Restoration of Water Bodies Impacted by Mine Drainage - the GeoMaTre Project. Findings for Mercury Assessment at Caveira Mine, Portugal.

Rita Fonseca (rfonseca@uevora.pt) (IES-University of Évora, Portugal), Teresa Albuquerque (teresal@ipcb.pt) (Cernas-IPCB and IES-University of Évora, Portugal), Joana Araújo (jfaraujo@uevora.pt), Natália Silva (motasilva.n@gmail.com) (IES-University of Évora, Portugal)

Background/Objective. Evaluating the effectiveness of geomaterials in retaining potentially toxic elements of mine effluents is a key issue for the environmental remediation of former mining areas. The project GeoMaTre (Institute of Castelo Branco and the University of Évora, Portugal), aims at finding low-cost solutions for water and sediments rehabilitation using raw geomaterials, on abandoned mines from the Iberian Pyritic Belt, a metallogenic province in SW Portugal and Spain, hosting the largest concentration of massive sulphide deposits worldwide. One of the case studies is the Caveira mine in southwestern Portugal. Large piles of mining wastes containing significant quantities of metals, record the long history of its exploitation, which began in Roman times with the extraction of Au and Ag, having focused after the exhaustion of its reserves, on the extraction of the remaining metals (Cu, Pb, Zn) and S, until the date of its abandonment in the 1960s. These waste piles represent the main sources of metals in the streams, some with very high toxicity, such as Hg, resulting from the mixing with the gold-containing ore, widely used in the past in gold exploration. The design of the best remediation technique using the most suitable geomaterials for retaining pollutant metals started with the study and characterization of the spatial distribution of Hg in stream sediments, given its environmental hazardousness and geochemical behaviour.

Approach/Activities. Sediments under the direct influence of the mine heaps were collected in February 2022, a period reflecting a climate change scenario as it was a very dry winter period with anomalous values in terms of precipitation and temperature. Mercury was determined in samples stored at about 4ºC using a mercury analyzer (NIC MA-3000) based on thermal decomposition, gold amalgamation, and cold vapour atomic absorption spectroscopy detection. A preliminary multivariate study was conducted to assess the spatial distribution of mercury (Hg) and to determine spatial patterns of Hg concentration. Geostatistical modeling was used, throughout conventional variography followed by Sequential Gaussian Simulation algorithm (SGS) and local G clustering, to the definition of hot and cold spots for contamination risk for sediments. The Standard Deviation map allowed the visualization of the correspondent spatial uncertainty and, therefore, acted as a measurement of the obtained robustness and provided a faster and more intuitive way to verify whether the problematic zones detected previously are true of concern. The main objective is the restoration of surface waters in this metallogenic province and the potential for reproduction in other territorial settings.

Results/Lessons Learned. Analysis showed very high values for Hg (50-130 $\mu g g^{-1}$), in the sediments of the mainstream crossing the mine heaps which reached 340 $\mu g g^{-1}$ near the major waterway of the region. Surface water is mainly used in agriculture, livestock, and domestic uses. These concentrations are well above the reference values, 0.3 $\mu g g^{-1}$, according to the European Regulation (2009) and according to the Hg considered thresholds, mitigation measures are required when the concentration is greater than 36 $\mu g g^{-1}$. The spatial hot spots identified for Hg contamination risk worked as a powerful tool for the definition of problematic geographies and definition of mitigation strategies. Given the high toxicity of this element, its concentrations will serve as a basis for the choice of the most suitable geomaterials for its retention, through laboratory scale tests, and the ability of these geomaterials to immobilise other metals with critical concentrations (Pb, Zn, Cu), should also be addressed.