Lake Affected by Acid Mine Drainage – A Case of Extreme Contamination

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Abstract

Sulfide mining, commonly associated with metal and coal deposits, produces reactive wastes typically stored in piles. These wastes pose a critical environmental problem, causing acid mine drainage (AMD) and contributing to the degradation of aquatic ecosystems.

The São Domingos mine in the Iberian Pyrite Belt was closed without environmental protection. Two streams that cross this mine have several acid lakes along their 20 km length and over a relative surface area of 6,000 ha, which flows into the Chança water reservoir used for public supply. One of the acid lakes, PAT7, is particularly notable for its massive presence of sulfate efflorescence. Therefore, the main objective is to understand the mineral-water interaction processes that influence the hydrochemical behavior of this lake. For this purpose, the mining waste surrounding this lake and twelve water sampling have been carried out over a complete hydrological year.

The results indicated a highly acidic environment, as evidenced by very low pH values (0.4) and high acidity concentrations (429.25 g/L $CaCO_3$). The driest months, July and August, coincided with the most extreme results, where salts completely covered the area. However, the electrical conductivity did not show the same trend. This parameter was highest in October (26,200 µS/cm) and May (27,300 µS/cm). PAT7 also has high concentrations of potentially toxic elements (PTE): Fe (134 g/L), Al (24.8 g/L), Cu (4.42 g/L), Ti (7.83 mg/L), Pb (27.3 mg/L), and Cd (18.7 mg/L), exceeding many severe cases of AMD contamination worldwide. The Spearman correlation between sulfate and acidity is high (0.991). This is also true for most PTE, sulfates, acidity, and among the elements themselves, which typically show values around 1. These results may be related to the location of the lake. PAT7, close to the metallurgical center of the mine, has surrounding dumps of fine sulfide-rich waste from ore treatment and extraction.

Understanding the evolutionary processes undergone by the wastes and the seasonal variations is crucial to assessing the drinking water reservoir's contamination risk. In this way, the present study supports future monitoring efforts and informs the relevant authorities of the critical need for urgent environmental remediation. This is particularly important as the mine is in the Mediterranean region, facing persistent droughts and critical water shortages.

Keywords: Iberian Pyrite Belt, mining waste, hydrochemistry characterization, extreme contamination, potentially toxic elements

Acknowledgments

This work is co-funded by the framework of the UIDB/04683 and UIDP/04683 – Institute of Earth Sciences programs.