TOPOGRAPHIC ANALYSES OF VALLEY NETWORKS AND VOLCANIC RIDGES ON THE FLANKS OF ALBA MONS, MARS. Stephen P. Scheidt[1], David A. Crown[2], and Daniel C. Berman[2]. [1]Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona 85721 (scheidt@lpl.arizona.edu), [2]Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, Arizona 85719.

Introduction: This research employs morphometric analyses [1,2] within a broader investigation of the geologic evolution of the northernmost Tharsis volcano, Alba Mons [3,4]. We are using imaging and topographic datasets to produce 1:1M-scale geologic maps that document geologic features of the volcano's summit region and western flank. Gridded MOLA topography [5] is being used to both validate and extend traditional photogeological mapping and quantitatively characterize intermingled fluvial and volcanic systems.

Background: Alba Mons is a large, low-relief volcano [e.g., 6-10]. The summit caldera complex, extensive lava flow fields, and prominent sets of graben have been described from early Viking Orbiter data [11-20]. A range of volcanic morphologies are present, including lava tubes, channels, and long tabular lobes [11-12, 19-20]. Dendritic valley networks have been mapped on the western and northern flanks of Alba Mons [13, 21-22] as well as on other volcanoes and terrains of Mars [e.g., 23-27]. Most fluvial systems have been dated to the Noachian-Herperian boundary, but the densest population of channels on the flanks of Alba Mons are considered to be Amazonian [26]. Parameterization of land surface topography (e.g., channel profiles, density, length, width, slope and curvature) has proven to aid the interpretation of channels at Alba Mons [22], Hadriacus Mons [27] and in lower latitudes [23-24].

Data Sets and Methodology: THEMIS infrared (IR) and CTX datasets were utilized for photogeologic mapping of linear features. Land surface morphometric parameters (i.e., slope and curvature) were determined from gridded MOLA topography (463 m per pixel) [1]. Noise in the topographic data was reduced by applying a 5×5 low pass Gaussian filter. In order to examine the correspondence of linear features, surface topography and shape using geographic information system (GIS) software, we calculated parameters over different local (1, 2 and 5 km) and regional (10, 25 and 50 km) length scales. Using geoprocessing functions, statistics of land surface shape parameters were extracted from pixels that are overlain by volcanic ridges and fluvial valleys to quantify the separability of features observed.

Geological Mapping Results: Photogeological interpretations produced a preliminary map showing the distribution of fluvial and volcanic features on Alba Mons [3,4]. Mapping of erosional valleys indicates significant fluvial dissection and two primary groups of channels (Figure 1): 1) valley networks that are concentrated on the northern flank and highest regional slopes and 2) elongate drainage systems on the northwestern flank, some of which extend for over 300 km. Trunk valleys are variably defined along their lengths and exhibit discontinuities. In general, mapped valley segments exhibit variable morphologies (e.g., width, depth of incision, and sinuosity). Dendritic patterns are more common on the northern flank and characterize some of the upper reaches of valley systems and adjacent terrains with relatively higher local slopes (> 1.5°, Figure 1). Elongate drainage patterns appear to be controlled by the distribution of volcanic ridges that are interpreted to be lava tube systems extending for hundreds of kilometers (Figure 2). Lava tubes are delineated by sinuous chains of elongate depressions that are often discontinuous and commonly located along the crests of prominent sinuous ridges that intermingle with fluvial valleys.

Topographic Analysis Results: Degradation and mantling of the surface often obscures the signatures of both volcanic and fluvial features in image data. However, topographic signatures in cross-sectional curvature (Figure 3) and topographic profiles (Figure 4) can be used to infer the flow paths of lava tube systems and incised fluvial channels. Converging local slope vectors help to delineate potential fluvial drainage basins, whereas divergent vectors highlight constructional volcanic ridges (Figure 2). Ridged lava tubes and incised erosional valleys are statistically separable using curvature statistics (Figure 3). In some cases, the continuity of lava tubes can be inferred without the presence of collapse features, and local topographic lows can be used to infer potential drainage pathways (Figure 4). These and other relationships will be leveraged from MOLA and higher spatial resolution, stereo-derived sources of topography (HRSC, CTX and HiRISE) as additional base layers to complement geologic mapping.

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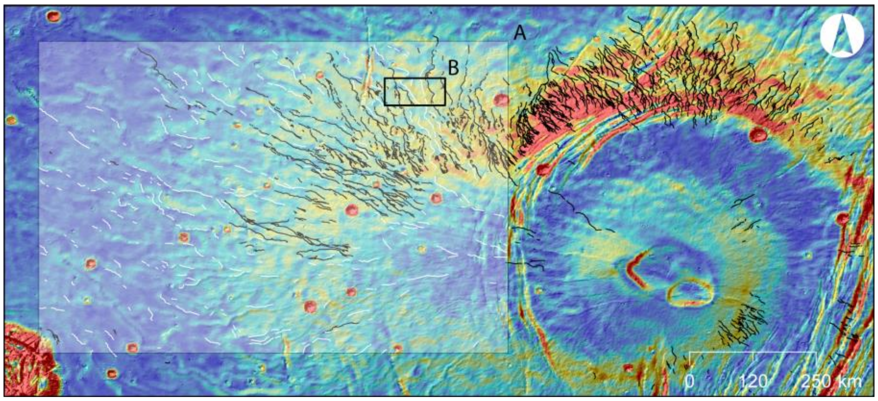

Figure 1. Fluvial channels (black lines) and volcanic ridges (white lines) mapped for Alba Mons. The image is a regional slope map calculated from MOLA data (5 km baselines). Higher slope values in red correspond to the densest valley networks; flat-lying areas are in blue; moderate slopes are in yellow. (A) Inset mapping area used for statistical extractions in Figure 3. (B) Inset for Figure 2.

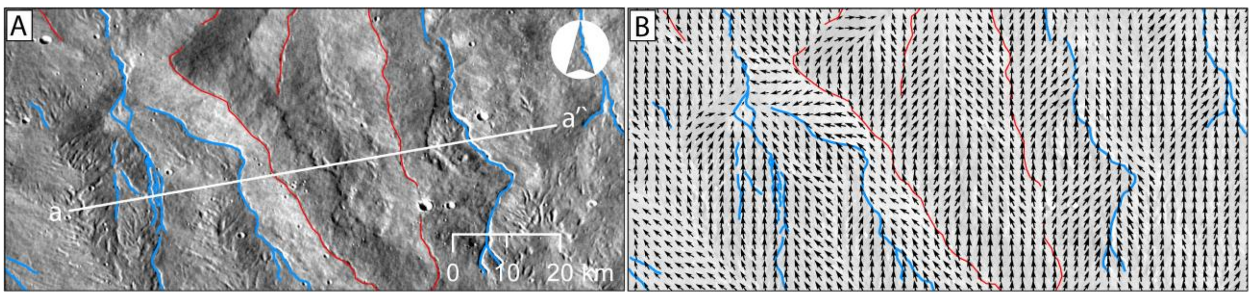

Figure 2. (A) THEMIS daytime IR data show valley networks (blue lines) and volcanic ridges (red lines). Dendritic patterns overprint the margins of some ridged lava tube systems. (Topographic profile a to a' is shown in Figure 4). B. The orientation and magnitude of slope (shown as scaled vectors, calculated using 2 km baselines) are overlain to illustrate patterns of fluvial drainage (convergent arrows) and construtional volcanic flow (divergent arrows).

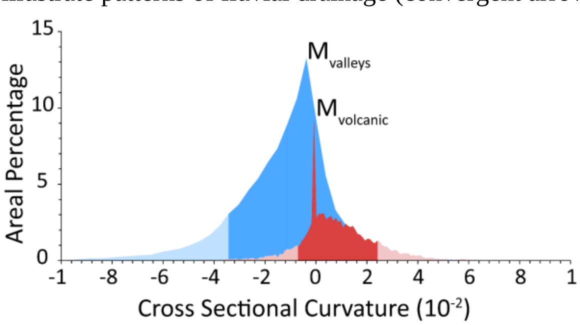

Figure 3. Land surface curvature was calculated from MOLA topography and extracted from pixels that overlap fluvial and volcanic features. The frequency distribution of cross sectional curvature for volcanic features (red) shows that surfaces are convex; the population is positively skewed. Pixels mapped as fluvial valleys (blue) are concave; the population is negatively skewed. The large spike in the frequency distribution of volcanic features ($M_{volcanic}$) shows a significant percentage as having no curvature. The majority of fluvial channels are convex ($M_{valleys}$).

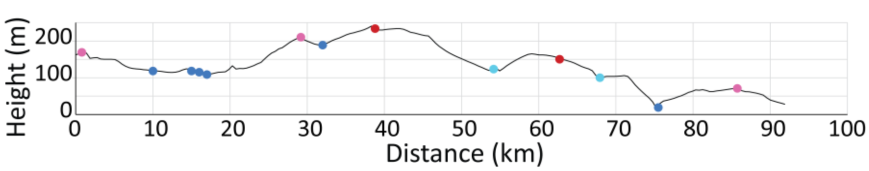

Figure 4. Topographic profile across valleys and ridges. Mapped linear features are overlain on the profile. Fluvial valleys are shown as blue points; lava channels atop ridges are red points. Features inferred from topographic analysis are light blue (fluvial drainage paths) and pink (crests of ridged lava tubes without sinuous chains of elongate depressions).