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The Enrichment of Potentially Toxic Elements in the Iberian Pyrite Belt's Abandoned Mines: Geomaterials as Purpose for Their Remediation

Conference

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Roberto Silva (rper.dasilva@gmail.com), Rita Fonseca (rfonseca@uevora.pt), *Joana Araújo* (jfaraujo@uevora.pt)**,** , (University of Évora, IES, Évora, Portugal)
Teresa Valente (teresav@dct.uminho.pt) (University of Minho, IES, Braga, Portugal)

Session

Part of - Innovative Characterization and Assessment Approaches

Track: A5. Innovative Characterization and Assessment Approaches

Background/Objectives

The Iberian Pyritic Belt (IPB), a well-known volcanogenic massive sulfide (VMS) province with important mining activity history, had, in the last decades, several mines ceasing their mining activities and becoming abandoned. The mining area of Caveira, in Grândola (Portugal), located in the western part of the IPB and the mining complex of Trimpancho (Spain), located in the eastern part of the IPB, both stopped operating in the 1960s and have been under our scope of study for the last 3 years due to poor management of the waste piles, with no policies to contain contaminants. High values of Potential Toxic Elements (PTE), such as Cu, Pb, Zn, Hg and As, in both mining areas, and their surroundings, led to serious focus of our studies in those regions, thus planning to test and apply geomaterials for containment of PTE's, from the mine tailings, and carry out trials for remediation of the surrounding mining areas. In 2022, an anomalously dry year, and 2023, sediment samples were taken from the watercourses under mining influence at both sites, and from areas upstream (geochemical background), with the aim of studying the Index of Geochemical Load (IGL) and the Enrichment Factor (EF) of the sediments in these metals at the interface with the water column, and to study metals in their most leachable forms and therefore most likely to contaminate downstream watercourses.

Approach/Activities

Fieldwork was carried out in both locations, with 33(32) sediment samples (Caveira) and 10(16) sediment samples (Trimpancho) collected, in 2022(2023) to analyze physicochemical parameters, such as pH and RedOx (due to the dryness

verified in 2022, RedOx was only obtained in 2023) and determine metals with the greatest potential for contamination, in their most leachable forms. Thus, all the sediments were characterized through detailed granulometric analysis, Aqua Regia digestion to determine the contamination levels and extraction with Ammonium Acetate at pH 4.5 to extract the exchangeable forms. Quantification of metals in extractable and exchangeable forms was achieved by using ICP-OES. To determine the standards to be applied in the IGL and EF formulas, some points outside both mine area of influence (upstream of the affected region) were used, using Fe as the dominant element for the EF formula.

Results/Lessons Learned

In the Caveira Mine System, sediments are mostly sandy, with low percentage of clay, with pH ranging from 2.06(2.35) to 7.39(7,6) in 2022(2023); while in the Trimpancho Mining Complex, sediments were well balanced between clay and sandy natures, with pH ranging from 1,1(2,79) to 5,76(6,83) in 2022(2023). Based on the data from the calculation of IGL and EF, 5% to 20% of the samples have extreme contamination on As, Cu, Pb and Hg, with peak values of 739.0(145.9) mg/Kg, 2034.7(2215.50) mg/Kg, 45480.3(18134.5) mg/Kg and 381.4(85.3) mg/Kg, respectively, regarding the Caveira Mine System in 2022(2023). For the Trimpancho Mining Complex, IGL and EF calculation showed that this region has a lower Geochemical Load Index but even so, around 20% of the samples analyzed show high to extreme contamination in Cu, Pb and Hg, with peaks of 602.7(298.7) mg/Kg, 1637.3(191.4) mg/Kg and 8.46(2.76) mg/Kg, respectively, in 2022(2023). High mobility was also noted, as the most leachable forms of Cu, Mn, Pb and Zn, have also high levels with, respectively, peak values of 512.7 mg/Kg, 101.3 mg/Kg, 38467.3 mg/Kg and 31.4 mg/Kg for the Caveira Mine System, and 722.5 mg/Kg, 1888.8 mg/Kg, 1527.9 mg/Kg and 2051.0 mg/Kg, for the Trimpancho's Mining Complex. In both regions, arsenic showed low mobility, with values below the detection limit. This knowledge will serve as a starting point for a more in-depth study on the evaluation of certain geomaterials and industrial wastes, such as carbonated sludge, iron oxides, clays or activated carbon, as pH increasers and retainers of the most mobile forms of these metals. This assessment will allow the use of materials that show greater efficiency as potential tools for the remediation of degraded mining areas. Its use can be made by covering piles of mining wastes or aquatic sediments with a higher degree of contamination, in order to avoid the spread of PTE's and reduce the acidity of the drainage water, which is very common in FPI mining areas.

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