POTENTIAL TOXIC ELEMENT MOBILITY AT ROŞIA MONTANĂ GOLD MINE (METALIFERI MTS., ROMANIA)

SERVIDA, D.[1]*, DE CAPITANI, L.[1], GRECO, G.[1], PORRO, S.[1], COMERO, S.[2], MARESCOTTI, P.[3], FORRAY, F.L.[4], GÁL, Á.[4] & SZAKÁCS, A.[5]
[1] Università degli Studi di Milano, Via Botticelli 23, I-20133 Milano, Italy
[2] Institute for Environment and Sustainability, Via Enrico Fermi, I-21020 Ispra, Italy
[3] Università di Genova, Corso Europa 26, I-16132 Genova, Italy
[4] Babeş-Bolyai University, M. Kogălniceanu 1, Cluj-Napoca, Romania
[5] Sapientia University, Str. Matei Corvin 4, RO-400112 Cluj-Napoca, Romania
* E-mail: diego.servida@unimi.it

Roşia Montană, the largest gold mine in Europe, was closed in 2006 after a long mining history, dating back to Roman times. The possibility to re-open the mine is mostly related to finding a solution to severe environmental problems. Waters draining the mine site are characterised by low pH and high concentration of suspended or dissolved potential toxic elements (PTE), leading to severe pollution of the Roşia and Abrud Rivers (BIRD *et al.,* 2005).

The two principal sources of PTE are the piles of waste rock stored during the old exploitation operations and the unexploited ore bodies still occurring inside the tunnels and in the open pits. This study faces the problem of characterizing the mineralogical and chemical composition of the Hop dump, one of the main waste-rock dumps of the Roşia Montană gold mine. Twenty-five samples were collected on the eastern part of the Hop dump, following a virtual squared grid (knots distance of 25-30m). Geotechnical, geochemical and mineralogical features of each sample were investigated. Moreover, the chemical reactivity was tested by means of static tests, following AMIRA procedure (IWRI and EGI, 2002), and kinetic tests following the “modified EPA method 1312” (SPLP–EPA, 1994).

It was assessed, matching field and analytical data with Positive Matrix Factorisation processing, that the waste rocks are composed by two principal lithologies: one labelled as “andesitic breccia"; the other labelled as “dacite”. A third independent factor was identified and related to the occurrence of “residual ore” in the waste rocks. The concentrations of PTEs in the waste rocks are below the regulatory limits, with the exception of As, which has concentrations up to 10 times higher than the threshold prescribed by international law. As a matter of fact, part of the As can be related to a natural background concentration in dacites, while another part is strictly related to the ore deposit. The SEM analyses showed that a part of the As content is associated to primary minerals occurring within the dacite-rich samples (particularly sulphides) and the remaining part is contained in the secondary authigenic mineral phases (mainly iron oxyhydroxides and oxyhydroxi-sulphates). The static test results and mineralogy indicate that, even if all the waste rock samples can produce acid, due to the occurrence of reactive sulphides, only the dacite-rich samples are expected to really generate acid mine drainage (AMD), since the andesite-rich samples contain enough carbonate minerals to determine an acid-neutralizing capacity (ANC) higher than the maximum potential acidity (MPA).

Kinetic tests showed that PTE contents in filtered solutions are generally low and under the law threshold: As ranges between 1 and 7 ppb, Cu ranges between 0 and 98 ppb and Zn ranges between 21 and 570 ppb. pH values of leachates greatly varies, from 2.9 to 8.9, and their sulphate content ranges between 13.5 and 475 ppm thus exceeding the European limit for drinking water standards. Comparison between the geochemical features of leached waters and bulk chemistry of waste-rocks shows that the release of As in aqueous solutions is very poor, despite its hazardous concentrations in the solid material (range 80–107 ppm). On the other hand, Cu and Zn contents in the rocks are lower, ranging between 30 and 47, and between 31 and 44 ppm, respectively, but they are characterized by a higher geochemical mobility.

Given the evidence of field and preliminary analysis on waters, the Hop dump contributes only to some extent to environmental pollution related to AMD processes, whereas it is conceivable that most of the potentially hazardous processes take place in the underground tunnels of the mine or in other waste-rock dumps which have not yet been analyzed.

References

AMIRA INTERNATIONAL (2002): ARD Test Handbook. IWRI and EGI.
BIRD, G., BREWER, P.A., MACKLIN, M.G., SERBAN, M., BALTEANU, D. & DRIGA, B. (2005): Journal of Geochemical Exploration, 86: 26–48.
U.S. ENVIRONMENTAL PROTECTION AGENCY (1994): SW-846 online.