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THE GEOLOGICAL FACTORS OF ECOLOGICAL RISK OF RUSSIA

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ABSTRACT
The geological factors (natural or technogenically transformed lithosphere), which organisms react by adaptations is possible to consider as ecological-geological risk factors (ERF). They cause sickness of the people, oppression of ability to live phyto-, zoo- and microbocoenoses. Nowadays the majority of the investigators of the ERF allocate paramount importance to the study of negative effect of technogenic (geochemical, physical) factors. However, the biotic component of the ecosystem is affected a constant pressure of the natural geochemical and geophysical factors. Their synergetic influence appreciably causes a degree of comfort of existence of the biota, because the evolution of the lithosphere and biosphere goes in close relation. According to the systematics of the medical-ecological, biogeochemical, geological, hydro-geological data, soils, rocks, fresh water of Russia and the other countries do not provide stable receipt in with a feed of all spectrum of vitally - important elements (I, F, Ca, etc.). As functional relations in "the lithosphere – biota" system the geological factors of ERF can be subdivided on a majority as: I - ecological - geochemical, II - ecological - geophysical and III - ecological – geodynamic by the time of influence (constant, temporary and short-term); the area of influence (local, regional and global); by a source of indignation (litho-, hydro-, atmogeochemical) and complex type by the form of ecological target (phyto-, zoo-, antropocentric and complex). The executed complex researches both natural, and transformed regions have allowed revealing the conducting local and regional ERF. Their knowledge allows at a regional level to adjust the quality of the imported foodstuffs (together with correction of a drinking water-supply) and to promote equalization of natural and technogenic effect of ERF.

Introduction

The biotic component of the ecosystem tests the continuous integrated effect of various abiotic factors (climatic, atmospheric, hydrological, space, geological, etc.). The article is focused on the analysis of dependence of a condition of alive substance from the structure and properties of the lithospheric substance.

The geological factors (natural or technogenically transformed lithosphere), which organisms react by adaptations is possible to consider as the factors of ecological-geological risk. They cause sickness of the people, oppression of ability to live phytocoenoses, zoocoenoses, microbocoenoses and their death in the critical situation.

Close functional connections in the system "lithospheric substance - person", which are fixed at present were formed during evolution of the lithosphere and biosphere as a result of the integrated effect on alive substance of the geophysical, geodynamic and geochemical fields [14-17].

Ecological-geological system is understood as complex dynamically open system in which sybsystem elements (sources of effect, geological component of natural environment, an ecological target) are closely connected by the cause - effect direct and feedback connections [7, 14].

If in the ecogeosystem the negative connections exist even between one of the components of the lithosphere and biota, i.e. representatives of abiotic and biotic subsystems, the ecogeosystem is possible to relate to the category of ecogeopathogenic.

The close negative functional connections existing between abiotic and biotic components cause formation of the ecogeosystems of a various hierarchical level - local, regional or global. Example regional ecogeopathogenic of systems of Russia are the biogeochemical zones (fig.1). The problem deficit in components of rock sphere members vitally indispensable for a biota and person (J, F, Zn, Se etc.) is an example of global nature encompassing Eurasia and other continents [4].

Proceeding from a type of a biotarget it is possible to talk about microbocentrical, phytocentrical, zoocentrical, antropocentrical or complex type of the system.

The system of modern criteria [3, 5, 6,12, 13] of valuation of quality of abiotic and biotic components is indicated in the table 1. Their cumulative usage allows to execute an integrated ecological-geochemical valuation of territories on the comfortability of existence for the various representatives of biota.

There are three levels of intensity of negative abiotic subsystem influence on biotic system, which coincide with ranks of lithospheric classes accepted in ecological geology, correlated with the condition of ecosystem [11, 14]. Ecogeopathogenic systems of the first level of effect correspond to a class of a conditional - satisfactory condition of lithospheric components and ecosystem zone of risk. Ecogeopathogenic systems of the second level of effect are adequate to a class of the unsatisfactory condition of lithospheric components and ecosystem zone of crisis. Ecogeopathogenic systems of the third level of effect correlate with a class of a catastrophic condition of lithospheric components and ecosystem zone of disaster.

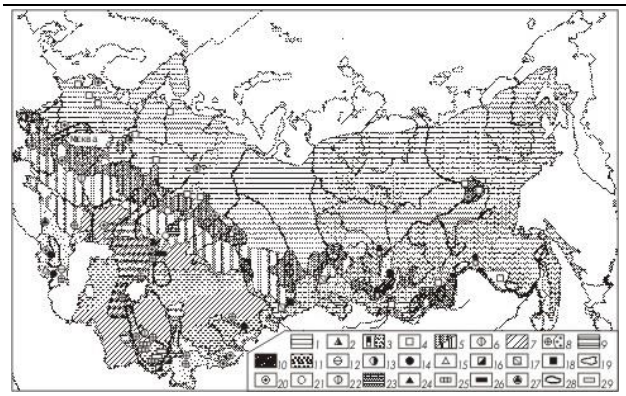

Figure 1. Schematic card of biogeochemical territory division of Russia and neighbouring countries [8]

I *- Biogeochemical zones (regions of biosphere) and zone provinces (zone subregions of biosphere).*

1 - 4 - Taiga-wood nonchernozem a zone [provinces: 1 - Poor of Co, Cu, J, Ca and P, 2 - Poor of J and Co, 3 - Enriched by Sr, poor of Ca, 4 - With the normal contents of Cu and Co, and also enriched by B and Sr on frozen soils (azonal provinces)]. 5 - Wood-steppe and steppe chernpzem zone (on grey wood and valley soils there are provinces, poor of J). 6 - 8 - Dry-steppe, half-deserted, deserted zone (provinces: 7 - With the rather unsufficient contents of J, superfluous — Mo and SO_4^{2-}; 8 - Enriched by B; there are provinces, poor of J. 9 - The mountain zones (meet provinces, poor of Co, Cu, Ca; the provinces, poor of J are widespread).

II *- Azonal provincaes (azonal subregions of biosphere). Provinces: 10 - Enriched of Co; 11 - Poor of J and Mn; 12 - Enriched by Pb; 13 - Enriched by Mo; 14 - Enriched by Sr and Ca; 15 - Enriched by Se; 16 - With the broken ratio of Cu, Mo, Pb; 17 - Enriched by U; 18 - Enriched by F, 19 - Enriched by Cu; 20 - With the broken exchange of Cu; 21 - Enriched by Ni, Mg, Sr, poor of Co, Mn; 22 - Enriched by Ni.*

If leading negative effect on biota on the territory render the ecological-geochemical factors of risk, it is possible to talk on the ecogeopathogenic systems of geochemical specialization.

If pathogenicy of tha ecogeosystem is stipulated mainly by ecological-geophysical or ecological-geodynamical factors of risk, so we has business with ecogeopathogenic systems of geophysical or geodynamical specialization.

However, more often there is a joint effect of ecological-geodynamical, ecological-geophysical and ecological-geochemical factors of risk. It is possible to speak about synergetic ecogeopathogenic systems, within the limits of which the wide spectrum of negative biological reactions at alive organisms is observed. The ecogeopathogenic systems are subdivided into three classes of genesis: natural, natural – technogenic and technogenic. We shall consider in more detail the above items on an example of ecogeopathogenic systems of geochemical specialization and we shall analyse the mechanism of diagnostics of the factors of ecological-geochemical risk, which have a leading role for the formation ecogeopathogenic systems of geochemical specialization. Depending on a component of the lithosphere, the factor, acting in a leading role of ecological-geochemical risk, ecogeopathogenic systems are classified on lithogeochemical, hydrogeochemical, atmogeochemical or complex type. It is necessary to note, that specifity of the urban area is the infringement of trophic connections. The natural-technogenic ecogeopathogenic systems of a complex type are more often in the urban area. This type of systems is allocated everywhere within the limits of urban territories (Ekaterinburg, Moscow, Norilsk, St.-Petersburg etc.) [9, 10,11, 18].

Table 1.The scheme of valuation of the ecological-geological system (Piece)

Component of the ecosystem	Geological component (Factor of effect)	Zone of violation of the ecosystem							
		NORM		RISK		CRISIS		DISASTER	
		Class of an ecological state of the lithosphere							
		Satisfacto-ry		Conditional satisfactory		Unsatisfactory		Disastrous	
		LEVEL OF EFFECT OF THE GEOLOGICAL FACTORS ON AN ECOLOGICAL TARGET							
		0		**I**		**II**		**III**	
ABIOTIC	Ground sedi-ments	< 10		10-30		30-100		> 100	
	Snow cover	32-64		64-128		128-256		> 256	
	Rocks soils	8-16		16-32		32-128		> 128	
	Under-ground waters	General contents of substances							
		< MAC		3-5 MAC		5-10 MAC		> 10 MAC	
BIOTIC	PHYTOCOENOSES	Concentration of microelements in hay crops, pasturable plants and vegetative forages (mg/kg of dry substance)							
		Element	**0**	Threshold concentration					
				I		**II**		**III**	
			Norm	Lower	Upper	Lower	Upper	Lower	Upper
		F	5-30	3-5	30-100	1-3	100-200	< 1	> 200
		J	0,2-2.0	0,1-0,2	2-5	0,05-0,1	5-20	< 0,05	> 20
		Se	0.05-1.0	0,03-0,05	2-10	0,01-0,03	10-50	< 0,01	> 50
		Cu	5-20	2-20	20-80	0,5-2	80-100	< 0,.5	> 100
		As Cd Cr Pb Ni Hg Sb contents in forages and hay crops of plants (exceeding MPL, times)							
		1,1-1-5		1,5-5		5-10		> 10	
		Contents of elements in dry weight: a) of pages of a birch; b) to needles of a pine, mg/kg							
		a) 10-30		30-50		50-130		> 130	
		b) 10-30		30-70		70-100		> 100	
	Microorganisms	Level of active microbic of biomass (decreasing in a number of times)							
		< 5		5-10		10-50		> 50	
	Animal	Case of home animals, %							
		Random		Sporsdic		Regu-lar		Total	
		< 10		10-20		20-50		> 50	
	The person	Pb contents in biosubstances (c – in the blood, in mkg/100 ml; d - in a hair mkg/g)							
		c)	0-9	15-19		15-44		>45	
		d)		9,8+-1,9		8	24	30	

Notes: the criterions are indicated selectively; Zc - total contents of toxic elements; MAC – maximum allowable concentration; MPL – maximum permissional level

One of the problems of ecological-geological researches is the revealing and mapping of ecologicical-geochemical factors of risk (natural and technogenic) capable to result in development of pathologies at biota. The minimal set of parameters for concrete regions will be determined by a type of its functional

use and is vital to allocate ecogeopathogenic systems both surplus, and defect and bias of chemical elements.

The usual practice of norming of limiting - high of concentrations of toxic substances in drinking waters and a meal, disregarding of achievement of biogeochemistry in the field of the lower threshold concentrations of biophilic (vital - important) elements is pernicious for health of a nation. A natural produce market of a meal generated in Russia, alongside with other social factors is one of the reasons of sharp deterioration of the health of the population. For want of anarchy of import of the foodstuffs, disregarding of the regional features and factors of ecological-geochemical risk, is possible the appearance of artificially generated food endemias, which are secondarily imposed on natural or tertiary imposed on innovated technogenic endemias.

The knowledge of the local factors of ecological-geochemical risk allows at a regional level to adjust the quality of the imported foodstuffs (together with correction of a drinking water-supply); also promote of equalization of the effect of natural and technogenic factors of ecological-geochemical risk.

The type of the ecogeopathogenic system predetermines the resource potential of the region, its functional usage and level of material inputs necessary on minimization of negative effect from the party of the lithosphere on biota.

Let's consider an example natural technogenic ecogeopathogenic of a system developed within the limits of an axial zone of Large Caucasus.

The ecological – geological researches within the mining area represent a complex of ecological – geochemical, ecological – geophysical, ecological – geodynamic, landscape-geochemical, biogeochemical, medical –ecological and social - ecological researches. The main purpose of it is determination of natural and technogenic geochemical impact on a biotic condition and health of the population. Technogenic anomalies have polycomponent composition so an integrated parameter of pollution (Zc) is used for valuation of a degree of pollution [1, 2]. At realisation of ecological - geochemical researches it is necessary to use criterion of environment evaluation from the position of an impact on a man's health. Cnsidering the total heavy metal content of in the soil (Zc), the 4-range estimation scale was worked outfor a system "a soil - a man" in the Tyrnyauz mining region.

The purpose of ecological – geological researches - an ensuring of the ecological safety of population existence. A component of ecological geological investigations is an ecological - geochemical studies. The primary task of ecological geochemical evaluation of condition of lithosphere is determination of the pathogenic lithogeochemical (technolitho-geochemical) anomalies, render their negative influence on the condition of the biota and the man's health, development of the objective criteria of determination of the areas of different ecological - geochemical environmental level.

The main purpose of the work was the development of methods of documenting of natural and technogenic geochemical factors of ecological risk for mining regions. For achievement of it a number of tasks was resolved: 1) typification of the region by ecological - geological conditions; 2) allocation of types, subtypes, kinds of ecological - geological systems by biotic and abiotic parameters; 3) ecological - geochemical demarcation of the region.

In the region 12 types of ecological - geological systems, 31 subtypes of ecological - geochemical conditions conditioned by the natural - technogenic factors are recognised. A major factor of ecological risk in the region is natural anomalies and technogenesis. The composition of contaminants is determined by a composition of ores and their source-rocks.

Technogenic anomalies have an element composition, so a total concentration factor Zc is the most useful factor for evaluation of contamination degree. A factor of soil pollution by metals is a sum of coefficients of metal concentration with the deduction of number of metals reduced to the unit. The factor is used traditionally for determination of the pollution level, but without the analysis of relationships in a system "lithotechnical environments - a man". It can be acted as a standard criterion of ecological -geochemical conditions and will allow to value a situation from the position of influence on a man's health. It is possible to conduct a correlation in a system "a soil - a man" according to the four-rank approximate estimation scale.

The most important is the factor of geochemical activity (GAF) as a characteristic feature of ability of vegetation of certain type to accumulate microelements. The factor could be defined as a sum of dark concentrations (coefficients of biological absorbing. Ah) of elements in the plant ashes.

As an example we will consider the region of Tyrnyauz Town (North Caucasus, Kabardino-Balkary, Baksan River basin). It is situated in mountainous mining region characterising by the presence of pathogenic natural and technogenic anomalies (Borisenko E.A., 1970; Alekseenko V.A. 1990; Avessalamova 1992, 1996; Gavrilenko 1993; Baraboshkina & Ziling 2000;). Tyrnyauz High Mountain tungsten-molybdic field is nearly 1,5 km high above the Baksan River valley. The region is characterised by sharp swings of absolute heights and broad spectrum of landscapes from mountain - steppe and mountain - meadow up to glacial - nival. It predestines heterogeneity of natural environments, fall into the area of influence of Tyrnyauz mining factory. The factory consists of the complex of separated enterprises, in accordance with mining and enriching a tungsten-molybdic ore: quarries of an open mining, mines and enriching factory with tailing dumps.

Technogenic anomaly was formed in the result of mechanical, water and air transportation of material during the exploration of the tungsten-molybdic field and technological cycle: (1) removing of the greater masses of rocks during the exploration and it storage in the dump; (2) destroying of the tailing dump under the influence exogenous processes (erosion, mud flows, eolation); (3) discharging of unrefined water from the mine, enriching factory and tailing dumps and (4) dusting of the excavated rocks in all stages of the technological chain. Those reasons have stipulated an intensive technogenic migration of material.

The composition of technogenic flows is characterised by polyelement paragenetic association (bismuth, molybdenum, tungsten and in scant fews - tin, stibium, arsenic). There ob-

serve sharp excess of fit in the grass within technogenic anomaly: 30-300mqs/kgs and more. Biogeochemical haloes of Mo have a complex structure and elongate along Baksan River valley. Their configuration is asymmetric and the largest local anomalies exist on the left bank of the river, where their contrast increases in the region of industrial enterprises of mining and enriching ore. A possibility of molybdenoses exists at the excess of threshold concentrations of fil in the grass at 6-14 mgs/kgs in calculation on the dry material according to Kovalsky (1974). It is the first standard criterion of ecological situation judgement in Baksan River region. However the biochemical processes in mammals is controlled by the complex of elements. For instance, Cu promotes a conclusion Mo from the organism, that reduces its toxicological effect. So correlation of Cu and Mo concentrations in herbs and the degree of their natural balance breaking were used as a second standard judgement criterion.

The most disadvantage situation was recognised for the region of Tyrnyauz factory mouldboards, along communications of an enriching factory and beside Bylym tailing dumps.

It is possible to consider a total factor of toxic elements concentrations (Zc) as a third standard criterion of judgement. It varies from 16 up to 128 in the region. Because of it one can recognise pneumoconiosis, chronic dust bronchitises, dust parinopharengiteses amongst typical professional diseases in the region, which were caused by the technogenic anomaly and by dusting.

The features of fluid and hard sewer were based on factors of it, main ions content, weighted materials, microelement composition of the bottom precipitation (dominates of Mo, W, Bi, Sn). They have different detour degree from the natural background under the influence of the factory. The technogenic flow of diffused elements (heavy metals) in the bottom deposits is denominated stronger and more long-lasting, han in the hydrogeochemical halo. So significant change of chemical and saline composition of Baksan River water is fixed in the limited area below Bylym tailing dump and is small in places of unset of mining water. A contrast geochemical anomalies are formed in the bottom deposits. They are fixed by the increase of element concentration degrees and an expansion of paragenetic associations with the evident prevalence of tungsten, molybdenum, tin and bismuth. These elements do not occupy such a leading position in background areas. The intensity of anomalies is downstream changed depending on new portions of industrial sewers. The total degree of elements accumulation falls with the distance from industrial zone. However, the flow of diffusing tracks over 10 km below field.

There are two main factors affect on the regional contamination level in Baksan River valley, which could reflect the integral evaluation of Tyrnyauz tungsten-molybdic factory influence.

The first one is enabling of the dust surges of the factory in airstreams. The process promotes a growth of the module of technogenic influence on the landscapes and leads to formation of the pedogeochemical anomalies with the accumulation of elements high destructive activity (Bi, Sb, As, Mo, V and others). The epiphyte and scum lichens are the indicator of the phenomena (Avessalamova 1996).

The second one is enabling of the industrial discharges (technogenous sewers) of the factory in the water flow of Baksan River with the formation of hydrogeochemical anomalies and diffusing haloes in the bottom deposits. This factor is considered above.

There were chosen three classes of ecological - geochemical condition in the region on the grounds of the analysis of all provided standard criteria of judgment: satisfactory, conditionally satisfactory, unsatisfactory conditions, which corresponds to standard, risk and crisis ecological zones.

The first zone (I) - ecological standard (background conditions) is more then 10 km far from the factory and includes the area where natural geochemical pathogenic anomalies and technogenic contamination are practically absent. The value of total factor of concentration of the elements is less than 16. The morbidity level of population is within average statistic limits.

The second one (II) - an ecological risk zone comprises both natural pathogenic geochemical anomalies and the region of moderate technogenic contamination. It is characterised by several parameters: module of the dust load (DI) varies from 1 to 5 g/cm per day; fit content in the grass ash varies from 30 to 100 mgs/kgs at Mo<Cu correlation and from 15 to 30 mgs/kgs at Mo=Cu correlation; coefficient of microelement accumulation in scum lichens varies from 5 to 20; value of biochemical activity (GAF) varies from 30 to 100 and coefficient of microelement accumulation in bottom deposits varies from 2 to 10. The value of total factor of concentration the elements is Zc=16-32 and there is a medium possibility of appearance of molybdenoses besides the livestock and in consequence - besides the man. There is also possibility for single diseases by the bronchitis and pneumoconiosis in the dust areas. It is the region where contents of fil in the milk and dung of livestock, wool of sheeps should be subjected to a constant checking.

The third zone (III) is a zone of crisis, which possesses a complex structure. It reaches its maximal pollution level in the quarries, mining enriching factory and tailing dumps. The area of such regions could be estimated at radius of first hundreds meters from the source of contamination. The whole area is chosen by the prevalence of the high level of techriogenic pollution of the components of natural environment. It is characterised by a module of the dust load variation from 6 to 16; variation of Mo content in the grass ash from 100 to 200 (and over 200 closer to the area of disaster) at the correlation Mo>Cu; variation of the factor of microelement accumulation in scum lichens from 20 to 50, value GAF from 100 to 300 (and over 300 closer to the area of disaster); variation of the factor of microelement accumulation of in the bottom deposits more than 10. The total contamination factor is 32-128. This is an area with the high degree of probability of disease an molybdenoses and professional pulmonary diseases of population. The duration of the livestock staying on its pastures requires shortening and following to the strict rules. The Bylym depression is a good example for it. There was fixed increasing of anionogenic elements mobility on quest slopes (under pH= 8,5-9,5), where the dust enters from highalkaline artificial soils of tailing dump. The infiltration of highalkaline Mo- rich sewers from the tailing dump also affects the grass if the hayfields and creates a real threat of mass molybdenoses disease of live stock.

Thereby, the region of Tyrnyauz Town is situated in the area of ecological crisis. It needs an urgent realisation of engineering -ecological protection for ecological - geochemical stabilisation of the situation in the region. The ways of protection should be focused on the reduction of dusting of the mouldboards, surges from the mining factory and preventing of infiltration of toxic sewers from mouldboards and tailing dumps.

The concluding

Nowadays the studying of the ecological risk is going mainly on the technogenically transformed territories. However, studying of the natural factors of the ecological risk is also of a high importance. This is confirmed by the simultaneous drop of the technogenic pollution and the rise of the illness by the ecological-dependant pathologies and the shortening of the life of the population in Russia and the other countries of the Former Soviet Union (p.1) Partially it was caused by the liquidation of the state programmes of rehabilitation of endemic territories that are characterized by natural geochemical and geophysical factors of natural ecological risks.

The development of mentioned ecological - geochemical criteria in the practice of engineering - ecological prospecting will enable classify the area according to their ecological - geochemical conditions and more objectively estimate the natural and technogenic factors of ecological risk.

It will enable to elaborate the programs of steady development at a local, regional and global level.

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