Geomorphological and mineralogical mapping of Hebes Chasma, Mars

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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 in the central VM, which is unique because it contains a huge mesa of ILD in a completely closed depression. We used topographic data from the HRSC camera onboard MEX to analyze the geometry of layering in Hebes Mensa with the Orion structural analysis software. Strike and dip were measured in 50m/px gridded Digital Elevation Models and corresponding orthoimages. These data have a higher spatial resolution than those used in an earlier study. We find that the layers dip gently in the downslope direction. These results are in agreement with our earlier results in Hebes Chasma and with our similar ILD studies in western Candor and Ophir Chasmata, also based on HRSC topography. A mineralogic map indicating concentrations of polyhydrated sulfates, kieserite, and oxides was produced from OMEGA spectral data. It shows that these alteration minerals are only observed in low-lying areas, which are not covered by landslides. We consider a lacustrine origin of the ILD in Hebes Chasma as unlikely. The downslope dipping of ILD layers is in agreement with a draping process, e.g., pyroclastic fall deposits from a W-E trending volcanic vent, or a series of WNW-ESE trending vents in an en echelon alignment. Thin, finely layered deposits on top of the plateaus surrounding vm (e.g., west of Juventae or south of Ius ChasmaTA) could represent that portion of the pyroclastics which escaped the troughs and were distributed on the adjacent high plains. The occurrence of alteration minerals only in very deep portions of Hebes Chasma 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. Alternatively, it can not be excluded that sulfates and oxides belong to ancient alterated deposits, which were exhumed during Hebes Chasma formation.