

NEW PHYLLOSILICATE MINERAL SIGNATURES FROM WEST OF NILI FOSSAE, MARS THROUGH COMBINED OMEGA-CRISM ANALYSIS. B.L. Ehlmann¹, J.F. Mustard¹, S.M. Pelkey¹, L.H. Roach¹, F. Poulet², J.-P. Bibring², S.L. Murchie³, and the CRISM Science Team. ¹Geological Sciences Dept., Brown University, Providence, RI 02906 (bethany_ehlmann@brown.edu), ²Institut d'Astrophysique Spatiale, Bâtiment 121, 91405 Orsay Campus, France. ³Applied Physics Laboratory, 11100 Johns Hopkins Rd. Laurel, MD 20723.

Introduction: Identification of olivine [1,2], low- and high-calcium pyroxene [2], and phyllosilicates [3] in Nili Fossae suggest it is one of the most mineralogically diverse regions on Mars. Analysis of spatial and temporal distribution of mineralogical units is ongoing [4-6]. A companion abstract addresses the stratigraphic relationship between phyllosilicate- and olivine-bearing units [7]. The Mars Express OMEGA spectrometer [8] identified phyllosilicates in ejecta from a ~50 km crater to the west of Nili Fossae (Fig. 1). We focus herein on Compact Reconnaissance Imager for Mars (CRISM) observations targeted to that ejecta. Using CRISM spectra acquired at 30-40 m/pixel scale, we identify signatures for new phyllosilicate mineralogies and find that phyllosilicates vary in composition over scales of <250 m, suggesting heterogeneity in environmental conditions and/or available primary materials at the time of formation.

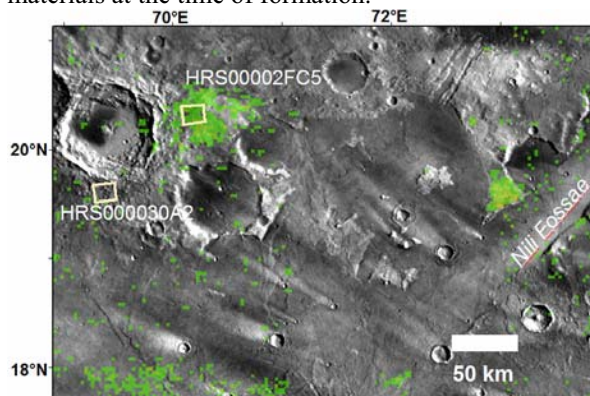


Figure 1. Viking digital image mosaic; CRISM images HRS00002FC5_07 and HRS000030A2_07 are outlined. OMEGA phyllosilicate identification is indicated in green from the D2300 parameter [10].

Methods: CRISM is a visible/near infrared, imaging spectrometer which at highest resolution can acquire targeted observations at 544 wavelengths and 15-19 m/pixel [9]. A subset of spectral data from 1.0-2.6 μm from two half-resolution observations are used in this abstract (Fig. 1). Data were processed to cosine-corrected I/F and then atmospherically corrected using an elevation-scaled atmospheric transmission spectrum derived from observations at the base and top of Olympus Mons. Areas with diagnostic spectral signatures were identified using summary parameter values [10], and representative spectra from these surface

units were collected. Spectra of interest were ratioed to similar albedo, spectrally neutral pixels in the same column to highlight spectral features.

Results: Both CRISM-imaged sites contain phyllosilicates. In Fig 2., areas which appear green in the false-color infrared composites contain a strong absorption feature at ~2.3 μm . Areas which are blue likely contain mafic minerals while those which are red-brown are relatively spectrally bland and were used as the denominator in spectral ratios.

No single spectrum is characteristic of the phyllosilicates in the crater ejecta (Fig. 3). Instead, at least 3 spectrally distinct types are present. In type A (see also spectra C), the most spatially abundant type observed at both locations, the spectral slope is strongly concave upward short of 1.8 μm . The most prominent absorption is at $2.34 \pm 0.02 \mu\text{m}$. The 1.9 μm feature may be present, although this spectral region is susceptible to artifacts introduced during atmosphere removal. The second phyllosilicate spectral type (B) also contains the 2.34 μm feature as well as additional absorptions at 1.4, 1.9, 2.2 μm . The third spectral type (D) contains strong 1.4 and 1.9 μm absorptions as well as a feature at 2.32 μm , at shorter wavelength than in types A-C. Further, the spectral rolloff continues from 2.4 μm longward, rather than plateauing as in A-C.

Implications: The most common spectral type (A, C) has subtle shifts in the position of the single ~2.34 μm absorption feature and differences in the magnitude of the 1.9 μm feature. The former results from metal-OH bonds while the latter is related to O-H stretching in bound water. This indicates phyllosilicates identified have likely (1) been subject to different degrees of dehydration and (2) may contain different abundances of, e.g. Fe and Mg, in the cation site.

CRISM is able to resolve multiple exposures of phyllosilicates at sub-OMEGA pixel sizes. This indicates that alteration minerals may be even more widespread on the surface of Mars than initially detected but at these smaller scales. OMEGA identified variation in the 2.3 μm absorption position and spectra consistent with A, C, and D and spectrally similar to Fe- and Mg-rich smectites such as chamosite and nontronite [3,5]. At higher resolution, CRISM data confirm these detections and also show the presence of a 2.2 μm feature (spectra B) at some locations. Over a distance of only 60 km separating the images, distinct

phyllosilicate spectral types exist and smaller intra-image variation of phyllosilicate type occurs on scales of <250 m.

Candidate minerals fitting observed features include those not previously identified on the surface of Mars, such as serpentine, Fe- and Mg-rich smectites such as saponite, and muscovite (Fig. 3). Spectral mixtures of Fe, Mg-rich and Al-rich phyllosilicates are also a possibility. Conclusive judgments await more refined data processing and further observations; nevertheless, small-scale mineralogic diversity combined with evidence for alteration of materials by long-term interaction with liquid water make this region a compelling site for exploration by landed missions.

Future work: Intra-image phyllosilicate diversity may be due to layering in small outcrops or all types may be contained within a contiguous geological unit with spatial variation in composition. High-resolution imagery, e.g. from HiRISE, can establish the relationship of these mineralogic signatures with geomorphic features. Additionally, we continue to examine OMEGA datasets combined with new CRISM images to determine the abundance of these types of phyllosilicates—and the possible existence of others—in

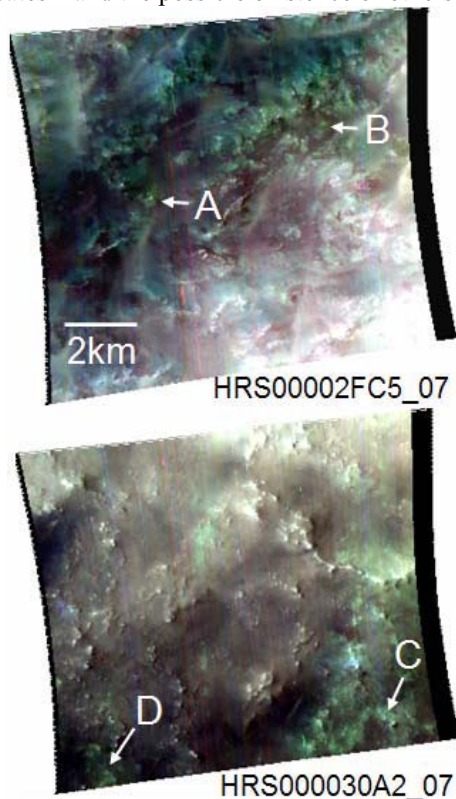


Figure 2. False color ($R=1.39$, $G=1.81$, $B=2.41\mu\text{m}$) composites of CRISM images. Green areas have phyllosilicate signatures. Letters indicate locations of Fig. 3 spectra.

Nili Fossae and adjacent regions. Together, this information will be utilized to constrain the environment of phyllosilicate formation.

References: [1] Hamilton V.E. and Christensen P.R. (2005) *Geology*, 33, 433-436. [2] Mustard J.F. et al. (2005) *Science*, 307, 1594-1597. [3] Poulet F. et al. (2005) *Nature*, 438, 623-627. [4] Bibring J-P et al. (2006) *Science*, 312, 400-404. [5] Mangold N. (2007), *JGR*, in press. [6] Mustard J.F. et al. (2007) *JGR*, in press. [7] Mustard J.F. et al. *LPSC XXXVIII* (this conf.) [8] Bibring, J-P et al. (2005) *Science*, 307, 1576-1581. [9] Murchie S. et al. (2007) *JGR*, in press. [10] Pelkey, S. et al., (2007), *JGR*, in press.

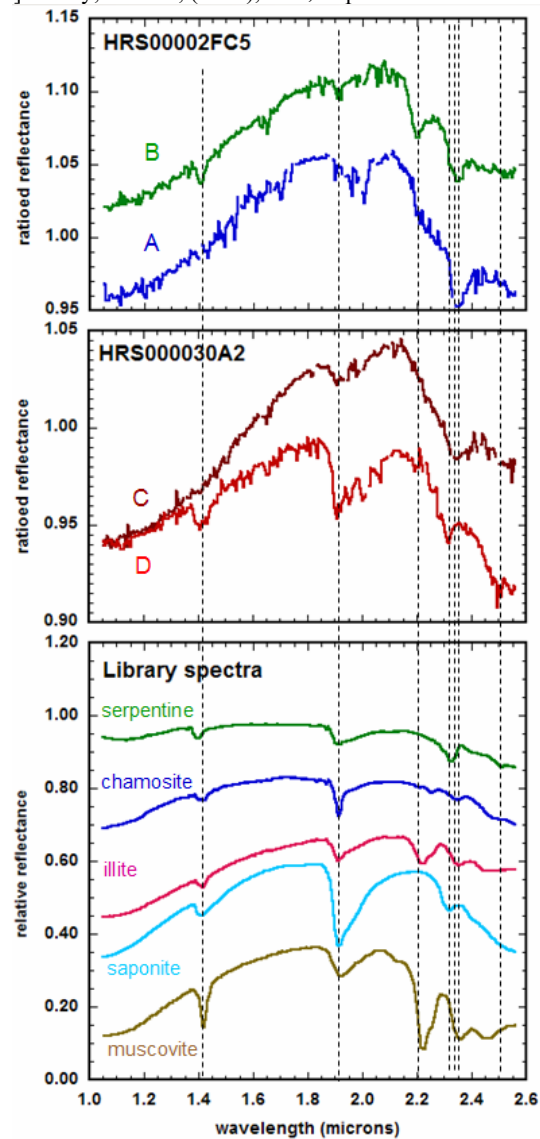


Figure 3. (top two panels) 3x3 averaged and ratioed CRISM spectra taken from locations in Fig. 2. (lower panel) candidate spectral library matches include minerals not previously observed on Mars, however, a mixture with montmorillonite is also a possibility