EGU24-4012, updated on 11 Sep 2024
https://doi.org/10.5194/egusphere-egu24-4012
EGU General Assembly 2024

Hyperspectral mapping of a kilometer of mantle rock core: insight into active serpentinization systems

Lucia Mandon[1,2], Bethany L. Ehlmann[1], Rebecca N. Greenberger[1], Eric T. Ellison[3], Lisa E. Mayhew[3], Alexis S. Templeton[3], and the Oman Drilling Project Science Team[*]
[1]Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA, USA (lmandon@caltech.edu)
[2]Université Grenoble Alpes / CNRS, Institut de Planétologie et Astrophysique de Grenoble (IPAG), Grenoble, France
[3]Department of Geological Sciences, University of Colorado, Boulder, CO, USA
[*]A full list of authors appears at the end of the abstract

Serpentinization is one of the major processes of silicate alteration in the solar system. Associated reactions are drivers for redox disequilibria and sources of H_2, which are favorable to habitability. Minerals formed are responsible for crustal density and magnetization changes, and a significant amount of water can be sequestered. Released gases are expected to affect climate and have been proposed as potentially responsible for warming early Mars [1]. However, depending on protolith and geochemical conditions, a diversity of mineral assemblages exist, and the full spectrum of serpentinization is not well understood. In addition, some products are not well characterized, reducing our ability to assess serpentinization in the solar system.

The Oman Drilling Project [2] is a multi-national collaboration to characterize the Samail ophiolite in Oman, which consists of altered oceanic crust. About 3.2 km of core were recovered and characterized with bulk rock and vein description, thin section photos, rock chemistry and mineralogy, microbial cell abundance, and borehole water properties, performed at regular intervals [2]. In addition, rock cores were analyzed using a hyperspectral imager covering the 0.4–2.6 µm range at a submillimeter spatial resolution (Fig. 1; [2]), allowing fine-scale characterization of the whole cores (as opposed to specific depth intervals), with tracking of most minerals of interest, hydration and Fe redox – of particular interest in understanding the fate of Fe in serpentinized systems and production of H_2. This spectroscopy technique is also widely used in planetary exploration to assess composition of surfaces (e.g., [3]); collection of spectra of materials present in the cores will aid in the detection and characterization of serpentinization on Earth, Mars, asteroids and ocean worlds.

Our ongoing study builds on previous hyperspectral analysis of the gabbroic section [4, 5], and focuses on the mantle section, some of which may be actively weathering. We will present our approach to automatically map minerals, hydration and serpentine redox on ~1 km of core from three boreholes, allowing us to investigate how these parameters vary with depth (e.g., what is the extent of carbonation and hydration in the oceanic crust/mantle?) and with variables that influence serpentinization processes (e.g., rock chemistry, faults, biology or fluid chemistry). This approach allows us to better understand serpentinization processes and products and their impacts on planetary crusts.

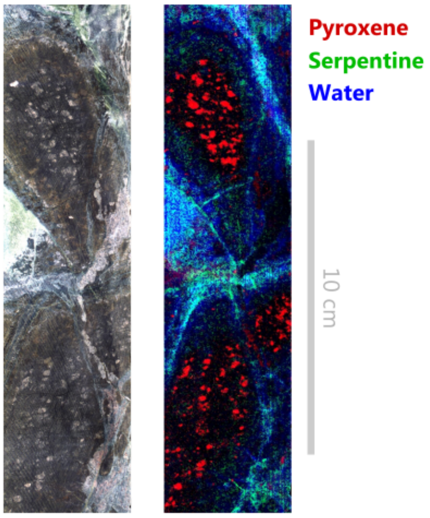

Figure 1. Spectral mapping of a portion of the Oman mantle core at a depth of 370 m (left: color composite from data in the visible; right: classification based on SWIR data).

[1] Ramirez et al. (2014), *Nat. Geo.* 7(1)

[2] Kelemen et al. (2020), *Proceedings of the Oman Drilling Project*

[3] Carter et al. (2023), *Icarus* 389

[4] Greenberger et al. (2021), *JGR: Solid Earth* 126(8)

[5] Crotteau et al. (2021), *JGR: Solid Earth* 126(11)

Oman Drilling Project Science Team: https://www.omandrilling.ac.uk/people