AN INTEGRATED STUDY OF INTERIOR LAYERED DEPOSITS IN HEBES CHASMA, VALLES MARINERIS, MARS, USING MGS, MO, AND MEX DATA.

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Introduction: Despite more than three decades of analysis, the origin of the Interior Layered Deposits (ILD) in the Valles Marineris (VM) trough system is still unknown. The advance of new remote sensing data obtained by the recent planetary missions Mars Global Surveyor (MGS), Mars Odyssey (MO), and Mars Express (MEX) allow investigation of the morphology and composition in unprecedented detail. This study focusses on Hebes Chasma (HC) in the central VM, which is unique because it contains a huge mesa of ILD in a completely closed depression.

Overview: Hebes Chasma covers an area of about 25.200 km^2 and has a maximum depth of ~8000 m (Fig. 1). It is cut by many tectonic faults, which were suggested to control the box canyon-like shape of the closed depression [1]. A prominent ILD (Hebes Mensa or HM) has a length of ~120 km and a width of 50 km. It is elongated parallel to the elongation of HC. It was early recognized that a lacustrine origin for Hebes Mensa is unlikely [2,3], because its height almost equals that of the surrounding plateaus. Also, HC does not have pathways for in- or outflowing surface water.

Layer Geometry: We used topographic data from the HRSC camera [4] onboard MEX to analyze the geometry of layering in HM with the Orion structural analysis software. Strike and dip were measured in 50m/px gridded Digital Elevation Models and corresponding orthoimages (Fig. 2a,b). These data have a higher spatial resolution than those used in an earlier study [5]. We find that the layers dip gently with up to ~12° on the northern ILD wall (wall slope ~20°) and with steeper slopes up to ~22° on the southern ILD wall (wall slope >30°). The layers always dip in the downslope direction (Fig. 2a,b). These results are in agreement with our earlier results [5] and those of [6], both in HC, and with our similar ILD studies in western Candor [7,8] and Ophir Chasmata [9], also based on HRSC topography.

Mineralogy: The imaging spectrometer OMEGA [10] onboard MEX provides information about the mineralogy of the uppermost surface layer. One of the most spectacular OMEGA results was the detection of sulfates in the VM [11]. We compiled a mineralogic map of HC showing concentrations of polyhydrated sulfates, kieserite, and oxides (Fig. 3). These minerals are observed in low-lying areas (cf. Fig. 1), which are not covered by landslides. They are associated with layers, as elsewhere in VM [11], but NOT to HM. A particularly interesting area is a depression immediately east of HM. Its walls are made up of layers, but it is questionable if these layers are of the same nature than the layers of the ILD. We tentatively suggest that they are in a stratigraphically lower position than the layers of the ILD. This depression shows the greatest diversity and largest abundance of alterated minerals.

Thermal Inertia: We used nighttime IR data from THEMIS onboard MO to produce a thermal inertia map (Fig. 4). In general, thermal inertia is higher in HC than on the surrounding plateaus or on the flat top of HM. There is no obvious correlation between thermal inertia and mineralogy shown in Fig. 3.

Interpretation: We consider a lacustrine origin of the ILD in HC as unlikely. The downslope dipping of ILD layers is in agreement with a draping process, e.g., pyroclastic fall deposits from an W-E trending volcanic vent. The occurrence of alteration minerals only in very deep portions of HC also argues against a deposition in a deep body of standing water. Groundwater, not meteoric water, might have played a major role in rock alteration, as elsewhere on Mars [12]. Alternatively, it can not be excluded that sulfates and oxides belong to ancient altered deposits [13], which were exhumed during HC formation.

References: [1] Wilkins, S. J. and Schultz, R. A. (2003) *JGR*, *108*, 5056, doi:10.1029/2002JE001968. [2] Malin, M. C. (1976) *Ph.D. Thesis*, Calif. Inst. Tech., Pasadena. [3] Peterson, C. (1981) *Proc. Lunar Planet. Sci.*, *12B*, 1459-1471. [4] Neukum, G. et al. (2004) ESA Spec. Publ., 1240. [5] Hauber, E. et al. (2005) *LPS XXXVI*, Abstract #1760. [6] Beyer, R. A. and McEwen, A. S. (2005), *LPS XXXVI*, Abstract #1070. [7] Fueten et al. (2006) *GRL* (in review). [8] Stesky, R. et al. (2006) *this conference*. [9] Zegers. T. et al. (2006) *this conference*. [10] Bibring, J-P. et al. (2004) ESA Spec. Publ., 1240. [11] Gendrin, A. (2005) *Science*, *307*, 1587-1591. [12] Grotzinger, J. P. et al. (2005) *EPSL*, *240*, 11-72. [13] Malin, M. C. and Edgett, K. S. (2000) *Science*, *290*, 1927-1937.

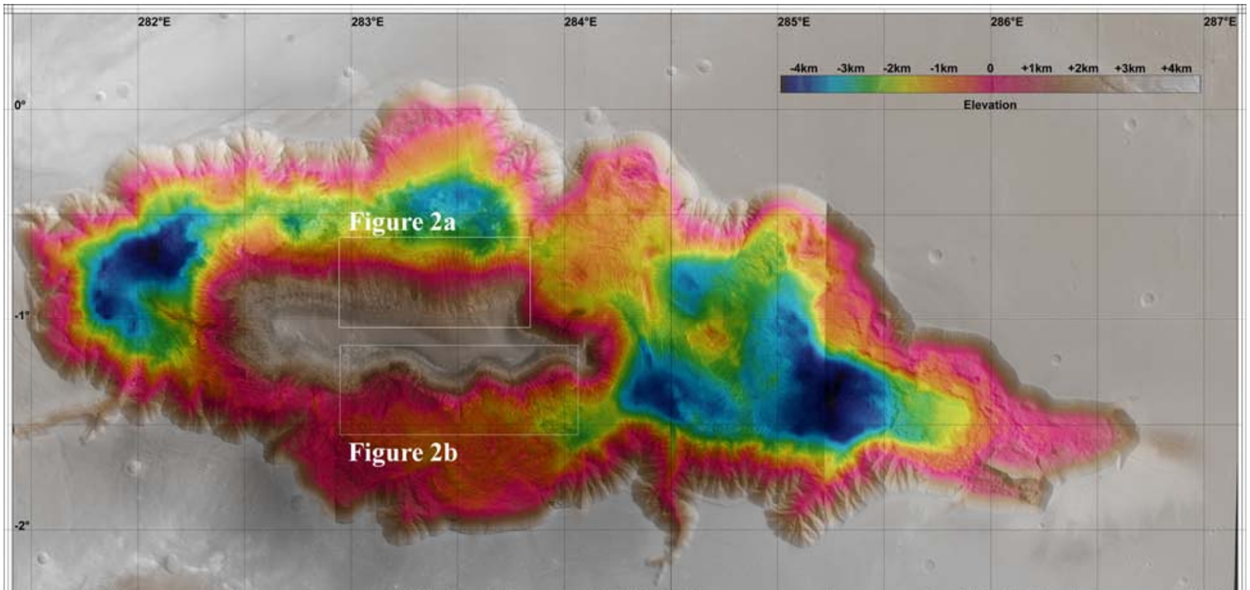


Fig. 1: Topographic image map of Hebes Chasma (HRSC image mosaic merged with MOLA topography)

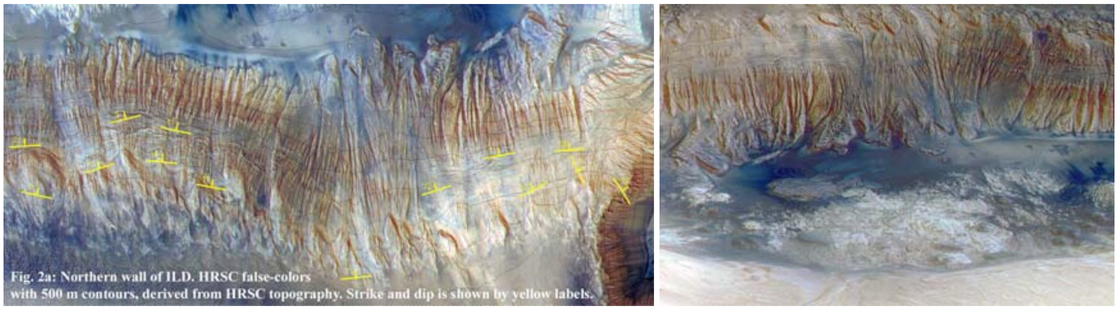
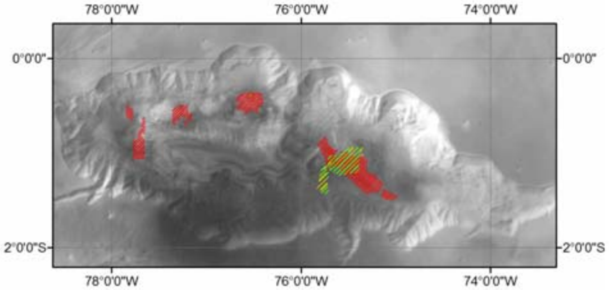


Fig. 2a: False-color HRSC images of northern wall of ILD. *(left)* strike and dip measurements shown by yellow labels (12.5 m/pixel; contour interval 500 m). *(right)* 3D view, looking from north.

Fig. 2b: Southern wall of ILD (see Fig. 2a for details). *(left)* strike and dip measurements. *(right)* 3D view (from S).



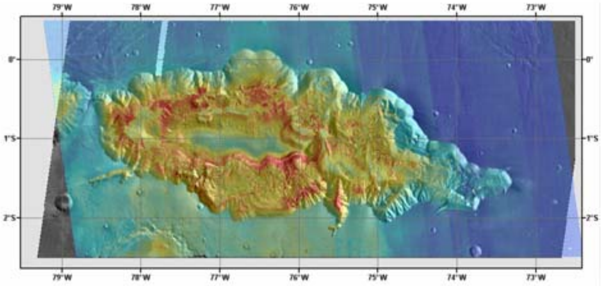


Fig. 3 *(left)*: Mineralogy derived from OMEGA data. Red: Kieserite, Green: Polyhydrated sulfates, Orange: Oxides.
Fig. 4 *(right)*: Thermal inertia from THEMIS data (red: high, blue: low) on THEMIS daytime IR mosaic.