INTERNATIONAL WORKSHOP

Recent Geodynamics, Georisk and Sustainable Development in the Black Sea to Caspian Sea Region

3 - 6 July 2005, Baku, Azerbaijan

SPONSORS

UNESCO International Hydrological Program

International Union of Geodesy and Geophysics

American Geophysical Union

Azerbaijan National Academy of Sciences / Geology Institute

HEIDELBERGER AKADEMIE
DER WISSENSCHAFTEN

Commission on Geophysical Risk & Sustainability
International Union of Geodesy and Geophysics

ExxonMobil
Taking on the world's toughest energy challenges.™

EMI Earthquakes and Megacities Initiative

Workshop Committees

International Steering Committee

T. Beer, Australia

F. Bendimerad, USA

A. Ismail-Zadeh, Russia/Germany (Co-Chair)

B. Mueller, Germany

B. Panahi, Azerbaijan

F. Spilhaus, USA

A. Szöllösi-Nagy, France

F. Wenzel, Germany (Co-Chair)

Local Organizing Committee

S. Akhundova, National Academy of Sciences, Baku, Azerbaijan

K. Aliyev, National Academy of Sciences, Baku, Azerbaijan

A. Ali-Zadeh (Chair), National Academy of Sciences, Baku, Azerbaijan

T. Ismail-Zadeh, National Academy of Sciences, Baku, Azerbaijan

A. Narimanov, SOCAR – State Oil Compani of Azerbaijan Republic

B. Panahi (Vice-Chair), National Academy of Sciences, Baku, Azerbaijan

T. Rashidov, National Academy of Sciences, Baku, Azerbaijan

The Workshop is dedicated to Professor Tofik Ismail-Zadeh (1930-2004), a prominent Azerbaijan geophysicist, honoured scientist of Azerbaijan, and fellow of the Russian Academy of Natural Sciences. The dedication is in recognition of his pioneering works in paleomagnetism, seismology, and seismic hazard and of his leading role in cooperation of academic and industrial research.

Workshop Summary

The human faces devastating geological and geophysical disasters on different scales in time and space: Earthquakes, landslides and erosions, mud volcanoes, rock falls, sediment pollutions, subsidences and collapses, floods and other water and weather related hazards. The geohazards affect not only the human life and health, but have also dramatic impact on the sustainable development, e.g. land value, deterioration of the environment, partial or total loss of infrastructure, and other social and economic processes on which life depends. Geohazards are also a pending danger for vulnerable lifelines and constructions such as water supply and reservoirs, pipelines, and power plants. A strong earthquake, for instance, in the vicinity of a big city (megacity) can change the life and development of the nation within minutes and can damage greatly the national economy throwing it back for tens of years, if the society has not prepared concepts for the case of emergency and for efficient rebuilding of most important infrastructure. A careful assessment of the geological and geophysical risks is required to reduce the number and effects of geophysical and triggered technological disasters and to maintain sustainability over the next decades.

The recent geodynamics of the Black Sea to Caspian Sea region is quite complicated and manifested in the surface as large earthquakes, landslides, mud volcanoes, and dramatic sea level changes. At the same time, the region plays today a key role in the energy supply for many countries in Europe and America because of intensive hydrocarbon production. The hydrocarbons have to be transported through pipelines located in areas endangered by geohazards.

To mitigate the tremendous effects of these disasters in the Black Sea to Caspian Sea region, an efficient collaboration between geoscientists, engineers and policy-makers is required. The first is to identify and assess the hazard and risk quantitatively, the second is to reinforce existing and to develop safe new constructions, and the third is to provide the base for appropriate scientific and engineering measures, to constitute rescue units and to take care for the public acceptance of the essential measures in highly hazardous areas.

As the population in this region continues to increase, the vulnerability to them is magnified with each passing year undermining our ability to maintain a sustainable development. Many of the large cities in the Black Sea to Caspian Sea region are subject to the combined threats of natural and technological risks. The sensitivity of technical constructions (power plants, embankment dams of reservoirs, pipelines, underground constructions such as wells, tunnels, storages) to geohazards requires a complex technological development. Currently, datasets are incomplete and erroneous, predictions in terms of location, time and scale of hazards such as earthquakes or landslides, in general, are still not accurate. All this illustrates the timeliness to organize the workshop where many of problems of regional geodynamics and geohazards can be discussed and analyzed.

The workshop should prepare a scientific background for enhancement of disasters risk preparedness and reduction. This is important, since, for example, an earthquake of magnitude about 7 may reoccur in the Black Sea to Caspian Sea region, causing a regional to global scale catastrophe. Such a large earthquake in the region could face the devastating damage and destabilized social order in the whole region. The workshop will bring together people of natural, social and political sciences and of industry to analyze the problems of geophysical and technological hazards, risks and sustainability in the region and to develop the social and political background and acceptance; in this way it even may contribute to the peace process in the Caucasus region.

The workshop will address the following key issues.

1. Which major geological and geophysical processes control the recent geodynamics of the region resulting in earthquakes, mud volcanoes, landslides, subsidence and collapse, and sea level changes? We intend to bring together leading experts in geodynamics and geophysics to clarify the question. The natural hazard assessment, risk estimations, geodynamic and risk modeling, development and implementation of early warning systems and other problems should be discussed.
2. How have humans altered the geosphere and the landscape, thereby promoting and/or triggering certain hazards and increasing societal vulnerability to geohazards? This question focuses on land use and development patterns (e.g. building on steep slopes, unstable ground, etc.), subsurface exploitation (through Caspian Sea oil and gas extraction) in combination with natural (tectonic) sea level changes, and the unsustainable growth of the large cities in the region (e.g. Baku with over 2 millions habitants) in hazard-prone areas.
3. How do geohazards compare relative to each other regarding current capabilities for monitoring, prediction and mitigation and what methodologies and new technologies can improve such capabilities to help civil protection at local and global scales? Can synergies in rescue resources be obtained? These questions address the role of the natural sciences in providing the background information for public policy and government decision-making. Even more, the effective co-operation between natural sciences and engineers can successfully provide tools to mitigate the disaster, e.g. computer aided comparison of pre-and post earthquake laser scanning data, which can be obtained within a few hours, will help to identify damaged and intact buildings and lifelines and help to guide effectively the rescue teams and their equipment. This co-operation should not of course stop at borderlines of each country. We will discuss how fundamental research can contribute to effective rescue programs and speedy and efficient rebuilding of lifelines.
4. What are the barriers to the utilization of risk and vulnerability information by governments (and other entities) for risk and vulnerability reduction policies and planning (including mitigation) for each of the geohazards? This question addresses the role of science in public policy decision-making, including how issues of risk and uncertainty, data quality and data quantity, influence who uses information, what information is used, the purpose for which it is used, and when it can and will be used.

To a certain extent these questions are addressed in the United Nations Inter-Agency Secretariat International Strategy for Disaster Reduction (UN-ISDR). The UN-ISDR report "Living with Risk: A global Review of disaster reduction initiatives" includes information on hazard assessment and awareness. The Heidelberg Academy of Sciences contributes with its World Stress Map Project (www.world-stress-map.org) a database of fundamental geo-information to the hazard community used e.g. for geodynamic modeling or vulnerability considerations of oil-companies. The importance of community interaction and participation was also stressed in the ICSU position statement on Natural Hazards at: http://www.iugg.org/ICSUposition.pdf Natural Disaster Reduction: Safer Sustainable Communities – making decisions about risk.

Local Information

General Data

Location: The Republic of Azerbaijan lies in the borderlands of Asia and Europe. It is situated in the south-eastern part of the Southern Caucasus and shares borders in the north with the Russian Federation, in the south with the Islamic Republic of Iran, in the west with Turkey, Georgia and Armenia, and in the east its neighbors across the Caspian Sea are Kazakhstan and Turkmenistan. Capital of Azerbaijan is Baku (Baki in Azeri) with a population of 1,807,300 (end 2004).

Monetary Unit: Manat (1 USD = 4726 Manat, 1 EUR = 5783 Manat, 1 GBP = 8636 Manat as on June 20, 2005). ***Important***: Please note that credit cards are not widely accepted in Baku. So please bring enough cash (in USD or EUR only) to pay your purchases in shops, hotel or restaurants. There are many currency exchange offices in the Baku city.

Accommodation

Best Eastern Absheron Hotel, 674 Azadlyg Av, Baku, 370010, Azerbaijan

Arrival

You will arrive to the Heydar Aliyev International Airport in Baku, the capital of Azerbaijan. There are taxicabs in the airport to pick you up to the Best Eastern Absheron Hotel where most of the workshop participants will be accommodated. Those who asked for assistance, the Local Organizing Committee will organize your collection in the Airport (at the exit from the custom-zone, look for a small poster with your name in a hand of the person who will drive you to the hotel). The fare for the way from the airport to the hotel is around 20-25 USD.

Visa

Foreign citizens can obtain a single-entry visa for stay up to 30 days at Heydar Aliyev International Airport in Baku upon arrival. The following documents are required in addition to payment of the visa fee ($40): one copy of the completed application form; one passport-size photograph; a photocopy of the passport data. You need to have a valid passport which should not be about to expire within 6 months of your arrival date. The whole process is hassle free and takes about 30 minutes.

Workshop venue

Conference Hall, Geology Institute, Azerbaijan Academy of Sciences, H. Javid av. 29A, Baku AZ1143, Azerbaijan.

Registration hours

July 3 from 18:00 to 19:30 at the Best Eastern Absheron Hotel (address above)
July 4 to July 6 from 8:30 to 9:30 at the Geology Institute, Azerbaijan Academy of Sciences, H. Javid av. 29A, Baku AZ1143, Azerbaijan.

Workshop Banquet

The Workshop Banquet will be held on July 3, 2005. The place of meeting is a lobby of the Best Eastern Absheron Hotel Time of gathering is at 19:30 (7:30 pm). The dinner is from 20:00 to 22:00 (8 to 10 p.m.)

Electrical Appliances. The electrical current in Baku is 220 Volts. British and American citizens will need an adapter.

TECHNICAL PROGRAM

July 3, 2005

18:00-19:30 Registration

19:30 Reception

July 4, 2005

Opening ceremony (Chair: B. Panahi)

9:30-9:45 *Addresses given by*

Ali-Zadeh, A., Chairman, Department of Earth Sciences, the National Academy of Sciences; Chair of the Workshop Local Committee
Beer, T., Vice-President, International Union of Geodesy and Geophysics

9:45-10:00 *Welcoming address*

Ismail-Zadeh, A., Co-Chair, Workshop International Steering Committee
Geohazards, georisk and sustainable development: Interdisciplinary approach

Keynote speeches

10:00-10:20 **Szöllösi-Nagi, A.**, Assistant Deputy Director, UNESCO & Secretary, International Hydrological Programme
Title to be announced later

10:20-10:40 **Link, M.**, Senior Adviser for Development Cooperation, German Parliament, Berlin, Germany.
The Geopolitical Role of the South Caucasus and its Relevance for the European Union

10:40-11:00 **Kipphan, H.**, Heidelberg Academy of Sciences, Heidelberg, Germany.
International Cooperations for Joint Research in Geology and Geophysics - Challenges, Demand and Opportunities for Science and Industry

11:00-11:30 Coffee break

Session 1: Geodynamics and Geohazards (Chairs: J. Knapp & A. Ismail-Zadeh)

11:30-12:15	**Panahi, B.**	*Geodynamics and seismicity in Azerbaijan and the adjacent Caspian sea*
12:15-13:00	**Gassanov, A.**	*Strong earthquake source zones of Azerbaijan and seismic risk of Baku*
13:00-15:00	Lunch break	
15:00-15:45	**Delisle, G.**	*Observations of methane flux from the Dashgil mud volcano/Azerbaijan*

15:45-16:30	**Knapp, J.**	*Potential geohazards in the Absheron Peninsula region*
16:30-17:00	Coffee Break	

Session 2: Seismic Risk Reduction and Management (Chair: B. Mueller)

17:00-17:45	**Wenzel, F.**	*Risk reduction in big cities – the concept of the Earthquakes and Megacities Initiative*
17:45-18:30	**Vergino, E.**	*CauSIN: The Caucasus Seismic Information Network. A model for cooperation*
18:30-19:15	**Chelidze, T.**	*Seismic risk in large cities of Caucasus. Tools for risk management*
20:00	Dinner	

July 5, 2005

Session 3: Geohazards and Risk in Caucasus (Chair: B. Panahi)

09:30-10:15	**Javakhishvili, Z.**	*Seismic hazard assessment of Georgia*
10:15-11:00	**Guliev, I.**	*Mud volcanism in Azerbaijan*
11:00-11:30	Coffee Break	

Session 4: Stress and Seismicity (Chair: V. Kossobokov)

11:30-12:15	**Mueller, B.**	*World Stress Map - a tool for geohazard assessment*
12:15-13:00	**Ismail-Zadeh, A.**	*Buoyancy-driven tectonic stress and seismicity in Europe*
13:00-15:00	Lunch break	

Session 5: Geophysical Risk and Sustainability (Chairs: A. Ismail-Zadeh and T. Beer)

15:00-15:45	**Beer, T.**	*The 50th Anniversary of the International Geophysical Year, Georisk and Sustainable Development*
15:45-16:30	**Paterson, J.**	*Different dimensions of risk and the possible legal responses*
16:30-17:00	Coffee Break	
17:00-17:45	**Nicolich, R.**	*The contribution of geophysical prospecting to the recognition of seismological risks*

17:45-18:30	**Kossobokov, V.**	*Quantitative earthquake prediction on global and regional scales*
18:30-19:15	**Kontar, A.**	*On sustainable industrial development of the coastal, shelf and continental slope areas of the Black and Caspian seas and geophysical risks assessment*
20:00	Dinner	

July 6, 2005

9:30-11:00	**Poster Session**
11:00-11:30	Coffee Break
11:30-13:00	**General discussions and workshop conclusion (Chairs: A. Szöllösi-Nagi, and A. Ismail-Zadeh)**
13:00	Field trip to mud volcanos
20:00	Dinner

List of participants

Speakers

Ali-Zadeh, Akif	Chairman, Department of Earth Sciences, National Academy of Sciences (NAS) & Director, Geology Institute, NAS, H. Javid av. 29A, Baku AZ1143, Azerbaijan., NAS (Chair, Workshop Local Organizing Committee), H. Javid av. 29A, Baku AZ1143, Azerbaijan.
Beer, Tom	Vice-President, International Union of Geodesy and Geophysics & Co-ordinator, CSIRO Environmental Risk Network, Private Bag 1, Aspendale, Victoria, 3195, Australia.
Chelidze, Tamaz	Director, Institute of Geophysics, Georgian Academy of Sciences, Alexidze 1, Tbilisi 0193, Georgia.
Delisle, Georg	Director, Geological Department, Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Stilleweg 2, D-30655 Hannover, Germany.
Gassanov, Arif	Director General, Republican Center of Seismic Survey, NAS, Nigar Rafibayli 9, Baku, Azerbaijan.
Guliyev, Ibrahim	Deputy Director, Geology Institute, NAS, H. Javid av. 29A, Baku AZ1143, Azerbaijan.
Ismail-Zadeh, Alik	President, IUGG Commission on Geophysical Risk and Sustainability & Russian Academy of Sciences & Geophysical Institute, Karlsruhe University (Workshop co-Chair), Hertzstr. 16, Karlsruhe 76187, Germany.
Javakhishvili, Zurab	Head, United National Survey for Seismic Protection & Depute Director, Institute of Geophysics, Georgian Academy of Sciences, Alexidze 1, Tbilisi 0193, Georgia.
Kipphan, Helmut	Chairman, Advisory Board, Heidelberg Academy of Sciences, Karlstrasse 4, Heidelberg 69117, Germany.
Knapp, James	Department of Geological Sciences, University of South Carolina, 701 Sumter St., Columbia, SC 29208, USA.
Kontar, Evgeny	P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, Nakhimovsky pr. 36, Moscow 117851, Russia.
Kossobokov, Vladimir	International Institute of Earthquake Prediction Theory and Math Geophysics, Russian Academy of Sciences, Moscow, Russia & Institut de Physique du Globe de Paris, 4, Place Jussieu, 75252 Paris, Cedex 05, France.

Link, Michael	Senior Adviser for Development Cooperation, German Parliament - International Politics Division, Unter den Linden 50, Raum 1.065, Berlin 10117, Germany.
Mueller, Birgit	World Stress Map Project, Heidelberg Academy of Sciences, Hertzstr. 16, Karlsruhe 76187, Germany.
Nicolich, Rinaldo	Department of Civil Engineering, University of Trieste, Via Valerio 10, Trieste, 34127 Italy.
Panahi, Behrouz	Chair, Department of Seismology, Geology Institute, NAS (Vice-Chair, Workshop Local Organizing Committee), H. Javid av. 29A, Baku AZ1143, Azerbaijan.
Paterson, John	School of Law, University of Aberdeen, Taylor Building, Old Aberdeen, AB24 3UB, United Kingdom.
Szöllösi-Nagy, Andras	Assistant Deputy Director, UNESCO & Secretary, International Hydrological Programme, 1 rue Miollis, Paris 75732, France.
Vergino, Eileen	Deputy Director, Center for Global Security Research, Lawrence Livermore National Laboratory, 7000 East Av., P. O. Box 808, L-189, Livermore, CA 94551, USA.
Wenzel, Friedemann	Vice Chair, Earthquakes and Megacities Initiative & Director, Geophysical Institute, Karlsruhe University, (Workshop co-Chair), Hertzstr. 16, Karlsruhe 76187, Germany.

Other Participants

Abdulsalamli, T	Geology Institute, National Academy of Sciences, Baku.
Aghayeva, Solmaz	Geology Institute, National Academy of Sciences, Baku.
Akhundov, Ibrahim	Az NIIGeofizika, Baku.
Akhundova, Svetlana	Geology Institute, National Academy of Sciences, Baku.
Akperov, Nazim	NIiPr Institute "Gipromorneftegaz", Baku.
Aliyev, Ali	Azerbaijan Ministry of Ecology and Natural Resources, Baku.
Aliyev, Chingiz	Geology Institute, National Academy of Sciences, Baku.
Ayyubova, Leyla	Geology Institute, National Academy of Sciences, Baku.
Balakishibeyli, Shahin	Geology Institute, National Academy of Sciences, Baku.
Babayev, Gulam	Geology Institute, National Academy of Sciences, Baku.
Bodnar, Dirk	BP Azerbaijan, Chriag-DWG New Well Planning, Baku.

Gasanov, Adalat	Azerbaijan National Science Foundation, Baku.
Gasanov, Ramik	Geology Institute, National Academy of Sciences, Baku.
Gasanov, Rauf	Geology Institute, National Academy of Sciences, Baku.
Isayeva, Maya	Geology Institute, National Academy of Sciences, Baku.
Ismail-Zadeh, Tair	Geology Institute, National Academy of Sciences, Baku.
Israfilov, Rauf	Geology Institute, National Academy of Sciences, Baku.
Israfilov, Yusif	Institute of Water Problems, Baku, Azerbaijan
Moustafaev, Vefa	UNESCO, Paris, France
Novruzov, Zohrab	Geology Institute, National Academy of Sciences, Baku.
Odjagov, Habib	University of Engineering and Construction, Baku, Azerbaijan
Samedov, Vusal	Geology Institute, National Academy of Sciences, Baku.
Seyid-Aliyeva, Dinara	Geology Institute, National Academy of Sciences, Baku.
Shakarov, Hafiz	AzNIIGeofizika, Baku, Azerbaijan
Shixaliyev, Yusif	AzNIIGeofizika, Baku, Azerbaijan
Tingay, Mark	World Stress Map Project, University of Karlsruhe, Germany
Veliyev, Gumbat	AzNIIGeofizika, Baku, Azerbaijan
Wegerif, Juliette	Fugro Offshore Geotechnics, Leidschendam, The Netherlands

ABSTRACTS

Mud volcano eruptions in the southeastern region of Azerbaijan: Case study of the Dashgil mud volcano

T. A. Abdulsalamli
Geology Institute, National Academy of Sciences, Baku, Azerbaijan

Mud volcanoes attract a considerable attention of earth scientists because of their importance in industry (e.g. hydrocarbon exploration) and in geological research. Mud volcanism in Azerbaijan is associated with seismicity and occurs in highly populated areas. Several hundred mud volcanoes are known in the eastern portion of Azerbaijan. They represent the final stage of a diapir-type ascent of fluid-rich unconsolidated sediments from deep levels of one of the deepest sedimentary basins on the Earth. The goal of this study is to understand mechanisms of mud diapirism and the ways which might improve the capability to detect precursors of mud volcano eruptions.

In 2003 the research agreement on the Dashgil mud volcano was signed between Bundesanstalt für Geowissenshaften und Rohstoffe (BGR) and Geology Institute, Azerbaijan National Academy of Sciences. A special equipment was set up to record the following parameters: CH_4, flow, pair, and radon. The recorded data are sent to PC at the central station. The computer reads the received information and displays the parameters as graphical images. We study temporal dependence of each of the four parameters. This research is of great importance in the understanding of mud volcano activity and its correlation with seismicity in the Absheron peninsula.

Stress state of the crust in Azerbaijan

S. T. Agayeva
Geology Institute, National Academy of Sciences, Baku, Azerbaijan
solmazagayeva@rambler.ru

The stress state of the crust had been studied using focal mechanism solutions of earthquakes occurred in Azerbaijan and various methods for the determination of main stress axes orientation. Focal mechanism analysis allows to distinguish two orientations of elastic stress acting along or across the geological structures of Azerbaijan. The focal mechanisms of large, moderate ($M \geq 4$) and small earthquakes ($M < 4$) are analyzed using the Wulf's stereographic net through the identification of P-wave first motions recorded on seismic stations.

Great Caucasus, Less Caucasus, Talish. The orientation of main stress axes of large earthquakes reflects the general extension in the Mediterranean seismic belt. The compression stress axes (P) are located in a horizontal plane across to extension of geological structures: Great Caucasus, P (PL=2° -38°), T (PL=60° -80°); Lesser Caucasus, P (PL=12° -20°), T (PL=37° -45°); Talish, P (PL=25°), T (PL=56°).

Caspian sea, Kura depression. The tension stresses axes (T) are located in a horizontal plane perpendicular to extension of geological structures: Caspian sea, P (PL=40-67°), T (PL=2° -35°); Kura depression, P (PL=55° -76°), T (PL=5° -30°).

Monitoring of earthquake preparation processes from space and on the Earth

I. D. Akhundov[1], M. A. Guseinov[2], L. N. Solodilov[3]
[1] Az NIIGeofizika, Baku, Azerbaijan
[2] NPF “Geoecoservis”, Baku, Azerbaijan
[3] FGUP VNIIGeofizika, Moscow, Russia
Akhundov_Ibrahim@rambler.ru

We will present a new theoretical model of earthquake preparation based on nuclear-physical, quantum, gravitation, and geomagnetic processes. A catastrophic earthquake can occur as a result of nuclear reactions of annihilation and synthesis taking place in a high temperature source region. The process of heating and temperature rise in sources of the future earthquakes is traced from space with the help of the infra-red (IR) radiation receiver. This provides a parameter of earthquake site.

When critically high parameters of temperature and pressure are reached, a flow of orbital electrons of chemical elements and combinations possessing certain chemical, photonuclear, quantum and gravitation properties, emits out of the source of the future earthquake. Due to the high potential of magnetic moment, the flow of electrons creates a magnetic storm on its way out of the source to the ionosphere. Duration of the magnetic storm determines magnitude of future earthquake. The emission of the orbital electrons gives rise to the beginning and acceleration of local magnetic dipole (LMD) and it is carried out as a result of photonuclear reaction. With the growth of angular velocity of LMD rotation, there occurs growth of its magnetic field tension, amplitude and frequency of fluctuations. Filling of the discrete-level structure of LMD with quantum energy takes place. Once the angular velocity of LMD rotation reaches the maximum value, the LMD precesses and describes circular conic surface. Also it makes nutational fluctuations emitting quanta of electromagnetic radiation which are reflected in the carrier of the information in the form of irregular pulsations, separated in time by periods of relatively calm field. After the quantum radiation the angular velocity of rotation and, respective, the quantum energy of the discrete-level structure of the LMD will be decreased. A cessation of the rotation gives rise to the process of destruction of the LMD structure and it is accompanied by volumetric radiation of elementary particles. This is recorded instrumentally in the form of bay-like variation.

Using a multi-component magnetometer (like that installed in the US MAGSAT), one can measure some components of vector of the dipole and non-dipole (determined by a flow of charged particles) magnetic fields. A few hours after the cessation of the process of destruction of the LMD structure there occur nuclear reactions of annihilation and synthesis resulting in earthquakes.

Seismic hazard and preparedness to earthquakes in Azerbaijan

S. B. Akhundova
Geology Institute, National Academy of Sciences, Baku, Azerbaijan
sakhundova@gia.ab.az

Azerbaijan is an earthquake-prone region in the Caucasus. According to the frequency of earthquake occurrences the territory of Azerbaijan is divided into several seismically active zones. City of Baku is among these zones where a strong earthquake may occur (with the intensity higher than 7). Before the 25.11.2000 earthquake the population of Baku was not aware of the problem of "living with risk". Their real estates were not insured and people had no idea on strong earthquakes and their consequences and on how to behave during the natural disaster. There also was no psychological preparedness to any hazards and psychological rehabilitation of victims. For this reason, besides exposed value damage caused by the earthquake to buildings and private properties, local people suffered a psychological shock. A prominent Russian scientist I.V. Shebalin wrote about social aspect of this event: “Earthquake is not just shaking of the Earth. It is the strongest social “shaking”… People are too much scared by the underground shocks”.

Unfortunately, there is no any Governmental National Program on seismic protection of population. Immediately after the earthquake NGOs and psychological associations started their activity in natural hazard enlightenment of the population. Unfortunately, some time passed and social interest to this kind of natural hazard became lower. Positive experience in earthquake preparedness should be used. A lecture course “Extremal psychology” should be also introduced in schools. Professional psychological survey should take preventive measures on psychological preparedness of population to different emergency situations and psychological rehabilitation. Much work should be done by insurance agencies because people in the post-Soviet territory did not have much experience of insuring their property. They should reconcile themselves to the loss of houses, property and to their living in temporary dwelling as well as to their emotional trauma. This provides participation of medical personal in such events. Also a role of mass media in hazard should be emphasized, because mass media are responsible for reliable information given to population for their psychological support, so that people would not believe in various rumors. Thus, we should take lessons from the past and prepare the population living with risk to the inevitable hazards.

Seismic hazard assessment in the Sheki-Ismayilli region

Leyla Jamal Ayyubova
Geology Institute, Azerbaijan National Academy of Sciences
eyyubovaleyla@rambler.ru

A rate of building construction in Azerbaijan increases with each passing year and makes the issue of seismic hazard and risk assessment quite important. I study seismicity of Sheki-Ismayilli region, one of the earthquake-prone regions in Azerbaijan. The regional seismicity is analyzed by using macroseismic and instrumental data. Based on the analysis of macroseismic data from 18 earthquakes occurred from 1872 to 2003 in the Sheki-Ismayilli region, a map of maximum seismic intensity for this region is developed. The maximum intensity for this region is estimated to be VII MSK. Also I analyze instrumental data from earthquakes occurred from 1935 to 2003. A catalogue of earthquakes recorded in this time interval includes 878 events of magnitude $3<M<6$. Temporal distributions of earthquake magnitudes and occurrence are studied. It is estimated that a $M=5.5$ earthquake can occur once per 100 years, $M=6$ earthquake once per 1000 years, and $M=6.8$ event once per 10,000 years. Based on this analysis, the Sheki-Ismayilli region can be considered as a seismically hazard region. To reduce and mitigate seismic hazard it is important to monitor the regional seismicity.

Modeling of amplification factor for Baku city

G. R. Babayev
Geology Institute, National Academy of Sciences, Baku, Azerbaijan
Gulam_Babayev@bakililar.az

Baku city, situated on the Absheron peninsula and being the capital of Azerbaijan, is located in the earthquake-prone region. A level of seismic risk in Baku is increasing with time because of the intensive construction of high civil and industrial buildings, population upsurge, enlargement of the city's area, the raise of underground water level and of the Caspian Sea, liquefaction, and landslide activity. Moreover it has been recently observed that tectonic conditions, intensity of earthquake occurrence, and local site effect with ground conditions are being changed. Therefore, there is a need to deepen and to advance the research of seismic hazard and risk analysis using modeling based on modern methods and approaches.

In this study, the seismicity of the Absheron peninsula is studied. We compile a catalogue of historical destructive, strong, moderate local-, near- and far-zones earthquakes. Active fault data, target earthquakes, attenuation coefficient, soil and rock properties, geological cross-sections, the borehole data of measured shear-wave velocity, ground modeling, amplification factor of the each geological unit, geomorphology, topography, base rock and surface ground motions are analyzed. We define an amplification factor of the each geological unit through shear wave velocity and apply the attenuation formula for calculating peak ground acceleration (PGA) at the base rock. A calculation of the PGA at the surface ground motion is proceeded by multiplication PGA at the base rock with amplification parameter of each surface layers. We identify some regularities in the attenuation of intensities. Quaternary deposits are examined in detail as Quaternary outcrops represent the fact of risk with increasing PGA value at the surface.

Finally, as a result of two deterministic approaches, a map of expected peak ground shakings for the Absheron peninsula is developed on the basis of active faults map for the Absheron peninsula and the empirical macroseismic field equation. The map is drawn in the form of seismic zonation in terms of intensity scale MSK-64. The modeling results are expressed in PGA value compared to intensity MSK-64 scale for Absheron peninsula for near- and far-zone target earthquakes. The modeled amplification factor enables to estimate a level of seismic motion and intensity of the studied area. The modeling is performed by using SHAKE code and MapInfo Professional 4.5.

The 50th anniversary of the International Geophysical Year, georisk and sustainable development

Tom Beer
Vice-President, International Union of Geodesy and Geophysics
Tom.Beer@csiro.au

The year 2007 marks the fiftieth anniversary of the International Geophysical Year (IGY). The International Union of Geodesy and Geophysics (IUGG) and others will be marking this anniversary – known as IGY+50 – at their quadrennial General Assembly in Italy by coordinating a sequence of activities:

- The eGY, or electronic Geophysical Year, being organised by IUGG. (http://maggy.engin.umich.edu/mist/VPubl/200403_2004EO110001_Baker_etal.pdf)
- The IPY, or International Polar Year, established by the International Council of Science (ICSU) (http://www.ipy.org/)
- The IYPE, or International Year of the Planet Earth, organised under the auspices of the International Union of Geological Sciences (IUGS) (http://www.esfs.org/)
- The IYPE has established eight major science themes – Groundwater, Hazards, Health, Climate, Resources, Megacities, Deep Earth, and Oceans. The Hazards theme is centred around the following key questions:

1. How have humans altered the geosphere, the biosphere and the landscape, thereby triggering certain hazards and increasing societal vulnerability to geophysical (geological and hydrometeorological) hazards?

2. What technologies and methodologies are required to assess the vulnerability of people and places to hazards and how might these be used at a variety of spatial scales?

3. How do geophysical hazards compare relative to each other regarding current capabilities for monitoring, prediction and mitigation and what can be done in the short term to improve these statistics?

4. What barriers exist to the utilization of risk and vulnerability information by governments (and other entities) for risk and vulnerability reduction policies and planning (including mitigation) from each of the geophysical hazards?

Following the 26 December 2004 Indian Ocean Tsunami, and the UN World Conference on Disaster Reduction held in Kobe, Japan in January 2005, ICSU decided to establish a major research program and initiative on Natural and Human Induced Hazards. The first meeting of the ad-hoc scoping group for this study is to take place in Paris in July 2005.

Seismic risk in large cities of Caucasus: Tools for risk management

Tamaz Chelidze, Zurab Javakhishvili
Institute of Geophysics, Academy of Sciences of Georgia, Tbilisi, Georgia
chelidze@ig.acnet.ge

The problem of natural and human-made disasters is extremely important for the sustainable development of large cities in the Caucasus region: practically all of them are located in areas prone to strong seismic impact. The occurrence of a strong earthquake can cause great losses in population, economical potential of the region, and catastrophic ecological consequences, in particular because of the development of inter-related infrastructures of production and transportation. A reliable assessment of seismic hazard requires comprehensive study of seismic processes, structure of the Earth's crust, active faulting and surface geology.

The main goal of the NATO project (SfP 974320) was to estimate seismic risk for components of the large cities of the Caucasus and to provide decision makers/politicians with the available knowledge. The methodology used will provide a lasting foundation and framework for the development of earthquake risk reduction in the cities of Baku, Tbilisi, Yerevan and Vladikavkaz.

During the project easily upgraded GIS databases for urban areas of the cities have been developed. Maps of seismic hazard of the studied territories, earthquake ground shaking potential, and scenarios of most dangerous events in Baku, Tbilisi, Vladikavkaz and Yerevan were compiled. Vulnerability analysis of specific and representative building types: hospitals, schools, hotels, common type of apartment blocks, etc. carried out. All elaborated material and knowledge will be transferred to authorities of participating countries, with the aim of improving preparedness, planning prevention measures, management of major risks, and implementing insurance policy.

Continuous 18 months record of methane flux from the Dashgil mud volcano, Azerbaijan

Georg Delisle[1], Manfred Teschner[1], Behrouz Panahi[2], Ibrahim Guliev[2], Chingiz Aliev[2], Eckhard Faber[1]
[1] *Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Hannover, Germany*
[2] *Geology Institute, National Academy of Sciences, Baku, Azerbaijan*
G.Delisle@bgr.de

Mud volcanoes are a major geohazard in Azerbaijan. To improve our understanding of their internal processes, the Azerbaijan National Academy of Sciences and the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) have initiated within the framework of a scientific and technical cooperation a systematic study to study in detail the characteristics of gas emission processes (in particular methane, CO_2 and radon) of mud volcanoes over extended periods of time. Previous estimates of gas flux from mud volcanoes are based on spot measurements at one time instant. In Dec. 2003 we have put in place a monitoring station over a gas seep in a salse in the caldera of the Dashgil mud volcano to initiate a long-time monitoring. The monitoring station is mounted on a floating platform over the gas seep. The rising gas bubbles are collected. The collected gas is forced through a flow meter and then past methane and radon sniffers. The methane sniffer contains an IR detection system capable to record concentrations between 0 to 100 %. The radon sensor is based on a semiconductor and detects the alpha-decay of ^{222}Rn at 5.4 MeV and ^{218}Po at 6.0 MeV. All data are logged on-site, averaging signals over 15 minutes. All data, which are collected in a 15 second interval, are transferred for storage via telemetry to a host computer in a nearby village.

After monitoring the situation at this site for over 18 months, we can report phases of nearly stable gas output interchanging with phases of rapid gas flux variations. The average gas output is near 2.5 l min^{-1}, peak output was observed at 3.0 l min^{-1}. Occasionally, gas output stops almost completely for one to several days before resumption “of production” at previous levels. The dominant gas component is methane at all times. Despite highly variable gas flux rates, the monthly output of methane is rather constant and averaging around 70 m^3 at this one site.

A frequency analysis of the available record demonstrates a periodicity of about 24 h for peaks in gas output. The high variability in amplitude of the daily gas output is tentatively interpreted to reflect changing physical properties of the ascend channel. Observed infrequent complete blockage of gas output is usually followed by slightly enhanced production, implying a valve type behavior of the ascend channel. Apparently, no great overpressures are required to reopen this “valve” after shut-in. The available record suggests that one-time spot measurements of the gas output rate might be well off the true average value.

To assess, if the characteristic gas output features at this site are representative, we have started to operate a second monitoring station on the distant Perikushkul mud volcano/ Azerbaijan since October 2004. We hope to be able to extend this monitoring effort in the future to more onshore and to offshore sites to establish similarities or differences in gas output characteristics. Ultimate aim of our efforts is to develop capabilities to predict imminent mud volcano eruptions.

Finite element modelling of structural and thermal influences on fractures and fluid flow

Andreas Eckert, Friedemann Wenzel
Geophysical Institute, University of Karlsruhe, Germany
Peter Connolly
Chevron/Texaco, Houston, USA

Geothermal energy production from the Coso field, located in the Eastern Californian Shear Zone (ECSZ), is reliant on a thorough understanding of the fluid flow network, which is controlled by the distribution and interaction of fractures and permeability. The Coso site is located within a transtensional bend regime that connects two of the major active fault zones in the ECSZ (Owens Valley Fault Zone, Airport Lake Fault Zone).

In this study, 3D finite element analysis is being used to model the in-situ stress field of the ECSZ and the Coso Range bend structure. Evaluating the most appropriate boundary conditions for this tectonically complicated region will be one of the major tasks. Two models, one for the ECSZ and a smaller one for the Coso Range will be used to analyse the stress data. After iteration of the best possible FE model results fracture networks and fluid flow characteristics will be derived. In order to achieve the most appropriate boundary and loading conditions for the Coso scale finite element model, a large-scale model of the whole ECSZ was necessary. On this scale regional tectonic influences, such as the Sierra Nevada block displacement, Basin and Range extension and GPS velocity constraints could be implemented and the results could be calibrated against stress orientations, slip rates, GPS vectors and magnitudes. Once reliable results have been achieved for the ECSZ, the resulting nodal displacement field has been applied as loading conditions for the Coso scale model. The 3D model of the Coso bend setting is based on analogue sandbox models, which provide a good fit of the regional fault distribution and geometry.

Initial results for the ECSZ model show that the Coso Range region could successfully be modelled as a transtensional regime. Stress orientations for the ECSZ model region match independent measurements (e.g. World Stress Map www.world-stress-map.org) and the FE displacement field provides a good fit to the observed GPS data. Further, the results from the ECSZ model could be successfully applied to drive the Coso scale model and first results will be presented.

Sources of strong earthquakes and seismic risk in Azerbaijan

A. G. Gasanov
Director General, Republic Center of Seismic Survey,
National Academy of Sciences, Baku, Azerbaijan

Spatial distribution of strong earthquake sources in Azerbaijan has been analyzed. It is shown that the majority of the strong earthquakes of mountain and submountain areas are shallow-depth events (10-15 km). The earthquake sources of the Kura and Gusar-Devichi depressions are deeper than the previous areas. The earthquake depths of the Caspian Sea area reach 35-40 km. A possible seismic risk to Baku city from these earthquakes has been analyzed. It is determined that the most dangerous earthquakes sources are located in the Caspian Sea and Shamakha city. In general the following factors influence the level of seismic risk: (i) high seismic hazard of closest earthquake sources; (ii) engineering and geological conditions; (iii) secondary effects resulted from earthquakes (landslides, fire, etc.); and (iv) seismic vulnerability of physical objects and population. A map of seismic risk for Baku city has been compiled on the basis of the analysis of the four factors.

Mud volcanism in Azerbaijan

Ibrahim S. Guliyev
Geology Institute, National Academy of Sciences, Baku, Azerbaijan
iguliyev@gia.az

Mud volcanoes of the South-Caspian Basin (SCB) are closely related to tectonic processes in the basin and the orogenic system of Greater and Lesser Caucasus. A periodical "brightening" of faults from the northern to southern flank of SCB determines the intensity of the mud volcanism in six main tectonic zones as a wavy rolling of eruptions of the volcanoes group from the north to the south. Two-century observations show that waves of volcanic activity flashes roll with definite sequence from the southern slopes of the Greater Caucasus to the northern slopes of the Lesser Caucasus. The intervals are as follows: 60-65 years for the near-flank zone and 25-30 years for the depression (submerged) part of the basin. At the same time the tectonic movement along the faults provokes the spasmodic or uneven fluctuations of the Caspian Sea bottom being the reason its temporary correlation with the flashes of the mud volcanic activity.

The maximum density of the mud volcanoes in SCB is observed in the Shamakhi-Gobustan zone. Tens earthquakes of various amplitude are recorded in this region every year. It was observed that the beginning of great mud volcanic eruptions is associated with the most intensive seismic-tectonic processes in the South Caspian region. It is important to emphasize that the regional earthquakes are shallow (their hypocentres don't exceed 12 km). It corresponds to the depths of thick highly plastic Paleogene-Miocene sandy-clay deposits saturated by hydrocarbons. The joint manifestation of the mud volcanism and shallow earthquakes shows the intensive processes in sedimentary strata causing mechanical instability as well as the formation of seal failure of the sedimentary rocks.

The statistic processing of 150-year eruptions of the mud volcanoes and astronomic periodicity of mutual location of the Earth, Sun and the Moon allowed establishing the closest relation between these phenomena and the important regularity. About 60% of all (over 200) eruptions take place during new moon or full moon. On this base the forecasting on volcanic activity is made. The results of the study of 300 mud volcanoes from various parts of the world in connection with 11-year cycle of the sun activity had revealed a good agreement between the mud volcanic periodicity and the sun activation. The recent sun activity (2000-2001) had provoked an activation of four mud volcanoes of the western flank of SCB during seven months.

Buoyancy-driven tectonic stress and intermediate-depth seismicity in Europe

Alik Ismail-Zadeh
Geophysical Institute, Karlsruhe University, Germany, and
International Institute of Earthquake Prediction Theory and Math Geophysics,
Russian Academy of Sciences, Moscow, Russia
Alik.Ismail-Zadeh@gpi.uka.de

The principal purpose of the study is to understand the interplay between intermediate-depth seismicity in Europe and tectonic stress induced by lithospheric deformations. I will present two case studies: the southeastern Carpathians (where large earthquakes occur in the Vrancea region, north-east of the Black Sea) and northern-central Apennines (where moderate to strong earthquakes occur in the Umbria-Marche region, Italy).

To analyze processes of stress generation and localization in and around the descending slab beneath the southeastern Carpathians, I develop a 3D numerical model of contemporary mantle flow and stress in the region. The input data of the model consist of (i) temperatures derived from seismic P-wave velocity anomalies and surface heat flow, (ii) crustal and uppermost mantle densities converted from P-wave velocities obtained from seismic refraction studies, (iii) geometry of the Vrancea crust and slab from tomography and refraction seismic data, and (iv) the estimated strain rate in the slab (as a result of earthquakes) to constrain the model viscosity. It has been found that major crustal uplifts predicted by the model coincide with the East Carpathian orogen and surround the Transylvanian basin and that predicted areas of subsidence are associated with the Moesian and East European platforms. I show a correlation between the location of intermediate-depth earthquakes and the predicted localization of maximum shear stress. Modeled tectonic stresses predict large horizontal compression at depths of about 70 to 220 km beneath the Vrancea region, which coincides with the stress regime defined from fault-plane solutions for the intermediate-depth earthquakes. This implies that buoyancy-driven descent of the lithosphere is directly linked to intermediate-depth seismicity.

On the basis of a revisited crust and uppermost mantle Earth structure that supports delamination processes beneath northern-central Apennines the continental deformation is studied and a model of the contemporary flow and stress distribution in the lithosphere is developed. The rate of the modeled lithospheric flow is in agreement with GPS data and its patterns explain the heat flux, the regional geology and provide a new background for the genesis and age of the recent Tuscan magmatism. The modeled stress in the lithosphere is spatially correlated with gravitational potential energy patterns and show that internal buoyancy forces, solely, can explain the coexisting regional contraction and extension and the unusual intermediate depth seismicity.

Geohazard, georisk and sustainable development: Interdisciplinary approach

Alik Ismail-Zadeh
President, IUGG Commission on Geophysical Risk and Sustainability
http://www.iugg-georisk.org
Alik.Ismail-Zadeh@gpi.uka.de

The IUGG Commission on Geophysical Risk and Sustainability (IUGG Georisk Commission) is dedicated (i) to promoting scientific studies applied to the reduction of risk from natural hazards in an increasingly urbanized world and sustainability and (ii) to reducing death and destruction from natural and technological hazards by providing hazards data and information to emergency managers, policy-makers, scientists and the general public in the most timely and effective manner as possible. This includes the integration of knowledge concerning environmental, social and economic processes. The fundamental scope of this Commission is to facilitate communications – between scientists via meetings, workshops and publications, as well as between scientists and decision makers, between scientists and the public, and between scientists and schools.

To integrate diverse data streams, to improve understanding of the natural phenomena associated with the disasters, to develop predictive modeling capability, and to generate and disseminate timely and accurate information needed by decision makers and the public, multidisciplinary and multinational research programs and research networks on geophysical hazards and risks should be developed. Scientists can and should help to save human lives by providing governmental institutions with accurate predictions on natural disasters with a good lead time. Real-time earthquake prediction experiments have proved statistically that seismic activity is not totally random. Thus scientists and decision makers have a probabilistic advantage in predicting large earthquakes. Because science is responsible for providing proper predictions of natural phenomena that cause disasters, reduction of predictive uncertainty is the most important challenge in natural hazards mitigation. The IUGG Georisk Commission is focusing on this objective as a common mission in all the georisk community.

Peculiarity of seismicity in the Balakend-Zagatal region: Implication for seismic hazard analysis

Tahir Ismail-Zadeh
Geology Institute, National Academy of Sciences, Baku, Azerbaijan
tair1964@rambler.ru

Study of seismicity in the Balakend-Zagatal region conducted both for the total number of moderate events and small earthquakes in Caucasus has demonstrated a temporal correlation of earthquakes. Small events in the region correlate well with the moderate events in the Caucasus in the time interval of 1980 to 1990. Despite the small time interval we believe that the regional seismicity may be considered as a result of sub-horizontal compressional deformations within the Greater Caucasus. It is shown that the processes resulting in deformation and tectonic movements of main structural elements in the Caucasus are located within the regional tectonic elements. The week dependence of the regional movements from the large-scale motion of the lithospheric plates and microplates is apparent from another geological and geodesic data as well. An important evidence to account for the independency of the movements comes from the regional radiometric studies revealing a horizontal displacement of gamma anomalies. This displacement seems to be associated with the mass transfer in the upper crust. Earthquake focal mechanism analysis in the Balakend-Zagatal region enables to argue that the regional stress field is stable. Local contraction and extension demonstrates however more complex nature of the regional stress field and deformations associated with the active processes in the upper crust. An estimation of the rheological properties for the crust as well as stress transfer in the Balakend-Zagatal region can clarify the peculiarity of seismicity.

Seismic Hazard Assessment of Georgia

Zurab Javakhishvili
Institute of Geophysics, Academy of Sciences of Georgia, Tbilisi, Georgia
z.javakh@ig.acnet.ge

Probabilistic seismic hazard maps are developed for the territory of Georgia. Cornell approach, namely computer program SEISRISK III (Bender and Perkins, 1987), are employed for the calculation of seismic hazard. Following the Cornell approach three main elements are used for this analysis: definition of seismic source zones, parameters of seismicity and attenuation relationships.

The seismic source zones are defined on the basis of different maps of active faults. All the seismic source zone schemes with different weights are used for calculations. The catalogue of earthquakes of Caucasus is used for the hazard analysis. Parameters of earthquakes are checked and recalculated. The duration magnitude calculated for several hundreds of moderate earthquakes of early instrumental period is added extending the data down to 1950-s. Seismicity in Georgia is studied using ZMAP software. A special algorithm is used to define foreshocks, aftershocks and swarms. As a result the catalogue of so-called independent events is compiled. *a* and *b* values are calculated for source zones.

A new attenuation relationship for the peak ground acceleration for the territory of Georgia is compiled on the basis of recent strong motion data. In the present study the effects from the moderate and small events in the close epicentral distances are investigated more precisely. The analysis of recent seismicity (for the last decades) shows that the “contribution” of these events in the regional seismic hazard is essential. The earlier attenuation model by Smit et al. (2000) is also incorporated. These attenuation models are used for calculation of acceleration and intensity levels having 1%, 2%, 5% and 10% probability of not been exceeded during exposure time of 50 years.

Potential geohazards in the Absheron Peninsula region, South Caspian Basin: Evidence from 2-D and 3-D seismic reflection data for massive slope failure and development of the Absheron Allochthon

James H. Knapp, Camelia C. Knapp, Patrick D. Duff
Dept. of Geological Sciences, University of South Carolina, Columbia, S.C., USA
knapp@geol.sc.edu

Massive slope failure in the South Caspian basin, identified on industry multi-channel seismic reflection data, characterizes a region in excess of 200 km^2 on the continental slope of the Absheron Peninsula [1]. First recognized in the Absheron PSA [2], the Absheron Allochthon is characterized by a highly faulted and disrupted stratigraphic sequence ~200-300 m in thickness, with extensive normal faulting updip and a clearly recognizable toe thrust along the downdip extent. Current constraints indicate that (1) the entire Absheron Allochthon is formed within Pleistocene-age sediments, (2) a thin section of sediment appears to post-date major movement of the allochthon, although some faults appear to be active and are expressed at the seafloor, (3) there are at least two different styles of sediment deformation within the allochthon, both as coherent blocks of strata between discrete faults and as highly-disrupted, chaotic seismic facies, (4) the base of the allochthon appears to correlate well with the presence of extensive, buried gas hydrate deposits [3], and (5) there are clearly slope failure features of different ages within the basin, including what appears to be a recent (active?) slump at the neighboring Shah-Deniz PSA to the west. These relationships suggest one of two possibilities for the age of the Absheron Allochthon: (1) Late Pleistocene movement, followed by relatively minimal deposition in Recent time, or (2) Recent (and ongoing?) development of the allochthon. Basin bathymetry suggests the former model is plausible, since rising sea-level has apparently displaced deltaic depocenters laterally by hundreds of kilometers.

The cause of massive slope failure and development of the Absheron Allochthon has been attributed to the dissociation of gas hydrates during rapid sea-level fall [4], but further investigation is warranted to evaluate the role of seismic activity and/or sediment loading in development of this regional feature. Such widespread slope instability could have important implications for resource extraction and transportation in the region.

References

[1] Knapp, C.C. and Knapp, J.H., Absheron Allochthon of the South Caspian Sea: Evidence for slope instability in response to gas hydrate dissociation. South Caspian Basin: Geology, Geophysics, Oil and Gas Content. Baku. Nafta Press. 257-268, 2004.

[2] Diaconescu, C.C. and Knapp, J.H., Buried gas hydrates in the deepwater of the South Caspian Sea, Azerbaijan: Implications for geo-hazards, Energy Exploration and Exploitation, vol. 18, no. 4, p. 385-4000, 2000.

[3] Diaconescu, C.C., Kieckhefer, R.M., and Knapp, J.H., Geophysical evidence for and thermobaric modeling of gas hydrates in the deep water of the South Caspian Sea, Azerbaijan, Marine and Petroleum Geology, vol. 18, no. 2, p. 209-221, 2001.

[4] Diaconescu, C.C. and Knapp, J.H., Gas Hydrates of the South Caspian Sea, Azerbaijan: Drilling hazards and sea floor destabilizers, *OTC Special Publication*, 2002.

On sustainable industrial development of the coastal, shelf and continental slope areas of the Black and Caspian Seas and geophysical risk assessment

Evgeny A. Kontar and Leopold I. Lobkovsky
P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences (SIO RAS), Moscow, Russia
ekontar@ocean.fsu.edu

Coastal, shelf and continental slope areas of the Black and Caspian seas are quickly becoming new major areas of industrial technological development owing to vast natural resources such as oil, gas and fish available in these areas. Therefore, understanding risks of natural and human-made hazards in these areas contributes to strengthening the scientific and technological basis of a number of industries including oil/gas production and transport. Traditional ways to evaluate geophysical risks at sea on- and off-shores are often not comprehensive enough and may result in lower estimates of the actual risks of the hazards. A combined approach developed recently at the SIO RAS provides more accurate evaluations, which may affect significantly human research and industrial activities in maritime areas. A rational for implementing the know-how developed at SIO RAS is that the traditional approach to evaluating geophysical risks through analysing historic data may well underestimate actual risks.

The new SIO RAS's approach has been successfully applied recently to evaluate risks of designing and building a submarine gas pipeline on the shelf and continental slope of the Black Sea ("The Blue Stream" project) between Russia and Turkey. The project was a success, and its results can be expanded into other areas of the Black Sea and into the Caspian Sea. Also we report here some results of the EU project which was designed to disseminate information to scientific and industrial communities on combined risks of submarine contaminated groundwater discharge, saltwater intrusion, coastal zone earthquakes, landslides, and tsunamis to create a consortium for conducting a large-scale international project devoted to investigation of combined geophysical risks in coastal, shelf, and continental slope areas. Results of this international project have a profound effect well beyond the research, namely, on industrial and economic development of the respective Black, and Caspian seas regions.

Broad knowledge about these results (e.g., maps of the micro-seismic, landslide, and tsunami zoning) would encourage interested industrial organizations to cooperate with SIO RAS on conducting more detailed geophysical risk evaluations for specific areas of their interest. This has already happened: SIO RAS was engaged in a project with the Lukoil oil company in the Black Sea and with the Kalmneft oil company in the Caspian Sea. While some societal groups are blindly against globalization, industrialization and might be opposing to the SIO RAS's study, our project meets high ethical standards because its implementation would encourage economic and industrial sustainable development and international cooperation in the Black and Caspian seas areas, and, at the same time, would eventually result in safer and cleaner environment. More detailed information can be introduced targetting potential risk groups, including local authorities and the general public, to enhance geophysical risks awareness.

Quantitative earthquake prediction on global and regional scales

V. G. Kossobokov
Institute de Physique du Globe de Paris, France and
International Institute of Earthquake Prediction Theory and Mathematical Geophysics,
Russian Academy of Sciences, Moscow, Russia
volodya@mitp.ru, volodya@ipgp.jussieu.fr

The Earth is a hierarchy of volumes of different size. Driven by planetary convection these volumes are involved into joint and relative movement. The movement is controlled by a wide variety of processes on and around the fractal mesh of boundary zones, and does produce earthquakes. This hierarchy of movable volumes composes a large non-linear dynamical system. Prediction of such a system in a sense of extrapolation of trajectory into the future is futile. However, upon coarse-graining the integral empirical regularities emerge opening possibilities of prediction in a sense of the commonly accepted consensus definition worked out in 1976 by the US National Research Council.

Implications of the understanding hierarchical nature of lithosphere and its dynamics based on systematic monitoring and evidence of its unified space-energy similarity at different scales help avoiding basic errors in earthquake prediction claims. They suggest rules and recipes of adequate earthquake prediction classification, comparison and optimization. The approach has already led to the design of reproducible intermediate-term middle-range earthquake prediction technique. Its real-time testing aimed at prediction of the largest earthquakes worldwide has proved beyond any reasonable doubt the effectiveness of practical earthquake forecasting. In the first approximation, the accuracy is about 1-5 years and 5-10 times the anticipated source dimension. Further analysis allows reducing spatial uncertainty down to 1-3 source dimensions, although at a cost of additional failures-to-predict. Despite of limited accuracy a considerable damage could be prevented by timely knowledgeable use of the existing predictions and earthquake prediction strategies.

The December 26, 2004 Indian Ocean Disaster seems to be the first indication that the methodology, designed for prediction of M8.0+ earthquakes can be rescaled for prediction of both smaller magnitude earthquakes (e.g., down to M5.5+ in Italy) and for mega-earthquakes of M9.0+. The monitoring at regional scales may require application of a recently proposed scheme for the spatial stabilization of the intermediate-term middle-range predictions. The scheme guarantees a more objective and reliable diagnosis of times of increased probability and is less restrictive to input seismic data. It makes feasible reestablishment of seismic monitoring aimed at prediction of large magnitude earthquakes in Caucasus and Central Asia, which to our regret, has been discontinued in 1991. The first results of the monitoring (1986-1990) were encouraging, at least for M6.5+.

Quantitative modeling of the structural and thermal evolutions of the PriCaspian Basin

Dmitry Krupsky (1), Alik Ismail-Zadeh (1,2), Helmut Wilhelm (2), Yuri Volozh (3)

(1) *International Institute of Earthquake Prediction Theory and Mathematical Geophysics, Russian Academy of Sciences, Moscow, Russia*
dima@mitp.ru, aismail@mitp.ru
(2) *Geophysical Institute, Karlsruhe University, Germany*
Alik.Ismail-Zadeh@gpi.uka.de, Helmut.Wilhelm@gpi.uka.de
(3) *Geological Institute, Russian Academy of Science, Moscow, Russia*

The PriCaspian basin is situated on the south-eastern portion of the East-European platform at the northern end of the Caspian Sea. The basin is approximately 600 km across from west to east and is underlain by Late Permian salt. The thickness of the sedimentary cover is more than 20 km in the basin centre. The basin infill is divided into three major sedimentary sequences: subsalt strata, salt, and overburden of the salt. The subsalt sequence contains Riphean through Lower Permian strata punctuated by unconformities. The subsalt sequence has a complex depositional history dominated by carbonate reefs and clastic fans. The salt sequence consists of Kungurian (ca. 260-258 Ma) salt overlain by Kazanian (ca. 258-252 Ma) salt which reaches a thickness of 4.5 km in the center of the basin. The overburden of salt consists predominantly of terrigenous Upper Permian through Neogene strata. The overburden is divided into three structural levels by gentle unconformities at Upper Permian-Triassic, Jurassic-Miocene, and Pliocene-Quaternary.

To understand the geothermal evolution of the basin, we study a geological profile across the Astrakhan crest of the PriCaspian basin. Initially we develop a 2-D geothermal model based on the analysis of lithologies, temperature measurements and some other log data, and age of the deposited sediments. The back-stripping technique is used to restore the structural evolution of the basin across the profile. Simultaneously a geothermal model is developed for each phase of the basin evolution in order to estimate temperature changes within the sedimentary layers in the geological past. The model results predict coupled structural and geothermal evolutions of the basin, and they can be used in oil industry to predict the subsidence history and thermal maturation of hydrocarbons.

The World Stress Map – an essential and easy accessible tool for geohazard assessment

B. Müller, A. Barth, O.Heidbach, J. Reinecker, B. Sperner, M. Tingay, F. Wenzel

World Stress Map Project of the Heidelberg Academy of Sciences
Karlsruhe University, Germany
Birgit.Mueller@gpi.uni-karlsruhe.de

The contemporary state of stress and its spatial and temporal variation is an essential parameter for a number of neotectonic and human-made geohazards. Earthquakes, e.g., are most likely to occur along faults characterized by a critical ratio of shear to normal stress. Stress release through earthquakes redistributes and perturbs the stress pattern on neighboring faults. If these faults experience such stresses in addition to a previous near critical state of stress they may fail. Stress data help to understand the faulting style and its variations and may contribute to define hazard microzonation areas. Local stress changes caused by production of subsurface resources or geological storage and disposal often trigger earthquakes and cause land subsidence. The risk mitigation for natural as well as for man-made geohazards requires decisive actions which are, in many fields, not well established. For the December 26 great earthquake and tsunami the fast and correct assignment of the earthquake magnitude combined with a regional warning system would have drastically reduced the losses. An important contribution from the geoscience community to geohazard assessment is not only to provide the relevant data as precise as possible in high-resolution data compilations, but also to guarantee their direct accessibility.

The World Stress Map (WSM) project is the global compilation of contemporary tectonic stress which is one fundamental parameter for geohazard assessment and research. Today, the WSM database contains data at more than 13,000 locations world-wide with all data being quality ranked and thus comparable. The principal findings of the WSM project were that plate-scale (first-order) stress patterns are caused by plate boundary forces. Local (second-order) perturbations in the stress field are associated with specific tectonic features, and topographically elevated areas are characterized by extension. Since the beginning in 1986 there is major progress in the spatial resolution and accessibility of the WSM. As a consequence, the WSM is a valuable tool of information for users in research, industry and geohazard application on different scales: On reservoir scale, the WSM is used to predict fracture development or stable drilling directions. On regional scales, stress data can reveal the tectonic regimes and stress concentrations, which may be analyzed in connection with neotectonic features such as actual fault movement as recorded by GPS. On a global scale, the comparison of stress and strain (rate) patterns provides insight into the rheological structure of the crust. On all scales numerical modeling of *e.g*. stress concentration effects, slip tendency or fracture reactivation potential uses the observed stress pattern from the WSM as validation parameter.

The world-wide accessibility of the WSM is guaranteed through the project website (www.world-stress-map.org). The WSM webpage provides, free of charge, the full database, detailed information on stress indicators used for the database and guidelines for data processing. Downloadable software tools and numerous regional stress maps as well as the possibility to create own stress maps via the CASMO tool of the WSM are highly appreciated by academic and industrial communities as well as governmental agencies.

The contribution of geophysical prospecting to the recognition of seismological risks

Rinaldo Nicolich
Department of Civil Engineering, University of Trieste, Italy
r.nicolich@univ.trieste.it

The physical properties of the subsoil are studied using geophysical methods. These studies are always indirect, such as gravimetric, magnetometric, magnetotelluric or reflection-refraction seismic surveys, and are often combined to obtain more accurate and reliable results. With these methodologies the oil industry commonly investigates the sedimentary basins to localize structures that may favor the accumulation of hydrocarbons. In the seismic surveys, transient or continuous forces are applied near the Earth's surface by controlled sources and elastic or seismic waves are generated and their propagation in the subsurface can be traced. Sensors (geophones or hydrophones) are used to measure the time taken to return to the surface by the signals reflected or refracted by discontinuities that define geological units each physically differentiated. Processed, the responses (seismic images) can be interpreted and attributed to variations in mechanical properties of the medium which originate the echoes and very often correspond to geological horizons, and somewhere to the presence of fracture zones, or to variation in the fluids content. The seismic images must be compared and supplemented with geological models established on well information and well logs.

New cutting-edge techniques used in seismic data acquisition and processing allow high quality data to be obtained in almost all geological contexts and make reflection seismics the most powerful tool in subsurface prospecting and oil exploration. The increasing power of new generation electronic instruments, workstations and personal computers brought data acquisition and processing much closer to geophysical services parties with adequate good quality and reduced costs. Hence seismic method was utilized in geothermal resources investigation, research of water strategic resources at shallow and intermediate depths, volcanic risks assessment, etc. The refraction method was the first to be used in the seismic exploration of oil reservoirs (in the USA and Iran). Today, the oil industry employs refraction seismic mainly to study shallow formations to correct their effect on the travel times of reflected events. Conversely, university researchers have applied wide-angle reflection-refraction studies to localize deep crustal interfaces characterized by the high amplitudes of the wide-angle reflections and by the velocities obtained from the refraction technique. Moho discontinuity at the base of the crust and velocity distribution within the crust were mapped out, indicating thickness and boundary conditions in different geological settings. These maps have been the inputs for the analysis of geodynamical behavior and signs for possible active movements within the crust, useful for seismotectonic mapping. The further addition of the seismic reflection imaging with deep penetration and long transects completed multidisciplinary programs to unravel the whole structure of the crust with clear seismic images and models (see e.g., the international joint-ventures investigating the Alpine chain). High-resolution application of the seismic reflection method has a central role in the identification and characterization of seismotectonic and seismogenetic zones and of the related capable (recent) faults. The earthquakes represent an important external risk for example for nuclear power plants and capable faults cause surface or near-surface displacements being considered to be the more critical for site safety. These projects require an additional close cooperation with geologists and seismologists, alike for feasibility and safety control in underground mining operations and tunneling, or in macrozoning for the location of seismic sources and in microzoning for the measure of terrains mechanical properties. Examples of some case histories are presented and discussed.

Methods for failure risk assessment in cities

Habib O. Odjagov
University of Engineering and Construction, Azerbaijan
fovgal@azeronline.com

The degree of risk assessment of injury and damage is associated with the problem of forecasting of reliability parameters and a residual resource of operating system. The important issue is to establish allowable terms of the further operation of individual object at certain value of failure risk. The responsibility for engineering decisions on measures for risk reduction or on a suspension of functioning of object lays on the commission consisting of relevant experts and representatives of administrative bodies.

One of the basic parameters of the object reliability is probability $P(t)$ of non-failure operation during the definite time interval or function of reliability. The function of failure risk (human injury and property damage) is defined as $Q(t) = 1 - P(t)$ supplementing $P(t)$ up to a unit and describing refusal probability. Some models of the theory of reliability apply to risk assessment, namely, the model of highly reliable systems for which emergencies represent rare events; the model of growing old systems which quality while in service worsens owing to creep; various weariness, deterioration, and other kinds of damages.

The forecasting of emergencies is possible if based on statistics and the discrete Poisson distribution that is frequently used to rare events and the natural phenomena. Our experience shows that the function $\lambda(t)$ is stable enough during long period, i.e. $\lambda(t)$ = const, after a small initial stage of operation (extra earnings). An influence of intensive ageing due to corrosion deterioration, weariness and other factors should be excluded by a regulation of allowable service life. Such data are of interest at decision-making on measures for reduction of failure risk.

Geodynamics and seismicity in Azerbaijan and the adjacent Caspian Sea

Behrouz Panahi
Head, Department of Seismology, Geology Institute,
National Academy of Sciences, Baku, Azerbaijan
bpanahi@gia.ab.az

Despite an extended research on geodynamics of the Black Sea to Caspian Sea region, a general approach to geodynamic interpretation of tectonic structures in the Caucasus region is in its infancy. It is mainly associated with the heterogeneous geological structure of the region revealed by geophysical, geochemical, petrological, and other studies. On the other hand, a clash of opinions on the geodynamic conditions of the Caucasus region, sometimes mutually exclusive, can be explained by a simplified interpretation of observations. Based on seismological evidences we interpret the regional geodynamics and associated seismicity as follow.

1. An analysis of earthquake depths of the Caucasus and Caspian Sea region has shown that there is no deep seismicity in this region. The depth distribution of the earthquakes depends on the elastic properties of the lithosphere, seismogenic structures, and shapes and sizes of the earthquake sources.
2. The spatial distribution of earthquake epicenters does not provide the basis to correlate the earthquakes with plate margin events. On the contrary, the intra-plate seismicity is more expressed in the region, and the earthquake source mechanisms are basically related to the regional structures.
3. The focal mechanism solutions show that the modern regional structures undergo near horizontal compression. However, the focal mechanism solutions for some earthquakes in the Black Sea, Kura and South-Caspian troughs indicate almost horizontal tension. Study of the mechanisms for small and large earthquakes within the southern slope of the Great Caucasus allows to argue that the regional stress field depends primarily on the local intra-plate conditions rather than on the orientation of the main axes of the general stress field.
4. Based on the studies of seismic regimes, quantitative estimations of seismicity, earthquake occurrence, and long-term parameters of seismicity, we provide an alternative interpretation of modern geodynamics and seismicity in Azerbaijan and the adjoining Caspian sea.

Georisk, sustainable development and regulatory failure: lessons from Chernobyl?

John Paterson
School of Law, University of Aberdeen
j.paterson@abdn.ac.uk

Whatever science has to say about risk and sustainable development, ultimately relevant decisions will be taken by political actors. The means they will most often use in order to implement those decisions, however, will be *legal* (for example, regulations). While law may, therefore, be the point of contact, as it were, between scientific expertise and policy decisions, on the one hand, and the individual or corporate actor, on the other, it can equally appear to be no more than a tool in the hands of more powerful forces and thus low in the list of priorities to be examined in this complex field.

Within law, however, there has been increasing discussion in recent years about whether it is actually able to produce the sort of social change that policy actors (and perhaps also scientists) believe that it can. It is, therefore, important to know whether law as it is traditionally understood can deliver what is expected of it and, if not, what sort of adaptations may be required in order to increase the likelihood of success.

This paper will begin by briefly reviewing some of the key literature on regulatory failure and consider the ways in which such a problem could serve to exacerbate the risk from seismic events.

The paper will then move on to consider a concrete example: the Chernobyl nuclear accident. Although this clearly belongs to the domain of technological rather than seismic risk, it is instructive for present purposes for at least two reasons. Firstly, this was an incident with an impact on a scale comparable to a major seismic event: while it certainly presented a severe challenge in the emergency phase, it has equally stretched scientists, policy makers and regulators in the ongoing rehabilitation phase and exposed many of the shortcomings of traditional regulatory approaches. Secondly, the common political and legal history of the countries affected by this event and many of those in the Black Sea to Caspian region—as former Soviet, transition economies—renders the example particularly pertinent.

The people and authorities affected by the Chernobyl nuclear accident have had almost 20 years to consider the shortcomings of traditional approaches. The past decade in particular has seen the emergence of a number of innovations. The final part of this paper will examine these new approaches and consider the extent to which they may offer lessons to scientists, policy makers and regulators concerned with seismic risk.

On importance of a mass-media in the sustainable development of the healthy society in Azerbaijan

D. E. Seyid-Aliyeva
Geology Institute, National Academy of Sciences, Baku, Azerbaijan
seyid-aliyeva@newmail.ru

Natural disasters cause human and environmental losses and can even threaten geopolitical stability as in many less developed countries. It is obvious that there is a need for a new approach capable to incorporate the mitigation of natural disasters within the cycle of sustainable development. Natural disaster mitigation is not yet an important issue in Azerbaijan and is not required by law. It is an issue of interest and will probably become to be important. Multidisciplinary studies including socio-economic analysis are the basic inputs for implementing sustainable development for the benefit of citizens and society. During socio-economic reconstruction of a society, social unrest, wars, and natural hazards mass media are of a great importance in the formation of the sustainability and healthy society of Azerbaijan. Sometimes nature gives an advance warning of a disaster, sometimes does not. You may have several hours to get out of the path of a hurricane. A tornado may be spotted several minutes before it strikes your area. An earthquake seems to give no warning at all. Understanding of earthquake phenomenon is of vital importance to the nation living in earthquake-prone regions. As the population increases expanding urban development and construction works encroach upon areas susceptible to earthquakes. With a greater understanding of the causes and effects of earthquakes, we may be able to reduce damage and loss of life from this destructive phenomenon. Role of mass media was considered in the development of “seismological” culture of community, its preparedness to seismic events as well as influence of mass media upon behavior of community during disaster.

Risk reduction in big cities – the concept of the Earthquakes and Megacities Initiative

Friedemann Wenzel[1], Fouad Bendimerad[2]
[1] Geophysical Institute, Karlsruhe University, Germany
[2] Risk Management Solutions, Inc., Newark, USA
Friedemann.Wenzel@gpi.uni-karlsruhe.de

We review the definitions, population trends and characteristics of megacities. Although megacities can be defined by their size, their nature also includes complexity in terms of administration, infrastructure, economics, traffic, etc. and rapid change of those constituents. Various factors contribute to the increase of megacities vulnerability to natural disasters including high population exposure due to concentration of housing in below standard construction, complex and ageing infrastructure, dependence of population welfare on proper functionality of lifeline systems such as transportation, power, water, and communication, lack of robustness of critical facilities such as public health, public safety and educational facilities, and weaknesses of preparedness programs and response and relief capabilities. The Earthquake and Megacities Initiative (EMI, http://www-megacities.physik.uni-karlsruhe.de/) works since 1998, under the umbrella of UNESCO, with more than 20 large cities around the world. From this experience the slow progress in disaster risk reduction is driven by five germane impediments that can be transformed into responsible policy and practice: Effective governance structures, multi-sectoral, inter-disciplinary work culture, and efficient use of resources, awareness and informed knowledge of risk, and high professional standards and ethics. A model is proposed to help cities understand the context of their exposure to risk, develop knowledge on the spatial, social and functional distribution of the risk, and address risk management in a holistic manner by which the components of disaster preparedness, disaster mitigation, disaster response planning, and knowledge development are examined within a realistic legal and institutional framework. This model is referred to as Disaster Risk Management Master Plan (DRMMP). DRMMP stresses the development of a process for long term planning and action that is specific to each city; it enables the understanding of gaps and constraints, provides the parameters for policy-making and supports the development of options for disaster risk mitigation. The knowledge produced by the DRMMP provides a city administration with the elements for putting together a city-wide disaster management plan, for making informed decisions about disaster management action, and for supporting public policy. Disaster assessment and use of information and communication technology (ICT) stay as the engine for the development of the knowledge on risk that supports the implementation of the DRMMP. ICT is used in many aspects of managing megacities, and can be efficiently extended to perform risk assessment studies. Institutions and communities who understand their risk parameters also understand the options for disaster risk reduction and the trade-offs associated with these options. Moreover, the quantification of disaster risk also permits realistic estimation of mitigation cost, and to monitor change in disaster risk over time. Disaster assessment and use of information and communication technology (ICT) stay as the engine for the development of the knowledge on risk that supports the implementation of the DRMMP. ICT is used in many aspects of managing megacities, and can be efficiently extended to perform risk assessment studies. Institutions and communities who understand their risk parameters also understand the options for disaster risk reduction and the trade-offs associated with these options. Moreover, the quantification of disaster risk also permits realistic estimation of mitigation cost, and to monitor change in disaster risk over time. Currently the Istanbul Earthquake Master Plan serves as best example for an appropriate strategy for disaster reduction in megacities.