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Weathering and evaporation experiments: can we get the recipe to form carbonates and sulfates in the ancient Jezero lake?

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The Mars 2020 mission landed in Jezero crater in 2021. Besides the search of past life, one main purpose is to analyze and sample aqueously altered rocks. Secondary phases such as carbonates and clays were previously detected from orbital missions, and their presence was confirmed during the first two years of the mission [1, 2]. These can be used as proxies for fluid composition and past environmental conditions, a key to understand Mars water history. The rover should encounter the marginal carbonates mapped from orbit in April 2023 [1]. To explain the formation of these carbonates, we are following a "source-to-sink" approach: we produce initial fluids by modelling kinetically the weathering and oxidation process relevant to the geological context, and we use them to feed formations scenarios. We are currently lab proofing the model by conducting weathering and evaporation experiments. The starting rock analog was prepared with a pristine basalt from the island of La Réunion. The initial solid was analyzed with high resolution SEM/EDS/EBSD to precisely determine the individual mineral composition and distribution to model it accordingly. We are running 8 controlled atmosphere reactors, 4 terrestrial witness and 4 blanks. The initial solution is whether deionized water or HCl/H2S solution. The runs are performed under CO2 rich atmosphere and variable pO2, at 20°C and 60°C (Figure 1). 11 samplings are made for each reactor, with a rapid pH, Eh and dissolved O2 measurements, and later concentrations will be measured with ICP-OES and ion chromatography. All our experiments were consciously numerically modeled beforehand to assess experimental effects such as solution removal from sampling or flushes. At the end of each weathering experiments, the fluid will be evaporated in an atmosphere-controlled desiccator. The solid secondary phases will be analyzed by XRD, SEM and in-situ techniques. We will discuss the experimental results and the robustness of the weathering model to get "the recipe" to make carbonates and/or sulfates in Jezero's geological context.

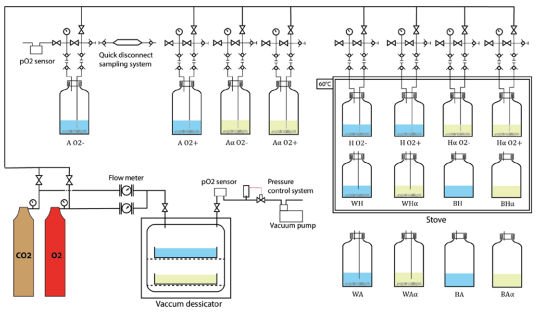

Figure 1. Experimental setup for weathering and evaporation. Reactors are prepared in an anoxic glovebox and then connected to the setup. All the reactors received 50g of the prepared initial solid and 500ml of solution. Samples are collected and sealed in a quick disconnect container for transfer and handling in a glove box. At the end of a weathering experiment, the solution is transferred inside a controlled atmosphere desiccator for evaporation. A = Ambient temperature, H = Hot/High temperature, α = H2S/HCl solution, O2- = low pO2, O2+ = maximum pO_2, W = Witness at terrestrial atmosphere, B = Blanks.

References:
[1] Farley et al. (2020), Space Sci. Rev. 216, 142 [2] Clavé et al. (2022), JGR Planets, 127.