MINERALOGY OF LAYERED DEPOSITS IN TERBY CRATER, N. HELLAS PLANITIA.

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Introduction: The recent detection of hydrated minerals on the surface of Mars has bestowed new insights into its aqueous past. Hundreds of hydrous silicates-bearing sites have been identified and analyzed, showing great diversity of geological setting and mineral composition (e.g. [1-7]). A great number of these sites are found over the northern Hellas basin and further north in Terra Tyrrhena [4, 10]. This study focuses on a subset of sites located within the 165 km Terby crater, on the northern edge of the Hellas impact basin. We report the identification of two distinct hydrous mineral-bearing exposures using OMEGA and CRISM spectral imaging data. These deposits are for the most part found in layered strata within terraced mesas.

Overview: Terby is a large, 165 km crater south of Terra Tyrrhena bordering the Hellas basin (Fig. 1). Its morphology is most uncommon as it is broadly flat, to the exception of the northern rim area. Wherever exposed by erosion, the underlying material are heavily terraced mesas, which are hypothesized to be the result of deltaic depositional processes [11, 12]. Hydrated minerals were first identified by the OMEGA instrument in layers within the northern mesas. We confirm these detections and report new sites and minerals signatures within Terby crater using CRISM high resolution observations. We used 6 CRISM observations of the mesas. Small sites exhibiting weak hydrous mineral signatures have been detected elsewhere in Terby crater (Fig. 1).

Method: In order to find hydrous mineral exposures we built spectral parameter maps from near infrared surface reflectance data. These parameters are spectral ratios that test each spectrum for absorption bands at key wavelength around 1.4, 1.9, 2.2 and 2.3-2.4 µm. Once maps have indicated possible sites of interest, we recover the spectral signatures and compare them to laboratory spectra of hydrous minerals. The maps shown in Fig. 3 are based on the depths of the 1.9, 2.32 and 2.4 µm bands or shoulders. Because of varying data quality amongst CRISM observations, we have adapted the thresholds of each map so as to have similar noise levels. Noisy data occurs when detector temperature is above its nominal value of less than 126K or when the atmospheric dust content in the atmosphere is high.

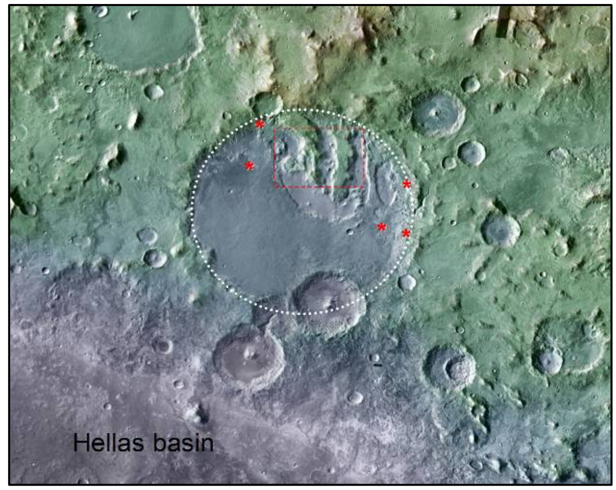

Figure 1. Regional THEMIS/MOLA mosaic centered on Terby crater (*74°E, 28°N*). The red rectangle indicates the main region of interest. Other minor sites not discussed herwith the presence Fe/Mg phyllosilicates are indicated by red stars.

Hydrous mineralogy. We have identified two spatially and spectrally distinct hydrated mineral units. Unit 1 has spectral signatures consistent with Fe/Mg phyllosilicates, while unit 2 corresponds to poly-hydrated sulfates or zeolites. Unit 1 signatures resemble laboratory vermiculite spectra (Fig. 2), although the position of the 2.32 µm is slightly shifted towards shorter wavelengths in comparison to other vermiculite-type signatures on Mars [4,8]. This may suggest a slightly more iron-bearing mineral assemblage. In addition, similar weak signatures have been detected elsewhere in the crater (Fig. 1).

Unit 2 signatures are overall weaker and less straightforward. Because of the spectral ambiguity between poly-hydrated sulfates and zeolites, it is not possible at this point to clearly identify the mineral specie(s). In Fig. 2 are shown a few examples of candidate matches to unit 2 signatures. The spectral ambiguity is problematic as zeolites and sulfates can be formed in different geochemical settings. Zeolites are found on earth in various environments including: deep sea sediments, saline alkaline lake sediments, tephra deposits, low grade metamorphic and hydrothermally altered rocks [13]. Sulfates are found in more restrictive conditions such as evaporitic acidic waver bodies or aqueous alteration of volcanic ash.

Geological setting : CTX and HiRISE imagery demonstrate that both units have distinct settings and never overlap. Unit 1 is always found locally at higher topography than unit 2, and near the mesas' summit. The latter is found in 3 out of 4 occurrences at the bottom of the terraced mesa (Fig. 3). CRISM high resolution coverage of the mesas is limited to these 6 observations, however, based on its morphology, we hypothesize that the zeolite/sulfate unit extends to many small bedrock exposures along the mesa floors, as exampled by the westernmost observation. Further investigation is under way to better constrain the geological settings for both units.

Ansan et al. [11, 12] have suggested the existence of sulfates at the bottom of Terby crater at a time when only OMEGA data was available. Sulfates may have formed in intermittent lakes after the depositional sequences that built the terraced mesas, in intermittent saline acidic lakes. Alternatively, they explain the presence of zeolite from diagenesis of compacted material at the sequence bottom.

Relationships with the northern cirum-Hellas province: They are many signs of intense intense aqueous activity to the north in Terra Tyrrhena [4, 8, 9, 10]. In addition, we have recently found vermiculite-type minerals in exposed stratified terrains in the northern circum-Hellas province. This leads us to believe that Terby is the most striking of many examples of hydrated layered deposits in the region. To date however, Terby is the only site where sulfates/zeolites have been detected in the northern Hellas rim.

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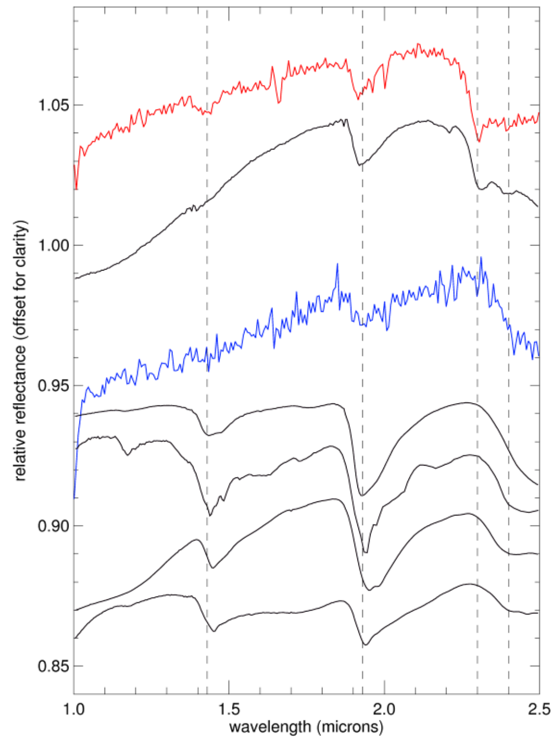

Figure 2. Spectral proof for units 1 (red) and 2 (blue). Lab spectra from the USGS and RELAB libraries are in black. From top to bottom: Vermiculite, Gismondine (zeolite), Scolecite (zeolite), Rozenite (sulfate) and Copiapite (sulfate).

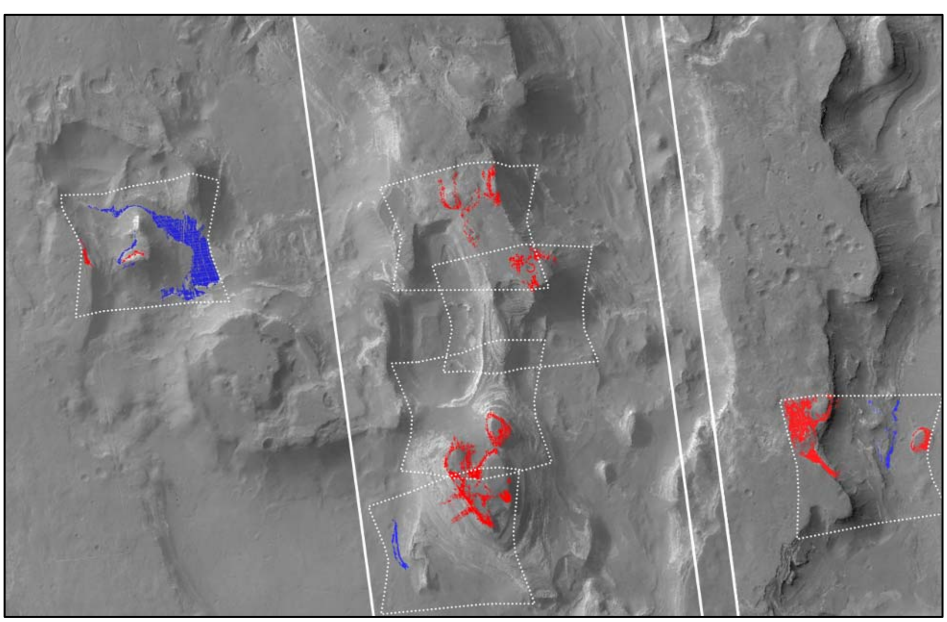

Figure 3. CTX mosaic map of the northern mesas in Terby crater. Unit 1 signatures (vermiculite) are in red and unit 2 signatures (Zeolites/sulfates) are in blue. CRISM footprints are represented in dotted lines.