BIOMOBILIZATION AND BIOACCUMULATION OF HEAVY METALS IN MONTANEOUS LANDSCAPE (BANSKÁ ŠTIAVNICA, SLOVAK REPUBLIC)

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The most legible manifestation of exploitation activities in mining regions are rests of mining dumps, which represent dumping grounds of dessintegrated rocks, fine-milled ores and chemical matters used during the dressing activities. Until now were these dumping grounds perceived only as a "memorials of the technical work" or as an anthropogenic relief-creating elements.

The surrounding of Banská Štiavnica is a very good model area. All this region, is even during the Ancient times (maybe even during Primeval Age), extensively remarked by mining activity.

To confirm that the origination of the percolating waters acidity is the activity of chemical-litotrophic thionic bacteria there were isolated the following species *Thiobacillus ferrooxidans*, *Thiobacillus thiooxidans*, *Leptospirillum ferrooxidans* and *Bacillus cereus*. The mentioned bacteria in dumping grounds are metabolically connected with sulphides. The dominant part of these sulphides is represented by fine-grained pyrite. It was proved that in percolating waters and in the influenced soils micro-fungi are present. One of the products of the metabolism of microorganisms are organic acids. It is assumed that these acids have an important role in the process of silicates and alumosilicates decay. The mechanism of biological oxidation under influence of thiobacteria initiates the hydrolytic process of sulphide minerals and cause creation of complex compounds of heavy metals.

These acid percolating waters extensively damage and destroy the entire biotope, contaminate the underground waters by Zn, Cu, Cd, Fe, Bi, Mn... The extraordinary negative influence has Al. Its concentration in acid water is very high. The result of biological-chemical environmental events is the biological transformation of the original sulphidic as well as of the alumosilicates. The main consequence of these processes is the pelitization and illitization. The affectation of H_2SO_4 and of the products of metabolism of species *Bacillus* cause releasing of Si, Al, Cr, Au, Ag... to the solution. The study of gold grain surfaces shows that the products of the bacterial metabolic processes reacted with Au and caused Au migration in the form of water-soluble complexes.

We recorded the following evolutionary vegetation stages on dumps and soils influenced by heavy metal pollution. On dump areas with fine-grained substrate originate plant groups in mosaic position: *Tussilago farfara, Agrostis tenuis* and *Artemisia vulgaris, Tripleurospermum perforatum, Daucus carota* and *Tanacetum vulgare*. On places where there is more humus, we can find next species: *Avenella flexuosa, Nardus stricta,* and mainly species from the surroundings: *Arrhenatherum, Tithymalus cyparissias, Veronica chamaedrys, Phleum pratense* and *Festuca rubra*.

The oldest dumps from 14. to 16. centuries, worked as meadows, are covered by grass, which consists of species resistant to heavy metals: *Acetosella vulgaris, Luzula campestris, Arrhenatherum elatius, Avenella flexuosa, Leucanthemum vulgare, Dianthus carthusianorum, Pilosella cymosa*. The soil in this stage has well developed two or three soil horizons.

Dumps from 18. and 19. centuries are predominantly planted by trees *Pinus nigra, Pinus sylvestris* and more rarely by *Picea abies*. On the youngest dumps subsist by autosowing *Betula pendula, Alnus glutinosa, Salix caprea* and some other plants. Analyses of plant tissues show high concentrations of heavy metals, e.g. in acid soil (pH = 4) contain *Acetosella vulgaris* up to 3500 mg Al in kg of dry sample.

Little mammals represent due their short living and limited, max. of 1–2 ha extent life-area an extraordinary convenient group for monitoring the contamination of environment. 142 mammals of 5 species were caught: *Apodemus flavicollis* (54.2%), *Microtus arvalis* (23.9%), *Clethrionomys glareolus* (18.3%) and rare *Pitimys subterraneus* and *Clethrionomys suaveolens*.

There were determined contents of Fe, Mn, Cu, Pb, Zn, Cd, Bi (Ni) in tissues of kidneys, livers and spleens of mostly abundant species. High contents of heavy metals were described in liver dry-tissues of *Apodemus flavicollis* ($mg.kg^{-1}$): Fe 3028, Ni 337, Mn 26, Cu 26, Zn 45, Pb 60, Cd 4 ppm and in spleen dry tissues of *Microtus arvalis:* Fe 952, Ni 2498, Cu 1371, Zn 295, Pb 122, Cd 5 ppm. Between heavy metal contents in plants and internal organs of little mammals from surface levels of dumps was found a trend of important positive correlation but it will be very convenient verify these data on the larger set of samples.