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Remote Sensing Observations of Sulfides and Sulfates for the Geologic Mapping of the Extreme Acidic Environment of Rio Tinto, Spain

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After its long reputation as an extremely polluted water river and anthropogenic mining waste dump, studies support Rio Tinto (southern Spain, Iberian Pyrite Belt) to be an extremely acidic environment where life relentlessly thrived long before human history. It has become clear that in this extreme environment, there are strong relationships between living and nonliving components at the microscale, resulting in the formation of micro-niche-based ecosystems. The site has therefore become a terrestrial analog of first interest for astrobiological and planetary science studies in terms of the search for life on Mars. The acidic environment is the product of the chemolithotrophic activity of microorganisms aggressively targeting sulfides (pyrite, chalcopyrite), here abundant, causing the leaching of iron and sulfur. This contributes to the formation of a variety of minerals, mainly gypsum, jarosite, goethite, and hematite, all of which have been detected on the Red Planet.

Identifying and discretizing sulfides and iron-bearing sulfates from orbit and landed missions has been a relevant method for searching for life on Mars, notably distinguished by its iron-sulfur-rich composition. Similar mapping sulfide and sulfate distributions on easy-to-access terrestrial analog are critical to improving our ability to interpret data from other worlds and contextualize astrobiological observations.

In this work, we present the spectroscopic analysis of remote sensing data over Rio Tinto, focusing on mapping the distribution of sulfides and sulfates as a proxy for the presence of biosignatures. We have studied multi- and hyper-spectral data from orbital and airborne spectrometers, cross-checking evidence from different datasets.

The results of our work have been cartographically formatted and served to support the geologic mapping fieldwork campaign held at the Rio Tinto in November 2023.