VOLUMETRIC CALCULATIONS OF VALLES MARINERIS USING MOLA DATA AND GIS.

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Introduction: Prior to Mars Global Surveyor (MGS), topographic estimations of the Valles Marineris trough system (VM) were accomplished using photogrammetric techniques. The statistical analysis [1] of the resultant digital terrain models (DTM's) provided a basis for understanding the erosional and structural character and geologic history of VM. However, MGS Mars Orbiter Laser Altimeter (MOLA) datasets coupled with geographic information systems (GIS) provide the means to re-quantify the volume and topography of VM to a higher degree of accuracy. As a result of these advancements, a reassessment of the topographic character of the Valles Marineris chasmata and the geologic history they imply is warranted.

Methodology: The techniques described herein are primarily a duplication of methods described and used by [1] in order to both directly compare and refine previous results based on enhanced MOLA measurements.

In order to calculate volumes of geologic materials and void spaces, it is necessary to have a base level to calculate from, either above or below. This level is determined through extrapolation of the topography surrounding the area of interest. A ~500-meter per pixel Digital Elevation Model (DEM) of VM and its surrounding topography was generated from the raw MOLA dataset. We used a block mean routine to thin the altimetry measurements and then used a spline interpolation to generate a surface. In a GIS, slope values were derived to most accurately determine the edge of the chasmata. Using the digitized area, we separated the DEM into two datasets: one consisting of circum-chasmata (plateau) elevation points and one consisting of inner-chasmata elevation points. A Triangular Irregular Network (TIN) was created to linearly interpolate across the "hole" in the plateau grid, effectively producing a 'lid' for the chasmata. Thus, interpolated pre- and post-erosional surfaces were created. Subtracting the "pre-erosional" surface from the existing surface, we were able to estimate the volume of void spaces residing within Valles Marineris (Figure 1).

Using the same techniques as described above, we are currently attempting to derive volumes of individual geomorphic units from geologic map units delineated by a digitized version of [2]. Furthermore, we are using methods outlined by [1] to determine volumes of material located *above* a base-level elevation interpreted to reflect trough depth prior to potential inner-chasmata volcanic construction.

Results: While this work is still preliminary, initial results are relatively compliant with the previous study [1]. Deviations are in part due to slightly different mapped areas and unit designation: [1] created a modified version of a geologic map of VM [2] for their study, whereas we are utilizing a directly digitized version of [2] fit to the topography. The regional extent of VM from the 1994 study was approximated for this investigation, however, the resulting calculated surface area within the VM was later determined to be 2.6% smaller than that found in [1] which will also produce differences in the overall results. Comparable measurements to the 1994 study are summarized in Table 1 (geologic units compared have a corresponding mapped area.)

The digitization of the chasmata rims produced 'errors' in the change in volume grid (Figure 1) taking the form of negative values comprising <2% of the total pixels within the grid. An 'error' in this case would be defined as any value(s) existing above the interpolated 'pre-erosional' plateau surface. The errors are most pronounced in areas of minimal relief as found along the boundaries of Juventae and associated chasma. The remaining error pixels exist as an extremely thin (~1-5 pixel depth) and unevenly distributed corona at the rim of the VM. This error distribution illuminates the level of approximation of the true plateau rim.

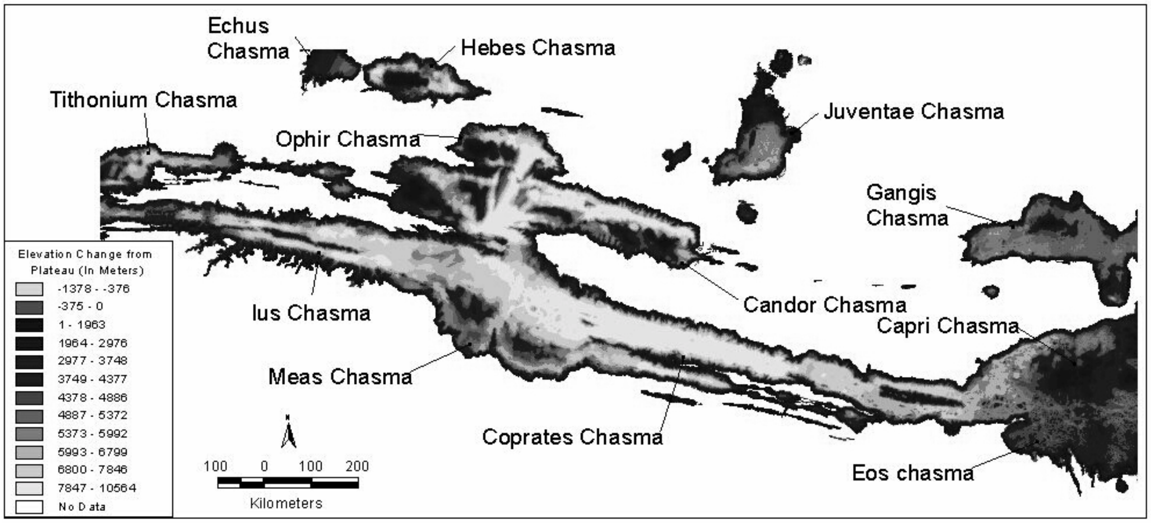
When the surface areas of geomorphic units [2] were measured, the dominance of two units was revealed: *ancient undivided material* (unit HNu) outcropping as wall rock, and *landslide material* (unit As), comprising 30.1% and 12.1% of total area, respectively. Other major units include *layered material* (unit Hvl, 8.5%) and Amazonian *massive material* (unit Avm, 6.8%).

Table 1: GIS Volumetric Measurements (km^2) within VM Compared to Photogrammetric Techniques

	This Study	Lucchitta *et al*, 1994
Total Surface Area	861,540 km^2	884,600 km^2
Wall rock Area	234,432 km^2	249,690 km^2
Combined Landslide Material	94,197 km^2	83,350 km ^{2}
Chaotic Material Area	59,007 km^2	90,370 km^2
Total Void Volume	3,862,861 km^3	3,566,910 km^3

Valles Marineris Topography: E. Noreen, and T. M. Hare

Figure 1: DEM of VM Elevation From Extrapolated Plateau Surface



Continuing Work: A detailed analysis of the volumes of geologic materials and the void spaces above them is ongoing. Three-dimensional modeling will also be conducted as well as spectral analysis to determine any topographic controls on minerologic deposition/emplacement to assist in refining interpretations of the origins of materials within the chasmata.

References: [1] Lucchitta, B.K., Isbell, N.K., and Howington-Kraus, A. (1994) Topography of Valles Marineris: Implications for Erosional and Structural History. *JGR*, vol. 99, #E2, 3783-3798. [2] Witbeck, N.E., Tanaka, K.L., and Scott, D.H. (1991) Geologic Map of the Valles Marineris Region, Mars, U.S. Geol. Surv. Misc. Invest. Ser. Map, I-2010.