of more effective methods which allow efficiently, competently and with high profitability to solve a problem of localization and elimination of oil outflows.

Technosphere is a steady source of emergencies which can have rather dangerous ecological consequences. The emergencies at producing and transportation of oil, industrial emissions of oil-processing and petrochemical plants in aggregate promote continuous pollution of water space. The annual emergencies on oil-processing plants are not only the reason of big material damages and also they are the reason of ecological crisises. If it will not be taken measures which are directed on improvement and development of innovation zero-discharge treatment technologies the existing technologies can only increase ecological tension. The measures which are directed on development of effective methods on purification of water surface from oil and oil products become very important. The existing mechanical and biological methods for the purification of areas polluted by oil often are not effective especially at purification of water surfaces and big ground areas polluted by oil [1]. Oil is one of the most dangerous and large-scale pollutants of environment. Annually in the world 50 millions ton of oil and oil products are lost in the process of oil-producing, storing, transportation and processing of oil. Now approximately 450 millions ton of

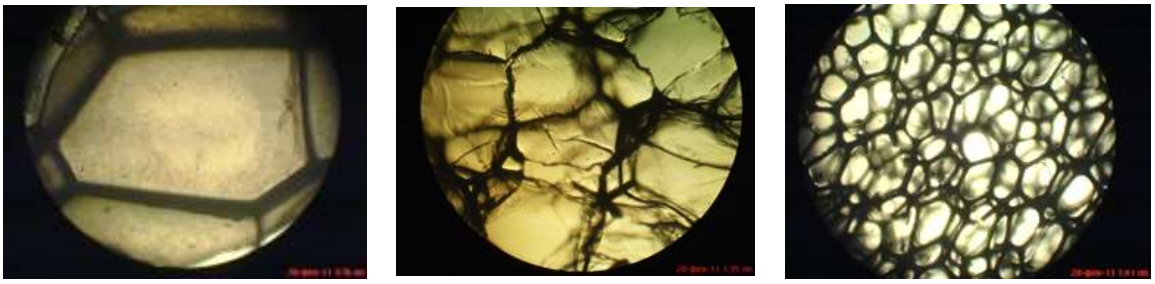
crude oil (15% of annual global oil production) goes into production from oilfields which are situated under seabed. On the whole more 2 billion tons of oil are produced from seabed and transported by sea. According to National Academy of Science of the USA 1.6 millions tons from this amount are spilled into a sea. But these 1.6 millions tons are only 26% of that oil which pollutes a sea for year. The rest of pollution (e.g. the remains of the combustive-lubricating materials) about three fourth from total pollution is the share of dry cargo ships [2, 3].

In this case pollution of sea space by oil and oil products leads to irreparable deterioration of quality of biological resources of ecological system and to reduction of their quantity. Recent events with catastrophic consequences which happened on the floating production platform in Gulf of Mexico are one more serious caution. This emergency shown that oil-producing on a sea is fraught with global ecological danger [4]. In connection with this now the investigations which are directed on development of methods of the efficient collecting of oil and oil products from water surface, assume ever greater importance. Other complication of a problem consists in that the light fractions which contain in oil evaporate eventually and some components with low molecular weight (less than 5 %) are being dissolved in water. This "atmospheric" process promotes that an remained oil becomes more viscous, heavy and incapable to float on a water surface. Therefore heavy fractions settle on a bottom of the seas and oceans, creating more dangerous situation for environment [5].

For last years the interest to use of various types of natural, mineral and polymeric sorbents for purification of a water surface from oil and oil products has considerably increased. The reason of such special attention to the sorption methods of purification consists, first of all, in technological effectiveness of process of dispersion and collecting of sorbents and in possibility of their regeneration for repeated use. Other feature of sorption methods consists in high selectivity of sorbents on oil and oil products. The oil collected by sorbents contains no more than 3-4 % of water. While oil collected by mechanical method contains 40-80 % of water [6].

Over a period of some years the researches on development of new types of highly effective foamed polymeric sorbents for purification of the areas polluted by oil are carried out in Scientific Technical Complex "Intergeo-Tethys" and in Azerbaijan State Oil Academy. Criteria of selection of polymeric sorbents with a glance of type of the spilled oil or oil products, scale of emergency, a thickness of oil layer etc. are developed [7, 8].

The decision of this problem became possible due to development of highly effective hydrophobic supersorbents on the basis of various types foamed polymers. In contrast to other sorbents the foamed polymeric sorbents have the high sorption capacity on oil and oil products, high floatability, hydrophobicity and ability of repeated regeneration. But solving of this problem must not base only on production of high-performance sorbents. It is necessary to develop equipment and technique (self-propelled floating facility, equipment for spraying sorbents and for their collecting from water surfaces; regeneration of sorbents with use of centrifuge; transportation and storing of the collected oil) which are able to maximally use the resource of the foamed polymeric materials. These questions successfully solve especially in more developed countries such as USA, Canada, Italy etc. because in these countries for realization of the abovementioned problem mainly attend to modernization of technological equipment for manufacturing and application of the foamed polymeric sorbents [3]. Just of that we want to achieve now in our country which has great opportunities for intensification of material and technical basis of oil industry and scientific laboratories. We would like to show how much effective is application of sorption method at purification of a water surface from oil and oil products on an example of the single-component integral foamed polymeric sorbents, which are produced on the basis of polyethylene (PE) and polyurethane (PUR). First of all it would be desirable to tell a little about a macrostructure of foamed polymeric sorbents with the closed celled structure. Macrostructure of the volumetric porous foamed polymeri sorbents consisting of system of emptiness (space of pores) which have the steady frame structure is shown on fig. 1(a, b, c).



a **b** **c**

Fig.1. Macrostructure microphotos of foamed polymeric sorbents with closed cellular macrostructure (a, b) and with porous macrostructure (c)

The macrostructure of a separate cell is shown on fig. 1a. From photo it is visible that only one side of cell is opened for sorption of oil. In other words the sorbent cell like the microcontainer is capable to fill its cavity with oil. Then in the process of regeneration the cell is being emptied for further use.

The technology of application of the foamed polymeric sorbent consists of four basic stages:

1. using sorbent by spraying on a water surface;
2. sorption of oil i.e. a saturation of a sorbent by oil;
3. collecting of sorbents which are saturated by oil;
4. regeneration of sorbents; separation from oil or oil products and then the iterative returning of sorbents which are disengaged from sorbate into process.

For use of sorbents on the above mentioned technology it was necessary, in order the sorbent had enough high sorption capacity, long floatability, hydrophobicity, ability to repeated regeneration and stability to influence of oil products. Introduction of oil-wetting agent into sorbent structure was leading to that, sorbent surface was badly being wetted by water and therefore selectivity of sorption process on oil and oil products was considerably being increased. Use of the cross-linking agent was promoting obtaining of a new polymeric sorbent with the spatial cross-linked structure [8].

Photos which show a flowing of sorption process of oil from a water surface are shown on fig. 2. Practically complete absorption of oil takes place in 60 minutes. If to pay attention to sorbents, it is possible to see that at oil absorption the middle part of sorbent remains light, i.e. free from oil. This circumstance testifies about that a part of cells remains inaccessible for sorption and also performs the function of air tank which supports a sorbent afloat. On fig. 2 (a, b, c), it is possible to see that in the beginning the oil film eventually is concentrating round of the integral sorbents (fig. 2b), and then completely is being sorbed in cavities of cellular structure. As shown in the photo practically all water surface is being purified of an oil film (a Fig. 2c). Maximum permissible concentration of oil in sea water amounts to 0.05 mg/l. If necessary by means of these sorbents the concentration of oil in sea water can be decreased up to 0.01 mg/l.

For all-round interpretation of the discovered laws, let's advert to the table-1. Research results of influence of exposure time of the integral foamed polymeric sorbents on the basis of PE and PUR with volume weight within 35-75 kg/m^3 on their sorption capacity on oil and oil products are adduced in this table. The comparative analysis of data which are adduced in this table shows that sorption capacity on oil and oil products at integral sorbents considerably above.

a b c

Fig.2. Photos of sorption of oil by integral sorbents on the basis of PE (a thickness of an oil film makes up 1 mm): a) the initial moment; b) in 15 minutes; c) in 60 minutes

Thus, according to the received data the integral foamed polymers are characterised by rather high initial speed of sorption. Practically in the first 3 hours of an exposure the sorption capacity of the integral sorbents approximates to a maximum and makes up 13.0 kg/kg for foamed polyethylene (FPE) and 26.8 kg/kg for foamed polyurethane (FPUR). High starting speed of sorption is one of the most important advantages of the integral sorbents. All these data are evidence of possibility of considerable increase of sorption capacity at the integral foamed polymeric sorbents. At the same time, such, comparatively high sorption capacity of samples on the basis of FPUR is reason of presence in its structure of macromolecules of various polar functional groups (amide, urethane etc.) which increase adhesion between sorbate and a sorbent.

Analogous researches have been carried out with integral sorbents at use as a sorbate of such oil products as diesel fuel, compressor and transformer oils. From the table-1 it is clear that in this case intensive growth of sorption capacity of the integral sorbents also is observed.

It is necessary to know that a sorption capacity of sorbents on examined oil products, comparatively more low, than on oil. This is reason for that in examined sorbents the volume weight makes up, about 35-75 kg/km^3. It promotes increase of sorption capacity basically on oil. Thus, comparatively the best rates on diesel fuel and oils were at foamed polymeric sorbents with volume weight 280-550 kg/m^3.

Table 1

Influence of type of foamed polymeric sorbent with volume weight 35-75 kg/m^3 and with exposure time on sorption capacity on oil and oil products. T=298 K.

Sorbent name	Exposure time, hour	Oil	Diesel fuel	Compressor oil	Transformer oil
		Sorption capacity, kg/kg			
Integral foamed polyethylene	1	13.0	5.3	7.6	7.0
	2	15.0	7.6	8.9	9.2
	3	16.1	8.9	10.6	12.3
	4	17.6	10.3	11.8	13.0
	5	18.2	12.0	13.2	14.2
	6	19.0	13.2	15.6	15.1
Integral foamed polyurethane	1	26.8	8.8	9.6	10.1
	2	33.4	11.6	13.4	13.9
	3	37.7	12.4	15.7	16.2
	4	38.4	13.3	17.2	17.8
	5	38.7	14.6	19.4	18.2

	6	39.1	15.0	20.2	18.5

The high starting speed of sorption of integral sorbents has great significance for the accelerated collecting of spilled oil at emergency situation. In this case the probability of dissolving of oil products in water and of precipitation of heavy fractions of oil on a sea bed is practically being minimized.

Analogous types of researches were carried out on a number of individual polymers and also on polymeric mixes. The collected experimental data on sorption characteristics of foamed polymers unambiguously gives the basis to suppose about their big possibilities at use as sorbents for oil and oil products [7, 8].

On the basis of the carried out researches it is possible to come to the conclusion that at selection of sorbents for sorption of oil and oil products from a water surface is necessary to have some data concerning scale of emergency, type of oil product, volume weight, sorbent structure and size of cells. The maximal sorption capacity on oil was reached at the volume weight of a sorbent 35 - 75 kg/m^3. In case of use of sorbents with volume weight 280 - 320 kg/m^3, comparatively high values of sorption capacity were obtained in process of sorption of compressor and transformer oils. At use of sorbents with the close-meshed macrostructure and with volume weight 480 - 550 kg/m^3, maximum sorption capacity took place in process of diesel fuel sorption. Last circumstance enables to assert about selective progress of sorption process of oil and oil products by foamed polymeric sorbents.

Becomes obvious, that depending on type of the spilled oil product on a water surface it is necessary to carry out individual selection of the polymeric sorbents intended for purification of polluted sites. Thus it is necessary to take into consideration not only scale of emergency, but also morphological features of a macrostructure of a sorbent and its volume weight. We gradually should depart from the stereotypic approach at interpretation of qualitative features of sorbents and basically should focus attention on an ascertainment of interrelation of their volume weight and macrostructure with sorption capacity. More it is necessary to focus on individual selection of sorbents, taking into account all criteria predetermining their expediency and efficiency of use.

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OIL SPILL DETECTION AND IDENTIFICATION USING RADAR SAR IMAGES APPLIED TO THE ALGERIAN COASTS

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The problem of the marine pollution is probably one of the most worrying aspects of the deterioration of the environment. The sea surface is frequently confronted to a provoked pollution, caused on large part, by the illicit discharge of hydrocarbons by the ships. Hydrocarbons are the most noted pollutants and the Mediterranean Sea contain about 20% of the world's pollution.The difference of roughness between the polluted surface and water makes the power of the signal backscattered by the oil spills toward the radar less than the one backscattered the water. It results in a dark surface on the acquired images. Nevertheless, look-alike provoked by natural phenomena present a similar radar signature to oil spills.In this paper, we present a complete methodology in order to differentiate oil spills from look-alike on the radar images. We developed an detection and identification process using neural network analysing the physical and geometric parameters of the suspected object. But these are not always sufficient to recognise the nature of the spill. Additional data, as the wind speed, prove to be necessary to improve the performances of this process. We developed a second neural network that considers, in addition to the physical and geometric parameters, the wind speed in the process of identification. We calculated the wind speed using to the CMOD4 model, empirical model that determines the radar backscattering coefficient according to the wind vector speed and the direction, and of the incidence angle of the satellite. We inverse this model for calculate the wind speed with a pre-evaluation of the direction of its vector. We developed a study to estimate the wind direction visually from the radar images. This evaluation is based on the inspection and the interpretation of atmospheric and oceanic phenomena.

We compared the results of identification obtained with the two networks; the process including the speed of wind provides more successful results with 89% of success rate against 83% for the first network. This work allowed us to appreciate the contribution of the evaluation and the interpretation of the atmospheric phenomena in the identification of the oil spills. We propose an application of oil spill detection service, through reception and analysis of the near real time satellite data, for early warning alerts the coast guard.

Keywords: oil spill, detection, identification, Neural Network, CMOD4 model, ERS SAR data.

DISTRIBUTION AND NATURAL TRANSFORMATION OF FUEL OIL SPILLED IN THE STRAIT OF KERCH IN NOVEMBER 2007 (THREE-YEAR OBSERVATIONAL RESULTS)

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On the 11th of November 2007 in the Strait of Kerch connecting the Black Sea and the Sea of Azov a strong storm caused a series of shipwrecks. Three dry cargo ships sank, two barges ran aground, the tanker "Volgoneft-123" was damaged and the tanker "Volgoneft-139" split in half resulting in a major oil spill. In total, 6,800 tons of sulphur cargo and 1,300 tons of heavy fuel oil were released.The present paper is devoted to the analysis of results of three-year study of the

pollutant distribution and natural transformation in the oil spill zone. The observations were started in 2007 and at present they are being continued. Since the accident, five scientific expeditions were carried out. The investigations included visual assessment and sampling of oil slicks, seawater and sediment cores. In totality 10 coastal and 11 maritime points were observed, 35 samples of water, 51 samples of oil slicks and 70 samples of bottom and coastal sediments were taken. Their analysis were carried out with the use of thin layer and column chromatography, optical and gravimetric methods making possible to determine separately the sum of saturated, mono- and di-aromatic hydrocarbons, the sum of polycyclic aromatic hydrocarbons and the sum of asphaltic components as well as the presence of hydrocarbons of contemporary biological origin. The results of the investigations show that the spill of heavy fuel oil composed mostly of macromolecular, non-volatile and insoluble substances hasn't increased considerably the water pollution level. The average concentrations of hydrocarbons were stably high: 0.16−0.21 mg/l in winter, 0.25−0.44 mg/l in summer. However such an important level of oil pollution has always been observed here because of intensive navigation and port activity. Nevertheless the notable augmentation of concentrations in summer might be caused by natural destruction of oil slicks stranded on the shore.As the density of fresh fuel oil is slightly inferior to the seawater, almost all the released pollutant drifted on the surface of water in concordance with the storm wind direction and was stranded on the shoreline during the first three days after the accident. Therefore apparently the bottom sediments were not contaminated. In the sandy-silty sediment cores up to 40 cm thick taken in the fairway of the Strait of Kerch the concentrations of the sum of oil components didn't exceed 0.15 mg/g of dry weight. Light-blue luminescence of thin layer chromatographic plates indicates that the most of these substances are of contemporary biological origin.In contrast with water column and bottom sediments, the coastal zone was hardly polluted by the spilled oil. Even after the termination of clean-up operations, numerous weathered oil slicks are still present in certain sectors, especially on limestone blocks of the Tuzla dam. In the course of time it's revealed an exponential decrease in their quantities and in the ratio between hydrocarbons and asphaltic components. The values of half-period of oil pollution transformation varied from 350 to 1020 days. The highest activity of natural cleansing process was observed on the rocky substrate and sandy beaches exposed to the influence of fresh air, solar radiation, storm waves and surf action.The study was supported by the Ministry of Education and Science of the Russian Federation (Government contract no. 02.740.11.0334, grants of the President of the Russian Federation nos. NSh-8030.2010.5, MK-4216.2010.5).

Keywords: oil pollution, fuel oil, transformation, coastal zone, natural cleansing

COMPARATIVE STUDY OF THE INFLUENCE OF THE IONS NA^+ AND K^+ IN THE INHIBITION PROCESS BY MASS LOSS

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The effect of variation of the corrosion levels has been studied experimentally by mass loss that proves to be a first approach in the study of the inhibition of corrosion of a metal in an electrolytic solution in order to determine the inhibitory efficiency of the tested product. Two inhibitors to basis of Na+ and K+, derivatives of phosphate and that didn't show effects of toxicity in the literature have been used: the sodium phosphate and the potassium monohydro-genophosphate. Four other inhibitory products have been tested in order to compare their inhibitory efficiency to the first two inhibitors. Tests have been led in three different environs, the first simulates the marine environment of the Mediterranean (3% NaCl), the second environ represents a solution of saturated calcium hydroxide $Ca(OH)_2$ simulates the concrete pore and the third one represents the concrete synthetic environment in the same conditions of temperature and relative humidity. Maximal value of the inhibitory efficiency has been valued respectively formerly to 80%, 75% and 74% for the sodium phosphate in the three environs; while for the potassium

monohydrogenophosphate, this efficiency has been evaluated at 65,5%, 66% and 51,5% in the same three surroundings of the study. The influence of the concentration as well as the effect of the PH have been interpreted.

Key words: concrete, corrosion, inhibitory, ph, phosphate, mass loss.

CLASSIFICATION OF ENVIRONMENTAL IMPACTS ON VITAL ACTIVITY OBJECTS AND OF RECOMMENDATIONS FOR DECISION MAKING

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To automate knowledge discovery in the decision support systems (DSS) the classification of environmental impacts on vital activity objects and of recommendations for decision making is required. In terms of time impacts of the environments can be classified as follows: possible negative impacts expected in the far future; possible negative impacts expected in the near future; immediate or direct impacts (at the time of disaster occurrence); impacts identified after disaster (post-disaster). The following are considered as objects that can be exposed to impacts: soil, forests (vegetation), water, air, biota; social economic spheres-sectors and related business processes; trade, communication, recreation; public organization and associations, state government and administration bodies; population, municipal services. Impacts may affect climate, safety of people and property, living standards, ecological, economic and social conditions. By the type of influence they can be natural-anthropogenic, political, psychological, physical (mechanical, thermal, and acoustic), chemical, and sector specific.Recommendations in case of natural disaster should be prepared for the following phases: mitigation, preparedness, response and recovery. Mitigation based on the knowledge of possible impacts involves the determination of specific measures to minimize risks. Mitigation in fact is a long-term planning at all levels of the country management in design and decommission of objects. Preparedness is the need for a decision maker to initiate disaster preparedness measures based on the prediction and knowledge of the environmental impact character.

Response in the time of disaster occurrence includes taking measures by emergency, health and social services and by volunteers and population.Recovery includes measures taken after disasters to relieve consequences and restore settlements.

Mitigation recommendations can be legal, awareness-related, organizational, science-technological, personnel-related, preparatory, ecological, economic, compensatory, warning, prohibitive, corrective, decontamination, protective, political, psychological.

Preparedness recommendations based on short- or long-range forecasts may be organizational, informational, prescriptive, warning, restrictive, prohibitive, preparatory-for-evacuation. Response (in the time of disaster occurrence) recommendations may be recommendations to localize the disaster, recommendations to evacuate people, recommendations to use physical and chemical methods to prevent impact. Post-disaster recovery recommendations are divided into search-and-rescue, emergency recovery, social, restrictive, involving various specialized services.

The above classifications will be further developed in the course of accumulation of new information on impacts and recommendations.

THE INFLUENCE OF ANTHROPOGENIC FACTORS TO THE HYDROLOGICAL REGIME OF RIVERS AND THE ESTIMATION OF ECOLOGICAL FLOW

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By the human economy activity the water regime of rivers, the condition of flows' formation subject to specific changes. Taking of subsurface waters for the usage in different fields of the economy, their returning into the rivers after changing of their quantity and the quality, the regulation of river flow by the river reservoir, changing of the flow direction, a deforestation or a reforestation, the drought of swamps and etc.may be belonged to such economical fields. In result of such huge human activities the natural regime and the quality of rivers' water subject to changes. The increasing of the anthropogenic factor's role by the implementation of different water management measures on the river basins in its turn requires the detailed study of happened and expecting changes. In result of human economy activity on the basins of many rivers of our republic the ecological condition has been subjected to serious destructions: the natural regime of rivers are destructed, the development of their biological environment aren't secured. In this point of view there requires to save the ecological minimal necessary flow volume in rivers. The security of ecological flow along the river may lead to save an important geographical landscape factor, normal hydrological condition. By this aim on using the water resources of rivers over the minimal flow period it is necessary to secure their certain quantity on the rivers' channel. In rivers, where have been created water reservoirs, on using a great quantity of water for irrigation there not observe a flow on their lower reach for a long time. So, these features are observed in Khachinchay, Terterchay, Gargarchay, Pirsaatchay, Agsuchay, Zogalavaychay, Devechichay and etc. It is necessary to held complex hydrological, hydrodynamic and hydro chemical researches by the aim to calculate the ecological flow for above mentioned rivers and the rivers, the source of which is on north-east (Gusarchay, Gudyalchay, Velvelechay)andsouth slopes (Alazanchay, Talachay, Kurmukchay, Balakenchay, Shirvanchay and Gobustanchay) of Major Caucasus mountains. The hydrological regime features and the type, the intensity of human economy activity of these rivers are studying, the influence anthropogenic factors to the river regime has been estimated. Ecological flow must be purposed for rivers, the anthropogenic load of which is increasing. The ecological condition of rivers is considered as acceptable, when the ecological flow is slow than the natural regime on flow's natural regime destructing period. It is impossible to rationally use the water resources of the territory and correctly estimate the human economy activity without the investigation all of these problems. Therefore the investigation of the influence of human economy activity to the hydrological regime and water resources of rivers, the estimation of the ecological flow are considered as thevery importantproblem of contemporary hydrology. The flow of rivers of researching region has been few studied for the human economy activity. These research works has been developed Kur and Araz rivers. These is an impotance, possibility of the estimation of research work about mean and short mountain rivers problems in Azerbaijan. On saying "the change of the river flow in result of human economy activity" we usually mean two directions of the problem: the first of them is the quality change of natural waters in result of the pollution, the another one is the quantity change of waterresources for the immediate use of water and thechange of its forming condition. For the forecast of the anthropogenic change of river flow and its quantity estimation different calculation methods have been grouped as a statistical, water balance, mathematical, modeling and active experimental methods. In mountain rivers, whichflow is formed on the mountain part of thebasin and is used on plain part of the basin the application of thestatistical (regression) method gives good results.

On researching of the problem rivers' flow of the territory has been analysed, the influence of rivers to the hydrological regime has been studied. So, in themain rivers of the territory – Alazan, Kurmukchay, Alijanchay, Turyanchay, Goychay and etc.the natural water regime has been generally destructed in result of human economy activity in theperiod after 1955-1960 y.y. The flow of rivers forms usually at the mountain part and after this part there has been created the water intake equipments and artificial channel. The water of these rivers has been used for different

problems (people water provision, irrigation and etc.). There has been used the hydrological similar method by the aim to quantifiably estimate the influence of the human economy activity to rivers' annual flow.

OIL PRODUCTION AND ECOLOGY OF THE CASPIAN BASIN

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At present time, one of the basic problems in ecology is pollutions from oil processes (on the whole, oil production and ending with use of oil products), as all of them finally promote strong environmental contaminations of the Caspian Sea. The intensive production of oil and gas fields in the Caspian Sea results in strong negative impact on ecology of the sea that is a serious problem for all countries of the Caspian basin – Azerbaijan, Iran, Kazakhstan, Russia and Turkmenistan. It should be reminded, that the Caspian Sea is the world's largest lake, stretching for 1030 m from the North to the South; it is closed water reservoir with relatively low percentage of salt, the surface of which is 27 m below the ocean.Now, there are 59 oil and gas fields in Azerbaijan, 18 out of which are offshore deposits, and the remaining 41 are onshore fields. There have been produced 190 million tones of oil at the Azeri-Chirag-Guneshli block of offshore fields since the start of oil production of the block in 1997. According to the State Oil Company of Azerbaijan Republic's forecasts, the oil production in Azerbaijan will have reached 60 million tones per year by 2015, and the gas production will have been 35-40 billion cubic m by the same time. The basic operational stages of oil are as follow: exploration, oil production, transport of oil, oil refining and oil chemistry, use of oil products and recycling waste products.

All above-mentioned stages to some extent fatally impact on ecology of the Caspian Sea. At exploration of oil deposits (drilling of wells), there is a strong pollution of ground and water with drilling slurry containing polymers, hydrocarbons and heavy metals. During oil production, the greatest danger among the all kinds of pollution is emission to an atmosphere of oil hydrocarbons, dump of sewage and also, floods of oil on a ground's surface. During oil refining and oil chemistry, negative impact on ecology is like on oil production. Recycling of waste products of the oil refining and oil chemistry industry is, also, major problem in environment's pollution.It should be noted, that the strongest pollution's source of the Caspian Sea is, also, the oldest onshore oilfields – Bibi-Heybat, Surakhani, Balakhani etc. In particular Bibi-Heybat: the first well with 21 m deep for oil production was drilled in Bibi-Heybat with a positive result (for the first time in the world in 1846).

The basic sources of the sea's pollution are drilling slurry, drilling fluid, oil pool waters and oil pool sand, which accumulate as waste in the process of exploration and drilling. An impact of waste products from oil industry on the Caspian Sea's ecology is very great; we'll especially note the drilling slurry, high volumes of which are produced by production and drilling.In summary it's worthwhile to note, that intensive development of oil production and oil chemical industry without full-scale implementation of purification devices lead to the sharp increase of pollution in the coastal zone of the sea.

For reduction of pollution (contamination) of the Caspian basin at carrying out of production's and drilling works, it's extremely necessary: to use less toxic chemicals to carry out these activities; decrease the volume of toxic released during production, drilling and production by proper storage with subsequent recycling by various ways (chemical, technical and mechanical); and at last it must be used waste-free technologies, including the complete detoxification of waste and their further re-use in the different industries.

BIOTECHNOLOGY OF AQUACULTURE FOR REHABILITATION OF STURGEON SPECIES' GENE POOL

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It is very important today both to rehabilitate the endangered species in the wild and to preserve their gene pool. Existing sturgeon hatcheries cannot increase the production of fry due to the shortage of sturgeon spawners. Experts of the Southern Scientific Center of the Russian Academy of Sciences (SSC RAS) have been involved in the studies on the preservation of rear and endangered fish species since 2004 within the framework of the RAS Programme "Biological resources of Russia: estimation of current status and fundamental basis of monitoring".A pilot experimental complex was established and developed at the SSC RAS Research Station in Rostov Region in 2004-2011 where the best elaborations of scientists in the field of biotechnologies of artificial reproduction and commercial cultivation of sturgeons have being carried out, using modern equipment.

A complex of flexible intensive methods has been developed, certified, and patented forming a single biotechnology of sturgeon cultivation in modular controlled systems, leading to obtaining commercial production of high quality at every stage of industrial process and preservation of rear and endangered species for rehabilitation of the wild population.Unique modular system allows regulating the parameters of water environment, simulating different environmental conditions close to the ones of natural marine and freshwater bodies, and conducting investigations under the human control with 100% load the year round. Uniqueness of the system is in the right selected blocks and modules allowing conducting the water cleaning successively with minimal water consumption of 3% per day of the total volume of water in the system.The studies resulted in the improvement of standard technological cycle of industrial sturgeon cultivation demonstrating that commercial fish with the average weight of 1.5 kg can be cultivated for one year, with the weight of 3.5 kg – for two years. It is also possible to get highly reproductive brood stock (sterlet, hybrids) within recirculation system for 2-3 years, which is 3-4 times faster than in the wild.The method of cryopreservation of sturgeon fishes' sex cells including two new sections of electrostimulation and defrosting with excretion of cryoprotector was developed.

The method increases the survival rate of cells and decreases the negative consequences of double thermal shock. The method allows long-term preservation of viable sex cells and their use for artificial reproduction of sturgeon fishes, formation of cryobank and brood stock with selected characteristics.The collection of live reproductive cells of rear and endangered fish species of the Russian southern seas has been formed consisting of 47131 mln sperm cells, 8977.5 ml. The collection is kept in liquid nitrogen with temperature of - 196ºC, frozen according to a new method.The technique of stage adaptation of sturgeon fishes to artificial conditions of water environment has also been developed. The scheme of formation of highly reproductive sturgeon brood stock and complex method of spawning control applying biologically active substances, hormonal stimulation and regulation of temperature conditions has been proposed.

As a result of studies, aquaculture methods, based on adaptive specific features of sturgeon fishes at different ontogenesis stages, has been developed allowing preservation of gene pool of rear and endangered fish species and reduction of rehabilitation time of populations in the wild.

THE INFLUENCE OF HORSERADISH (ARMORACIA RUSTICANA) AND COMMON COMFREY (SYMPHYTUM OFFICINALE) UPON THE EDIBLE TERRESTRIAL SNAILS HELIX ASPERSA MULLER (CORNU ASPERSUM) DURING HEAT WAVE AND DROUGHT AS MEANS TO IMPROVE SNAIL FARMING TECHNOLOGIES

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Many perennial plants are often huge biomass producers capable of capturing the solar energy and producing valuable nutrients, plants that represent food source for many herbivores. Some plants have toxic properties to some animal species whereas to others they represent a priority in herbivore's diet. We investigated the influence of *Armoracia rusticana* and Symphytum officinale upon the development of one of the most farmed and consumed terrestrial snails Helix aspersa Muller (Cornu aspersum), an excellent animal protein source for humans. The experiments took place in town of Băişoara, Cluj County, Romania in the June – August 2010 interval.

The adult Helix aspersa Muller snail populations in the witness lots display a survival mean rate under extreme heat wave and drought conditions of just 6.50 ± 1.29 while the population in the experimental lots with *Armoracia rusticana* and Symphytum officinale presented higher survival mean rate of 14.00 ±0.82 and 16.75 ±1.50 respectively. As far as prolificacy, the witness enclosure batches accounted for 100 ±5.72 while the batches in experimental enclosures accounted for 248.00 ±8.29 and 140.00 ±5.10 respectively. We included the fitness component test, as an indicative of snail's vitality and energetic condition, measuring their crawling mean speed and the mean heart bit rate of new born baby snails that have similar body weights.

While the heart bit rate differences between the different batches were not significant, the mean speed presented significant differences directing us to the conclusion that plants such as *Armoracia rusticana* and Symphytum officinale not only represent valuable nutritive foods to Helix aspersa Muller adults and youngsters but also have protective values against stress conditions such as severe drought and prolonged heat waves.

Such plants can represent an additional assurance for an efficient and ecological snail farming technology as an important source of quality animal protein for human consumption, capable to deliver a high quantity of animal protein from a given land surface, representing a venue towards sustainable agro-economical development.

Keywords: food selection, ecological farm management, sustainable development, agro-economics, bioeconomics, mollusk, *Cornu aspersum*, *Helix aspersa,* Băişoara, Cluj-Napoca, helicicultura, energy budget, fitness component, performance, standard metabolic rate, survival, brown garden snail, HBR, heartbeat rate, crawling, speed.

THE INFLUENCE OF SOME PERENNIAL PLANTS AND SEL-PLEX UPON THE DEVELOPMENT, RESISTANCE TO EXTREME CLIMATE CONDITIONS AND MEAT QUALITY OF THE EDIBLE TERRESTRIAL SNAILS AS ONE OF THE MOST EFFICIENT AND ECOLOGICAL SOUND ANIMAL PROTEIN SOURCE FOR HUMAN CONSUMPTION

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One of the most acute problems the humanity is confronting with in the light of Global warming is the availability of food to the ever-growing population. Quality foods respecting the food hygiene and offering the proper nutrients are becoming a scarce commodity. Considering the ecological impact that the agro-food production sector has upon the carbon footprint, we investigated the potential that farming of edible terrestrial snail *Helix pomatia* and *Helix aspersa* Muller (*Cornu aspersum*) can provide humanity the necessary animal protein while reducing the need for energy input. Observing the feeding behavior of snails preferred perennial plants were identified. From those plants we selected the species with the highest productivity of biomass and the most resistant to extreme conditions without the need for energy and human resources input to maintain them. Snail's development, survival rate, prolificacy, meat quality and resistance during stress conditions such as hibernation and aestivation were measured while and after being exposed to different feeding conditions and extreme climate conditions such as high air temperature and draught. Temperatures such as 32^0 C – 37^0 C were frequent and lasting for long periods during the 91 days of the experiments that were conducted from month of June to August 2010 in the town of Crăieşti, Cluj County, Romania. Considering the fact that for *Helix* (sp) the edible part of the plants represents the leaves, the availability lipids and organic nitrogen expressed here as crude protein content in the leaves of seven different perennial plants have been determined. Alternative animal protein production can be integral part of a Global strategy as to implement the real value and non-monetary value concepts as basic reference to be the Global economy; a strategy that is aimed to provide non-monetary economical means for survival of human species while protecting the environment and sustaining overall life on Earth. The article presents just an aspect of an agricultural activity and it is intended to be viewed also as a brief and provoking model concept of efficient alternative means for producing food of the highest quality while using the natural resources at their potential without disrupting the ecosystems. Proper natural resources management makes the foundation of sustainable agro-economic development.

Keywords: *Helix pomatia, Helix aspersa*, brown garden snail, *Cornu aspersum*, Cluj-Napoca, helicicultura, food selection, ecological farm management, mollusk, performance, survival, non-monetary, organic foods, snail breeding, escargot, USAMV, economy, public health, food safety, food security, sustainable development, agro-economics, bioeconomics.

TREATMENT OF URBAN WASTEWATER TREATMENT (CITY OF ANNABA IN ALGERIA) BY THE LIME WASTE FROM THE ENGI

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The method used at the National Industrial Gases Company (ENGI) Annaba, for the manufacture of acetylene is reacting calcium carbide with excess water. Such a process necessarily leads to the parallel fabrication of lime slurries. The amount of this by product, which is considered industrial waste, increasing day by day. This residue, no commercial value, raises problems of landfill or long-term storage. This rejection, highly alkaline, has led to disasters affecting the soil, water, wildlife, plants and even animals.These findings led us to assign primary objective of our work to enhance this by-product in the protection of the environment, especially in water treatment. The widespread use of this product in water treatment would provide a very large market and simultaneously allow a dual action favorable to the environment: the elimination of waste and water treatment.

The main objective of this study is to assess the performance of the lime waste, a byproduct of the manufacture of acetylene, nival in the elimination of suspended solids and removal of organic matter in wastewater city of Annaba.

Keywords: coagulation-flocculation, milk of lime, organic matter, wastewater, pollution.

PROBABILITY DISTRIBUTION ON FAULTS NEAR THE CITY OF THESSALONIKI (NORTHERN GREECE)

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Many studies found that stress triggering and fault interaction theories can be incorporated into quantitative earthquake probability estimates. Using two methods of time dependent probability estimates this work aims at the evaluation of the occurrence probability of anticipated earthquakes in the city of Thessaloniki, an urban center of 1 million people located in northern Greece, conditional to the time elapsed since the last stronger event on each fault of the study area and to the history of the following events on adjacent active faults. The city of Thessaloniki was chosen as a case study because is the second largest city in the territory of Greece surrounded by several small towns and villages. It has suffered significant damage due to strong earthquakes several times in the past. The latest destructive earthquake occurred in 1978 (M=6.5) and caused the collapse of buildings and loss of life in the city and nearby villages. In this study we start from the estimate of the probability of occurrence for the stronger known earthquake on a fault in the period 2011-2041 (30 years) based on a time-dependent renewal model. For this probabilistic earthquake forecast the coseismic stress changes of strong earthquakes ($M \geq 6.5$) that occurred since the beginning of 20^{th} century in the study area are calculated. The coseismic stress changes are translated into earthquake probability using an earthquake nucleation constitutive relation. According to this the occurrence rate of the anticipated earthquake is calculated taking into account both permanent (clock advance) and temporary (rate-and-state) perturbations. Earthquake probability on a fault is lowest after the last event but as tectonic stress grows the odds of another earthquake increase. For all needed calculations a probability density function (pdf) for the time of failure for an earthquake of defined magnitude on the fault of interest must be taken into account along with the calculated stress changes on the fault.The technique for incorporating stress changes

into the estimation of earthquake probability has introduced some uncertainties on the input parameters that affect our results. In order to check if our results are reliable and to confirm the consistency of the model another method is used, giving the option to compare the results of both methods. This new technique can be used with any physical model of earthquake nucleation and can also be used to directly compare the implications of different physical models. This method is modular in that it can be used for any probability density function, any stress change and any quantitative nucleation model. The estimated probability values that obtained using the above methods concern the probability in each part of a given fault or fault segment, and the probability distribution is illustrated across the specific fault. All calculations were performed at 10km depth but it was necessary to check whether the estimated probability values vary with depth. Therefore, all estimations were performed for each fault or fault segment at the depth of 8, 12 and 15km. The probability calculations were carried out and given for the entire study area during the next 30 years, in the form of tables and maps.

ENVIRONMENTAL PROCESS BASED EDUCATION AND RESEARCH FOR BETTER LIFE AND ENACTMENT OF INTERNATIONAL POLICY ACT ON ENVIRONMENT 2011

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During the last two centuries along with advancement of Science, Engineering and Technology, there has been considerable developments in different sectors viz., industry, agriculture, entrepreneurship, business, infrastructures, utility services etc., subsequently, it was realized that there were many adverse impacts on environment and society. These developments have sustained the environmental growth.Sustainability of design and development, quality of life, safety on earth and continuous improvement of our environment is of utmost important. Sustainable development means industrial development should occur and must be continued without damages to the environment. Hence, hectic industrial developmental activities during the last two centuries have caused considerable environmental and social impacts. These impacts can be measured, monitored and mitigated by imparting environmental process based education and research for better life. While planning and decision making process of developed and developing of the most of the world projects, the potential adverse impacts on environment and society should be scrupulously assessed, evaluated and mitigated.

Therefore, project planning and decision-making should include the integrative consideration of engineering or technical, economical, environmental, ethical and social factors. The most important of these considerations can be referred to as "Concept of the Four Es and 1 S" which must be involved in any organizational planning and decision making process. As per the recent research results in some case studies, environmental contamination and pollution has reached beyond safe limits which seriously affects the life on the earth. Toxic emissions from industries, thermal power plants, auto exhaust pollution in large metropolitan areas, photo chemical smog etc., have been poisoning the atmosphere beyond the permissible levels which causes serious health hazards.

Air pollution problems result in adverse environmental health and social impacts.Mindless disposal of untreated industrial wastes, radio-active wastes, municipal wastes, solid wastes, agricultural wastes, domestic wastes etc. have contaminated and polluted the water, soil and land beyond the tolerable limits, which adversely affects land fertility, water quality, vegetation, aquatic and marine life. This is proving more and more hazardous as this development continuously damaging the environment viz., melting of glaciers, climate change, carbon tetra chloride emission, green house gas emission, ozone layer depletion etc. For example, due to continuous increase in CO_2 concentration in the atmosphere due to industrial emission which lead to climate change.

This decrease in glaciers contribute about 29.5 % of sea level rise since 1991. Water supplies stored in the glaciers were projected to decline. Besides contaminating and polluting air, water, soil and land, intensive technological activities lead to depletion of natural resources. What was required was to bring our energy and intellectual capacity in tandem whereby we can meet the challenge effectively and efficiently without major disruption, without compromising on the livelihood of future generation of their needs. Development would have occurred without damages to the environment and major disruption, and the process of industrialization would have occurred in an innocuous manner by utilizing the resources effectively and efficiently in an environmental friendly manner. Now, these environmental problems are the present environmental challenges and opportunities for improvement. We have to be conscious about these environmental issues individually. In order to overcome these environmental problems and to move forward, will require new and more effective and efficient solutions, technologies, processes and products alongside behavioral change. Reemphasizing that prior to the enactment of National Policy Act on Environmental 1970 in USA, only technical or engineering and economical factors dominant the planning and decision making process in most of the world projects. As per the research results in some case studies elucidate that project planning and decision-making process must include the integrated consideration of engineering or technical, economical, environmental, ethical and social factors.

This important consideration can be referred to as "Concept of the Four Es and 1 S" in organizational planning and decision making process. There areecological and biogeochemical principles and tools such as energy flows and material cycling, element ratios, mass balance , element cycling etc. available in order to solve major environmental problems that we face in our world today such as global warming, acid rain, environmental pollution, and increasing greenhouse gases. Based on research conducted on this principles and tools, it may be noted that about 80% of thebiogeo cataclysmdisasters are preventable.

Keywords: environmental act, biogeochemistry, cataclysm, education, environment, policy, impact assessment

MODELING OF CONSEQUENCES ON ENVIRONMENT THROUGH ANALYSIS OF INDUSTRIAL RISKS

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Industrial activities involve risks and dangers that cannot be always defined.The risks must be identified and reduced to minimum for the success and safety of the factories. The process of risk management represents a method that involves all the main components affecting risk.The consequences on the environment are therefore modelled for the purpose of evaluating the different risk effects. Presented further will be the possibilities for occurrence of adverse effects in operative conditions and during accidents.

Key words: industrial risks, environment, modeling of consequences, operative condditions, initiating event.

RISK REDUCTION DUE TO INDUSTRIAL POLLUTION BY GEOSPATIAL MODELING

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Selection an appropriate location for establishment of the industries, the process is too complicated for decision makers and analysts' persons. Simultaneous attention to the criteria of technical, economic, social, environmental and political are principal needs of this process.Due tothe combinednature ofthis process, simultaneouslyapplying of severaldecision-makingtoolssuch asGeospatial analyzeandmulti-criteriadecision makingmethodsis essential toselectthecorrect-location. Howsoever, Geospatial system is as an efficient way to employ and manage various data that they can be utilized in location more appropriate places for the suitable site to decrease Industrial Pollution. The implementation methodologyutilize Geospatial technology for the management and visualization of spatial data that fuzzy logic sets is used to identify the best location for industrial site.

Key words: Risk Reduction, Geospatial Models, Fuzzy Logic Sets, W L C, Industrial Pollution.

NEW CONCEPT OF FOREST FIRE DANGER FORECAST IN RUSSIAN FEDERATION

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Forest fires destroy state wood fund, pollute an atmosphere and kill people and damage of settlements in various regions of the world annually. It is necessary, to carry out the forecast of forest fire danger with purpose of minimization of ecological, economic damage, number of victims, and also rational use of means for protection of woods from fires. Indexes and systems for estimation of fire danger in woods (for example, in Canada, USA, Europe) worldwide are developed for the decision of the specified problems. Nesterov's criterion is applied as state standard in Russia. However, it physically is not substantial and does not take into account anthropogenous loading and storm activity.Purpose of present work is creation of the conceptual project of the Russian Forest Fire Danger Forecast System on base of deterministic-probabilistic approach.Predesign research of the Canadian, American, European systems of forest fire danger estimation is lead.

The basic requirements with which the modern system of forest fire danger forecast to boreal forests should satisfy are formulated. Conceptual base for creation of such system for territory of the Russian Federation is considered. Association of subsystems of gathering, storage and processing of the information in uniform hardware-software complex is offered. It is offered to use supercomputers with parallel data processing in role of the calculator.

Program realizations of deterministic-probabilistic techniques of forest fire danger forecast are offered as software. Questions of creation of new state standard based on deterministic-probabilistic technique of forest fire danger forecast are discussed.

MATHEMATICAL MODELING AS A TOOL TO PREDICTION OF FOREST FIRE DANGER

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It is necessary to note imperfection of existing systems and methods of forest fire danger forecast both in Russia, and in other countries of the world. Basic lack of all systems is an ignoring real physical and chemical processes at occurrence of fire. In the scientific literature broad attention is given to research of processes of forest fuel drying, distributions of surface and crown fires in view of physical and chemical processes. However, deciding stage of forest fire occurrence is an ignition of forest fuel by source of the raised temperature. Such sources can be a natural and anthropogenous origin.Purpose of research is creation of complex of mathematical models for studying processes of ignition of forest fuel by sources of raised temperature.

Till now forest fires from thunder-storms create intense conditions, for example, in taiga. In present work various mathematical models of deciduous and coniferous trees ignition by cloud-to-ground discharge are considered. Questions of creation of mathematical model of forest fuel ignition by electric spark are discussed. Principal cause of forest fire occurrence is human activity now. In work the mathematical model of forest fuel ignition by particle heated up to high temperatures is considered.

Such particles can be formed as result of inflating outstanding fires and welding /cutting of metals. Generalized mechanisms of forest fire occurrence from storm activity and anthropogenous loading are discussed in summary.

ENVIRONMENTAL PROTECTION FROM EXPOSURE ELECTROMAGNETIC RADIATION

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Researches of characteristics of reflection of electromagnetic radiation on the thickness of the layer of material deposited on a metallic or dielectric substrate. Established that in the wave dispersion of the substance covering a range of election of its layer thickness values and the frequency of the incident radiation, in which reflected waves are absent. Equations were obtained between these values election, the dielectric properties of the coating and substrate materials and the minimum number depending on the thickness of the reflected signal.

Their authenticity was confirmed by experimental studies of reflection characteristics of binary solutions of polar liquids. The possibility of practical application of the phenomenon found in the environment and the accumulation of solar energy by creating a non-reflective and antireflective coatings, as well as to increase the sensitivity of detectors and development of various microwave methods of quantitative and qualitative analysis of the properties of matter, including its methods of analysis through remote sensing.

HUMAN, NATURAL ENVIRONMENT AND ARCHITECTURE

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From the time immemorial, human beings have been accompanied with the nature and natural organisms. These interactions sometimes lead to different and contradictory paradigms but the natural organisms have always been the inspiring sources for humans. Like other human beings, architects enjoyed such an inspirations and criteria as well (Lang, 2002:40).

However, they necessarily not always successful as degree of their success depended upon their perception and understanding of the nature of organisms. Later, some biological comparisons were introduced focusing on formal and structural aspects to have wider perspective about the nature of the organisms and new rules and regulations. These gave rise to critical faults and disadvantages.

Like human beings themselves, their architectures possess integral, united and harmonic system that is demonstrated in the best possible form in the natural organisms. But, these organisms lack divine or spiritual aspects, to distinguish humans from the other organisms, As such, inspiration and modeling from the ongoing rules and regulations within the structure of the organisms, are a kind of physical recreation of human architecture and therefore, fulfillment of the divine and spiritual needs and attaining an appropriate space in this regard would be possible only through knowing the nature of the organisms and spiritual dimensions.

The present work attempts to introduce some of the principles, rules and regulations related to the natural organism and then describes how to apply those organisms in architecture. Finally, it realizes the ways of going beyond the motional principles in order to attain a multidimensional humanistic architecture.

Keywords: Architecture, Organism, Nature, System, and Modeling.

ADDRESSING THE ENVIRONMENTAL SAFETY IN EMERGENCY SITUATIONS

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Modern humanity is faced with the fact more and more natural disasters occur, with great destructive power, resulting in the death of the living forces, causing tremendous damage. Natural disasters trigger man-made disasters that could put mankind on the brink of survival. Security issues and human society requires in order to avoid catastrophe, develop and implement stringent measures to prevent and survive in conditions of disasters, beyond manifestation of hazards during response and recovery operations. Providing real-life safety of humanity in violation of the natural balance of nature is possible in developing the program serial for Action and the preventive measures at the stage of the forecast of the situation and minimize damage from natural disasters. It is known that natural disasters are taking place in Azerbaijan, causing serious damage to the economy and population. Despite the on going work in the Republic of grandiose, reveals some natural volatility and the new high-risk areas. As part of the rehabilitation of affected natural disaster areas for their further development, it is important to create an information of data bank.

This will enable the optimum way to disaster relief, recovery and accordingly its required financial costs. In determining the plan and program of action during disasters, the localization of the affected areas and damage in the shortest possible period, to minimize the damage, you need a full analysis of the environment, which should be reflected in the information and maps. Comprehensive analysis of the situation and the available database is needed for decision-making at all levels. In the region there are lagging behind in research and work to develop a database for high-risk areas, including the prediction and the estimated mapping.The problem of the comparability of diverse information about the objects can be overcome by the possibility of spatial referencing based on geographic information systems (GIS). For Azerbaijan, its separate areas to accommodate the natural features, its vulnerable areas - high-risk areas for the population and the economy as a whole, will require a comprehensive environmental studies and preparation of large-scale maps.

Conducted research and collected information in a single country, as well as in different countries, agencies, companies and organizations in different directions, require the creation of a unified information system. This requires the development of GIS expertise to save lives.With the changing of the geodynamic situation, increase the level of preparedness of the population in potentially dangerous areas to natural emergencies, man-made and man-made, it is particularly important.

ANALYSIS AND INTERPRETATION OF HEAVY METALS ATMOSPHERE CONCENTRATION OBTAINED BY NUCLEAR TECHNIQUES IN ALGIERS URBAN SITE

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The low part of the atmosphere, troposphere, is characterized by a strong human activity accompanied by a serious deterioration of the quality ofair in this layer due to the rejection ofpollutants.

Among these pollutants one finds heavy metals (Fe, Mg, Pb, Zn, Sc…) contained in the suspended matters.The nuclear techniques such as, the XRF (X-rays fluorescence) and the NAA (Neutron Analysis Activation) constitute effective tools to identify and quantify heavy metals in air. X-ray fluorescence (XRF) analysis is a fast, non-destructive and environmentally friendly analysis method with very high accuracy and reproducibility. All elements of the periodic table from beryllium to californium can be measured qualitatively and quantitatively by study of X rays response emitted by samples after irradiation.In the NAA process, a nucleus absorbs a neutron. The nucleus becomes excited, and immediately releases a gamma ray and decays to a lower energy level, although it still is in an excited state. Then after a period of time (dependent on the nucleus) the excited nucleus emits and a gamma ray. Analysis of the spectrum of gamma rays emitted allows determination of the elemental composition of the air samples collected in high KASBAH.Analysis of matrix correlation put in an obvious existing relation between different elements, and meteorological parameters.

Key words: Heavy metals, X-rays fluorescence, Neutron activation, orrelation.

FUZZY RULE BASED FIRE RISK ANALYSIS OF ISTANBUL'S STREETS AND AVENUES

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The mega city Istanbul is one of the oldest and most populous cities onearth. This historical city is under a constant threat of fires. In Istanbul, which has many different types of housing units, streets andavenues, the Fire Brigade both responds to the fires and takes measuresto prevent fires. In this context, residential areas need to be keptunder constant monitoring, and extra measures need to be taken in areaswhere fire and fire response risks are high. It is crucial that theseactivities are carried out within the framework of a sustainable andsystematic risk management approach.

This study, in cooperation with the Fire Brigade of Istanbul, develops afuzzy rule based fire risk model. With this purpose, inputs to be usedin identifying risk levels were defined, and these inputs were gradedfor each avenue and street in the pilot area. Then, risk levels of thesestreets and avenues were calculated using a fuzzy rule based model. Oncethe streets and avenues were classified in terms of fire risks, measuresto be taken to manage and systematically minimize the risks wereexamined.

Keywords: Risk Analysis, Fuzzy Logic, Fire, Istanbul.

ECOETHIC PROBLEMS IN AZERBAIJAN AGRICULTURE

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Started from the half of XX century ecological problems which surrounded the world didn't pass off our republic unnoticed. The pollution of air, water basin and soil reached to the limits, process of degradation of winter and summer pastures, soil cover generally in the result of erosion and salinization, forest reserves were totally destroyed or left fragmentally in some region of the republic. Fluctuation of sea level, problems connected with ozone layer, global changes of climate connected with other high scaled processes – the consequence of all these are at such level in Azerbaijan that cannot be left without attention. Problem of global warming very closely connected with other global ecological problems such as wilderness, degradation of biological diversity and others.

In period of formation of global thinking and civilization among countries international image of the government evaluated according to the actions which were taken for the protection of natural reserves. That is why today azerbaijanian community shows urgency to the formed relationship of environment, natural ecosystems, and relation of surface and underground reserves. This is only part of world-wide crisis which affects not only moral life of humanity but also modern society including all systems of community relations. We can only resist it with the power of human common sense and unity.

In 30-40 years of the last century in the result of application of scientific-technological revolution and slogan "don't expect kindness from nature, subdue it to yourself" to human society high scaled intervention to nature began which sequence was acceleration of global ecological crisis.

If in 70-80 years of XX century situation of global ecology and protection of natural resources was in the second place for humans after the problem of peace and war, so after the postponement of "Cold War" it was the problem number one.

Pollution of water and air basin, destruction of tropic woods which considered our "lungs", problems connected with ozone holes, global changes of climate, global wilderness and global decrease of biological differentness stepped to the limits.

In recent decades some kind of animals and plants species disappeared, rare landscape and ecosystems destructed. The process acquires high scaled character.

These problems didn't pass off our republic unnoticed. From old times Azerbaijan differed for its suitable climate condition, rich plant cover, clear water and productive soils. In the middle of XIX century most part of ecosystems and landscape complexes of Azerbaijan protected and kept in anthropogenic form. But in recent 100-150 years especially during XX century though on one hand development of industry, transport and agriculture caused social-economical and cultural progress in Azerbaijan on the other hand showed negative influence on environment.

For the base of creation radical changes in natural conditions of Republic appeared numerous works such as intensive use of underground and surface resources, construction of industrial institutions and water reservoirs, building of channels and collector-drainages, improvement of power engineering and communication, creation of automobile roads in mountain areas, cutting of woods on plain and mountain territories for construction of settlement, widening of arable and pasture areas.

The result of all these was repeated increase of anthropogenic influence to environment and to its separate components: air, water, land cover. In consequence pollution of land, air, water basin reached such level that it become dangerous for human life in some areas. At the result of erosion and salinization of soil cover degradation process of winter and summer pasture increased, forest ecosystem completely destructed in different regions or changes in natural-historical structure and areal are observing. On the other side decrease of biological differentness, aridity, wilderness, fluctuation of Caspian Sea, global climate changes connected with the problem of ozone layer, rise

of hothouse gas in atmosphere and sum of all these factors increased negative influence to Azerbaijan nature.

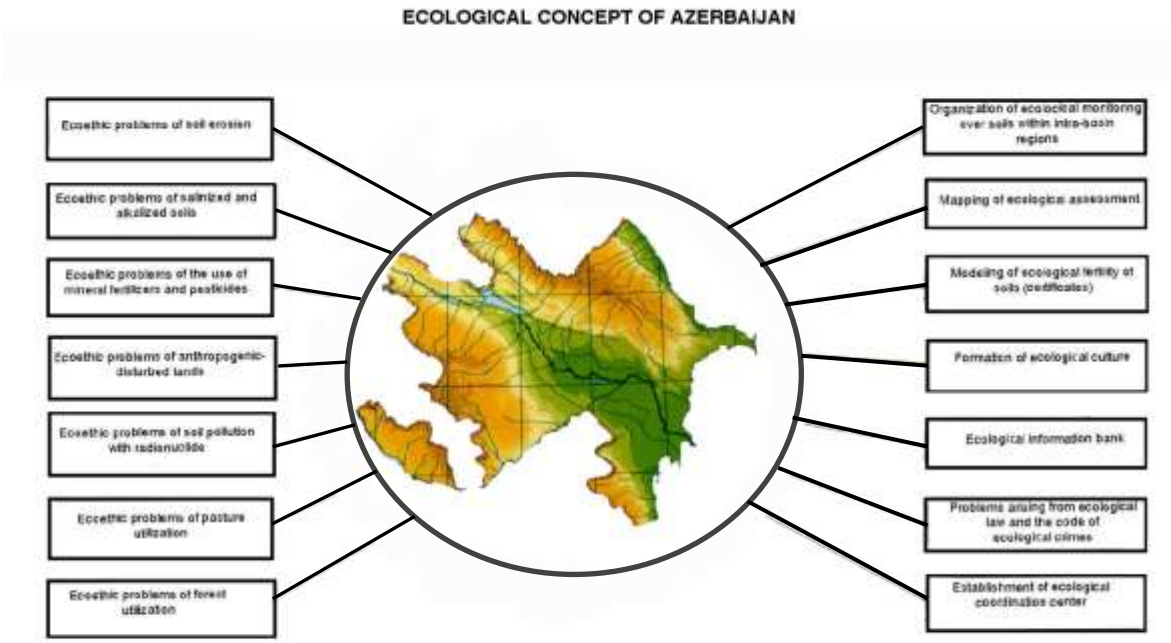
Rise of Republic population in XX century also caused some ecological problems which consequence was accelerated influence anthropogenic factor to natural ecosystems. Today population of Azerbaijan is 9 million people, but it is important to note that rise of population is not connected just with natural rise, approximately 12,5% of population increased in 90-years of XX century.

Besides, cause to such rise was deportation of azerbaijanian people living in Armenia, which consequence was orientation of 250 thousand people in different regions of Azerbaijan. With the beginning of Armenian aggression 20% of invaded lands of Azerbaijan exposed to total destruction. Agricultural products were taken from alternate cultivation. Irrigation infrastructure completely destructed in giving territories.

More than 700 thousand people have to move from Daglig Garabakh (Upper Garabagh) territory and settled in Azerbaijan territory.

That is why one of the most important reasons of ecological problems was military aggression of Armenia.

For creation of complete idea about existence of ecoethic problems in country is useful to be acquainted with concept of systematic investigation of ecological problems in Azerbaijan. (8).



1.1. Ecoethic problems of soil erosion

The exposure soil to different level of erosion is one of characteristic ecological problems of our Republic. But real disaster of land management in our republic and in the world is the water erosion (31% of land) and wind erosion (defilation) which actively influence 34% of surface land. Relief of the territory plays an important part in erosion process.

Relief of the territory intensively influences to erosion process and gradually changes under its influence. At the result of agricultural activities 30 thousand hectare of land cover destructed, but 40% of land cover exposed to erosion processes, result of wrong land reclamation work shows

its negative influence, in results underground water level and salinization of arable land increases. In arable regions of the country more harm gives irrigational erosion.

In appropriation of mountain mass under not follow antierosional activities washout of the soil will decrease which shows negative influence on productivity and often causes take out of the plant from agricultural cultivation. Very often antierosional processes causes washout of the 100 t/ha soil, especially in irrigation season. Erosion negatively influences on land cover and most time destructs it completely. Biological productivity of plants, qualitative and quantitative indicators of grain, wool and tea decreases. Mountain and plain regions of Azerbaijan exposed to irrigational erosion (5,7).

At the result of wrong irrigation activities productivity of the land decreases. Intensity of the wind erosion depends on the speed of the wind, soil resistance, and diversity of plant cover, relief peculiarities and the line of other factors. Great influence to its increase is given by anthropogenic factors. For example, destruction of plants, wrong implementation of agrotechnical activities activates erosion processes.

Dusty storms take away the most productive layer of the land, can capable to winnow near 500 t soils from 1 hectare ploughed territory in an hour, and also negatively influence on all components of environment, pollutes air, water basin and especially dangerous for human health (10).

Research works shows that total territory of lands exposing to erosion is 31444,7 thousand hectare in our Republic, which means 36,4% territory of Azerbaijan (5,7).

In the way of struggle against erosion which became one of the important ecoethic problems for our soil and plant cover, complex measures are needed to be carried out.

1.2. Ecoethic problems of salinization and alcalination

Problem of salinization and alcalination are the most important problems among the ecoethic problems. Nowadays approximately 37000 thousand hectare soils from all existing land (8641506 hectare) in Azerbaijan exposed to degradation. According to recent years information some thousand hectares of arable soil exposed to salinization and alcalination (10). Soil salinization is wide spread in Azerbaijan. 60% of Kur-Araz plain occupying 2,2 million hectares territory consists of average and full saline soil. Generally in the territory of our Republic total area of average and full saline soil is 1,3 million hectares (1). Process of salinization and alcalination are natural process, if necessary actions are not taken its areal will increase and negatively influence on agricultural products, formation of winter pasture distinctive for plain areas, also negatively influence on woods in plain areas. Results of observation showed that because of uncalculated actions and lack of experience, people carried out irrigational activities without consideration of soil type and hydrological condition which consequence become salinization and swamping of great territories (10).

That is why these lands considered useless from the point of view of land reclamation and ecology. Knowing its negative dynamics is necessary to take otherwise actions, such as taking certain ecoethic measures (derange, washout, chemical melioration, necessary administrative and legal activities and others).

1.3. Ecoethic problems of using fertilizer and pesticide

In normal natural conditions all processes which happens in soils becomes balanced. But very often breaking of balanced condition is human's mistake. At the result of humans improved agricultural activities soil pollution, changes in its structure as well as destruction happens. Modern agriculture which widely uses fertilizer and different chemical substance for combating agricultural pests is significantly influence chemical composition of land. Today quality of substance involving to turnover in the process of agricultural activities is identical as in production industries. That is why production and application of fertilizer and toxic chemical substances to agriculture increases every year. But purposeless and uncontrolled use of them brings to the destruction of turnover and substances in biological sphere (6). System of rational implementation of fertilizers restores natural

flow of elements in biological rotation and sometimes capable to liquidate deficit or excess of elements in some landscape complexes and geochemical territories. That is why one more ecoethic problem is optimization of feeding substance balance. This problem is directly connected with application of mineral organic fertilizer to the fields of agriculture.

From all above mentioned came to the conclusion that negative results in implementation of mineral fertilizers including pesticides depends not only on their quantity but more often on culture and their ecoethic use.

1.4. Ecoethic problems of technically broken soils

Starting from the second half of XX century development of transport, metallurgical and heavy industry brought to the repeated acceleration anthropogenic influence to soil. More scaled and important is the pollution of environment by chemical substances. Among them are gas and aerosol pollution of mass-industrial origin. Industrial wastes also cause intensive pollution of soil. Every year million ton of industrial waste is formed in our country, 50 million ton especially toxic for environment and human health. Great territory of land is covered by wastes which intensively pollutes soils and their ability of self-cleaning is evidently limited. Implemented works in metallurgical industry for taking minerals and organic substances causes ecoethic problems of soils. Land productivity also becomes worse at the result of mud volcanoes eruption, swamping, production and transport. Total area of such territories is more than 49,6 thousand hectares. 33,3 thousand hectares are swamping soils and soils polluted by oil wastes. Researches shows that soils in oil fields are polluted by different level depends from oil wastes (oil, water polluted by oil wastes and minerals, deep oil wells, chemical reagent substance) (9). For implementation of re cultivation soils polluted by oil wastes more attention should be given to the level of pollution of l soil type, sub-type, and kind. Results of investigation helped to define level of pollution of land type, sub-type and kind with oil and oil waste in our Republic especially in Absheron peninsula (14). In conclusion these lands are divided into 1 type, 6 sub-types and 20 kinds.

Besides oil and gas, mineral products also mine in the territory of our Republic for decades. Today approximately 360 source of mineral product defined in the territory of our Republic. 63 of them are perspective for exploitation. In the time when the source is defined upper and lower layer of the soil profile (A_RB, B) combined in the territories where restoration work no more implements. Investigations showed that as a result of getting mineral products and also implementation underground and surface communication net 21,5 thousand hectares of soils are taken from rotation of agriculture.

1.5. Ecoethic problems of soil pollution by radionuclides

Azerbaijan territory characterizes by wide ecological problems spectrum from which depends Influence of induced radionuclides to environment of humans. Problem of pollution of soil and plant cover by induced radionuclides appeared in conjunction with atom experiment which more intensively implemented in 50years of XX century. Significant rise of access limit of induced radionuclides to external environment with the line of their existent reserves in the soil which combined in the period of atom experiments creates potential danger of radioactive pollution for plant-growing products and other objects of external environment.

Azerbaijan territory is the region of quite different soil-climate conditions. It situates between 40^o and 50^o north parallels where intensive radioactive wastes are observing after atomic experiments. That is why radiological evaluation spreading of ^{90}Sr and ^{137}Cs in soil of Azerbaijan undoubtedly expresses practical interest as well as theoretical interest. Besides induced radionuclides natural radionuclides also exists in Azerbaijan territory. Observation of (2) global existence of ^{90}Sr and ^{137}Cs in soils of Azerbaijan showed that in conjunction with climate, hydrography and orographic basis of their replacement in Azerbaijan territory obeys law of zoning during long years dynamic. Mountain areas of Small Caucasus, Great Caucasus and subtropical zone of Lankaran district are distinguishes according to maximum composition of these radionuclides. As a result of atomic catastrophe in Chernobyl, level of radionuclides is raised in different regions of Azerbaijan. Though in solution of ecoethic problems different agrotechnical,

agrochemicalal, phitoreclamation and other measures implements more important among them are prophylactic actions for preventing their spreading in environment.

1.6. Ecoethic problems in using of pastures

Territory of natural feeding stock of our Republic consists of winter and summer pastures, hayfields and grasslands. There are natural biogeocenosis and acquires special place in our agriculture (3,10). Alpine and subalpine grasslands of Azerbaijan have very rich plant-growing cover. Being feeding stock for cattle-breeding this territory also protects soils from erosion processes and also balancing water regime in mountain areas. Only 60-70% of summer pastures of State Land Fund of Azerbaijan considers useful (5,10). The rest of the remaining part destructed and became stony area under the influence of erosion. Overflow becomes the reason of bad water regime in rivers. In pasture for breeding of horned cattle is necessary to use rotation system. Restoration of broken territories is possible in such use. In order to keep plant-growing cover of summer pastures and protect from washout is necessary to use them as common pasture. The result of such rotation is weakening the processes of erosion.

1.7. Ecoethic problems of soil desertification and forests using

Azerbaijan is a country where forest massive acquires small territory. Though only 12% of territory of the country is covered by forests. Our forest differs by various floras and faunas. Most of them included to the "Red Book" of Azerbaijan, but for their protection necessary measures are still being implemented. But it is pity to accept that decrease of territories covered by forest is not only the problem of our state but also all the world. Destruction of forest directly influences decrease of organic substance in soils, besides destructs soak source of carbonic gas. Also destruction of forest in global, regional and local level changes climate conditions, decreases biological differentness of plant-growing cover and animal world. That is why stability of biosphere destroys, process of soils desertification accelerates as well as overflow, water and wind erosion.

In 1998 Azerbaijan confirmed "For struggle against wilderness in countries which suffer from droughty and wilderness" Convention of United Nation Organization signed in Paris (4). Ecological processes interconnected and stimulate each other. For example soil degradation – wilderness stimulates degradation process of biological differentness, which consequence is the changes in climate. Certainly, there is also otherwise connection. Problem of wilderness is one of the most actual ecological problems in our country. 11% of land belongs to Forest Fund, 56% to State Fund in our country. These territories on the basis of tenant rights are given to farmers. By rising live-stock of cattle the farmers who engaged in ship-breeding and cattle-breeding exposes soils to degradation.

1.8. Measures taken for facilitating of negative results of global ecological problems in Azerbaijan

As for measures taken for facilitation of negative results of global ecological problems in our country is necessary to note that more than seven National and State programs were created only in recent five years: decrease of poverty, improvement of forests, stable development, development of regions, winter-summer pastures, alternate source of energy, improvement of Absheron Lakes (11-13). Now the implementation of planned measures in using financial source of international institutions, State Oil Fund of Azerbaijan and others is necessary.

Scientific basis of systematical approach in investigation and solution of ecological problems contains "Basin method". A question may arise why in solution of ecological problems "Basin method" takes generally? Ecological method of basin gives opportunity to define quantity and source of pollution. It means that ecological method of internal method responsible for the pollution level of environment - what, where and how much.

Generalizing above mentioned can offer the following, more optimal solution ways of ecological problems:

1) Basin method, 2) Map of ecological assessment, 3) Map of salinization, 4) Models of ecological productivity, 5) Rational use of pastures, 6) Protection of forests, 7) Soil recultivation, 8) Culture of using mineral fertilizer, pesticides and radionuclides, 9) Creation of ecological informational bank, 10) Ecological pension fund, 11) Codex of Ecological Crimes, 12) Ecological coordination center.

Term "Ecoethic" introduced as a system connecting human community with nature, as well as system connected economic, agricultural, legal and other relations.

According to given concept relation of nature and community in conjunction with complex ecological characteristic problems and ways of their solution directly or indirectly divides into three groups (8):

1. Firth group includes some ecological problems of Azerbaijan and ways of their solution: protection of forest and problem of their restoration, soil erosion and ways of struggle against them, degradation of natural feeding stuff and their useful use, problem of technically soil polluted and process of their recultivation, enactments of protection soils from radionuclides, struggle against salinization and alcalination, problem of using mineral fertilizer and pesticides.
2. Second group includes organizational questions which could be helpful in solution of ecological problems and activities based on scientific and scientific-production character, organization of ecological monitoring of soils, creation of maps of ecological assessment, production of certificates for ecological improvement of soils.
3. Third group includes problems which could be helpful in solution of ecological problems: activities connected with the improvement of Codex of criminal norm in conjunction with ecological law and ecological crimes, creation of ecological aid fund and pension fund, creation of ecologic data bank, and centers of ecologic coordination.

That is why for definition of ways of ecological problems the results of recent year's investigations which implemented in our Republic and abroad is used. But it is not all aspects of the given problem and only part of it. For the protection of our Republic from complete destruction people must be careful to environment by taking into consideration ethic sides of the given problem. Especially ecoethic aspects in solution of ecological problems. Correspondently, strict control, comprehensive investigation of the problem, objective assessment of all factors influence to environment, and minimization its negative influence is necessary.

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BUSINESS SCHOOLS' GLOBAL RESPONSIBLE LEADERSHIP

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1. INTRODUCTION

The modern era demonstrates global challenges to all the humanity: earthquakes, volcano eruptions, tsunamis, changes in the climate regime of the planet, scarcity of natural resources, environmental pollution, global financial, economic and energy crises. Natural and economic disasters threatening the security of global development and necessitated the search for effective approaches aimed primarily to prevent, and secondly, to eliminate the consequences of extreme natural, environmental and economic situations. The scale of today's natural, environmental and economic disasters proves the impossibility of overcoming their consequences through the aid of the forces and resources of one state. The solution of these problems is possible by formation of the certain global, international and regional systems of management. Through the joint efforts of scientists, international organizations and governmental agencies of different countries it is possible to prevent and reduce the risks and negative effects of the natural and economic disasters. There are they who will enable the reduction in losses and damage caused by natural disasters, the stability of the social and cultural systems, the decrease in the number of ethnic and inter-state conflicts, the reduction in the negative impact on the environment, the rational use and preservation of natural resources of the unique areas and regions. The international community has formulated the basic principle of natural and ecological safety of the planet - the principle of sustainable development. The imperatives of the sustainable development are based on the idea of harmonizing the interests of the governments, transnational corporations (TNCs), national and international business-structures and individuals on the basis of the standards and norms of the economic, social, environmental and legal responsibility. The sustainable development of the regions and the world as a whole must be achieved through an integrated approach to solving the specific problems of the governments in certain regions by parties concerned within the region (governmental agencies, public and private financial institutions, socio-economic partners and non-governmental organizations, business and educational institutions) and international organizations and communities. The concept of the global responsibility should be viewed as the unification of the world community by a single initiative to solve the problems of natural, environmental and economic disasters. According to the 72% of top-managers who participated in the survey research «A New Era of Sustainability UN Global Compact – Accenture CEO Study 2010» for the UN Global Compact Leaders' Summit 2010, the education appears as the most critical issue of the global development. Both efficiency and sustainability of the development of our planet depends on this issue. Each fourth manager in the mentioned research noticed the lack of managers' necessary knowledge and skills as the main obstacle to implementation of an integrated approach to the corporate social responsibility (CSR). Most managers of the business structures are convinced that it's necessary to make changes in the management study programs in order to form the responsible behavior and adapt to a company to the changing environment. The success of the concept of global leadership in the CSR sphere depends on the changing patterns of peoples', companies', corporations', governments' and international institutions' responsible behavior. The analysis of research of corporate responsibility issues proves its magnitude. The above mentioned problems are studied by politicians, political scientists, philosophers, doctors, environmentalists, economists, physicists, geologists, etc. The theoretical foundations of the modern concept of corporate social responsibility are formulated by the scientists of the leading business schools. [2, 3, 5, 7] The European countries provide the examples of the government's interest in the role of coordinator and motivator of CSR business. [9] The features of the present stage of corporate social responsibility development in the context of the principles of global leadership are also studied by the Ukrainian scientists. [4, 13-15] Ukraine is one of the active participants of the global leadership initiatives in CSR. The Ukrainian Network of the Global Compact (GC) of the UN has become one

of the three networks (Serbia, including Japan), whose work was recognized by UNGC as the most active and effective in 2010. The main activities that demonstrate this activity and effectiveness are: National competition of business case studies on CSR in 2009 and 2010; National Journalism Competition for the best analytical material on the topic of CSR in Ukraine in 2009 and 2010; round tables "Implementing CSR course in Ukrainian universities: methodologies, preliminary results and perspectives", "The role of business schools - the union to prepare responsible leaders"; meeting of the Advisory Council on the draft National Concept for the development of corporate social responsibility in Ukraine; the official registration of CSR manager profession; the "Corporate social responsibility" program development for the Bachelor "Economics and Business" and "Management and Administration" students' [6] and Ukrainian Summer Institute teaching CSR. The state represented by the Ministry of Education and Science of Ukraine (Order № 99 from 10.02.2010, "On the Concept Master in Ukraine") recommends the discipline "Corporate Social Responsibility" to become normative. Innovative initiative UNGC in Ukraine, a group of scientists and responsible companies - leaders of the Ukrainian business environment is the integration of CSR materials into the master programs and the original master CSR programs contest. The above analysis provides the basis to a conclusion about the importance of the development of the idea of global leadership in CSR. Despite the vast amount of scientific publications about the CSR the issues of formation, development and establishment of CSR mechanisms within the global management are insufficiently considered in the national competent studies, weak, fragmentary, not systematically and selectively represented in bachelor's and master's programs of Ukrainian and foreign universities and business schools.

The necessity and importance of studying the problems of formation of leadership in CSR, a platform creation for interaction of international, governmental, business and educational institutions, the definition of methodological approaches to the development of responsible management training programs determines the relevance and purpose of the article presented.

2. RESEARCH RESULTS

Analytical assessment of foreign and Ukrainian practice of teaching courses (basic and specialized courses) and programs (bachelor, master and PhD) about CSR gives the evidence of not systemic and selective approach to their integration into undergraduate and postgraduate programs of the Ukrainian and foreign universities and business - schools [2-7, 10-12].

Nowadays there is a global responsibility of business schools that have joined the UNGC initiative and publish their sustainable development reports. The concept of global responsibility of a business school is seen as a formation of effective and responsible management, capable to identify the world's vital issues related to the aversion and consequences' prevention of natural, environmental and economic disasters; preservation of the environment; struggle against social inequality and asymmetry of the world's economic development; creation of a welcoming investment climate and a favorable regulatory environment for international companies; the new knowledge, skills and mindsets of business environment production; users' education; and implementation of innovative technologies. The basic behavioral formats of global responsibility of business schools is breeding a new generation of managers, united by the philosophy of global business responsibility; expansion of existing and introduction of new, innovative courses and programs of CSR; activation of this directions of scientific research; teaching orientation on the socio-cultural transparency, on the dialogue in the interaction at work and on the environmental issues. Therefore, the business schools' attention has to be attracted by the International initiative "Teaching Principles for Responsible Management UN PRME". Now 290 companies and organizations have joined. Ukrainian: Kyiv - Mohyla Business School, International Management Institute and many others are among them. Moreover for the last several years a group of teachers at the School of International Management at Kiev National Economic University named after Vadym Hetman headed by Doctor of Economic Sciences, Professor Dmytro Lukyanenko conducts research "Global Governance and CSR". The first results of these studies are reflected in the teaching of those respective topics of the bachelor and master courses "Global Economy", "International Management", in interdisciplinary training "Technologies of cross - cultural management: adaptation to the real environment", master program "Management of International

Business", in preparation of master's and doctoral research papers, in the research project "The introduction of managerial practice Green office in Ukrainian companies".

An innovative scientific development is the original project of a Master's program "Global Responsible Leadership" (by Ph.D. Panchenko, E.G. and Ph.D. Petrashko L.P.). The methodological and methodical aspects of its formation are shown in Table 1.

Table 1

The project of the original MBA program "Global Responsible Leadership"

Module name	Basic/ Selective	N Credits	Seme-ster
1. The prospects of global management in the context of sustainable development (lecture)	Basic	10	1
1.1. Debate "National Strategy for Sustainable Development"	Selective		1
1.2. Workshop "Specificity Diagnostic CSR international companies"	Selective		1
2. Ethical Dilemmas of Global Management (lectures)	Basic	10	1
2.1. Workshop design models of ethical decisions in the international business environment	Selective		1
2.2. Debating society "Market Ethics"	Selective		1
3. Corporate management standards and corporate social reporting (lectures)	Basic	10	1
3.1. Integrated assessment of the level of transparency and system of international corporations in the area of CSR (practice a week, a report)	Basic		1- 2
3.2. Training on "Social Reporting"	Basic		2
4. Business - the leaders of corporate social responsibility (optional)	Interactive module (research and results' presentation)	20	2
4.1. Dissertation			
4.2. Studies of business - CSR practices of multinational corporations			
4.3. The formation and development of case studies on CSR of multinational corporations			
4.4. Group project "Implementation of innovative practices of CSR in business structures"			

The main purpose of the master's program "Global Responsible Leadership" is to develop the basic knowledge on CSR, to study the practical tools in the implementation of socially responsible behavior of corporations in today's business environment, to prepare responsible leaders-integrators, which will provide re-orientation of company strategies towards sustainable development and responsible business, the creation of effective partnerships to prevent and reduce the effects of natural, environmental and economic disasters in the world.

3 CONCLUSIONS

In today's crucial moment in world economic development, when the concept of sustainable development should be integrated into business strategies of most companies in the world it is required for business school to form a basic understanding of the theory and practice of global management perspective for their students: developing the global responsible leadership, contributing to obtaining the respective professional competencies, which provide mechanisms to implement global responsible behavior in today's business environment. These are the purposes the master's program "Global Responsible Leadership" is designed for.

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MECHANICAL-MATHEMATICAL MODELING AND MONITORING FOR LANDSLIDES

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INTRODUCTION

Landslides process is one of the most widespread and dangerous processes in the urbanized territories. In Moscow the landslips occupy about 3 % of the most valuable territory of city. In Russia many towns are located near rivers on high coastal sides. There are many churches and historical buildings on high costs of Volga River and Moscow River.

The organization of monitoring is necessary for maintenance of normal functioning of city infrastructure in a coastal zone and duly realization of effective protective actions. Last years the landslide process activization took place in Moscow.

Landslide motions is extremely actual and difficult problem which decision is necessary for preservation of valuable historical monuments and modern city constructions. There are near 15 places of deep landslides and many shallow landslides in Moscow (Fig.1).

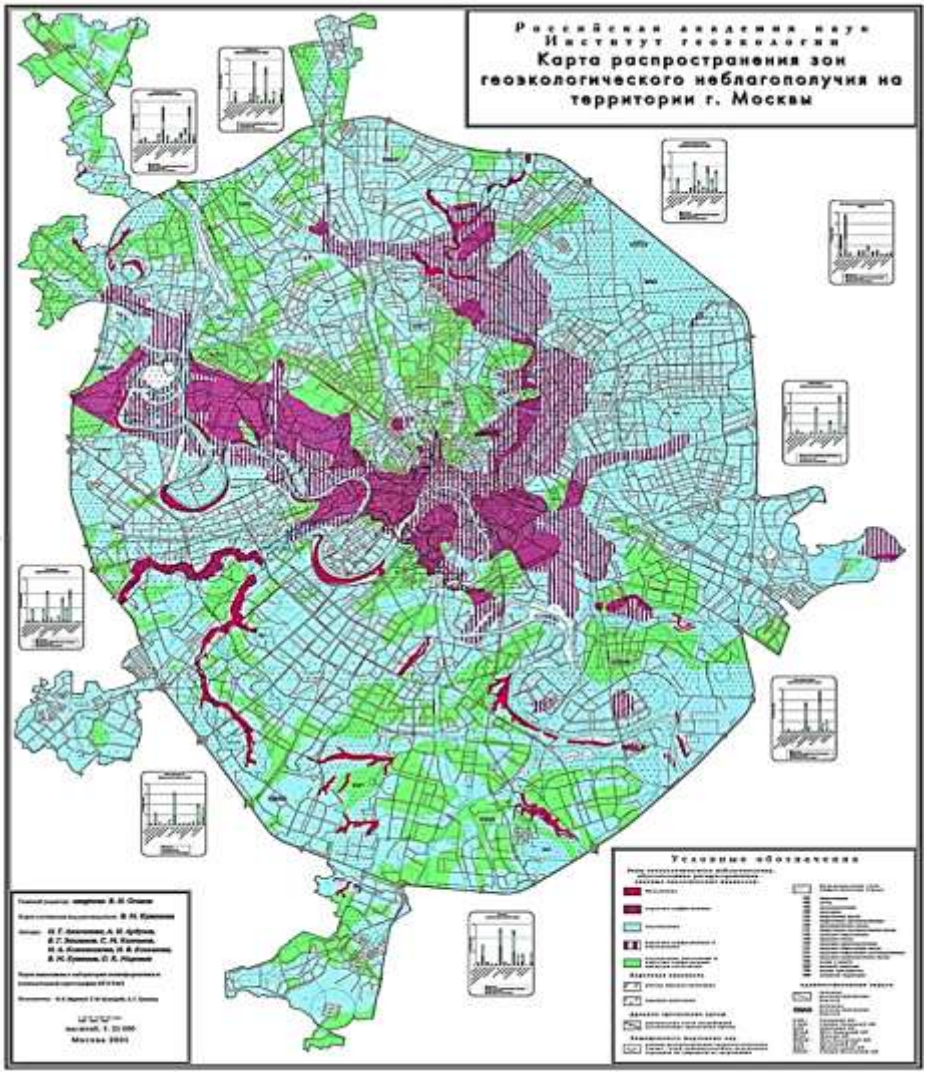


Fig.1. Map of zones of geological trouble in Moscow. (In red – landslide zones). Institute of Environmental Geoscience, Russian Academy of Sciences. Osipov V.I. (editor), Kutepov V.M., Mironov O.K. et al.

One of landslide sites is on Vorob'yovy mountains, on a high slope of the right coast of the river Moscow. Within the limits of a considered site there is a historical monument of federal value - «Andreevsky monastery», based in 1648. (Fig. 2, 3).

Also there the complex of buildings of Presidium of the Russian Academy of Sciences, constructed in 70-80th years of 20-th century (Fig. 4), bridge with station of underground "Vorob'yovy mountains" and a sports complex are located. Landslide slope (Fig. 5) is in an active condition. In June 2007 a rather big landslide took place there near ski-jump (Fig 6).

Another landslide site is in a southeast part of Moscow near museum - reserve "Kolomenskoye"(Fig. 7, 8, 9). Last serious activization of a landslide has taken place there in 2002.

Catastrophic activization of the deep blockglide landslide in the area of Khoroshevo on the left-hand shore of the Moskva River at Karamyshevskaya enbankment took place in 2006-2007. Deep landslide activization was in Moskvorechye area in September 2009. Such complicated situation demands development of new investigations of landslide prone zones [1-4].

Fig. 2. Vorob'yovy mountains.

Fig. 3. Andreevsky monastery.

Fig. 4. Presidium of RAS.

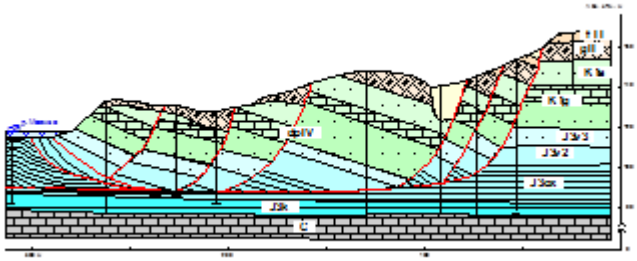


Fig. 5. Schematic cross-section of landslide slope at Vorob'yovy mountains.

Fig. 6. Ski jump.

Fig. 7. Museum - reserve "Kolomenskoye". Common view.

Fig. 8. Museum - reserve "Kolomenskoye".
The church of Beheading of the Honest Head of Iowan Predecessor.

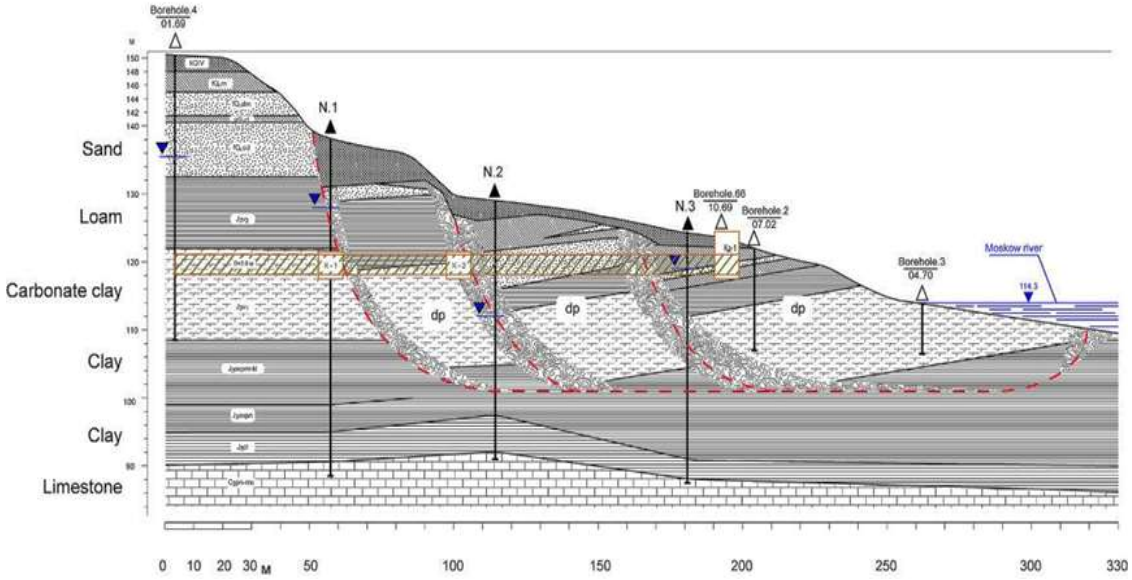


Fig.9. Deep blockglide landslide.
Moscow, Kolomenskoye. N.1, N.2, N.3 - extensometers, inclinometers.

Mechanical-mathematical model for landslide movement

One of methods of studying of landslide processes is mechanical-mathematical modelling of gravitational movement of matter on landslide a slope. At different stages of the development the landslide process can be described by various mechanical and rheological models. At the stage of formation of cracks, losses of stability, break of blocks the models of the elastic medium and model of destruction are applied. During slow movement of soil on the slope the model of high viscous incompressible fluid can be applied. Such model allows to estimate velocities of movement in a layer and to compare them to results of monitoring. Boundary conditions of a problem thus also depend on a concrete situation. So, in case of slow movement on the bottom border of a layer the condition of sticking is used. If the process of debris flow, underwater landslip or snow avalanche is considered, the condition of sliding or more complex boundary condition is possible on the bottom border. The choice of adequate model of process and statement of initial and boundary conditions is an independent mechanical problem.

Let's consider movement of landslide masses on a slope as movement of high viscous incompressible fluid described by equation of Navier-Stockes and continuity:

$$\frac{d\vec{v}}{dt} = \vec{F} - \frac{1}{\rho} gradp + \frac{\mu}{\rho}\Delta\vec{v}$$

$$\text{div } \vec{v} = \mathbf{0}$$

$\vec{v}$ – vector of velocity, F – force of gravity, p – pressure, ρ – density, μ – viscosity, t – time.

Let the characteristic horizontal scale of a body of landslip L considerably surpasses its thickness h. We shall count also a landslip extended enough in the plan that allows to consider three-dimensional model as two-dimentional one for sections of landslide bodies. Following works [5-7] and applying a method of decomposition on small parameter, it is possible to get the equation of continuity and an approximated equation of the Navier-Stockes in dimensionless form for slow motions in a thin layer:

$$\begin{cases} \dfrac{\partial P}{\partial X} = \alpha\mu \dfrac{\partial^2 U}{\partial Z^2} \\ \dfrac{\partial P}{\partial Z} = -\rho \end{cases}$$
$$\frac{\partial U}{\partial X} + \frac{\partial W}{\partial Z} = 0$$

P – is dimensionless pressure, U,W – dimensionless velocities, F – Frude number, R – Reynolds number, ρ – density, μ – viscosity, ρ_0, μ_0, u_0 – scales of density, viscosity and velocity.
Then it is possible to get the velocities and pressure in the layer:

$$P = \rho\left(\varsigma^* - Z\right)$$

$$\alpha = \frac{F}{R\left(\frac{h}{L}\right)^3} \qquad \boldsymbol{R} = \frac{\boldsymbol{u_0 L \rho_0}}{\boldsymbol{\mu_0}} \qquad F = \frac{u_0^{\,2}}{gL}$$

$$U = U_0 + \frac{\rho}{2\alpha\mu}\frac{\partial \varsigma^*}{\partial X}\left[\left(\varsigma^* - Z\right)^2 - (\varsigma^* - \varsigma_0)^2 \right]$$

$$W = W_0 + \frac{\partial U_0}{\partial X}(\varsigma_0 - Z) + \frac{\rho}{\alpha\mu}\frac{\partial^2 \varsigma^*}{\partial X^2}\left[\frac{1}{6}\left(\varsigma^* - Z\right)^3 + \frac{1}{3}\left(\varsigma^* - \varsigma_0\right)^3 - \frac{1}{2}(\varsigma^* - Z)(\varsigma^* - \varsigma_0)^2 \right] +$$

$$\frac{\rho}{2\alpha\mu}\left(\frac{\partial \varsigma^*}{\partial X}\right)^2 (Z - \varsigma_0)^2 + \frac{\rho}{\alpha\mu}\frac{\partial \varsigma^*}{\partial X}\frac{\partial \varsigma_0}{\partial X}\varsigma_0(\varsigma^* - \varsigma_0)$$

ς_0 – the bottom border of a layer,

ς^* – the top border.

Let on the bottom border the condition of sticking is satisfied:

$U_0=W_0=0$

The discharge of matter along the layer is:

$$Q = \int_{\varsigma_0}^{\varsigma^*} U dZ = -\frac{\rho}{3\alpha\mu}\frac{\partial \varsigma^*}{\partial X}(\varsigma^* - \varsigma_0)^3$$

Since Q=const lengthways X, then:

$$\frac{\partial Q}{\partial X} = 0$$

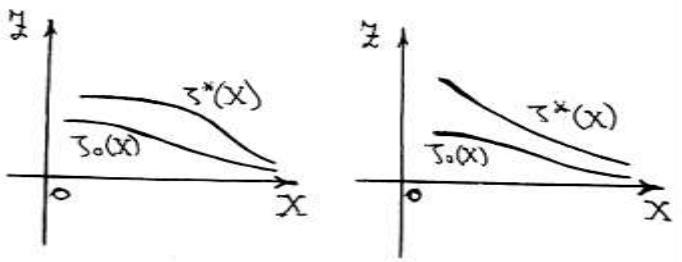
$$\frac{\partial^2 \varsigma^*}{\partial X^2}(\varsigma^* - \varsigma_0)^7 + \frac{9\alpha\mu Q}{\rho}\left[\frac{3\alpha\mu Q}{\rho} + (\varsigma^* - \varsigma_0)^3 \frac{\partial \varsigma_0}{\partial X}\right] = 0$$

The condition of convexity of upper boundary is:

$$\frac{\partial^2 \varsigma^*}{\partial X^2} < 0 \Rightarrow$$

$$\frac{3\alpha\mu Q}{\rho} > -(\varsigma^* - \varsigma_0)^3 \frac{\partial \varsigma^0}{\partial X}$$

This expression enables to analyze the form of the surface of moving matter (Fig. 10).



a) b)

Fig. 10. The various possible form of landslide surfaces: a) convex, б) concave.

Structure of clinoforms (convex) can arise, if:

1. Q is large, that is flux is high
2. μ is large. It means that matter spreads bad and can support big angle
3. ρ is small. It means that matter has large specific volume and is friable
4. grad ς_0 is small, that is angle of lower boundary is small
5. $(\varsigma^* - \varsigma_0)$ is small, that is thickness of sedimentary layer is small. Under fixed Q it means that velocity of flux is high and formation of clinoformes and even overturning of rockes are possible

All these conditions seem to be natural enough to an explanation of formation of structures such as inflows and clinoforms of sedimentary cover that speaks about correctness of the model.
It is important to define the place of maximal velocity on the slope. An optimum place for location of monitoring post is the point of maximal speeds of movement of masses of landslide.

Let's consider the massif of sedimentary rocks with the top border ς^* representing landslide slope. The bottom border ς_0 is compatible with an axis X. The maximum of horizontal speed U is reached on the top border ς^* of the massif owing to condition:

$$\frac{\partial U}{\partial Z} = -\frac{\rho}{\alpha\mu}\frac{\partial \varsigma^*}{\partial X}(\varsigma^* - Z) = 0 \Rightarrow Z = \varsigma^*$$

Point of the maximal horizontal speed on the surface ς^* can be found from a condition of equality to zero of the first derivative:

$$\frac{\partial U^*}{\partial X} = 0, where U^* = -\frac{\rho}{2\alpha\mu}\frac{\partial \varsigma^*}{\partial X}(\varsigma^*)^2$$

From here it is easy to receive the condition:

$$\frac{\partial^2 \varsigma^*}{\partial X^2}\varsigma^* + 2(\frac{\partial \varsigma^*}{\partial X})^2 = 0 \quad (1)$$

It is necessary to mean, that ς^* (X) is known function – the surface of landslide slope. And the received condition allows to find a point on a slope where speed of movement is maximal.

Let's consider for presentation and an illustration of the received decision the surface of a landslide as (Fig. 11):

$$\varsigma^*(X) = -thX + 1$$

Then the condition (1) gives:

$$th^2 X - thX - 1 = 0$$

Whence we receive

$$thX = \frac{1-\sqrt{5}}{2}$$

and

$$\varsigma^* = \frac{1+\sqrt{5}}{2} \approx 1{,}62$$

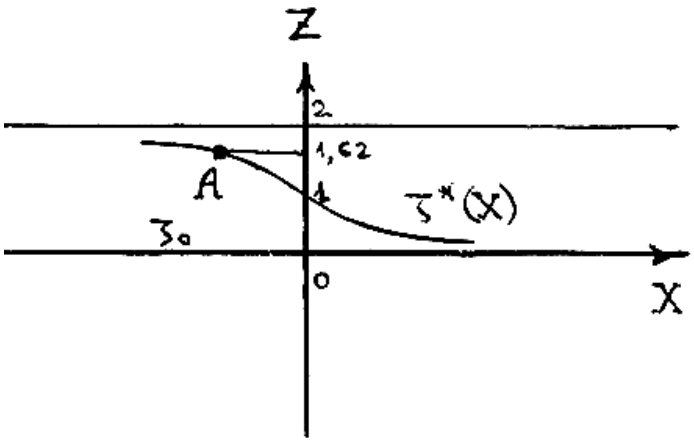


Fig. 11. Point A of the maximal horizontal speed of movement of masses on the surface of slope.

Such position of the point of the maximal horizontal speed is represented real, and more exact data on a structure of landslide and its surface will enable to define such point on a concrete slope. The point of maximum of speed on a slope defines the place of possible failure of a landslip in case of achievement of limiting pressure in massif of rocks. There could be several points of local maximum of speed on a slope, that characterizes an opportunity of failure of a landslip on each terrace of a slope. The places of minimum speed can be used for building constructions and

oil-gas pipelines. Model velocities of matter can be compared with real velocities that give possibility to calibrate the monitoring equipment and define the real mechanical parameters of media.

CONCLUSIONS

Landslides process is one of the most widespread and dangerous processes in the urbanized territories. The landslide process activization took place in Moscow last years. Such complicated situation demands development of new investigations of landslide prone zones. Mechanical-mathematical model of high viscous fluid is elaborated for simulation of matter movement on landslide slopes. The results of modelling give possibility to investigate some fundamental aspects of material behaviour of landslide. The results of modelling give possibility to define the place of highest velocity on landslide surface, which could be the best place for monitoring post position. Model can be used for calibration of monitoring equipment by comparison of model and real velocities.

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USE OF REMOTE SENSING AND GIS METHODS FOR MITIGATING THE IMPACT OF EARTHQUAKES IN CITIES

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1. INTRODUCTION

All over the world, natural disasters, technological accidents and "Natech" accidents, i.e., industrial accidents triggered by natural events, have frequently undesirable effects on many important economic and social parameters, causing environmental pollution, damage to infrastructure as well as injuries and casualties [1]. The increasing number of disasters necessitates

the existence of methodologies and practices that serve for the prevention of environmental risks in terms of protecting the citizens against the effects resulting from a disaster. Due to the importance of the consequences to people and economy, many initiatives have been launched worldwide to assess and reduce urban vulnerability, increase cooperation and exchange of knowledge in earthquake mitigation and preparedness and enhance the organization of civil protection.

Towards this direction, many cities and public authorities have made efforts to establish methodologies, policies and practices aiming at the organization of response actions for protecting citizens. This happens more often at the urban environment where there is a high population density and the effects of a destructive event could be severe. Therefore, authorities attempt to define in the frame of the preparedness phase of disaster management the actions that should be taken after the occurrence of a disaster so as to protect the people who are in danger, e.g. define secure areas for people to assemble after an earthquake, make evacuation plans. Moreover, after the occurrence of a disaster, the competent authorities are asked to offer immediate support and relief to citizens who have suffered from the event [2]. In order to achieve the above mentioned tasks and priorities, Disaster Management Systems (DMS) have been developed and they contribute to decision making and management during the preparedness, response and recovery phases of civil protection [3], [4]. Most of these systems are based on Geographical Information Systems (GIS) or webGIS platform. The results of these systems can be exploited by many different scientists, professionals, civil servants, as well by private and public sector agencies and, of course, civil protection authorities. They deal with the most dangerous natural disasters like earthquakes, floods, forest fires, sea level rise and, possibly, tsunamis. They also employ numerous databases, e-maps and satellite images containing information regarding the type of disaster, its effect to the environment and society and also related to other data, i.e., demographic, financial, land use, structural elements of buildings, technical infrastructure etc.

For decades, Geomatics, i.e., integration of Remote Sensing, GIS, GPS and Surveying techniques, have played a vital role in seizing damage information because of earthquake events and assisting civil protection activities [5], [6]. Remote Sensing (RS) techniques have been increasingly used to identify, detect and monitor the impact and effects of natural disasters like earthquakes, landslides, tsunamis and floods [7]. In case of post-earthquake urban damage assessment, remotely sensed data offer advantages over traditional methods of field survey as it is low-risk, as well as a rapid overview of building collapse across an extended geographic area [8]. Medium resolution satellite data like SPOT, LANDSAT [9] or ERS [10] have been used for the identification of the damage extent and distribution. Recently, high-resolution imagery of commercial satellites such as IKONOS, QuickBird, RapidEye and GeoEye-1 can provide powerful information of natural and/or man-made disasters at an early stage as well as estimate local site conditions influencing earthquake effects [11], [12].

Numerous projects funded by European and national authorities have used RS and webGIS methodologies for estimating human losses, organizing response activities, predicting the vulnerability of structures and recording damage after a devastating event. Some examples to this direction are the HAZUS software [13], the Risk-UE project [14], the SeisIMPACT project [15], the SELENA project [16], the SyNaRMa project [17], the RESA project [18], etc.

This paper, based on the results of already implemented and related EU projects, describes the contribution of RS and webGIS methods towards mitigating the effects of earthquakes mainly in cities. In fact, this contribution is illustrated in correlation to the three main components of Civil Protection for disaster management, i.e., Preparedness, Response, and Recovery. Finally, examples are given on the application of the above mentioned procedures at the city of Grevena, in Northern Greece as obtained from the EU projects *SyNaRMa – Information System for Natural Risk Management in the Mediterranean* and *IRIS–Integrated European Industrial Risk Reduction System*.

2. USE OF RS AND GIS DURING THE PREPAREDNESS PHASE OF EARTHQUAKE DISASTER MANAGEMENT

Preparedness refers to the phase where the competent authorities plan, organize and get prepared for the confrontation of a possible future natural disaster. This is an ongoing process that is aiming at mitigating of the effects of an earthquake by preparing emergency plans, exercising the authorities and the population and trying to predict areas of high degree of vulnerability.

Local site conditions play an important role when considering earthquake shaking and damage intensities and their local variations. The ground-shaking during an earthquake predominantly depends on several factors such as the magnitude, properties of fault plane solutions, the distance from the fault and local geologic conditions. The most intense shaking experienced during earthquakes generally occurs near the rupturing fault area, and decreases with distance away from the fault. Within a single earthquake event, however, the shaking at one site can easily be stronger than at another site, even when their distance from the ruptured fault is the same.

Using GIS and webGIS tools and integrated geo-data analysis, it is possible to make visible factors that are related to the occurrence of higher earthquake shock and/or secondary effects, i.e., lithology (loose sedimentary covers), faults, steeper slopes, etc. Using RS data, some of those causal factors can be determined systematically (fig. 1).

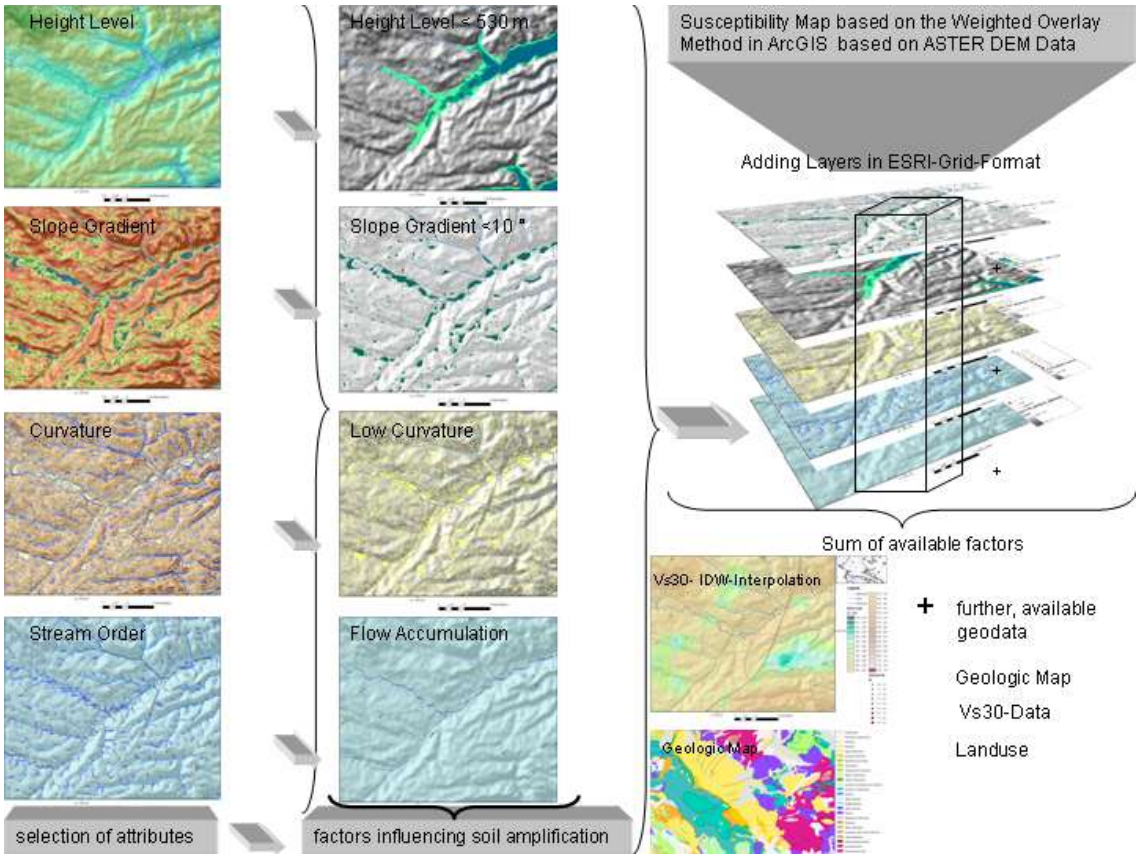

Fig. 1. Some of the causal or preparatory factors influencing earthquake ground motion and related secondary effects that can be visualized in a GIS system using RS data (e.g. SRTM and ASTER DEM digital elevation models) [18]: lowest height levels providing information of areas with relatively higher groundwater tables, lowest slope gradients (< 10°), lowest minimum curvatures, providing information of broader valleys, basins and depressions with younger sedimentary covers and higher groundwater tables, highest flow-accumulations providing information of higher groundwater tables, etc. Other available geo-data can also be stored in the GIS databases, i.e., can be Quaternary sediment distributions and faults from geologic maps derived, LANDSAT ETM imageries derived lineaments, earthquake data, etc.

For example, from slope gradient maps those areas with the steepest slopes can be extracted, and from curvature maps the areas with the highest curvature can be determined as these are susceptible to landslides that could follow an earthquake shock. Then, height level maps help to search for topographic depressions and broader valleys covered of almost recently formed sediments, which are usually linked with higher groundwater tables. In case of earthquakes, those areas often show the highest earthquake damage intensities. Thus, this information is essential in

order to locate the most disposed grounds for quicker response in case of a catastrophic event but also for the planning of the rebuilt of earthquake prone areas. Lastly, lineament analysis based on LANDSAT or DEM derived morphometric maps such as hillshade or slope maps helps to detect possible fault and fracture zones that suggest the planning of additional geotechnical investigations (fig. 2).

Satellite Imageries that can be used for emergency preparedness and disaster inventory may come from satellites LANDSAT (spatial resolution: 15-30 m), QuickBird (spatial resolution: 0.61-2.8 m), IKONOS (spatial resolution: 0.82 Ç 3.2 m), etc. Also, RapidEye satellites are the first commercial system capable of taking images of the Earth's surface at high repeat rates, which ensures that its information products are always up to date. The RapidEye Earth observation system comprises five satellites equipped with optical cameras with a spatial resolution of 5 m. Every day, the system may be aimed at any point on Earth, and its imaging capacities may be allocated in a timely manner, so as to meet requests regarding the surface segment to be shown and the time at which images are to be recorded. Demonstration tests in the scope of the IRIS -Integrated European Industrial Risk Reduction System EU-project have proven, that that RapidEye images taken at 12.30 UTC were available for evaluations after only 5 hours [1].

A GIS and/or webGIS system is founded on a detailed digital map of the area under consideration. The databases of the GIS can be distinguished into two categories, the general/basic databases which constitute the geographical background (RS imageries may effectively assist the collection of these data) and several specific databases related to special characteristics and factors affecting the type of disaster, the built environment as well as the human society.

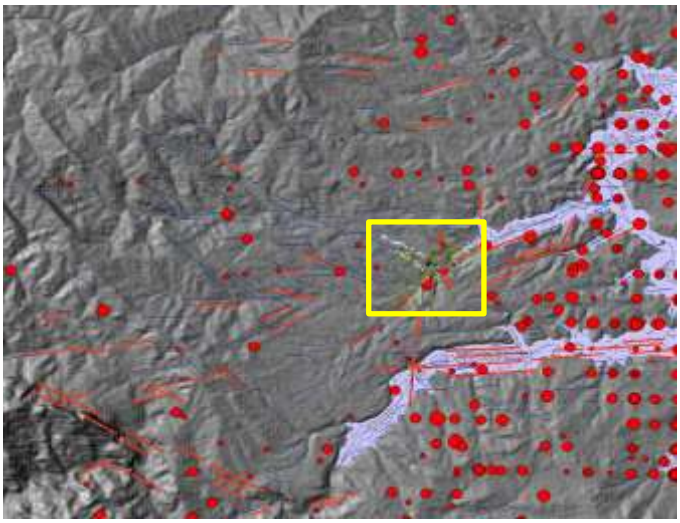

Fig. 2. Lineament map of the broader Grevena area (the city is shown in the yellow frame) along with lineament analysis (blue lines) and probable faults (red lines) based on LANDSAT ETM imageries, as well as recent seismicity (red dots). Areas of almost recently formed sediments that are more susceptible to ground motion are also displayed (in light blue color)

These databases can be historical seismicity, recent seismicity, faults, focal mechanisms of earthquakes, macroseismic intensity for past events, seismogenic sources, geologic data, land use, infrastructure (bridges, railroads, roads, river embankments), industrial sites, etc. Also, in order to predict the possible damage a building may suffer, scenarios of ground acceleration due to a hypothetical earthquake can be derived by the seismologists [19], thus providing maps of ground shaking in terms of various peak ground motion parameters (e.g. PGA and PSA) (fig. 3). As it is possible to interpolate and compute PGA or PSA values for every building (fig. 4), these scenarios assist the civil protection authorities to estimate the buildings with natural frequency equal to the ground motion frequency, a fact that could lead into resonance phenomena and possible damage.

Another category of data that can be stored in the GIS system is the vulnerability of existing buildings to earthquakes so that a prediction can be made in near real-time of the buildings and areas that could suffer the most damage after the disaster event takes place. In this case, emergency rescue teams might be sent first to those places situated in areas with higher estimated susceptibility to earthquake shock and earthquake related secondary effects. Several techniques have been developed for the appraisal of the vulnerability of existing buildings [20], [21]. Furthermore, the evaluation of the vulnerability of buildings in combination with earthquake scenarios and population information, can lead to safe estimations regarding the potential human losses. The important ingredients of earthquake loss estimation are ground motion, direct physical damage to general building stock, casualties as direct social losses and financial damage estimation. Usually, existing techniques attempt to calculate, map, and display damage and loss estimates according to particular scenarios. As the estimation of the vulnerability of all buildings in a city could be a costly procedure that would last for a long period of time, the priority should be given to public buildings, health facilities and buildings that host the activities of large number of persons (hospitals, schools, administrative buildings, shopping malls, theaters, etc.). A rapid visual screening methodology for the evaluation of the seismic capacity of public buildings in the town of Grevena within the framework of the SyNaRMa System is based on the procedure proposed by the Greek Earthquake Planning and Protection Organization (OASP) with enhancements [22].

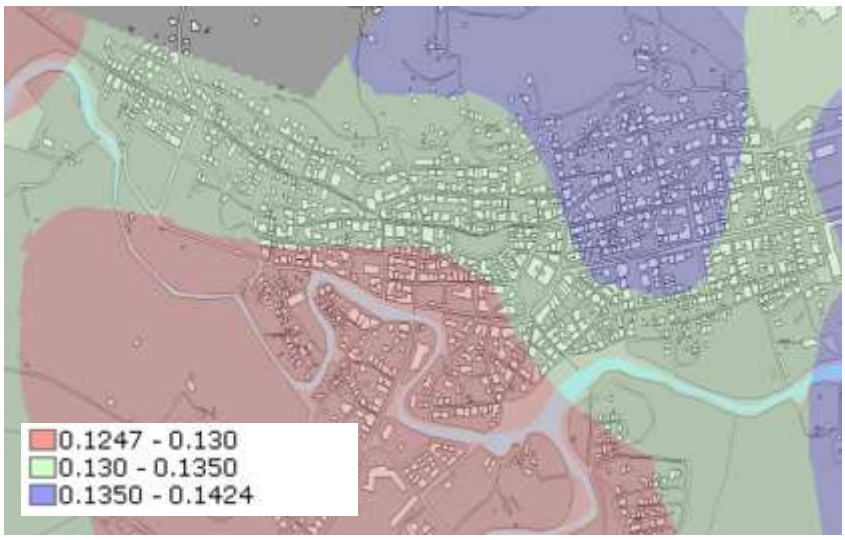

Fig. 3. Peak ground acceleration (PGA) map computed by a scenario earthquake in Grevena [19]

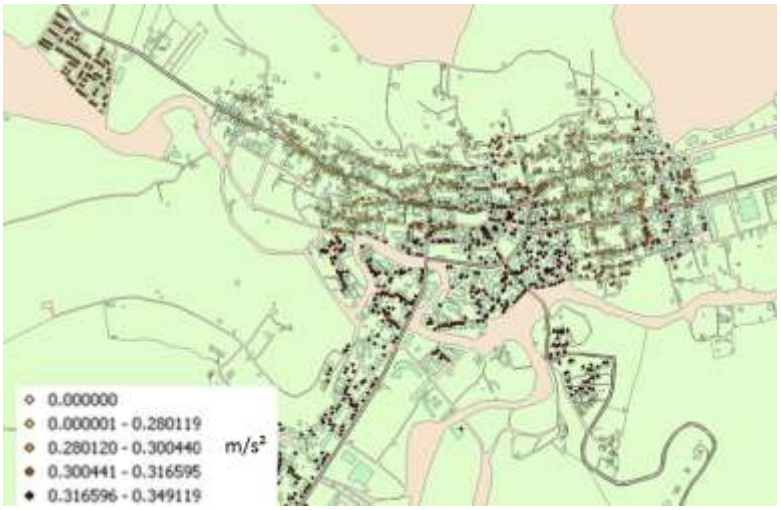

Fig. 4. Peak spectral acceleration (PSA) values interpolated for each building in Grevena as derived according to a scenario earthquake in the SyNaRMa System

Another critical aspect that has to be taken into account in cities during the preparedness phase of disaster management is the evaluation of existing civil protection plans concerning secure assembly areas and shelter camp areas to be used by citizens. This evaluation serves for the assessment and improvement of existing plans by verifying their efficiency as well their rate of preparedness for people with disabilities, children and elderly people.

Multi-criteria analysis can be employed in order to decide the location of the absolutely necessary areas in the usually dense urban environment. Similarly, an emergency road network that should be kept open after an event must be evaluated and suggested. For this reason, a thorough study of the possible collapse scenarios for different categories of buildings must be done, as collapse occurrences are one of the main reasons for closed roads that could cause delays for rescue teams and assistance personnel to move around or people to run away from their damaged or destroyed residences (fig. 5) [23].

Fig. 5. Assembly areas (flagged) and emergency road network in the city of Grevena as determined with the use of GIS tools. Collapse buffer zones around existing buildings (purple color) and buffer zone alongside Grevenitis River (light blue color) can also be seen [23]

Finally, webGIS components can be used for the collection and analysis of real damage to the built environment thus providing valuable information on the behaviour of buildings and the severity of people's distress (fig. 6). The relevant database must be developed during the preparedness phase, so that input of inspection data can be done in the field when necessary with the use of special devices (netbooks, tablet PCs, and smart phones) and the proper communication link.

3. USE OF RS AND GIS DURING THE RESPONSE PHASE OF EARTHQUAKE DISASTER MANAGEMENT

During the response phase emergency services and rescue teams try to assist the injured and find people missing at locations where buildings collapsed. In this procedure, webGIS may provide the effective management of the post-seismic inspection forms, operating as a platform for the on-site recording of damage and human losses/missing persons in a single geo-database from field crews through the use of mobile devices. So, the rescue teams may access the system and enter data about the event in almost real time. As a result, the competent authorities have almost immediately a first picture of both the event itself as well as the size of the disaster. This information facilitates the response of the authorities and offers for more effective emergency actions. Moreover, while the rescue teams are in situ, they may download from the GIS system data about specific buildings, i.e., building construction plans of a collapsed building that are very important in order to identify passages that will bring them close to trapped or injured people.As an example, each building of Grevena was attached with the relevant inspection form following the 1995 earthquake and the

result is presented in fig. 7, where the overall picture of damage can be seen. This overall picture can be easily obtained by viewing the livability characterization of the buildings. This is an easy and rapid way to categorize buildings according to the damage they sustained. Hence, buildings may be categorized into those with no or light damage (green dots), moderate damage (yellow dots), serious damage (red dots) and those that collapsed (black dots).

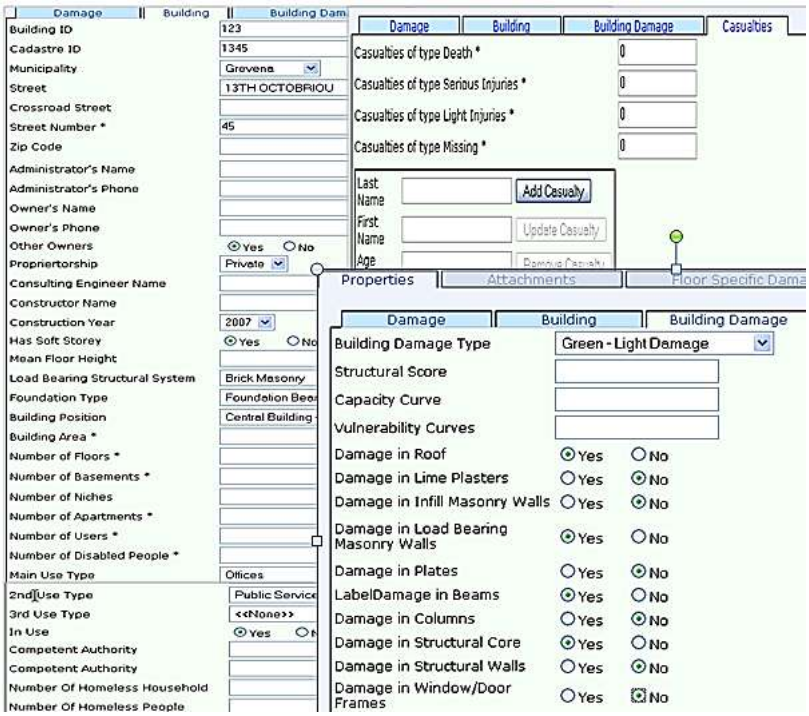

Fig. 6. Electronic forms for the importation of inspection data concerning earthquake damage of buildings as used in the SyNaRMa system. They include general information, structural properties of the building, observed damage and casualties

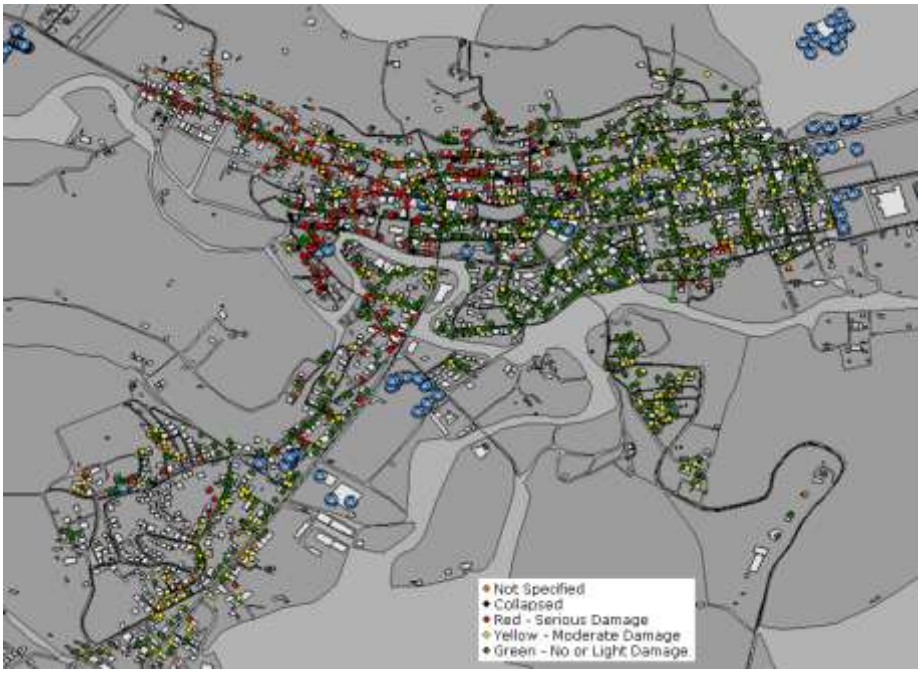

Fig. 7. Classification of the structural condition of the buildings at the city of Grevena after the 1995 earthquake. Blue dots refer to public buildings

RS imageries acquired by a number of methodologies may also have an ever-increasing role for damage mapping and debris distribution localization, provided that they will be available immediately after the catastrophic event in order to be used during the response phase.

4. USE OF RS AND GIS DURING THE RECOVERY PHASE OF EARTHQUAKE DISASTER MANAGEMENT

During the recovery phase, after the immediate needs were met and assistance was given, actions are being undertaken in order to re-built the destroyed building stock and infrastructure trying to restore the affected area to its previous state. In order to secure a successful restoration campaign during this phase, it is necessary to conduct as accurate as possible the assessment of the damage caused to the urban area. The GIS systems facilitate this process based on the damage data of buildings that has been recorded to the system during and a little after the response phase. As it was mentioned above, the data is stored to the prototype building damage geodatabase and facilitates the estimation of the overall damage caused due to the disaster as well as an approximate repair cost. Such estimation helps the competent authorities to assess the financial and social effects of the disaster that occurred. Furthermore, civil protection authorities may decide about rehabilitation, reconstruction planning and implementation, according to priorities set based on the inspection data collected in the field. Even more, by using the GIS tools, different layers of information may be selected and overlaid within the system, allowing the user to take effective actions and assisting the process of decision making.

A very important part is the possibility offered through a GIS system to jointly 616nalyse the predictions resulting from scenario earthquakes during the preparedness phase along with the real results of a seismic event. Therefore, there is the ability to evaluate the scenarios and the models used in them so that they may be improved/calibrated in order to become more accurate and to better fit to local/regional conditions (fig. 8).

Fig. 8. Display of the SyNaRMa system showing the comparison of reported building damage from the 1995 earthquake at the city of Grevena with the scenario earthquake results

5. CONCLUSIONS

Provided that many and different kinds of natural disasters will always happen, the question that has to be answered is how human losses and the consequences of disasters to the natural and built environment can be minimized. It is evident that the use of RS and web-based Geographic Information Systems along with the related geo-databases may assist local and national authorities

to take action in order to meet the above objective. In fact, these tools may efficiently support the organization of public protection activities. The evaluation of satellite imageries, digital topographic data and open source geo-data can contribute to the acquisition of the specific tectonic, geomorphologic and topographic settings influencing local site conditions in the region under investigation. In this way, RS methods can facilitate the identification of areas that are more susceptible to earthquake ground motions and present high damage expectancy due to local site conditions in case of a severe earthquake. RS data and GIS integrated evaluations and analysis can contribute to a better planning of cost and time intensive geotechnical measurements which are of main importance to be considered at a local basis. Furthermore, RS data and results can be combined with updateable and dynamic scenarios for earthquakes and more categories of data in the geodatabases of a webGIS system assisting the procedure of preparedness and increasing the sufficient organization and effectiveness of response and recovery activities. Finally, webGIS components can be used for the collection and analysis of real damage to the built environment thus providing valuable information on the behaviour of buildings, the cost of repair and re-habilitation procedures.

Acknowledgements

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RESOLUTION OF THE WORLD FORUM – INTERNATIONAL CONGRESS "NATURAL CATACLYSMS AND GLOBAL PROBLEMS OF THE MODERN CIVILIZATION" - GEOCATACLYSM-2011

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The World Forum – International Congress "GEOCATACLYSM-2011" was held on 19-21 September 2011 at the Lutfi Kirdar Congress Centre, Istanbul, Turkey.

The World Forum was attended by scientists from more than 30 countries. The exhibition which was held during the Congress demonstrated the modern achievements in the field of science and technology, and personal exhibition halls of famous scientists were set up: for Honorary Chairman of the Congress, Professor, Doctor Franz Halberg, Honorary Director of the Halberg Chronobiology Center (University of Minnesota, Minneapolis, USA); and Academician of the Russian Academy of Sciences, Professor Victor Khain (Lomonosov Moscow State University, Moscow, Russia).

The sections held within the Congress included: Special Section "Earthquake Forecasting – 2011"; Section on Earth Sciences; Section on Cosmic-terrestrial relations, chronobiology, BIOCOS program; Section on Health Care; Section on Construction; Section on Economy, Finances and International Law; Section on Emergency Management; Section on Ecology and Environment.

More than 200 presentations of the Congress participants were heard, dedicated to various topical problems of reducing risks and negative effects of natural disasters.

Among those who delivered their speeches at the Plenary Session of the Congress Opening on September 19, 2011 were:

Honorary Chairman of the World Forum:

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Prof. Dr. Vitaly Starostenko, Director of the Institute of Geophysics of the National Academy of Sciences of Ukraine (Kiev, Ukraine)

Congress participants are concerned about global changes in the geological and geophysical parameters of the Earth and near-Earth space, any increase in the number and energy of natural cataclysms on Earth: in the lithosphere, in the Earth's interior, in the hydrosphere, atmosphere, ionosphere, and magnetosphere, all harboring potential dangers to humanity.

Technogeneous consequences of natural disasters can cause irreparable damage to the ecology and environment and can lead to irreversible processes in the planet's biosphere. Global climate change connected with natural and anthropogenic factors brings about destruction of the global

ecosystem, desertification, soil degradation, depletion of the ozone layer and other negative consequences which may cause food shortages for inhabitants of large territories across the planet. The health and well-being of humans are inextricably linked to geological and environmental change.

It must be taken into account that the biosphere is very sensitive to any changes in the environment, which requires constant monitoring and in-depth studies of such influences. This could be facilitated by the creation of a multilingual Internet database for collecting, storing and analyzing information that reflects spatio-temporal changes in geological, geophysical and astrophysical properties of the environment and biophysical and physiological parameters of plants, animals and humans.

Harbingers of undesirable effects of space weather upon communications in us (as well as among us, the latter the sole current official concern) are detected by monitoring, i. a., the human blood circulation. With chronobiologically interpreted around-the-clock surveillance of blood pressure and heart rate, we can start to transform health care into an improved since self-surveillance-based and hence cost-effective cyber-care, detecting alterations in the variabilities in us via an international automatic website for analyzing physiological, epidemiological and physical variables, by (also-automatic) repeated passes over the accumulating data.

Natural cataclysms can in a short span of time lead to catastrophic consequences for whole regions of the planet; take lives of many people; deprive populations of large areas of shelter and livelihood; destroy economies of entire states and cause large-scale epidemics and severe infectious diseases. Today, the world community is not prepared for such a likely development of events. Meanwhile, the geological life of our planet has repeatedly seen spans of a significantly increased incidence of natural cataclysms, and the next such span, as many geological indicators suggest, has already begun.

The Forum participants emphasize that the biggest loss from natural disasters is suffered by less developed countries and low-income population. Special programs must be implemented to reduce negative consequences of natural disasters for those countries.

The participants have decided as follows:

– To approve the Istanbul Declaration on Natural Cataclysms;

– To send the Istanbul Declaration on Natural Cataclysms to the UN Secretary-General, UNESCO, European Commission, heads of state, to parliaments and governments of all countries, and authoritative international organizations;

– To approve the time of the next, third World Forum – International Congress "Natural cataclysms and global problems of the modern civilization" as September, 2014.

– To approve Moscow, Russian Federation as the place of holding of the next World Forum.

– To address the Russian Academy of Sciences proposing to participate in organization of the next, third World Forum – International Congress "Natural cataclysms and global problems of the modern civilization" in September, 2014 as a major co-organizer together with the International Committee GEOCHANGE on Global Geological and Environmental Change (Germany), World Organization for Scientific Cooperation WOSCO (Germany) and other organizations.

– To entrust the Chairman of the Board of the World Forum Prof. Elchin Khalilov to address the International Geological Union and International Union of Scientific Societies for integration of the World Forum into the International Geological Congress and conferences of the International Union of Scientific Societies.

– To approve the creation of a multilingual Internet database for collecting, storing and analyzing information that reflects spatiotemporal changes in geological, geophysical and astrophysical properties of the environment and biophysical and physiological parameters of humans and animals.

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