MEDICAL GEOCHEMISTRY RESEARCH IN SLOVAK REPUBLIC

S. RAPANT[1], S. CICMANOVÁ[2], M. KHUN[3], V. LUCIVJANSKÁ[2], D. MACKOVÝCH[2] and S. PRAMUKA[2]

[1]*Geological Survey of the Slovak Republic, Mlynská dolina 1, 817 04 Bratislava, Slovakia; rapant@gssr.sk*

[2]*Geological Survey of the Slovak Republic, Reg. Distr. Spišská Nová Ves, Slovakia*

[3]*Faculty of Natural Sciences Comenius University, Mlynská dol. 1, 842 15 Bratislava, Slovakia*

Abstract: The possibilities of usage of results of the geochemical mapping and national geochemical databases in the problem solving of influence of geochemical background on the health state of population of Slovak republic are presented in this article. The comparison and interconnection of results of the geochemical mapping and indicators of the health state of population by usage of statistical methods revealed significant correlation between the distribution of several chemical elements and the health indicators (mean age, reproduction health, mortality rate due malignant tumours, etc.). Common geochemical and medical research realised in Zlatá Idka village confirmed exceeding limit values (Sb and As) of toxic elements in both geological environment and locally grown vegetables, fruits and biological materials of people.

Key words: Medical geology, environmental geochemistry, health, Slovakia

INTRODUCTION

Recently to a greater extent, in Slovakia as well as in many other countries, issues of medical geology have being solved in the scope of geological works financed from the state budget. A pilot project of these geological works, which has been solved since 1999, is the project of the Geological Survey of the Slovak Republic – *The evaluation of potential influence of geochemical environment on the health state of population in the region of the Spišsko-Gemerské Rudohorie Mts.(Rapant at al, 1998)* The essential aim of the project is to elaborate and to verify methodical principles of evaluation of influence of either excess or deficiency of chemical elements within geological environment on the health state of population in one of the most contaminated regions (covering 1 400 km^2) of the Slovak Republic. Methodological ways of interconnections of geochemical and medical data and their further mutual assessment have being developed, aiming on the final analysis of environmental and medical risks of the area studied. The advance of works is depicted in the picture 1.

MATERIALS AND METHODS

Geochemical data represent national geochemical databases, acquired in the frame of *Geochemical Atlases and Environmental-Geochemical Mapping Programme* of the Slovak Republic (Vrana at al 1997; Rapant at al, 1999), which have been completed by new samples and analyses. New samples are focused on verification and detailization of older research. The folowing elements are mapped in detail:: Al, As, Cd, Cu, Cr, Cr^{6+}, Hg, Pb, Sb Recently, detailed geochemical works are focusing also on monitoring of mobility and bioavailability of metals (4-step sequential extraction) of waters, soils and sediments, toxicity (tests of acute and chronical toxicity) and at some elements, their valence is also being observed (Sb^{3-5}, As^{3-5}, Cr^{-6}).

The health state of inhabitants of the Slovak Republic is monitored and assessed within 2 873 health-territorial units (HTU), from which 72 represent towns (≥10 000 inhabitants) and 2 801 countryside municipalities. As health indicators we use demographic and medical data, (for instance a mean age, reproduction health, total mortality, mortality rate due malignant tumours, etc.). All medical and demographic data used in given research represent average values of 5-years period – 1993−1997.

RESULTS AND DISCUSSION

In evaluation of potential influence of geochemical environment on the health state of inhabitants we come out from assumption that increased contents of contaminants in environment negatively impact on the health state of inhabitants – they manifest themselves by elevation of values of negative indicators or by change of their interactions. As the first step we used Spearman`s correlation coefficient to analyse a statistical dependence between an element content within geochemical environment and indicator of the health state. At homogenisation and integration of databases geochemical data are into form of health indicators data. Health indicators represent one standardised indication (calculated for 100 000 inhabitants and averaged to a 5-years period) for each administrative district or HTU under evaluation. Geochemical data (as well as one standardised indication representing an average chemical element content in soils, waters, etc. within each administrative district evaluated) have been acquired using two-stage correction (inverse distance and moving median) of primary data. From the viewpoint of various phenomena and causes impacting the health state of population (besides geochemical environment it is influenced mainly by life style, genetic factors, level of health services), correlation coefficients between health state indicators and chemical elements contents in geochemical environment, are relatively low. Their values range around 0,1 only (Rapant et al, 2000) in calculations from countrywide data (2 801 HTU for countryside population). In the pilot territory of the Spišsko-

Gemerské Rudohorie Mts. (82 HTU), where we can expect an increased influence of the geochemical environment on the health state of population due to a relatively higher degree of contamination of the geological compound of the environment, correlation coefficients values range between 0,3–0,5. Preliminary results depicted in tab.1 show that significant correlation relations between distribution of some chemical elements and occurrence of individual indicators of health state have been statistically approved. In some cases the high level of significance of correlation relations together with published data on the effect of individual chemical elements on human health (tab. 2) suggest, that the mentioned stochastic relations would be possibly considered in some cases as causal, e.g. distribution of As versus $CHLBW_{2500}$, PYLL, Cu versus PYLL, Sb versus $CHLBW_{2500}$ and others (for explanations see tab. 2). It is being shown definitely that for solution of this topic it is optimal to use parameters of the countryside inhabitants. It is also probable that chemical elements regarding their relation to individual health indicators might be divided as follows:

Causal elements – with confirmed and approved relation between health indicator and abundance or deficit of chemical elements in the geochemical environment.

Indicative elements – with high stochastic dependence based on the geochemical affinity to the causal elements.

A causality of a negative impact of increased chemical elements contents in the geochemical environment upon the health state of the population of the pilot territory of the Spišsko-Gemerské Rudohorie Mts. is being verified by mutual geochemical and medical research in one of the most contaminated municipalities of the region – the Zlatá Idka Village. The village is characteristic by increased geogenous Sb and As contents in all compounds of the geological environment. Recently, detailed geochemical works are focusing on monitoring of mobility and bioavailability of metals (4-step sequential extraction) of waters, soils and sediments toxicity (tests of acute and chronical toxicity) and at some elements, their valence is also being observed (Sb^{3-5}, As^{3-5}, Cr^{6}). Parallelly, the State Health Institute of the Slovak Republic has monitored As and Sb contents in biological materials of people (blood, urine, hair and fingernails), as well as contents of the above elements in locally grown vegetables and fruits. In several cases, in biological materials of people and locally grown vegetables and fruits, biological limits for contents of toxic metals have been exceeded.

Recently, the solutions of the issues of the impact of contaminated geological environment on the state of health of the population have reached the stage of preliminary results. The designed methodological principles of joining geochemical data with medical and demographic indicators of the health state of inhabitants will be in-process in all geochemical environments (soils, sediments, ground-, surface waters) and in much wider range of chemical elements and indicators of the health state of inhabitants.

CONCLUSION

Achieved results might be considered as preliminary by now. Designed methodological principles of joining geochemical data with medical and demographic indicators of the health state of inhabitants will be in-process in all geochemical environments (soils, sediments, ground-, surface waters) and in much wider diapason of chemical elements and indicators of the health state of inhabitants.

Approved relationship between health and environmental - geochemical parameters may be a very important tool for the environmental and health risk analysis in decision processes. The results of interconnection of such parameters anables early recognition of the health risks, although these migh not be prevented completely but their consequences may be reduced.

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Tab. 1 *Relationship between chemical elements contents in environment and the indicators of the health state of population in 82 HTU of the Spišsko-Gemerské Rudohorie Mts., region*

element	***health indicator***	***R***	α	***significance***
soils				
Al	*PYLL*	0,26	0,022	+
	$CHLBW_{2500}$	0,26	0,000	+++
	MR_{MT}	0,12	0,304	-
	MR_{MI}	0,15	0,189	-
V	*PYLL*	0,37	0,000	+++
	$CHLBW_{2500}$	0,38	0,000	+++
	MR_{MT}	-0,03	0,787	-
	MR_{MI}	0,13	0,251	-+
stream sediments				
As	*PPDP*	0,47	0,000	+++
	$\mathrm{MR}_{\mathrm{MTL}}$	0,33	0,002	++
	PYLL	0,28	0,009	++
	CHLBW_{2500}	0,09	0,419	
Bi	*PPDP*	0,45	0,000	+++
	MR_{MTL}	0,14	0,182	
	PYLL	0,19	0,074	
	CHLBW_{2500}	-0,02	0,799	

Note: R – Spearman`s order correlation coefficient; α - confidence level, $\alpha \leq 0.001$–very high dependence **+++**, $\alpha \leq 0.01$–high dependence ++,
$\alpha \leq 0.05$– verified dependence **+;** PYLL – directly standardised number of potential years of lost life; CHLBW_{2500} – percentage of children with low birth weight under 2 500 g of all new-borns; $\mathrm{MR}_{\mathrm{MT}}$ – mortality rate due all type of malignant tumours for 100 000 inhabitants ; $\mathrm{MR}_{\mathrm{MI}}$ – mortality rate due myocardial infarction for 100 000 inhabitants; PPDP – percentage of previous deaths of population below 65 years.; $\mathrm{MR}_{\mathrm{MTL}}$ – mortality rate due to malignant tumours of lungs for 100 000 inhabitants

Tab. 2 *Selected examples on effect of deficit or abundance of individual elements in Geochemical environment on occurrence of some disease*

	Deficit	***Abundance***
Al	–	– Alzheimer disease (?)
As	– insufficient hair growth – spleen enlargement	– lung cancer, cancer of skin, tetartogeonic effects, skin diseases
B	–	– gastrointestinal diseases
Ba	–	– mechanical damage of lungs, sromach cancer – nervous poison – effect on central nervous system
Be	–	– „Urov disease“ – berylliosis – professional or long-term exposure – carcinogenicity, elephanitiasis
Ca	– deformations of bones	– urine stone – relationship between water and mortality - atherosclerosis, hypertension .inverse hardness (Ca+Mg)
Cd	– growth reduction	– cancer of prostate – environmental carcinogen
Co	– anemia – avitaminosis – deficiency diseases	– thyroid gland diseases (ratio Co / I)
Cr	– diabetes	– carcinogenicity, mainly professional exposure – lung cancer (Cr in asbestos)
Cu	– anemia	– Cu – poisonings, relationship between Cu content in water and therosderois
F	– developmental defects of bones and teeth (caries)	– flourosis (spottedness of teeth) – relationship between high content of F in enviroment and cardiovascular diseases
Fe	– anemia	–
Hg	– unknown	– dependence of struma enlargement on Hg and I concentration in environment – damages of central nervous system – acute toxicity – kidney and liver damages
K	–	– practicaly untoxic – possible influnce on the hypertension
Li	– relationship between deficit of Li in drinking water and atherosclerosis	– anticipated „protective“ functions
Mg	– conection with cancer pathogenesis – „anticancerogenic“ effect	– anestesis – conection with cardiovascular diseases (Ca+Mg)
Mn	– deformation of skeleton	– limbs shakiness – hard of hearing
Mo	– teeth defectiveness - caries	– gastrointestinal disorders in cattle – growth reduction
Na	–	– cardiovascular diseases
Ni	– skin diseases	– carcinogenicity (tetrakarbonyl Ni, Ni in asbestos)
Pb	–	– sclerosis multiplex – carcinogenicity in conection with Pb content in soil – positive correlation between Pb content in drinking water and mortality of cardiovascular diseases
Sb	–	– professional exposure – poisonings, damages of skin and eyes, respiratory effects – long-term exposure – respiratory effects, cardiovascular diseases, gastrointestinal disorders
Sn	– growth reduction	– indirect effects (professional exposure)
Sr	–-	– diabetes, “Urov” disease – negative correlation between Sr content in the environment and mortality of cardiovascular diseases – increased content Sr in cancer tissues
V	– cardiovascular diseases	– negative influence only by professional exposures
Zn	– strong reduction of growth – insuficient wound healing	– increased cancer mortality (mainly stomach cancer)
Zr	– decreased number of erytrocytes	– conection with elephanitiasis

Fig. 1 *Scheme of interconnection and evaluation of geochemical and medical data*