DETECTION OF SERPENTINE ON MARS BY MRO-CRISM AND POSSIBLE RELATIONSHIP WITH OLIVINE AND MAGNESIUM CARBONATE IN NILI FOSSAE. B. L. Ehlmann[1], J. F. Mustard[1], S.L. Murchie[2], and [1]Department of Geological Sciences, Brown University (bethany_ehlmann@brown.edu), [2]Johns Hopkins University Applied Physics Laboratory.

Introduction: Serpentines are 1:1 trioctahedral phyllosilicates with general formula $(Fe,Mg)_6Si_4O_{10}(OH)_8$ and form during metamorphism, hydrothermal activity, or weathering of ultramafic rocks. Serpentine is an expected aqueous alteration product on Mars, given the mafic to ultramafic crust and prevalence of olivine. Serpentinziation reactions produce H_2, which can serve as an important energy source for chemosynthetic organisms [1] or react abiotically with CO_2 to produce methane [2]. The detection of methane, with heterogeneous distribution and seasonal variation in abundance, has been reported in data from the Planetary Fourier Spectrometer [3] and from ground-based observations [4]. We report here the detection of serpentine by the CRISM spectrometer on the Mars Reconnaissance Orbiter in the Thaumasia and Nili Fossae regions of Mars [5]. A possible relationship with the olivine-Mg carbonate rocks in Nili Fossae [6] is discussed.

Identification and occurrences of serpentine: In three CRISM images to date, a spectral class occurs which is distinguished by a sharp absorption at 2.32 µm and additional absorptions at 2.51 and 2.11 µm (Fig. 1). There is a 1.9 µm band indicating the presence of H_2O, and which varies in strength and breadth in the three spectra. There is an additional sharp vibrational band at 1.39 µm. All of these features are consistent with the presence of an Mg serpentine e.g. antigorite, lizardite, or chrysotile. Serpentines have numerous combination overtones of metal-OH bends and stretches from 2.3-2.7 µm [7-9]. The strongest of these is centered at 2.32 µm for Mg-OH in Mg serpentines. In Fe serpentines, this band is at longer wavelengths and sometimes accompanied by aluminum bands at shorter wavelengths [10]. The 2.50-2.51 µm band is the next strongest of these features. Serpentines also have a diagnostic band at 2.10-2.12 µm. Near 1.4 µm, serpentines have an OH stretch overtone at 1.39 for Mg serpentines which shifts to somewhat longer wavelengths (1.40-1.41 µm) for Fe serpentines [7].

Serpentines can be distinguished from the Mg smectite, saponite, which also has a band at 2.32 µm, by the sharpness and position of the 1.39 band and the additional band at 2.10 µm (Fig. 1). Stoichiometric serpentine does not have molecular water in its structure which would create the 1.9 µm band so we are likely observing serpentine in mixtures. In all three images, the area of the surface with this spectral signature is less than 7x7 CRISM pixels (18m/pixel).

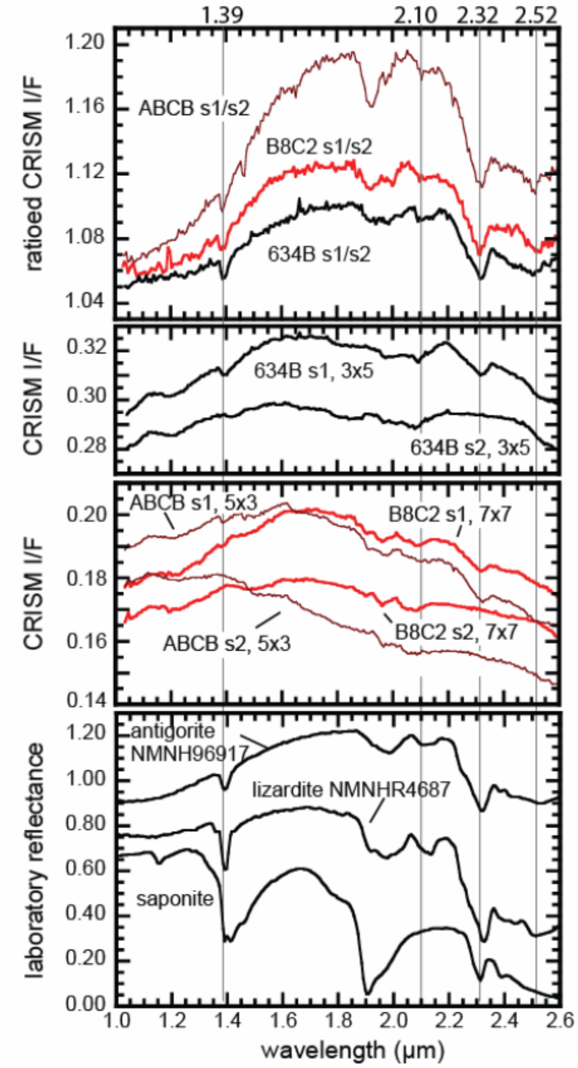

Figure 1. (top) ratioed and (bottom) unratioed spectra of inferred serpentine bearing materials acquired by CRISM over Thalmasia (FRT0000634B) and Nili Fossae (FRT0000ABCB, FRT0000B8C2) compared to library spectra from the USGS spectral library [9].

Correlation with olivine and carbonate in Nili Fossae?: The occurrence of serpentine in Thaumasia (27°S, 101°W) is on an eroded ridge, not obviously associated with olivine, although both olivine and chlorite are found in nearby outcrops. The relationship of serpentine to other minerals is also unclear in one of the Nili Fossae detections (FRT000ABCB) in heavily eroded terrain where kaolinite, low-calcium pyroxene, and olivine are also found in the image. However, in FRT0000B8C2, the serpentine is closely associated with Mg carbonate bearing rocks. Fig. 2 shows the locations of the serpentine detections in Nili Fossae relative to locations of Fe/Mg smectite, magnesium carbonate, and olivine.

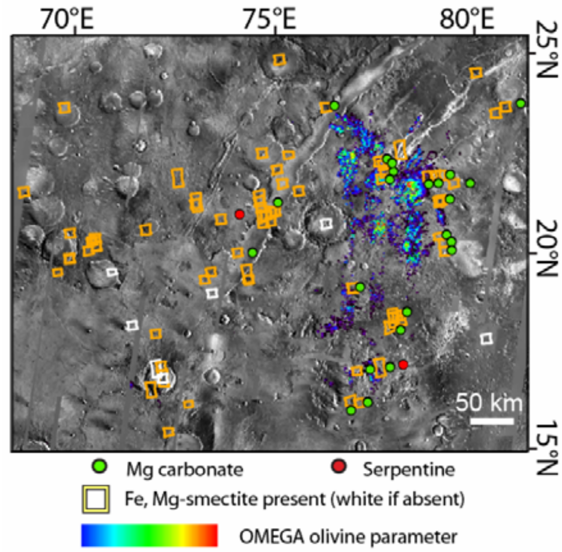

Figure 2. Locations of definitive serpentine detections in and around Nili Fossae along with olivine [16], Fe/Mg smectite, and magnesium carbonate [6].

Around the Isidis basin, a banded olivine unit drapes pre-existing Fe/Mg smectite in a consistent stratigraphy over 1000s of km [11, 12]. In some places this olivine is apparently altered to magnesium carbonate which occupies an identical position in the stratigraphy [6]. However, in some locations, the olivine is partially altered [13]. This alteration product is distinct from the Fe/Mg smectite or the Mg carbonate, distinguished by a principal absorption at 2.32 μm rather than at 2.30 μm as in the smectite and the carbonate (Fig. 3). This weak 2.32 μm absorption is consistent with the presence of serpentine seen elsewhere in the region, although, in the absence of other diagnostic absorptions, a more Mg-rich smectite such as saponite is also a possibility. An olivine-serpentine-carbonate assemblage in eastern Nili Fossae would be typical of weathered, serpentinized ultramafic rocks on Earth [14, 15] and would indicate a hydrothermal alteration process which could have served as an energy source for microorganisms and led to production of methane.

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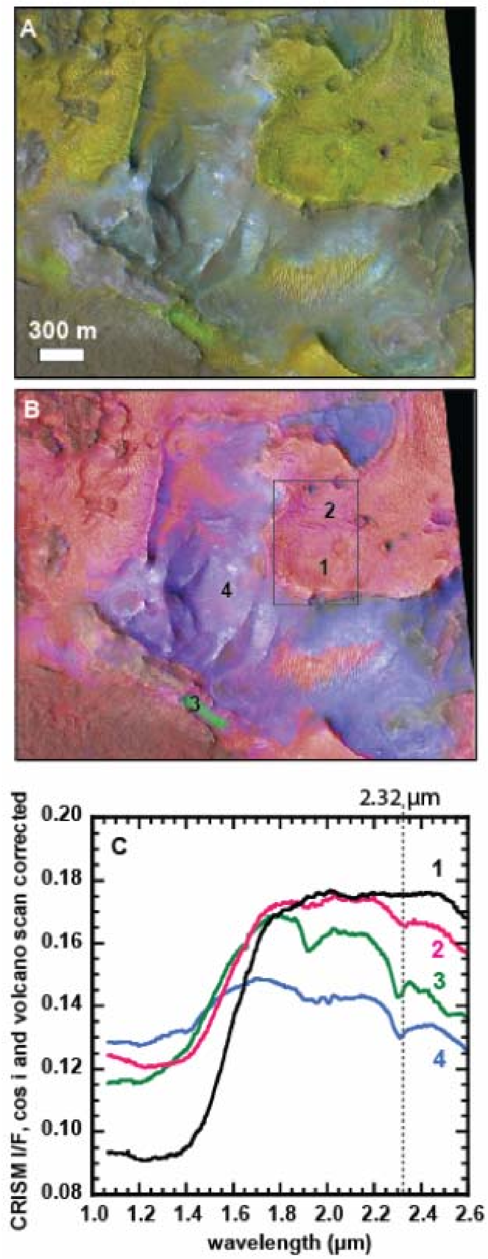

Figure 3. (a) CRISM false color from FRT00003E12 (R: 2.38, G: 1.80, B: 1.15 μm) used to colorize HiRISE PSP_002888_2025_RED. (b) Parameter map (R: OLINDEX, G:BD2500, B: D2300) scaled so that carbonate is green, olivine is red, Fe/Mg smectite is blue, and partially altered olivine is magenta. (c) unratioed 5x5 CRISM spectra from the locations in (b).

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