

# Mineralogical and geochemical Characterization of mining waste in Zeïda abandoned mine (High Moulouya, Morocco)

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In Zeïda abandoned mine, the physicochemical and mineralogical features of the different mine waste materials were done in order to define the environmental factors that control the concentrations of the PTEs. Twenty samples were collected from waste rock heaps and mine tailings. Particle size analysis was performed using wet sieving and hydrometer methods. Concentrations of major and trace elements were analyzed using inductively coupled plasma mass spectrometry (ICP-MS). The mineralogical composition of mining waste was undertaken through X-ray powder diffraction (XRD).

Waste rock heap materials can be classed as loam, silty loam, and clay loam, whilst the mine tailings belong to sand and sandy loam classes. The main mineralogical phases of waste rock heaps consist of quartz, illite, kaolinite, K-Feldspars, plagioclases, dolomite, muscovite, biotite, gypsum, and halite with a small amount of iron oxides. The main lead minerals were oxidized cerussite, galena, Pb-barite, anglesite, and wulfenite. Mine tailings are quite different and marked by the absence of carbonates and by the presence of a small percentage of kaolinite. The results indicate high average contents of Pb, Zn, Cu, As, and Cd, exceeding the geochemical background values. The highest concentrations were observed for As and Pb in waste rock heaps ( $Pb_{max} = 150000$  mg/kg,  $As_{max} = 114$ mg/kg).

According to regression analysis, Pb is poorly correlated with Fe, Al, and K, suggesting that both clay and Fe-oxyhydroxides are not retaining Pb. Strong linear relationships were observed between Pb-S and Pb-Ba indicating that the environmental factors which control the distribution of Pb are galena and Pb-barite. The strong correlation between Pb and As suggests that the two elements mainly originate from the same bearing mineral. Analysis of mine tailing and waste rock heaps revealed an extreme level of contamination, particularly of Pb and As.

**Keywords:** Zeïda mine, tailings, waste rock heaps, environmental factors, potentially toxic elements, lead, arsenic galena, Pb-barite.