A GIS BASED COMPILATION OF MORPHOMETRIC PARAMETERS OF VALLES MARINERIS ILDS

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Introduction: Light toned layered deposits (LTLDs) or interior layered deposits (ILDs) as they are referred to within the chasma of the Valles Marineris (VM) canyon system, are ubiquitous in the equatorial region of Mars [1,2]. They are characterized by rhythmic layering, and higher albedo compared to the surrounding basalt. The objective of this study is to compile a morphometric database of all the ILDs occurring within the VM chasmas and then to study them using spatial statistical techniques. Previous studies of ILDs are mostly constricted to a specific geographical setting [3-7]. This study aims to provide insights into the factors that govern the spatial distribution of the ILDs across the VM canyons. The results of the first part of the study, focused on recording the morphometric properties of the ILDs of the VM, are presented here.

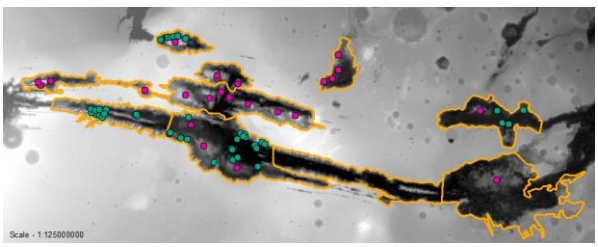

Figure 1: MOLA DTM of Valles Marineris region showing the ILDs surveyed till date. The pink circles indicate major deposits with volumetric information. The green circles represent all other small deposits. The orange lines show the digitized boundary of the chasmata.

Data and Methodology: Greyscale images from Context Camera (CTX) [8] laid over color coded DTMs were used for delineating the boundaries of the ILDs in the VM region. Mosaicking, mapping, and subsequent measurements of area and volume were carried out in ArcGIS 10.1. CTX images providing coverage of the ILDs were mosaicked together and the ILDs were mapped at a scale of 1:150000. High Resolution Stereo Camera (HRSC) DTMs [9] were used for primary volume estimations. For places without HRSC stereo coverage, Mars Orbiter Laser Altimeter (MOLA) DTMs [10] were used. Volumes of the deposits were calculated between the surface of the ILDs and a reference plane computed to mimic the floor on which the ILDs have been deposited. This reference plane was calculated using 2 different techniques [11]. Method 1: In the first approach, a horizontal reference plane corresponding to the lowest elevation of a deposit was computed. Method 2: The second method uses a 2nd order polynomial surface calculated by interpolating the elevation values of the floor unit adjacent to the ILDs. Since the first method will be an overestimation and the second an underestimation of the deposit volumes, the entire range between the two will be taken into account for further analysis.

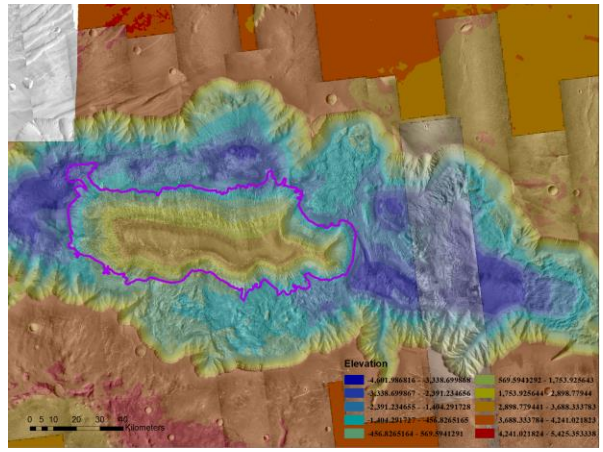

Figure 2: Boundary of Hebes Mensa mapped using CTX mosaic laid over color coded HRSC DTM.

Chasma name	Hebes
Chasma volume (cu. km)	109344.00
Mound name	Hebes Mensa
Latitude	1.00676 ° S
Longitude	76.7683 ° W
Area (sq. km.)	4424.28
Perimeter (km.)	454.68
Minimum elevation (m.)	-3775.31812
Maximum elevation (m.)	3571
Minimum slope	0
Maximum slope	1401.516854
Surface area (sq. km.)	4663.857386
Volume - estimated by method 1 (cu. km.)	22248.29577
Volume - estimated by method 2 (cu. km.)	17426.52456

Table 1: Morphometric parameters that were recorded for Hebes Mensa.

Results and Discussion: Figure 1 shows the locations of the 70 deposits that have been identified across the 9 chasmata (Tithonium(4), Ius (14), Melas (26),

Candor (7), Ophir (2), Hebes (7), Juventae (4), Ganges (5) and Capri (1)). All of the surveyed deposits fall into one of the following categories: huge mesas/plateaus, wall exposures, small outcrops and floor units. Volumes have been estimated for 23 out of the 70 deposits using the above mentioned methods. The geographic and morphometric attributes were recorded in a spatial database. Table-1 is an example of a record from the database corresponding to the ILD in Figure-2.

Future Work: The next stage of this work will incorporate spatial statistical analyses to understand the spatial distribution of the ILDs across the VM troughs. Preliminary results from cumulative frequency distribution studies suggest that the deposits might follow a power law distribution. Further analysis needs to be done to deduce a well-fitting model. The compiled database also contains information about the volumes of the chasmata of VM. This allows for mass balance studies and investigations of the relationship between the size of the deposits and the size of the parent chasmata.

References: [1] Lucchitta, B. et al. (1992) in Mars. [2] Komatsu G. et al. (1993) JGR 98, E6, 11,105-11,121. [3] Malin M. C., Edgett K. S. (2000) Science 290, 1927–1937. [4] Nedell S. S. et al. (1987) Icarus, 70(3):409–441. [5] Popa C. (2007) LPS XXVIII, Abstract #1848. [6] Rossi A. P. et al. (2008) JGR, 113, E08016. [7] Lucchitta, B. K. (1990) Icarus, 82(2), 476-509. [8] Malin, M. C., et al. (2007) JGR 112, E05S04. [9] Jaumann, R., et al. (2007), Planet. Space Sci., 55, 928– 952. [10] Zuber, M. T. (1992) JGR, 97(E5), 7781– 7797. [11] Shover K. R. et al. (2016), LPS XLVII, Abstract #2057. Author A. B. and Author C. D. (1997) *JGR, 90,* 1151–1154.

Database access: For access to the complete database, please contact the authors.