CRISM-OMEGA OBSERVATIONS OF PHYLLOSILICATE-OLIVINE STRATIGRAPHY IN NILI FOSSAE, MARS.
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Introduction: The Nili Fossae region, Mars, has been the focus of much study [1, 2, 3, 4] due to its superb exposures of bedrock and mineralogic diversity. OMEGA's detection of abundant phyllosilicate in this region [5, 6] afford the opportunity to examine the nature of alteration, its time, and geologic setting. These subjects are important in assessing the habitability of Mars. CRISM data [7], with its high spectral and spatial resolution, are being used to address these questions. In particular we are interested in determining the mineralogy at high spatial resolution, whether the alteration is Noachian in age, and assessing if the alteration is due to surface, crustal, or hydrothermal environments. The coordinated observations of OMEGA, HiRISE and CRISM in Nili Fossae allow linking mineralogy and morphology enabling new insights into these questions.

Datasets and Methods: Compact Reconnaissance Imaging Spectrometer for Mars is a visible-near infrared (VNIR) and infrared (IR) imaging spectrometer on the Mars Reconnaissance Orbiter (MRO) that can acquire high resolution targeted observations at 544 wavelengths from 0.36-3.92 µm at 15-19 m/pixel and multispectral mapping data with 72 wavelengths at 100-200 m/pixel. Observations are processed to account for all instrumental effects and reduced to radiance. From these data, I/F is calculated and then corrected for solar incidence angle, and the effects of atmospheric transmission absorptions using an approach similar to that used by the OMEGA experiment [5]. The transmission spectrum is derived from a CRISM observation across Olympus Mons.

HiRISE (High Resolution Imaging Science Experiment) is a high resolution camera aboard MRO capable of acquiring co-aligned imagery with CRISM and has a spatial resolution as fine as ~25 cm/pixel [8].

OMEGA (Observatoire pour la Mineralogie, l'Eau, les Glaces et l'Activité) is a VNIR and IR hyperspectral imager on the ESA/Mars Express mission [9]. It has a 1.2 mrad IFOV, a spatial sampling that varies from 300 m (at pericenter) to 4.8 km (at 4000 km altitude), and a 7 to 20 nm spectral resolution in 352 spectral bands over 0.35-5.1 µm.

OMEGA data have been analyzed to produce mineral indicator maps [10, 11]. From these maps we have targeted several key regions, and two of the first CRISM observations and their relationship to OMEGA mineralogy are shown in Figure 1a. RGB infrared browse images of the CRISM observations are shown in Figure 1b, where phyllosilicate regions appear as green, olivine-rich as brown-yellow, and low albedo, mafic rocks as blue. Figure 1b (lower) shows the location of the HiRISE coordinated observation. We have calculated olivine and phyllosilicate mineral indicators from the CRISM data that are merged with HiRISE (Figure 2), where olivine is shown in red and phyllosilicate in green. Representative CRISM spectra are shown in Figure 3.

Results: HiRISE data show dark buttes, a few hundred meters in size, preserving the remnants of a tens of meters-thick unit which once covered the region where the southern CRISM observation was taken, and it is similarly represented in the northern observation. Olivine is in high abundance in the regions covered by sand dunes and mobile material. The olivine may be derived from the erosion and breakdown of the cover unit, but this awaits further observations. Phyllosilicate is clearly concentrated in the units that lie beneath the cover and mobile materials. This unit has a very distinctive morphology. In the northern observation, it is largely observed as knobs that emerge from the mobile cover. In the south, it also occurs as knobs, but more commonly as a smooth surface, perhaps planed by erosion, with a dense network of linear features (Figure 2). The linear features are arranged in a fractured pattern, perhaps as polygons of dessication fractures. This texture is also observed in the phyllosilicate-bearing rocks units in Mawrth Valles. There are regions that are clearly olivine with no indication of alteration, and areas of only phyllosilicate without olivine. Where mixed, it is not clear from these data whether this is due to in situ alteration or spatial mixing.

Conclusions: These observations confirm previous observations [3,4] that the phyllosilicate rocks are older than the olivine-bearing rocks, and that there was a cover of rock that has been removed from the region. We expect more CRISM observations in the coming months in the areas of highest OMEGA detections of phyllosilicate to further resolve the outstanding questions for this important region. Coordinated data analyses of these observations will be continuing.

References: [1] Hoefen, T. M. et al. (2003) *Science* 302: 627-630. [2] Hamilton, V. E. and P. R. Christensen (2005) *Geology* 33, 433-436. [3] Mustard, J. F. et al. *(in press) JGR*. [4] Mangold et al., *(in press) JGR*. [5] Bibring, J.-P., et al. (2005) *Science* v307, 1576-1581. [6] Poulet, F. et al., *Nature*, (doi:10.1038/nature04274), vol. 438, 623-627. [7] Murchie S. et al. *(in press) JGR*. [8] McEwen A. et al. *(in press) JGR*. [9] Bibring J.-P. et al. *ESA SP 1240*, 37, 2004. [10] Pelkey, S. M. et al., *(in press) JGR*. [11] Poulet et al., *(in press) JGR*.

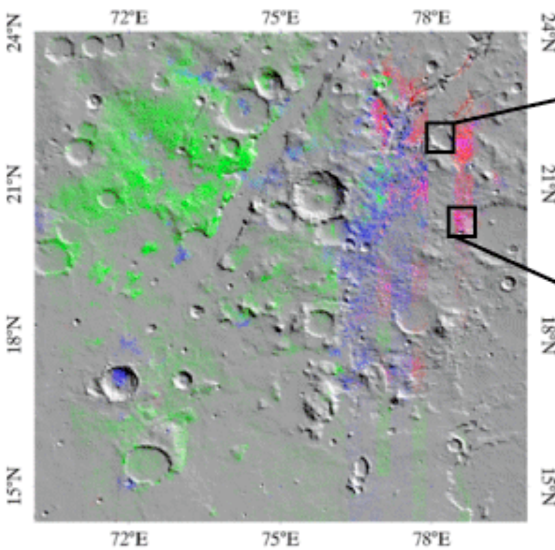

Figure 1a. OMEGA mineral indicators (red=olivine, green-low-Ca pyroxene, blue=phyllosilicate). CRISM observations are shown in the black boxes

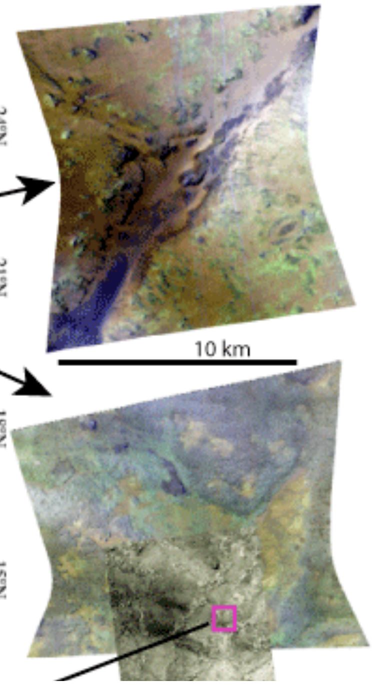

Figure 1b. IR RGB images of CRISM obsevation FRT00003584_7 (top) and FRT000028BA_7 (bottom). HiRISE data (TRA 000883_2005) are superimposed (grey regions) where the magenta box shows the region highlighted in Figure 2 (B=1.06 µm, G=1.80 µm, R=2.4 µm)

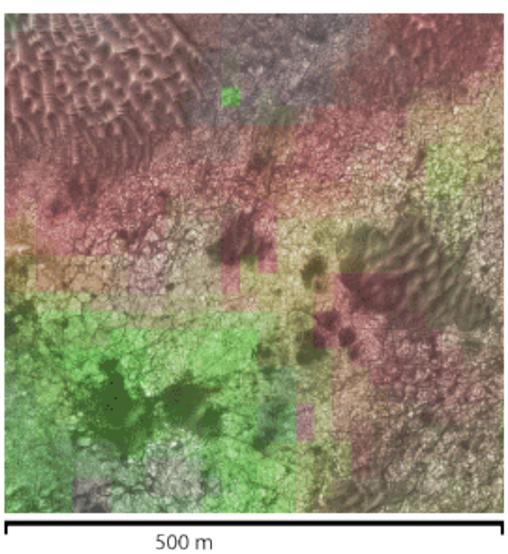

Figure 2. CRISM mineral indicators (red=olivine, green=phyllosilicate) merged with HiRISE imaging data (TRA_000883_2005).

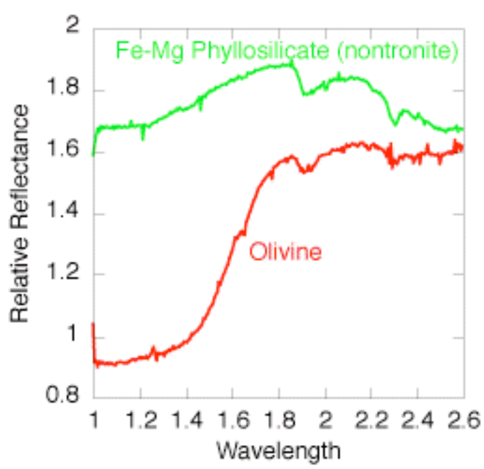

Figure 3. Relative reflectance spectra (ratioed to the blue regions in Figure 1b) of phyllosilicate- and olivine-rich region. Note the strong 1.9 and 2.3 µm bands.