COMPARISON OF INTERIOR LAYERED DEPOSITS IN CHAOTIC TERRAINS.

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Introduction and background: This study combines high-resolution image, elevation and spectral data in a comparative study of ILDs located in the eastern Valles Marineris and their adjacent chaotic regions in order to ascertain possible correlations.

Interior layered deposits (ILDs) have been reported from several regions of Valles Marineris and craters in strong association with chaotic regions, hydrated minerals and hematite [1-3]. Several studies concering their origin, whether volcanic or sedimentary [4-6] are on record.

Observations on ILDs: The characterization of ILDs showed that they partly vary in terms of erosional shape, thickness, elevation, material competence and possibly mineralogy, but are mostly comparable concerning their morphologies. On the tops of ILDs, two different types of morphology were ascertained (Fig. 1) which correlate with respect to their mineralogical properties. At the time, the two types differ in their albedo as well as in their state of weathering and erosion. Oddly enough, there is no correlation with elevation, thickness, or competence (derived by TES-TI) that could reinforce the above correlation. However, there is a correlation in the close proximity to outflow channels and in the visual state of rock break-up between hydrated and probably non-hydrated ILDs (Fig. 2). Furthermore, stair-stepped morphologies observed in ILDs suggest they have alternating strata of competent and less competent material. Actually, thickly bedded lower units and thinly layered upper units can be observed (Fig. 4). Moreover, there are signs that the ILD material is highly consolidated, which is confirmed by meter-sized boulders and talus at the base of steep scarps (Fig. 4). Different hydration states of sulfates are present here and have been reported from ILDs in the western Valles Marineris [8]. These demonstrate post-deformational humidity changes may be responsible for volume changes, angular joints and rock fragmentation into boulders as seen in Fig. 4. This observation is also confirmed by convoluted patterns on the spectrally neutral cap rock (Fig. 3, 4) which may indicate dehydration. Since ILDs show different morphological units these in turn are ascribed to certain elevations (Fig. 2). The occurrence of hydrated sulfates in turn indicates sufficient water or humidity may have been present up to a certain elevation. Iani 2, Iani 3, and Ganges 1 are sulfate-bearing up to the top (-3000 m and -500 m), so the original uppermost elevation of hydrated sulfate could be higher than measured (Fig. 2).

Morphological units: For Aureum 2 (Fig. 2) two morphological units could be discerned (Fig. 2, 4) and compared to their spectral properties (Fig. 3). The boundary between both is at -4250 m (Fig. 2). The lower unit (unit 1, Fig. 4) is thickly bedded and features a high albedo, steep scarps, coarse-grained (boulder) material and angular joints on a massive-appearing surface (Fig. 4). Kieserite and polyhydrated sulfates (PHS) were identified by CRISM on well-eroded ILD surfaces within unit 1 (Fig. 3, 4). They were identified by their typical 1.6-1.9-2.4µm and 1.4-1.9-2.4 µm absorptions [1]. Kieserite is restricted to steep, high albedo regions that produce talus rock debris and boulders (Fig. 3, 4) in parts shows angular joints. It forms cliffs and apparently is interlayered with PHS within unit 1 (Fig. 3, 4) or massive. PHS are slope-forming and of lower albedo often observed on (Fig. 3, 4). PHS interlayered with kieserite was also observed on ILDs in the western Valles Marineris e.g. in East Candor Chasma [8]. The upper unit (unit 2) is characterized in parts by a slightly lower albedo and thin bedding (Fig. 2, 4). It features a stair-stepped morphology implying alternating strata (Fig. 4) which, in turn, indicates material differences, meaning that some materials are less resistant to weathering and erosion and is thus of different consistency. It features monadnocks and surface vales. Apparently, some materials are less resistant to weathering and erosion, so that the surface ultimately looks rough, sharp-edged and irregular. This unit corresponds to the cap rock ILDs shown as type 2 in Fig. 1. However, the cap unit (unit 2) is spectrally neutral (Fig. 3) which either indicates mineral features are covered by aeolian material or there are no hydrated or iron-bearing minerals at all. The exposure of PHS and kieserite on different regions, their different appearance (Fig. 3, 4) and the certainty that they require different conditions for their formation [9] may suggest that PHS could have formed secondarily out of kieserite by water absorption due to surface humidity.

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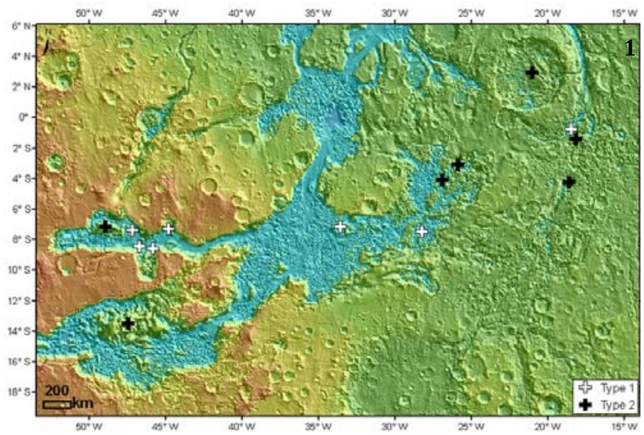

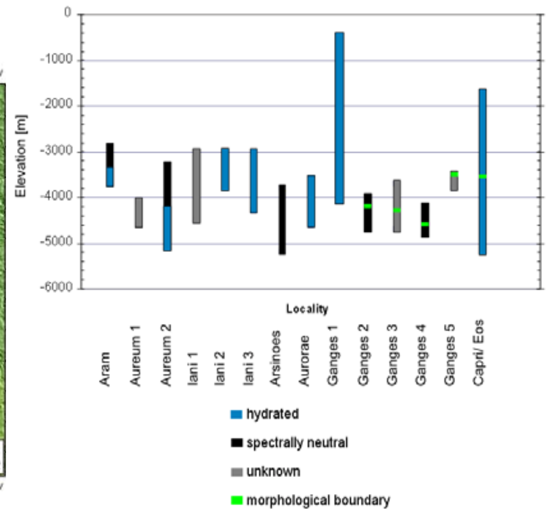

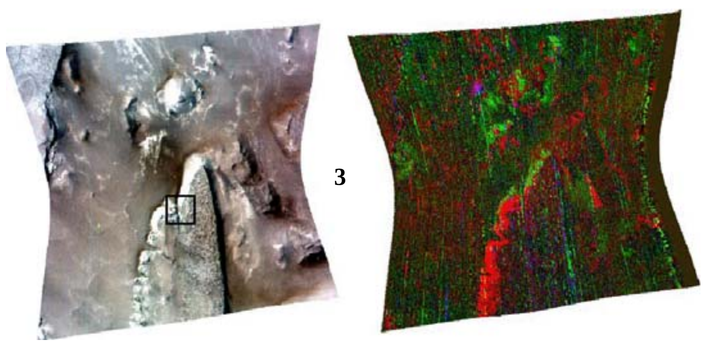

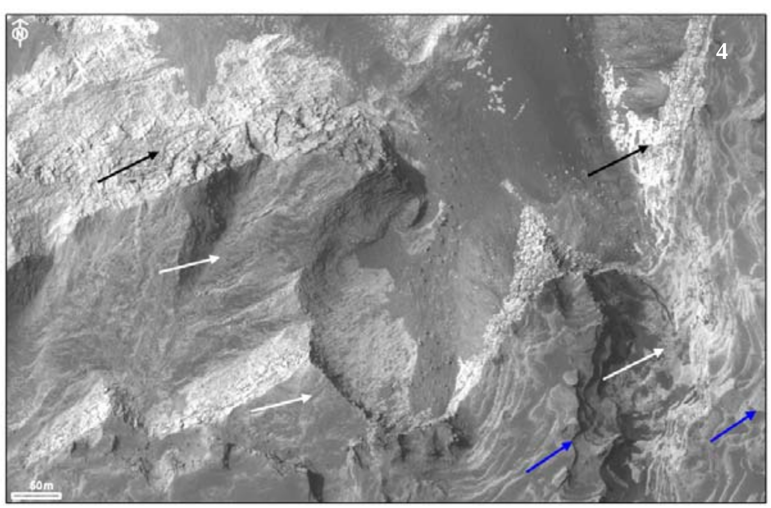

Fig. 1: *MOLA map of the research area showing the two different surface morphologies on the top of ILDs. Surface type 1 (white crosses) showing an 'adjusted' surface structure probably highly affected by wind erosion, as indicated by grooves and flutes. Surface type 2 (black crosses) displays surface vugs and sharp-edged crests and corresponding to cap rock. Layering is extremely fine especially in type 1.* ***Fig. 2:*** *Diagram showing the extent of hydrated units within ILDs in elevation. Overall hydrated minerals were detected between -5200 m to -500 m within chasmata. In chaotic terrains, hydration is found from -5100 m to -3000 m. Hydration boundaries correlate with the morphological differences between units within ILDs. Their upper unit mostly corresponds to spectrally neutral cap rock (Fig. 1, 3) whereas the lower unit is hydrated in most cases. Elevations are based on HRSC DTMs.* ***Fig. 3:*** *CRISM observation (orbit FRT00009DAD) in Aureum Chaos (27°W/4.3°S; cf. Aureum 2 in Fig. 2). Black box indicates Fig. 4. (right) Green represents kieserite, and red PHS. PHS appears above kieserite in low albedo regions within unit 1. Kieserite is evident in several high albedo features as monadnocks whereas PHS apparently is distinctly layered (Fig. 4). Note that the cap rock unit (unit 2) is spectrally neutral.* ***Fig. 4:*** *Discrepancies between unit 1 and unit 2 (HiRISE orbit PSP_007217_1755). See Fig. 3 for context. Unit 1 coincides with kieserite-rich material (black arrow) and polyhydrated sulfates (white arrow). Unit 1 features thickly bedded strata, whereas unit 2 (cap rock unit) displays distinct layering of convoluted strata and a stair-stepped morphology (blue arrow). Note angular joints, talus and boulders within unit 1 and rock rock-break-up indicating highly consolidated material.*