



## Report on the X International Workshop “Physics and Forecasting of Rock Destruction” (Failure 2016)

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<p>X МЕЖДУНАРОДНАЯ ШКОЛА-СЕМИНАР «ФИЗИЧЕСКИЕ ОСНОВЫ ПРОГНОЗИРОВАНИЯ РАЗРУШЕНИЯ ГОРНЫХ ПОРОД» И VI РОССИЙСКО-КИТАЙСКИЙ НАУЧНО-ТЕХНИЧЕСКИЙ ФОРУМ «ПРОБЛЕМЫ НЕЛИНЕЙНОЙ ГЕОМЕХАНИКИ НА БОЛЬШИХ ГЛУБИНАХ»</p> <p><b>ТЕЗИСЫ ДОКЛАДОВ</b> Апатиты, 13-17 июня 2016 г.</p> <hr style="border-top: 1px dashed #000;"/> <p>X INTERNATIONAL WORKSHOP «PHYSICS AND FORECASTING OF ROCK DESTRUCTION» &amp; VI RUSSIAN-CHINA SCIENTIFIC FORUM «CHALLENGES OF NON-LINEAR GEOMECHANICS AT LARGE DEPTHS»</p> <p><b>ABSTRACTS</b> Apatity, June 13-17, 2016</p>		

The X International Workshop “Physics and Forecasting of Rock Destruction” (<http://www.xmsc.ru>) was held in in Apatity, Murmansk region, Russia 13–17 June, 2016. This Workshop was combined with the VI Russian-China Scientific Forum “Challenges of Non-linear Geomechanics at Large Depths”, which were thematically close to each other. Both conferences have been organised by the Mining Institute Kola Scientific Center of Russian Academy of Sciences (RAS). Co-chairmen of Organizing Committee of the jointed workshop were Prof. N.N. Melnikov (Mining Institute KSC RAS, Apatity, Russia), Prof. G.A. Sobolev, (Schmidt Institute of Physics of the Earth RAS, Moscow, Russia), Prof. V.N. Oparin (Institute of Mining SB RAS, Novosibirsk, Russia) and Prof. Qian Qihu (University of Science and Technology, Beijing, China).

The Workshop and Forum were aimed at improvement of information exchange between scientists of different Russian regions and foreign countries concerning the modern

achievements in multidisciplinary investigations in the area of regularities of rocks destruction and decrease of engineering-seismic risk. The goals of the meeting correspond to the main aims of IASPEI Commission on Earthquake Generation Process: Physics, Modeling and Monitoring for Forcast:

- Problems in the theory of rock destruction, mathematical and physical modeling of processes in the sources, the spatial-temporal patterns of development of earthquake sources, rock bursts, influence of trigger mechanisms on the processes of instability of rocks.
- The theory and practice of studying, prediction and prevention of catastrophic events.
- Problems of catastrophe theory and phase transitions in energetically open systems, self-organized criticality, and collective behavior of cracks.

- Precursors of earthquakes and the methods of their separation from the background noise, as well as new approaches to earthquake prediction.
- Prognostic methods and algorithms, methods and software to identify anomalies for forecasting using a complex of seismological, geophysical, hydrodynamic and geochemical parameters.
- Deformation of stress rock massifs under impact of earthquakes, rock bursts and blasts.
- Rock destruction mechanisms around underground excavations and in focal sources of catastrophic events (mining-induced earthquakes, rock bursts, sudden coal and gas releases) at large depths.
- Experimental methods of discovery and research of fissure structures of rocks and rock massifs under strong compression.
- Modern methods, measurement tools and monitoring systems to diagnose and control stress-strain state of rock.
- Advanced approaches to manage stress-strain state of deposits mined in large depths.

Workshop work took place in three scientific directions. The **first** direction was focused on problems of the theory of rock destruction, mathematical and physical modeling of processes in the sources, the spatial-temporal patterns of development of earthquake sources, rock bursts, influence of trigger mechanisms on the processes of instability of rocks.

The **second** direction was dedicated to the discussion of problems of catastrophe theory and phase transitions in energetically open systems under conditions of self-organized criticality, and collective behavior of cracks.

The **third** area was related to precursors of earthquakes and the methods of their separation from the background seismic noise, as well as new approaches of earthquake forecast, prognostic methods and algorithms, methods and software to identify precursory anomalies using a complex of seismological, geophysical, hydrodynamical and geochemical parameters.

The participants of the Russian-China Scientific Forum discussed studies on the theory and practice of studying, prediction and prevention of catastrophic events in mines. The work was also aimed at consideration of challenges of non-linear geomechanics at large depths. Researchers discussed key questions of mechanisms and particularities in deformation of stressed rock massifs under impact of mining-induced earthquakes, rock bursts and blasts; zonal disintegration of rocks around underground excavations and stages of catastrophic events generation (mining-induced earthquakes, rock bursts, sudden coal and gas releases) at large depths; dynamics-kinematic characteristics of pendulum waves, results of experimental methods of discovery and research of fissure structures of rocks under strong compression. Discussions also concerned modern methods, measurement tools and monitoring systems to diagnose and control stress-strain state of rocks and new approaches to manage stress-strain state of deposits mined in large depths.

Specialists have noted sudden elevation of interest to study processes of rocks destruction in upper part of the Earth crust based on the understanding that it is a non-linear dissipative system. Relating to the Earth crust conditions, a theory of dynamics of dissipative systems has still to be developed with taking into account hierarchy-blocked structure of lithosphere, heterogeneity and discontinuity in strength and stress state, as well as different-scale of flowing processes and multiple fluctuations of external and internal origin. Understanding is developed on trigger effects resulting in instability of rocks. Laboratory and in-situ experiments are of great importance. For the first time specialists have paid much attention to particularities in interaction between geomechanical and physical-chemical gas-mass-exchange processes during coal fields development.

Participants of the X International Workshop and VI Russian-China Scientific Forum adopted a Resolution in which was noted:

1. To focus efforts of scientific society on revealing and classifying potential sources of future seismic (dynamic) events being in metastable state; observing development dynamics and response of such zones on external impacts by using a complex of methods, including active environmental impact methods;
2. To consider performance of different-scaled laboratory and in-situ experiments and observations for stress-strain state of natural objects as an important task to improve knowledge on deformation process properties;
3. To develop methods and facilities of non-destructive control for rocks strength under long impacts conditions, to search macroscopic characteristics describing readiness of a source to a catastrophic extension;
4. To increase reliability of information on properties and conditions of rocks, in particular, in regions containing essential structures, which is possible by using existing test sites, constructing new specialized observation test sites and wider performing in-situ experiments. Also it is necessary to improve equipment research base which is possible through joining efforts of several organizations and specialists during planning and performance of works;
5. Special attention should be paid to practical decision of tasks on decreasing damage of natural and mining-induced catastrophes on the basis of complexing all totality of monitoring and modeling data;
6. To pay attention to importance of improving a monitoring methodology for the Earth's interiors with the aim of efficient solution of inverse tasks;
7. To recommend activation of research on inter-influence of geomechanical and fluid-dynamic processes for purposes to forecast hazardous geodynamic event taking into account an important role of water/gas in rocks and geological-tectonic structures for creating conditions for rocks destruction. To consider reasonable performance of laboratory experiments with participating specialists from different institutions;
8. To develop cross-boundary systems of multilevel monitoring for mining-engineering systems and their territories jointly with foreign researchers accordingly to conditions of the western sector of the Arctic;
9. To develop generally acceptable multi-parameter databases for complex analysis of prognostic information;
10. To note the importance of deepening cooperation between researchers of different scientific branches in order to provide success in understanding processes of natural and mining-engineering systems evolution, which can be achieved by regular performance of complex international scientific conferences.

Holding of the Workshop and Forum has allowed all participants to detect development, estimate a level of innovations presented within the themes declared and actively participate in discussions of reports both in the lecture hall (Fig.1), and in the process of direct communication.

At the Workshop and Forum 103 researchers participated, of which 3 academicians, 2 corresponding members of RAS, 31 Dr. Sci. and 41 Ph. D. There were 19 women and 84 men among the participants. The participants presented 36 scientific-research, educational, design organizations and mining enterprises from Russia (63 participants), China (36), Tadzhikistan (1), Kazakhstan (1), Kyrgyzstan (1) and Greece (1). Geography of participants is demonstrated on Fig.2. At the Workshop and Forum were presented 15 plenary lectures and 91 session (including 5 poster papers) presentations. All abstracts submitted for the workshop were published in the Abstract Volume which was distributed among participants.

The workshop was supported by IUGG/IASPEI and co-sponsored by Russian Foundation for Basic Research and few Russian Joint Stock Mining Companies.

The social program included acquaintance with a unique exposition JSC "Apatit" Museum (Kirovsk City), telling the history of the discovery of mineral resources of the Kola Peninsula, the organization of mining and processing enterprises in the region (Fig.3, 4). The big impression on the conference participants produced a rich collection of minerals and rocks of the Kola Peninsula. At the end of the conference was organized acquainted with the city-port of Murmansk - the capital of the Kola Peninsula with a visit to the legendary, the world's first nuclear-powered icebreaker "Lenin" (Fig.5).



Fig.1. On plenary lecture.



Fig.2. Geography of participants.



Fig.3. Workshop participants.



Fig.4. At the entrance to the museum of JSC "Apatit". Dreaming miner.



Fig.5. The world's first nuclear-powered icebreaker "Lenin".

Vice-chairman of Combined Workshop,  
Past President of ESC,  
Dr. Sci.

Alexey Zavyalov