An Earth analogue for multiple acidic alteration pathways: insight from clay mineralogy and chemistry of the Riotinto mining district (Huelva, Spain)

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On Mars, clays indicate sustained aqueous activity in previous geological times. Combined satellite and in-situ measurements of Mars surface have detected mineral assemblages indicating processes for which Earth analogues exist. Among them, aluminous clay-sulphate assemblages have been observed, which suggest alteration by acidic fluids.

The Riotinto mining district (SW Spain) provides an ideal Earth analogue setting for such Martian processes. The parent rocks belong to an Upper Palaeozoic (Late Famennian-Tournaisian) volcano-sedimentary complex including siliciclastic sediments, mafic and felsic volcanics. All of them underwent hydrothermal alteration, thus enriching the mineralogy with quartz and illite. The oxidation of an extensive pyrite-rich orebody occurred due to fluctuation of the water table, and ultimately contributed mild to extreme acidic fluxes that leached the surrounding rocks for over 20 million years [1]. The resulting mineral assemblages are strongly dependent on their acidic alteration intensity.

The paragenetic assemblages clearly reflect three different leaching patterns and alteration sequences, which can be summarized as follows:

Mild: from chlorite to vermiculite, mixed-layered phases, and kaolinite;

Strong i): from kaolinite and mixed-layered phases to jarosite-group phases;

Strong ii): from kaolinite to alunite, jarosite-group phases, and iron oxides.

Our findings suggest that, even within this general scheme, the specific alteration pathways can be different. The presentation will focus on the latest mineralogical and chemical discoveries that lead to the validation of the aforementioned alteration sequences.

[1] Essalhi et al., 2011. Mineralium Deposita 46, 981-999.