

PHYLLOSILICATES RELATED TO EXPOSED KNOBS IN SIRENUM FOSSAE, ARIADNES COLLES.
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Introduction: The Sirenum Fossae region on Mars hosts a variety of enigmatic deposits, including light-toned knobs in several large basins [1,2] and extensive mantling deposits [3,4]. The large, degraded basins in the region (170° to 192° Lon, -30° to -50° Lat), including Gorgonum Chaos, Atlantis Chaos, and Ariadnes Colles have been proposed to have been the site of a large paleolake that overflowed to create Ma'adim Valles [6,1]. Hydrated and phyllosilicate minerals have been identified in this region and in the nearby Columbus Crater [1,5,8-10]. Here we supplement these mineral identifications with additional analysis of CRISM data of the deposits comprising the enigmatic knob fields [5] in Ariadnes Colles. Ariadnes Colles (as well as Atlantis and Gorgonum Chaos) contain Knob like deposits [7], light toned in color, that have been exposed from underneath a large volcanic deposit (the “Electris” deposit) [11,12]. These “knobs” were hypothesized to be evaporate and or sedimentary lake floor deposits or possibly eolian-reworked sediment [2].

Methods: HiRISE, CRISM, as well as CTX and THEMIS data were used to look for and study the Knobs and their composition. The phyllosilicates were located and identified using full resolution target (FRT) CRISM data targets. CRISM targets are spectral images ~10 km wide from 0.4 – 4.0 μm comprised of 544 wavelengths with a resolution of 18 meter per pixel [13].

The data was processed using the appropriate atmospheric and photometric corrections. The spectra shown in figure 1 are derived from a commonly used technique of ratioing areas that exhibit possible phyllosilicate absorptions using summary parameters with points that have low spectral contrast in the image along the same sample lines. This mitigates instrumental artifacts and remaining atmospheric bands. ROI size varied, though were all greater in area than 5x5 method ROI's.

Results and Discussion: Due to atmospheric conditions and dust, only a few of the CRISM targets were able to be used. However, we were able to verify the consistency of the composition of the light toned material present in the knobs. The light toned deposits exhibit very strong 1.9- μm and 2.3- μm band absorptions indicative of Fe/Mg-phyllosilicates [14]. The 2.3- μm absorption however is centered on 2.3112-2.3178- μm band. The 1.4- μm absorption is either too weak to be discerned, or is centered near 1.3949- μm . when these

two details are combined, it is very strong evidence and an indicator that these light toned deposits have a Mg rich composition [15]. The 2.31-2.32 μm band absorption is indicative of a trioctahedral Mg endmember such as saponite and hectorite [14,15]. The 1.39- μm absorption results from the 3Mg-OH octahedral cation, further indicating the presence of Mg in the knobs [14,16,17]. It is possible however that there is mixing of Fe/Mg smectites present in the knobs, most notably in FRT00013786 and FRT0000A106 the 2.3- μm absorption ranges from 2.29-2.31 μm [18].

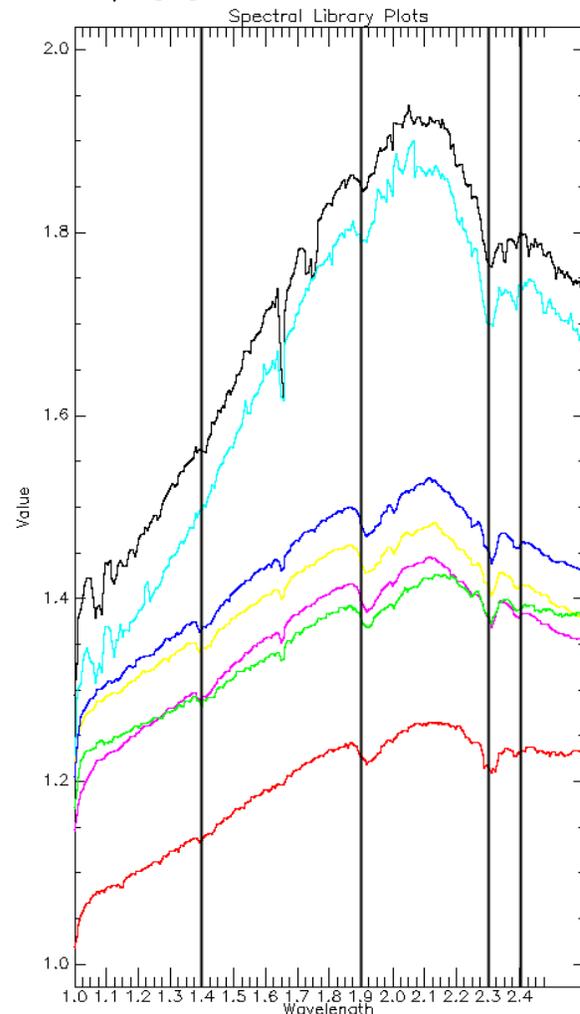


Figure 1: (In descending order/color): [Black, 13786_ratio_2], [Cyan, 13786_ratio_1], [Blue, 8C90_ratio_4], [Yellow, 8C90_ratio_3], [Pink, 8C90_ratio_1], [Green, 8C90_lower_ratio_2], [Red, A106_ratio_2]

Also of note is the possible presence of Al- phyllosilicates in the FRT00013786 spectral ratios. A very weak 2.2- μm and comparatively stronger 2.35- μm absorption is present, but this might be caused by the presence of chamosite instead of an Al-OH vibration [14,15].

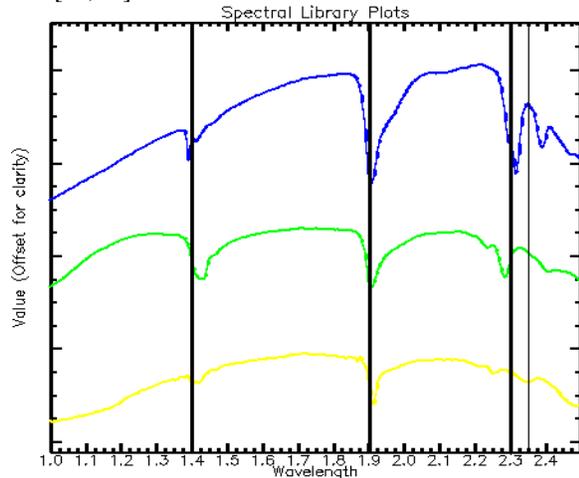


Figure 2: Reference spectra, blue is Mg-rich Saponite (LASA53), green is Fe-rich Nontronite (NCJB26), yellow is chamosite (LACH17)



Figure 3: VNIR image of CRISM target FRT00013786, approximate resolution of 20 meters per pixel. Light toned areas bare phyllosilicates.

It is also of interest to note that the 1.4- μm absorption varies between 1.38-1.41 μm . The 1.43- μm absorption indicative of 2Fe-OH octahedral cation is absent in almost all of the extracted ratios, except for in FRT0000A106 and in FRT00008C90. On the whole however, the knobs are mostly composed of Mg-Rich phyllosilicate with some mixing of Fe and Al phyllosilicates as well. As for the identity of the phyllosilicate, Saponite, Hectorite, and Sepiolite are possibilities, with saponite being the most similar. However giving the general composition, some conclusions can be made. The general composition indicates a magne-

sium rich smectite with potential iron smectite mixing, as well as possible Al smectites. However magnesium is by far the most dominate cation, with iron either mixed in as another cation or from dust.

Working within this range of possibilities for the composition of the knob deposits, we find supporting evidence for a paleo lake environment in Sirenum fossae. Magnesium rich phyllosilicates can form in arid desert conditions such as paleo-desert lakes with alkali water (pH of 8-10) [19] and that the knobs could be sourced from weathered volcanic detritus in an alkali environment [19,20]. Although given the range of minerals identified, this is but one possible source.

Conclusion: What can be concluded from these results is that: (1) the high albedo deposits contain phyllosilicate material; (2) this phyllosilicate material is Mg rich in composition with possible mixing in of Al and Fe rich phyllosilicates in small amounts; (3) that the composition of the knobs is mostly consistent, however variations due to differences in atmospheric conditions and other factors are present. (4) These Mg rich smectites do support the original hypothesis of a paleo lake environment, as Mg rich smectites form from either weathered volcanic detritus or progressive accumulation in marine or lacustrine water [19, 20].

References:

- [1] Irwin, R.P. et al. (2002) *Science*, 296, 2209-2212.
- [2] Moore, J. M., Howard, A. D. (2003) *Lunar and Planetary Sci. Conf. XXIV*, Abstract 1402.
- [3] Grant, J. A., Schultz, P. H. (1990) *Icarus*, 84, 166-95.
- [4] Grant, J. A. et al. (2010) *Icarus*, 205, 53-63.
- [5] Wilhelms D. E. et al. *Lunar Planet. Sci. Conf. 19*, 355 (1989).
- [6] Irwin, R. P., III et al. (2004) *J. Geophys. Res.*, 109, E12009, doi:10.1029/2004JE002248.
- [7] Baker D.M. et al. (2009) *LPS XL*, Abstract #1835.
- [8] Altheide, T. S. et al. (2010) *Lunar and Planetary Sci. Conf. 41*, Abstract 2479.
- [9] Noe Dobrea, E. Z. et al. (2008) *AGU Fall Meeting Abstracts*.
- [10] Wray, J. J. et al. (2009) *Lunar and Planetary Science Conference 40*, Abstract 1896.
- [11] Schultz P.H. (2002), *LPSC XXXIII*, Abst. 1790.
- [12] Moore J.M. and Howard A.D. (2005), *LPSC XXXVI*, Abst. 1512.
- [13] Murchie S. L. et al. (2009) *J. Geophys. Res.*, 114, E00D07, doi:10.1029/2009JE003344.
- [14] Poulet F. et al. (2005) *Nature*, 438, 623-627, doi:10.1038/nature04274.
- [15] Ehlmann B.L. et al. (2009) *J. Geophys. Res.*, 114, E00D08, doi:10.1029/2009JE003339.
- [16] Clark R.N. et al. (1990) *J. Geophys. Res.*, 95(B8), 12,653-12680.
- [17] Bishop, J. L. et al. (2002) *Clay Miner.*, 37, 607-616.
- [18] Perry K. A. (2010) *LPS XLI*, Abstract #2605.
- [19] Velde B., Meunier A., *The Origin of Clay Minerals in Soils and Weathered Rocks*. (Springer, Berlin, 2008).
- [20] Chamley H., *Clay Sedimentology* (Springer, Berlin, 1989).