



## **Laboratory analysis of sulfate precipitation processes from acidic brines using combined Raman and LIBS spectroscopy**

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Since the arrival of the two MER's rovers to Mars and the discovery of jarosite the sulfate deposits related to evaporitic processes in acidic conditions have received increasing interest. The study of the processes of precipitation, evaporation and the formation of efflorescences of sulfates in several terrestrial analogues are relevant on comparing with the results obtained on Mars surface by rovers and orbiters. In addition to the in-situ analysis at the field, laboratory work is needed to understand in detail these processes under controlled conditions (temperature, relative concentration, pH, etc.) using synthetic and natural brines.

In this work results obtained on the simulation of precipitation processes using natural acidic waters from Rio Tinto (Spain) as well as synthetic brines with controlled concentrations of sulfates, iron (II and III), magnesium and potassium are presented and discussed. For that purpose a dedicated evaporator device has been developed in which temperature, surface slope, evaporation rate and illuminating light and daily cycles can be controlled.

The main techniques used for this study are Raman, LIBS (Laser Induced Breakdown Spectroscopy) and IR spectroscopy and X-R diffraction. Raman spectroscopy has been used for mineral identification and for in-situ and on-line analysis of the evaporation process of brines and desiccation of efflorescences at several temperatures. In addition LIBS has been used for in-situ identification of the elementary compositions of the liquids and precipitated products. IR and XRD have been used as complementary techniques for mineral identification of the precipitates

The results obtained suggest that simulation methods in the laboratory under controlled conditions and with in-situ techniques able to follow in real time the processes are very useful. The obtained information about intermediate and final products as well as on kinetics parameters of the processes is very valuable to modeling accurately the natural processes. In the particular case of Rio Tinto formation of copiapite and coquimbite and their transformations at different temperatures have been studied in detail.