Goldschmidt 2024 Abstract
https://doi.org/10.46427/gold2024.23017

Studying water-rock and microbe-mineral interactions in planetary geochemistry and astrobiology

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Water-rock interactions are pervasive throughout Earth's Critical Zone, and also during the early history of Mars. Laboratory experiments examining the formation [1] and dissolution [2] of specifically martian phases such as poorly crystalline silicates and clay minerals under Mars-relevant conditions such as in concentrated brines [3], can help interpret the characteristics of past liquid water on Mars. Water-rock interactions on Mars can also be quantified and interpreted using numerical models to better understand these past environments [4].

The dissolution kinetics of nutrient-containing minerals such as phosphates can also help understand the past habitability of Mars [5]. Trace element signatures, biologically impacted minerals, and isotopic signatures resulting from microbe-mineral interactions may also be valuable as biosignatures [6, 7]. Water-rock interactions and microbe-mineral interactions can therefore also help understand the astrobiological potential of Mars.

Finally, samples are currently being collected and cached on Mars for potential return to Earth [8, 9]. These samples include samples of the Mars regolith or soil [9] (Figure 1), which contain aqueously altered clasts that could contain potential past evidence of life it was present; the ubiquitous, potentially global, fine-grained Mars soil; and airfall dust. Return of Mars samples to Earth will allow them to be analyzed using cutting edge techniques in Earth's most sophisticated laboratories, to make unprecedented progress in the understanding of the history of water-rock interactions, and potentially biota if it was present, on that planet.

References:[1.]Gainey, S.R., et al., Nature Communications, 2017. **8**(1):1230 DOI: 10.1038/s41467-017-01235-7. [2]. Ralston, S.J., et al., Clays and Clay Minerals, 2021. **69**(2):263-288 DOI: 10.1007/s42860-021-00124-x [3]. Steiner, M., et al., GCA, 2016. **195**:259-276 . [4]. Hausrath, E.M., et al., EPSL 2018. **491**:1-10. [5]. Adcock, C., E. Hausrath, and P. Forster, Nature Geoscience, 2013. **6**(10):824-827. [6]. Colburn, B., et al., *AbSciCon*. 2024: Providence, RI May 5-10 [7]. Cycil, L.M., et al. *AbSciCon*. 2024: Providence, RI. May 5-10 [8]. Simon, J.I., et al., JGR Planets 2023. **128**(6): e2022JE007474. [9].Hausrath, E.M., et al., JGR Planets, in revision.

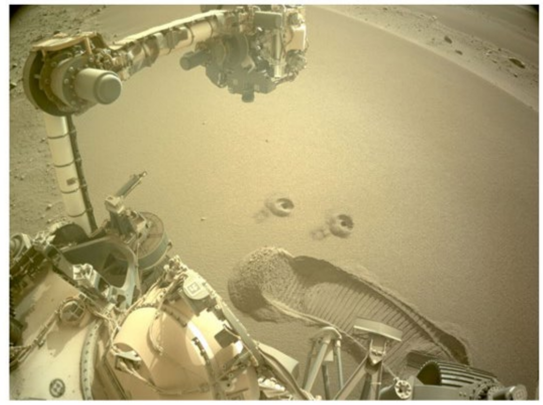

Figure 1. *Image of the surface soil/regolith of Mars after collection of the samples for caching and potential return to Earth. Image credit: NASA/JPL-Caltech.*