

WIDE-SCALE GEOCHEMICAL AND FLUID-DYNAMICAL “EXPERIMENT” AND ITS POSSIBLE CONSEQUENCES IN THE NEAREST FUTURE

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At the modern pre-crisis stage of development of civilization, comprehension of ways of the humankind’s development and its interaction with natural systems acquires the special urgency. On correct evaluation of interpretation of interacting the natural and anthropogenic processes both prognoses of local character and general strategy of Society development will depend, which, at the end, will determine a future of the humanity. Modern challenges of civilization become more large-scaled, significant contribution to increasing the negative tendencies the geological branch introduces. This relates both problems of exhaust of mineral and raw material base, global pollution because of geological activity and seismic danger. Continuity of modern dangerous tendencies may result in origin of ecological collapses of global scale in the nearest future.

In the given work, the attempt is made to analyze the situation from the most general point of view, using methods of thermodynamics, including non-linear ones. As it is known, the classical thermodynamics considers closed systems, where it is absent exchange of substance and energy with environment. In such systems, equilibrium takes shape and regulation is realized by inversed feedbacks. In a closed system, growth of entropy level takes place in due course. The learned object – the Earth – is a long time in the equilibrium state. From this the conclusion follows about existence of certain grounds to consider it as a closed system. So, in the given system for a long time such parameters as velocity of axial rotation, velocity of rotation around the Sun and other keep constancy with high precision. At the same time in the Earth’s system exchange of energy and substance occurs, therefore in a certain degree it is an opened system too. Incidentally, the possibility appears for development of processes connected with entropy reduction, i.e. increasing the level of system’s organization.

Thus, the Earth is simultaneously both a closed and an opened system, where processes of disorganization and self-organization take place in parallel. The Earth itself can be considered as united “geological organism” and such a notion occupies strong position in the present-day science. On Professor S.Kh. Karpenkov opinion, the comprehend necessity to consider the planet as a united system, as an entire natural body appears, for which its own laws of development are inherent [1]. Such an idea has formed as a result of analysis and generalizing the large amount of scientific data, obtained last time, as well use of new theoretical views. Totality of forming on its basis notions demands to consider our planet both as united natural body and as a self-organizing system, development of which is initiated by fight of two fundamental tendencies – trend to order disturbing and trend to forming the most regulated structures [1].

Study of self-organization in geological systems and disorganizing anthropogenic activity can help in comprehension of processes of destroying the substance organization and intensity of energy exchange and will give possibility to form substantiated strategy of development, minimizing the geoeological risk and increasing the degree of seismic safety.

In course of evolution on a level with self-organization in biosphere in interaction the processes had occur of self-organization in geosphere, which at last had been formed the modern conditions, favorable for vital activity of high plants and animals. Now on natural processes the anthropogenic activity is put in significant degree, which brings misbalance into dynamic equilibrium, formed in the natural systems [2].

At the up-to-date stage of development scales of non-favorable anthropogenic impact to natural systems are extremely increased. According to expression of the Academician V.I.Vernadsky, the man becomes the greatest geological force [3]. Increasing volumes of fluid extraction to provide the power requirements and to meet the other needs become the cause of significant alterations in the geological environment. This results in breaking the organization of the self-regulated natural system, contributes to crisis development and is dangerous for future of the humanity. Probably, anthropogenic changes in the geosphere are no less dangerous for the future as degradation of biosphere under influence of human activity.

Artificial defluidization of bowels can be considered as a large-scale geoeological experiment, which has become the secondary effect of human activity. The scale of such activity increases from year to year: the amounts of hydrocarbons extraction are growing, the number of wells is increasing

and they become deeper. If the average depth of the exploitation wells was 1083 m in 1940, it had been increased to 4430 m by 1981.

Some information illustrating the scale of influence of oil extraction on geological environment is given in the tab.

	World	Russia
Average depth of wells in 1995, m.	1619	2471
Average radius of area of dry land per 1 well, km.	7,2	6,2

Data in the Table show that wells are distributed rather closely and this may lead to the fact that influence of wells on fluidal system will stop being insulated, influencing only local sites, adjoining to wells, but will become united, forming the solid field of influence, affecting globally resilient- plastic properties of the upper crust. When occurring the cyclic geodynamical processes with dislocation of big mass and energies the given elastic and plastic system (EPS) in pre-anthropogenic period provided dissipation of energy by big amount of earthquakes of relatively small magnitude. Depressurization of insulated fluidal system and extraction of fluids result in alteration of EPS of lithosphere, because of just water, liquid and gaseous hydrocarbons maintain, basically, resilient- plastic properties this system. Evidently, that breaking of processes of substantial organization and intensity of power exchange will be reflected inevitably in tectonic processes too.

In the XX century the increasing defluidization of bowels took place. If in the first half of the twentieth century they were local sites, now they form rather united field. Scales of anthropogenic activity so increased that it has a significant influence on geological environment. Increasing defluidization of bowels because of oil- and gas development results in disturb of equilibrium, having place in the sub-surface that increases the probability of global geocological disasters.

Increasing scales of impact on the geosystem lead to global changing the upper crust properties, preventing natural course of geodynamic processes. Owing to changing the physical and mechanical properties, possibility of energy release by relatively weak earthquakes reduces and accumulation of energy takes place, which may release by superpower tectonic earthquake. Many scientists understand now the idea that tectonic processes reflect the general direction of the Earth development. They recognize as well that different levels of organization of given self-developing system exist, including mineral and formation level and geotectonic organization of lithosphere. Simultaneously it is established availability of tectonic periodicity of different level, type and genesis, which directly depend on rhythms of space supersystem and peculiarities of functioning of supersystem "the Earth". It is following from this that geogenetic law, opened by the Academician D.V. Rundquist, can be promising for determination of criteria of complicated correlations of geotectonic and stratigraphic time.

Depressurization of insulated fluidal system of the upper crust results in alteration of EPS of lithosphere, because of just fluids of this system maintain elastic and plastic properties. Unbroken EPS answers on geodynamical influences by a number of relatively small earthquakes. When the scales of defluidization reach certain limits EPS (the upper crust) will transform in the hard, brittle and non-elastic system and will counteract forces caused by cyclic geodynamic processes, leading to accumulation of energy in the underground, and then when exceeding limits of strength – to sharp release of energy as a super earthquake of Magnitude 9 and more [4]. According to this mechanism, it can take place catastrophic earthquakes of Magnitude 9 and more [4]. At the end of the XX century several times less seismic energy has been discharged than at the beginning of the century. It can be explained by accumulation of energy because of change of elastic and plastic system of the upper crust, and this, in its turn, can initiate super-magnitude tectonic earthquakes, one of which has been occurred at the beginning of XXI century.

At the modern stage, we cannot still predict with sufficient share of probability the scales of negative consequences, especially in a long-term prospect. For increasing of reliability of prognoses it is necessary modeling in laboratory the alterations, occurs in geological environment and carrying out the whole complex of investigations. First of all this is strength study and resilient and plastic properties of rocks under influence of fluids in correspondent thermobaric conditions, accounting factor of time. On the first stage, one can be limited by study of properties of geological samples at temperatures not exceeding 400°C and pressures up to 4 kbar. Besides, it is necessary to research the processes of stress accumulation and its relaxation, depending on geochemical transformation of geological substratum and other factors.

Thus, the basic conclusions may be formulated:

1. Geological environment is a partly closed system and partly opened one; therefore, it has property of parallel evolution in two opposite directions, connected with both growth and reduction of entropy level.
2. In geological medium as in a closed system, the equilibrium state is maintained by regulation with the aid of negative feedback, but the opened system allows to realize the mechanism of positive feedback.
3. The close state of the geosystem allows maintaining the dynamic equilibrium for a long time striving for maximum of entropy according to the second law of thermodynamics.
4. Artificial opening of bowels in the course of geological activity in global scale breaks established in geological time equilibrium between processes of self-organization and disorganization that may result in destruction of old connections and on mechanism of positive feedback will result in cooperative processes, i.e. in collective behavior of their components. Super high magnitude tectonic earthquakes, volcanic eruptions and other geocological catastrophes can be real manifestations of it.
5. The Earth as a geological object is a self-regulating and self-organizing system, and the more man-made impacts will be exerted the stronger will be probably return reaction.
6. Accelerated anthropogenic development is manifestation of positive feedback of opened system - anthroposphere, giving increase of the non-equilibrium state that brings nearer time of crisis and in the nearest prospect must lead to destruction of available connections, returning the system into the equilibrium state.
7. For reliable prediction of further alteration of geological environment, it is necessary to carry out more large-scale and all-round investigations in laboratory conditions and modeling of these processes.

References

1. *Karpenkov S.Kh.* Conceptions of modern natural science // M.: Kultura i sport. 1997. P. 241.
2. *Maghidov S.Kh.* Self-organization in geological environment and geocological catastrophes // Proceedings of XVII scientific and practical conference on Daghestan nature protection // Makhachkala. 2003. P. 127-128.
3. *Vernadsky V.I.* Biosphere and noosphere // M.: Nauka. 1989. P. 145-150.
4. *Maghidov S.Kh.* Seismic danger and possible geocological consequences of development of oil-gas deposits on Caspian Sea.- Influence of seismic danger on pipelines in Trans-Caucasian and Caspian regions // M.: 2000. P. 274-275.

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