HEAVY METAL POLLUTION IN THE AREA OF CRUCEA URANIUM MINE (ROMANIA)

PETRESCU, L.[1] & BILAL, E.[2]
[1] Department of Mineralogy, University of Bucharest, 1 Nicolae Bălcescu Blvd., 010041 Bucharest, Romania
E-mail: lucpet@geo.edu.ro
[2] Département Géochimie et Procèdes de l'Environnement, École Nationale Supérieure des Mines, 158 Cours Fauriel, 42023 Saint Etienne, France

Inductively Coupled Plasma – Atomic Emission Spectroscopy and X-Ray Fluorescence Spectroscopy methods were used to evaluate the metals (ppm) from soils for the mine dumps of Crucea-Botusana uranium deposit (Bistrița Mountains, Romania) related to exchangeable fraction and respective available for vegetation roots. Samples were collected in June 2004 from different mine dumps in the Crucea-Botusana uranium deposit, mainly from G1, G4, G5, G6, G8, G9, G1/30 and G950 mine waste galleries.

Prior to "blaming" mining activities for the contamination of the environment, one must first determine the baseline contamination due to the natural existence of the mineralization in the area. In the mineralized area, there is an increase of the uranium concentration in the soil as a result of supergene alteration of the uraniferous formations. After having calculated the means and the standard deviations for the trace elements in the soils, we were able to determine the 95% confidence limits. Thus, the values of 61.92 ppm appear to be the anomalous threshold for uranium and 43.04 ppm the background level. In the case of thorium the background level is 14.78 and the geochemical threshold is 30.30 ppm. Anomalous values for U, exceeding the geochemical threshold, were determined for the soil of the former experimental gallery, G5 gallery and for the soil from the proximity of the ore bunker. In the case of Th, we determined values above the geochemical threshold only in the soil samples taken from the G8-gallery waste dump.

The enrichment in any of such elements represents a negative factor for the environment. The pollution of the environment is, almost always, caused by a mixture of contaminants and not by one single element. This is why, in the environmental studies, we used the cumulative enrichment factor (or the contamination index) of the geological materials in order to identify the multi-element contamination, which may increment the toxicity of the metals. The contamination index (CI) is calculated according to formula:

$$CI = \frac{\sum_{N=1}^{n}\left(\frac{C_N}{B_N}\right)}{N}$$

; where: C_N = total concentration of the element, expressed in ppm; B_N = background value of the concentration for the same element, expressed in ppm; N = total numbers of elements. In our case, CI varies from 1.485 to 5.02, indicating that all the mine dumps contain radioactive and heavy metals at levels that may induce toxicity in the ecosystem. The wastes that could represent a greater danger are those connected to the Ae, G8 and G1/30 galleries.

The short-term impact on the soil-to-plant system depends on the bioavailability of heavy metals. In order to select the mine dumps that could induce a short-term impact on the environment, the danger index (DI) was calculated. This one derives from CI and was calculated according to formula:

$$DI = \frac{\sum_{N=1}^{n}\left(\frac{C_{exchangeable\ fraction}}{C_{available\ for\ vegetation\ roots}}\right)}{N}$$

; were: $C_{exchangeable\ fraction}$ = the concentration of metals determined after extraction with $MgCl_2$, expressed in ppm; $C_{available\ for\ vegetation\ roots}$ = the concentration of metals determined after extraction with EDTA, expressed in ppm; N = number of elements. The calculated DI has proved that none of the examined mine dumps represent a danger for the vegetation.

By comparing the contamination index with the danger index the following tendency was emphasized: CI of mine dumps G1, G1bis, G4, G5, G5bis, G6, G8, G9, Ae, G1/30 and G950 is >1, while DI is < 1. This indicates that the related dumps are contaminated, but the short-term impact on the environment is not alarming.

Based on the contamination index and danger index calculated for the mine dumps, we can conclude that Crucea-Botusana mine don't need urgent remediation.

Acknowledgments

The inorganic chemical components were determined at Département GENERIC of the École Nationale Supérieure des Mines de Saint Etienne (France) under Rhône-Alpes Region – TEMPRA Project 00825042. The authors thank Dr. Jacques Moutte and Frederic Gallice for technical assistance.