

BUILDING A SPECTRAL LIBRARY OF IRON-BEARING BRUCITES. C.H. Blaske^{1*}, R.N. Greenberger², B.L. Ehlmann², E.T. Ellison³, A.S. Templeton³, L. E. Mayhew³, ¹School of Earth & Space Exploration, Arizona State Univ. ²Division of Geological & Planetary Sciences, Caltech. ³Dept. of Geological Sciences, Univ. Colorado, Boulder. *cblaske@asu.edu

Introduction: On Earth, serpentinization of ultramafic oceanic crust produces H₂, used by microbial communities for chemical energy [1]. Evidence for the production of H₂ has been found across the solar system, including on Enceladus [2]. The presence of serpentinized rock on Mars [3] suggests that it may have been able to produce H₂ and host environments favorable to microbial communities in the past. Analyzing the reactions involved in serpentinization and its products on Earth is important to the long-term investigation of these environments on other worlds.

The Oman Drilling Project was conducted on the Oman Ophiolite, one of the best places to study active serpentinization on Earth [4]. The obducted oceanic crust's olivine- and pyroxene-rich rocks were exposed to water as they were uplifted, causing serpentinization to occur. H₂ production can be regulated during serpentinization by the initial formation of brucite ((Mg,Fe)(OH)₂), which can later oxidize and release H₂ [5]. Tracing this intermediate product of serpentinization is key to understanding the record of habitability on solar system bodies.

Methods: We are developing a spectral library of iron-bearing brucites using synthetic samples prepared in an anaerobic chamber (~4% H₂, <50 ppm O₂) by coprecipitation of FeCl₂, MgCl₂, and NaOH. We compared Fe-bearing brucite to pure Mg-brucite, as well as the forced oxidation by H₂O₂ when salts like NaCl and NaCO₃ were present or absent (since these salts might encourage the formation of particular oxidized product phases, e.g. iowaite or pyroaurite). We also tested Fe-bearing brucite that was gently, partially oxidized by sodium nitrate. Samples that were not fully oxidized by H₂O₂ were dried and measured from 0.35 - 2.5 μm inside an argon

glovebox. Spectra of the dried samples were taken over the course of several weeks to measure sample stability and any change in spectral features. We examined two diagnostic features: the location and strength of the OH overtone at 1400 nm, and the (Mg,Fe)-OH absorption feature at 2300 nm. A strong H₂O absorption line at 1900 nm and its contribution at 1400 nm caused challenges in interpreting the signals.

Results: Ideally, spectral features will be easily identifiable with a sharp decrease in reflectance around the wavelength of the feature. However, sufficiently drying the samples in order to highlight the OH overtone and the (Mg,Fe)-OH feature proved to be difficult, especially with unoxidized samples that were dried in the argon glovebox without an oven. Figure 1 shows the comparison between a pure Mg(OH)₂ brucite (Sigma Aldrich) and both oxidized and unoxidized Mg66 brucites, where the 2300 nm feature is weaker. We will investigate new protocols to dry samples in future work.

Using a spectral continuum removal, we were able to pull out trends to understand the effects of Mg#, oxidation, and salt treatment on the locations of diagnostic features (Fig. 2). For the OH overtone at 1400-1450 nm, the Fe-bearing brucite had metal-OH overtones at longer wavelengths than the purely Mg-OH brucite. Fe-bearing oxidized samples have a band center at a location several tens of nm longer than the unoxidized samples. Samples treated with salts have band centers at a higher wavelength compared to their untreated counterparts (Fig. 2A).

The (Mg,Fe)-OH band features at 2300 nm were especially difficult to analyze due to their shallow depths, but in unoxidized samples the features occur at several nm longer than the

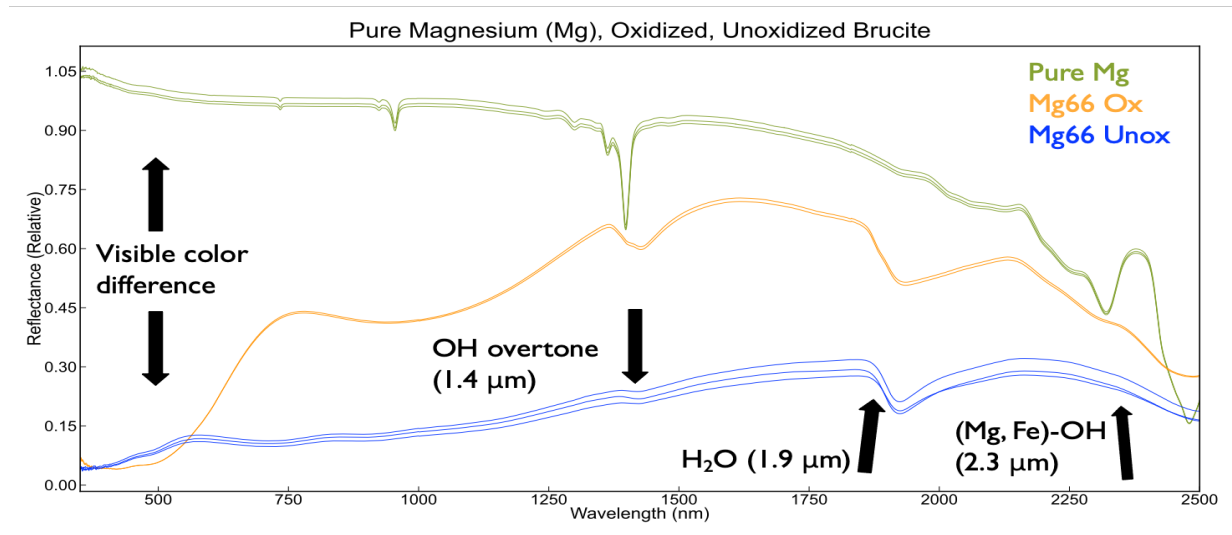


Figure 1: Spectra of pure Mg(OH)₂ and oxidized and unoxidized Mg_{0.66}Fe_{0.33}(OH)₂ measured in this study. Residual water in the samples significantly alters the strength of the diagnostic features.

oxidized samples (Fig. 2B). The oxidized, treated samples had no discernible features around 2300 nm.

These results are similar to those of Fox et al. [6], who found that the (Mg,Fe)-OH feature in smectite clays shifts longer with decreasing oxidation, while the OH overtone feature near 1400 nm did not change location with oxidation. Developing a library of the diagnostic features and spectra of these minerals is a step towards capturing the

diversity of the products of serpentinization that rovers may encounter on Mars.

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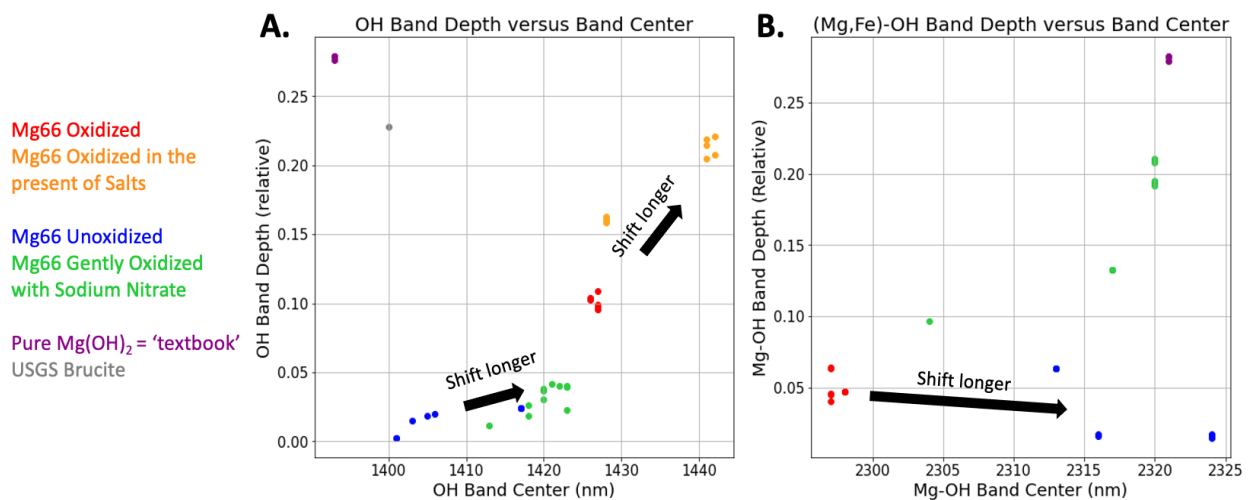


Figure 2A: Salt-treated and oxidized samples have 1400 nm OH overtone features at longer wavelengths.

Figure 2B: Unoxidized samples have a longer center wavelength for the (Mg,Fe)-OH feature around 2.3 μm.