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Geochemical specialization of bedrock and soil as indicator of regional geochemical endemicity

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A relationship between geochemical specialization of geological complexes and areals of some endemic diseases was established. The conception of geochemical endemicity of territories was proposed by the authors in 1998. Geochemical endemicity depends on the parameters and peculiar features of regional background revealing in an enhanced or deficient content of chemical elements relative their clarke values. G_{en} is a special coefficient for quantitative assessment of geochemical endemicity. Qualitative and integral assessment of geochemical endemicity is shown on an example of the South Altai.

Key words: regional geochemical endemicity, geochemical endemicity index, geological complexes, geochemical assemblages, soil, the South Altai

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INTRODUCTION

Within the limits of any given territory the envirogeochemical situation is controlled not just by anthropogenic impact or naturally anomalous concentrations of toxic chemical elements related to mineral deposits, but also by a regional geochemical background. Unlike the first two controls, which are relatively well documented (Буренков и др., 2000; Геохимия ..., 1990; Требования ..., 1999), the role of the regional geochemical background remains underestimated. However, it is the background level that defines the geochemical specialization of a territory and is quite influential in formation of the envirogeochemical situation. A series of reclamation measures could be applied for rehabilitation of local pollution zones, *e.g.*, sanitary recultivation, modification in technology of industrial (mining included) enterprises, relocation of urban areas in unpolluted areas, etc. In the case of a certain regional geochemical specialization of a territory due to enhanced or deficient contents of chemical elements, the choice of reclamation measures seems to be rather limited.

A. P. Vinogradov established a relationship between concentrations of certain chemical elements in environmental units and the health problems of humans and animals. He introduced a biogeochemical hypothesis on the formation of the disease centers along with notions on a biogeochemical province and biogeochemical endemicity (Виноградов, 1938). As demonstrated by the publications issued by the Biogeochemical Laboratory headed by Vinogradov and his follower V. V. Koval'sky (Ковальский, 1982), relatively enhanced background levels (2–3 times above clarke) may cause serious health problems.

The Kashin–Beck (Urov) disease is a classical example of an endemic disease caused by envirogeochemical specialties of a territory. This heavy disease (deforming osteochondroarthritis) is clearly localized in East Siberia, China, and Korea. It is caused by a toxic action of P and Mn. The landscapes within these areas carry enhanced contents of these chemical elements (Геохимия ..., 1990).

The modern method of complex geochemical mapping (Буренков и др., 2000; Требования, 1999) allows to allocate and contour potentially ecologically hazardous territories of different hierarchical levels – provinces and zones (scale 1:5,000,000), zones and regions (scale 1:1,000,000) on an objective and quantitative basis.

ENVIROGEOCHEMICAL ZONING OF RUSSIA

The first attempt to reveal and contour potentially hazardous ecological zones and provinces was made by one of the authors of the present article while compiling the Map of Geochemical Specialization of Structural-Formational (geological) Complexes of Russia (The Map ..., 1997). Areals of some endemic diseases caused by excess or deficiency of chemical elements (Table 1) over the Russian territory spatially coincide with geochemical specialization of geological complexes (Fig. 1).

Molybdenum. Two large geochemical provinces of enhanced Mo content, one in the Transbaikalia and the other in the Far East, were revealed. Endemic gout and molybdenoisis are typical of them.

Strontium. Two large geochemical provinces of enhanced Sr content, one in the southern part of the Russian Plain and the other in the East Transbaikalia, were revealed.

Fluorine. Deficiency of F is typical of many regions of Russia, the largest being in the SW part of the Russian Plain, the South Urals, and the Altai.

Selenium. The European part of Russia (the Russian Plain) is characterized by abundance of Se-deficient areals. Some Se-deficient zones were revealed in the Transbaikalia, Yakutia, and the Far East geochemical region (the Bureinsky massif). Se-abundant zones were revealed in the SW part of the Russian Plain and Tuva Republic.

1 lentelë. **Cheminiø elementø ribinës koncentracijos aplinkoje: galimi poveikiai biotinei aplinkai (pagal Kovalská, 1969; nauji duomenys iš Maksimovskis ir Pevzneris, 1997)**

Table 1. **Threshold concentrations of chemical elements in the environment: possible post-effects on biotic media (by Kovalsky, V. V., 1969, new data added by Maksimovsky, V. A. & Pevzner, V. S., 1997)**

Chemical element	Content of chemical elements, ppm		
	Deficient	Normal	Excessive
Se	Vitamin E deficiency, cancer, Keihin disease	–	Anaemia, neurosis, alkaloisis, blindness, baldness, selenosis, white-muscular disease (animals)
Mo	Plant diseases	1.5–4.0	Gout, Mo toxicosis (animals)
Be			Berylliosis, endemic enteritis
Sr	–	Up to 600.00	Osteochondroarthritis, Urov (Kasin-Bek) disease, rachitis, bone mincing (animals)
P + Mn			Urov (Kasin-Bek) disease
Co	Acobaltoisis, lizukha, hypo- and avitaminosis of B vitamin, increase of endemic wen	7–30	Depression of vitamin B synthesis
Cu	Anaemia, lizukha, osseous system diseases, lying and non-ripening of cereals	15–60	Anaemia, icterus, affection of liver, disturbances of secretion functions, chlorosis of plants
Zn	Paraketoisis of pigs, sterility, Prasad disease, chlorosis of plants	30–70	Anaemia, depression of oxidizing processes
Fe + Mo + Zn	Increase of metabolism, chlorosis of plants		Break-outs of rodent-plague
Hg + Cd	–		Minamata syndrome, Itai-Itai disease
Fe + Mo + Mn + V	Caries	0.5–1.5	Caries
I	Endemic wen (misbalance of Co, Mn, and Cu leads to increase of endemic wen)	5–40	Weakening of thyroid gland activity
Cd	–		Cadmiosis, cancer
Mn + Co + Zn + Mo	–		Epizootic break-outs among rodents
B			Boric enteritis, pulmonary diseases
F	Endemic wen		Fluorosis

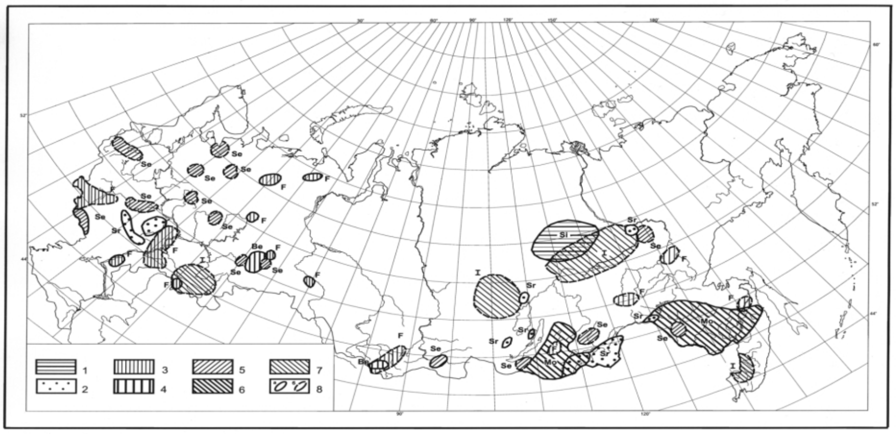

Fig. 1. Areals of some endemic diseases in Russia (by Pevzner, V. S., Maksimovsky, V. A., Ermakov, Yu. N.).
Endemic diseases: *1* – silicotic urolitias (Si), *2* – Urov disease (Sr), *3* – dental fluorosis (F), *4* – endemic enteritis (Be), 5 – Se toxicosis or white-muscular disease (Se), *6* – Mo gout, molybdenoisis (Mo), *7* – endemic wen (I); chemical elements concentration areals: a) excessive, b) deficient

1 pav. Kai kuriø endeminiø ligø Rusijoje plotai (pagal Pevzner V. S., Maksimovsky V. A., Ermakov Yu. N.).
Endeminës ligos: *1* – silicio urolitas (Si), *2* – Urovo liga (Sr), *3* – dantø fluorozë (F), *4* – endeminis enteritas (Be), *5* – Se toksikozë, arba baltoji raumenø liga (Se), *6* – Mo podagra, molibdenozë (Mo), *7* – endeminë lipoma (I); cheminiø elementø koncentracijø sritys: a) perteklinë, b) deficitinë

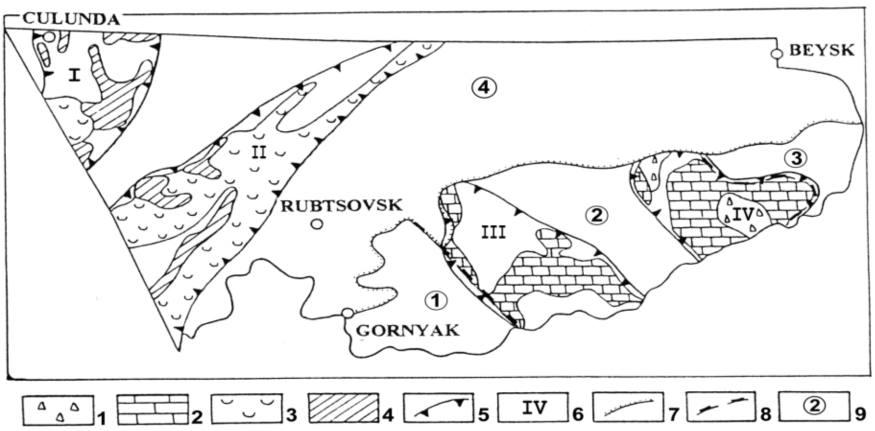

Fig. 2. Altai Krai (southern part): endemically hazardous territories
Geological complexes: *1* – collision-related intermontane depressions (D_{1-2}), *2* – inner shelf (O_2–S_1); dry steppe landscapes: *3* – pine groves in steppe on arenaceous soil, *4* – solonets and solonchak steppe; *5* – boundaries of envirogeochemical zones; *6* – envirogeochemical areas: I-Kulunda, II-Mikhailov, III-Kolyvan, IV-Anui; *7* – margins of a basin cover; *8* – boundaries of geological zones of Paleozoic basement; *9* – numbers of the geological zones: *1* – Rudny Altai, *2* – Gorny Altai, *3* – West Sayan, *4* – Kulunda

2 pav. Endemiškai pavojingos teritorijos Altajaus kraðte (pietinë dalis).
Geologiniai kompleksai: *1* – tarpukalniø ádubos, susiformavusios struktûroms susidûrus (D_{1-2}); *2* – vidinis šelfas (O_2–S_1); sausastepiø kraðtovaizdþiai; *3* – puðø giraitës ant smëlingo dirvoþemio, *4* – druskoþemiø ir sûroþemiø stepë; *5* – aplinkos geochemijos zonø ribos; *6* – aplinkos geochemijos plotai: I – Kulundos, II – Michailovo, III – Kolyvano, IV – Anuji; *7* – baseino dangos ribos; *8* – paleozojaus pagrindo geologiniø zonø ribos; *9* – geologines zonas þymintys skaièiai: *1* – Rûdinis Altajus, *2* – Kalnø Altajus, *3* – Vakarø Sajanai, *4* – Kulunda

Iodine. The maximum spatial extent of endemic wen was allocated in the South Urals, Yakutia, and Primorski Krai, where I-deficiency was fixed in bedrock, soil, and water.

A similar relationships between geochemical specialization of geological complexes and endemic diseases have been found for other chemical elements (Be, Si, Co, Cd, etc.).

GEOCHEMICAL ENDEMICITY: NOTION AND ASSESSMENT

Thus, it seems logical to introduce the notion of the ***geochemical endemicity*** of territories, which is defined by the disturbance of equilibrium in chemical composition and ratios between chemical elements typical of a territory with regard to clarke of these elements (Криночкин, Головин, 2001). The values of geochemical endemicity can be defined as deviations of regional background (Fersms) regarding clarke expressed as excessive ($C_{elt}/C_{clarke} \geq 1.5$) and/or deficient ($C_{elt}/C_{clarke} \leq 0.7$) content levels of chemical elements.

To quantify the geochemical endemicity of environment media, we introduce the geochemical endemicity index G_{en} defined as $G_{en} = (\Sigma K_{ce} + \Sigma(1/K_{cd})) \times (n_1 + n_2)/N$, where G_{en} is a geochemical endemicity (envirogeochemical hazardousness) index, K_{ce} and K_{cd} are clarke-normalized contents of excessive and deficient chemical elements, n_1 is the number of excessive elements observed, n_2 – *ditto*, deficient elements, N is a total number of chemical elements analyzed.

GEOCHEMICAL ENDEMICITY OF THE SOUTH OF THE ALTAI KRAI, RUSSIA

Here is an example of the geochemical endemicity case history from the south of the Altai Krai, Russia (Криночкин, Головин, 2001).

The ***geology*** of the territory is inhomogeneous. It lies in the west of the Altai–Sayan folded area and occupies the southern part of the West Siberian Basin. The former structure is a composite of geological structural units (the structural and formational zones): Rudny Altai, Gorny Altai, and West Sayan; the Kulunda zone is a fragment of the West Siberian Basin (Table 2, Fig. 2).

The ***geochemical endemicity of the geological complexes*** that underlie the region is characterized by accumulation of a few chemical elements and a deficiency in numerous elements (Table 2). The most common deficient elements are Y, Zr, Sc, Co, Nb, Yb, Ni, Ti, Ba, Ge, and V.

Table 2. **Altai Krai (southern part): envirogeochemical characteristics of geological complexes**
2 lentelė. **Altajaus kraðtas (pietinė dalis): geologiniø kompleksø aplinkos geochemijos charakteristika**

Geological complexes	Geochemical associations (clarke-normalized values)		G_{en}
	Gain	Deficiency	
Kulunda			
Quaternary ($Q_{I–IV}$)	$B_{6.6}Pb_{2.8}Sr_{2.2}$ $Sn_{1.8}$	$(GaZnMn)_{0.7}(TiBaGeCr)_{0.6}(NiZr)_{0.5}$ $(NbCo)_{0.4}(YbYBe)_{0.3}Sc_{0.2}$	36.6
Neogene ($N_{1–2}$)	$B_{7.3}Pb_{2.5}Sr_{2.2}$ $Sn_{1.8}$	$(TiBaGaMnZnMo)_{0.7}(CrGe)_{0.6}$ $(NiZr)_{0.5}(NbBeCoYb)_{0.4}Y_{0.3}Sc_{0.2}$	38.3
Rudny Altai			
Collision-related granitoids ($C_{2–3}$-P)	$(MoPb)_{1.5}$	$(PB)_{0.7}(LiCu)_{0.6}(YbSn)_{0.5}(BaAgY$ $Nb)_{0.4}(ZnGeZrNi)_{0.3}(TiV)_{0.2}$ $(ScCo)_{0.1}$	53.1
Collision-related volcanic and intermontane depressions (C)	$Zn_{1.7}(MnBSn)_{1.5}$	$(PAgLi)_{0.7}(VTi)_{0.6}Co_{0.5}(BaYb)_{0.4}$ $(GeY)_{0.3}(NbZrSc)_{0.2}$	28.8
Outer and central zones of an ensialic island arc ($D_{2–3}$)	$Zn_{2.1}(CuSn)_{1.6}$	$V_{0.7}(LiTi)_{0.6}(GeCrYbCoNiBa)_{0.4}$ $(YZrNb)_{0.3}Sc_{0.2}$	28.2
Inner zones of an ensialic island arc ($D_{2–3}$)	$Zn_{2.7}(PbMo)_{2.0}$ $Mn_{1.8}Sn_{1.7}Cu_{1.6}$	$Li_{0.7}Ni_{0.6}(TiVGe)_{0.5}(YbCoBa)_{0.4}$ $(YZrNb)_{0.3}Sc_{0.2}$	31.2
Paleozoic basement of an ensialic island arc (PZ_1)	$Cu_{1.9}Mn_{1.8}Zn_{1.6}$	$(AgB)_{0.7}(TiCoLi)_{0.6}(GeBa)_{0.4}$ $(YbScZr)_{0.3}(NbY)_{0.2}$	22.3
Gorny Altai			
Collision-related granitoids ($C_{2–3}$–P)	$Pb_{2.1}$	$Ag_{0.7}(VCuMo)_{0.6}(ZnTiGe)_{0.4}$ $(BaCoYbCrNb)_{0.3}(YZrNi)_{0.2}$ $(ScB)_{0.1}$	48.7
Front and inner zones of volcano-plutonic belts (D_2)	$Mn_{2.8}Sr_{2.0}Ge_{1.8}$ $Pb_{1.5}$	$V_{0.7}(YbLi)_{0.6}(ZnCo)_{0.5}$ $(GaAgCrNi)_{0.4}(PCuTiScMo)_{0.3}$ $Y_{0.2}(SnZr)_{0.1}$	57.4
Collision-related intermontane depressions ($D_{1–2}$)	$Sr_{2.0}$	$Ag_{0.7}(MnBaCu)_{0.5}(GaGeBNbTi)_{0.4}$ $(CrYb)_{0.3}Y_{0.2}(CoSnMoLi$ $VNiPZn)_{0.1}$	95.3
Inner shelf of passive continental margins (O_2 – S)	$Sr_{3.0}$	$(PbZr)_{0.7}Y_{0.6}Sc_{0.5}(CuCo)_{0.4}(VTi)_{0.2}$ $(CrPNiBBaGeYbMoGaLiNbAg)_{0.1}$	128.9
Outer shelf of passive continental margins (V-O_1)	$Sr_{5.0}Mn_{3.2}Ag_{2.9}Ge_{1.6}$	$Cr_{0.7}(BaYbNi)_{0.6}Co_{0.5}$ $(ZrLiTiGaNb)_{0.3}(MoY)_{0.2}Sn_{0.1}$	39.2
West Sayan			
Collision-related granitoids ($C_{2–3}$–P)	$Pb_{4.0}Li_{2.6}Sn_{2.4}$	$(YbGe)_{0.6}Cu_{0.5}(ZnNb)_{0.4}$ $(YTiVCrBa)_{0.3}(ZrNi)_{0.2}$ $(CoScB)_{0.1}$	54.6
Enzymatic island arc (Riphean–Cm_1)	$Mn_{2.0}B_{1.8}Nb_{1.5}$	$(MoCr)_{0.6}(GeGaNi)_{0.5}(AgYb)_{0.4}$ $(VLi)_{0.3}(CoSnScZr)_{0.2}Zn_{0.1}$	34.8

Enhanced Zn, Cu, Mn, and Sn contents are typical of the geological complexes of Rudny Altai. Sr, Mn, and Pb accumulate in the Gorny Altai structural-formational zone, Mn, Pb, Li, and Sn – in the West Sayan structural-formational zone and B, Pb, Sr, Sn in the Kulunda structural-formational zone.

The G_{en} range for the majority of geological complexes is rather narrow (22.3–57.4), reflecting a low geochemical endemicity and a weak envirogeochemical hazard. The G_{en} level in the Gorny Altai, in the collision-related mid-Devonian intermontane depressions (95.3) and the upper Ordovician–Silurian inner shelf zones of the passive continental margins (128.9) is much higher, and these geological complexes could be classified as potentially hazardous (Table 2, Fig. 2). Both geological complexes accumulate Sr (G_{en} = 2.0–3.0), and the majority of elements studied are deficient. Collision-related intermontane depressions spread at the eastern flank of the Gorny Altai are composed of terrigenous sediments. The geological complex of the inner shelf zones of the passive continental margins is composed of carbonaceous–terrigene deposits and is widely spread at the eastern and western flanks of the Gorny Altai structural-formational zone.

The landscape sequence beginning with mountains in the south-east, which pass in the north-west direction into plains, defines the ***landscape chemistries*** of the region. Mixed mountainous forests and steppe dominate in the southeast, forested and meadow steppe in the central plains, whereas dry steppe controls the west and north-west of the region.

Lower G_{en} values observed in natural landscapes indicate a lower grade of the ***landscape geochemical endemicity*** as compared to the underlying bedrock (Table 3). The above-clarke Pb, B, and P levels and deficiency in Ni and Zr are typical of the landscape series of the region studied. A decrease in Pb, B, P, and Cu in combination with increased Sr and Ba contents is an inherent feature of the mountain landscapes passing into those of plains. The same trend is typical of the role the deficient chemical elements play in the geochemical endemicity of the landscapes; this feature became most contrasting in the dry steppe landscape.

Two groups are distinguishable by the G_{en} threshold level in the region studied: (1) $G_{en} < 10$ and (2) $G_{en} \geq 10$ (Table 3). The latter comprises an endemic solonets and solonchak dry steppe. Its geochemical endemicity controls the endemic diseases of cattle. This fact favors the notion that within the limits of the region under consideration, geochemically similar landscapes (relatively high G_{en} values, excessive toxic chemical elements and/or deficient biophiles, similar migration conditions) may be hazardous with respect of endemic diseases. Dry steppe landscapes of pine groves on arenaceous soil match these criteria, and this unit is specified as potentially endemic (Fig. 2).

Envirogeochemical zoning of the South Altai, conducted in respect of spatial distribution of geological complexes and landscapes characterized by enhanced levels of geochemical endemicity, outlined four envirogeochemical areas hazardous in respect of endemic diseases: (I) Kulunda, (II) Mikhailov, (III) Kolyvan, and (IV) Anui (Fig. 2).

The Kulunda area (I) lies in the south of a B-bearing province dominated by the solonchak and solonets dry steppe; an excessive accumulation of toxic chemical elements and a deficiency in biophiles is typical here. The original chemistries of soil and, consequently, forage caused an excess in B and Mo in the living organisms at a sharp deficiency in Cu and development of related endemic diseases (Плотников и др., 1985; Скуковский, Ковальский, 1985).

In *the Mikhailov area* (II), dry solonets and solonchak steppe is confined mainly to its SW part, and its geochemical features are similar to those of Kulunda. The dry steppe landscapes of pine groves on arenaceous soil are potentially hazardous in respect of endemic diseases. The chemistries of this landscape are marked by the below-clarke level of a greater part of chemical elements and a very weak P and Ba accumulation.

The Kolyvan area (III) comprises the western part of the Gorny Altai. Within its limits, a geochemically endemic complex of the passive continental margin's inner shelf occurs. Chemical elements typically accumulated here are Sr, Mn, Pb, Ag, and Ge. The envirogeochemical situation in this area is estimated as potentially hazardous.

The Anui area lies in the east of the Gorny Altai. It is almost entirely underlain by sharply endemic geological complexes (those of the inner shelf of the passive continental margin, O_2–S, and collision-related intermontane depressions, D_{1-2}). Typically, Sr is excessively accumulated here, whereas the majority of chemical elements are deficient. The envirogeochemical situation here is classified as potentially hazardous.

CONCLUSION

Thus, the geochemical endemicity studies of the geological complexes and natural landscapes assist in revealing the endemic disease controls and delineation of territories potentially hazardous in this respect. Such territories require special follow-up inter-disciplinary (*e.g.*, biochemical, sanitary, zoological) studies. These are due to be oriented to revealing the synergetic effects that

Table 3. Altai Krai (southern part): envirogeochemical characteristics of natural landscapes
3 lentelė. Altajaus kraštas (pietinë dalis): gamtiniø kraðtovaizdþiø aplinkos geochemijos charakteristika

Geochemical landscapes	Landscape components	Geochemical associations (clarke-normalized values)		G_{en}
		Gain	Deficiency	
Mountainous mixed forest on the mountainous and forest podzolized brown soil	Soil, A-horizon	$Pb_{3.7}(BP)_{2.1}(CoCu)_{1.5}$	$(CrAg)_{0.7}(ZrSrNi)_{0.5}$	5.8
	Stream sediments	$B_{2.0}(PbCoP)_{1.6}Mo_{1.5}$	$Sr_{0.6}Zr_{0.5}Ni_{0.4}$	4.5
Mountainous steppe on mountainous leached chernozem	Soil, A-horizon	$P_{2.3}B_{2.2}Pb_{1.7}Cu_{1.6}Co_{1.5}$	$Y_{0.7}Ag_{0.6}(SrNi)_{0.5}Zr_{0.4}$	7.2
	Stream sediments	$B_{2.1}P_{2.0}Pb_{1.5}$	$(YCrYb)_{0.7}Ag_{0.6}Sr_{0.5}Zr_{0.4}\ Ni_{0.3}$	7.3
Forested and meadow chernozem steppe	Soil, A-horizon	$B_{2.2}P_{2.1}Pb_{1.5}Co_{1.5}$	$(YbAg)_{0.7}Y_{0.6}(SrZrNi)_{0.5}$	6.8
	Stream sediments	$B_{1.9}(PbP)_{1.7}$	$(YbSr)_{0.7}Y_{0.6}(ZrNi)_{0.5}$	4.3
Dry kastanozem steppe	Soil, A-horizon	$(MoPb)_{1.7}(BCo\text{Đ})_{1.5}$	$(YSr)_{0.7}(ZnMn)_{0.6}(ZrNi)_{0.5}$	7.6
	Stream sediments	$(BPbMo\text{Đ})_{1.5}$	$(CrSnAsY)_{0.7}(ZnNi)_{0.6}Mn_{0.5}Zr_{0.4}$	9.0
Dry solonets, solonchak, and kastanozem steppe	Soil, A-horizon	$B_{1.9}(MoP)_{1.7}Pb_{1.6}Ba_{1.5}$	$(SnTi)_{0.7}(MnYbZnCr)_{0.6}Y_{0.5}(ZrNi)_{0.4}$	13.5
	Stream sediments	$Sr_{4.9}B_{2.5}Ba_{1.7}\ (PMo)_{1.5}$	$(VAs)_{0.7}(MnGaSnYbCu)_{0.6}(TiCrY)_{0.5}(ZnZr)_{0.4}Ni_{0.2}$	27.2
Pine groves in steppe on arenaceous soil	Soil, A-horizon	$(PBa)_{1.5}$	$(VGa)_{0.7}(TiSrMnYb)_{0.6}(SnAgCuY)_{0.5}(ZnCrZr)_{0.4}Ni_{0.3}$	19.4
	Stream sediments	$Ba_{1.6}P_{1.5}$	$(AsCo)_{0.7}(TiYbSn)_{0.6}(YAgZr)_{0.5}(MnCr)_{0.4}(CuZn)_{0.3}Ni_{0.1}$	22.3

provoke and develop endemic diseases provoked by geochemical associations of excessive and deficient chemical elements.

It should be emphasized that the natural landscapes inherit to a great extent the underlying bedrock chemistries, but the geochemical endemicity in landscapes is less contrasting as compared to bedrock. Probably this is a demonstration of the "buffer" role of the supergenic re-distribution of matter between the lithosphere and the biosphere, which creates and maintains optimum life conditions on the surface of our planet.

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DIRVODARINIØ UOLIENØ IR DIRVOÞEMIØ GEOCHEMINË SPECIALIZACIJA – REGIONINIO ENDEMIZMO INDIKATORIUS

S a n t r a u k a

Geocheminis endemizmas priklauso nuo regioninio fono parametrø ir ypatumø bei atsiskleidþia tiek padidëjusiu, tiek ir deficitiniu cheminiø elementø kiekiu, lyginant su jø klarkais. Pateikiamas endeminiø ligø paplitimo plotø Rusijos teritorijoje þemëlapis bei autoriø papildyta V. Kovalskio sudaryta ligø lentelë. Teritorijø geocheminio endemizmo sàvokà autoriai pasiûlë 1998 m. ir ávedë specialø jo kiekybinio ávertinimo koeficientà G_{en}. Ðis rodiklis nustatomas geologiniams kompleksams ir ant jø susiformavusiems gamtiniams kraðtovaizdþiams. Gamtiniai kraðtovaizdþiai paveldi po jais slûgsanèiø sedimentø geocheminius ypatumus, bet, palyginus su jais, yra maþiau konstastingi. Turbût tai rodo medþiagos supergeninio persiskirstymo tarp litosferos ir biosferos buferiná vaidmená. Ðis persiskirstymas sudaro ir palaiko optimalias gyvenimo sàlygas mûsø planetos pavirðiuje.

Nustatytas ryðys tarp didesniø G_{en} rodiklio reikðmiø ir kai kuriø endeminiø ligø arealø pailiustruotas Pietø Altajaus pavyzdþiu. Pradþioje analizuojami rajone slûgsanèiø geologiniø kompleksø endemiðkumo rodikliai; nustatyta, kad daugelis jø yra panaðaus lygio, iðskyrus du itin endemiðkus kompleksus, kuriuose kaupiasi Sr, o dauguma kitø elementø yra deficitiniai. Endemiðkumo rodiklis to rajono kraðtovaizdþiuose nustatomas pagal dirvoþemio A horizontà ir upiø dugno nuosëdas.

Geologiniø kompleksø ir gamtiniø kraðtovaizdþiø geocheminio endemizmo tyrimai padeda atskleisti endemines ligas ir apibrëþti teritorijas, kurios ðiuo poþiûriu yra pavojingos. Tokiose teritorijose bûtina vykdyti specialius tarpdisciplininius (t. y. biocheminius, sanitarinius, ziologinius) tyrimus, kurie atskleistø pertekliniø ir deficitiniø elementø asociacijø sukeltà sinergetiná poveiká.

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ГЕОХИМИЧЕСКАЯ СПЕЦИАЛИЗАЦИЯ КОРЕННЫХ ПОРОД И ПОЧВ КАК ИНДИКАТОР РЕГИОНАЛЬНОГО ЭНДЕМИЗМА

Р е з ю м е

Геохимический эндемизм зависит от параметров и особенностей регионального фона и обнаруживается как повышенным, так и дефицитным содержанием химических элементов по сравнению с их кларками. Представляется карта распространения эндемических болезней в России, составленная В. Ковальским и дополненная авторами настоящей статьи. Понятие геохимического эндемизма территорий было предложено авторами в 1998 году. Ими введен специальный коэффициент G_{en} для количественной оценки геохимического эндемизма. Этот показатель определяется для геологических комплексов и сформировавшихся на них природных ландшафтов. Природные ландшафты наследуют геохимические особенности подстилающих отложений, но являются менее контрастными по сравнению с ними. Это, по-видимому, указывает на буферную роль супергенного перераспределения вещества между литосферой и биосферой. Это перераспределение создает и поддерживает оптимальные условия для жизни на поверхности нашей планеты.

Установлена связь между повышенными значениями показателя G_{en} и ареалами распространения некоторых эндемических болезней. Эта связь продемонстрирована на примере Южного Алтая. Вначале рассматриваются показатели эндемичности залегающих в районе геологических комплексов и показывается, что большинство из них характеризуются похожим уровнем G_{en}, кроме двух особенно эндемичных комплексов, в которых накапливается Sr, а большинство других элементов являются дефицитными. Показатель эндемичности ландшафтов этого района определяется на основе А горизонта почв и речных донных отложений.

Исследования геохимического эндемизма геологических комплексов и природных ландшафтов помогают раскрыть эндемические болезни и оконтурить территории, которые являются в этом смысле опасными. На таких территориях необходимо проводить специальные междисциплинные (т. е. биохимические, санитарные, зоологические) исследования. Их целью должно быть определение синергетического воздействия, которое вызвано ассоциациями повышенного и дефицитного содержания элементов.