STEREO-DERIVED TOPOGRAPHY OF INFLATED LAVA FLOWS NEAR ELYSIUM MONS, MARS. E. C. Marcucci and R.R. Herrick, Geophysical Institute, University of Alaska Fairbanks, 903 Koyukuk Drive, Fairbanks, AK 99775 (emma.marcucci@gi.alaska.edu).

Introduction: Large shallow-sloped lava flows emplaced on Mars may be akin to pahoehoe flows on Earth [e.g., 1]. As such, identifying pahoehoe lava flow features, such as inflated lava, lava tubes, and tumuli, on Mars is of interest [e.g., 2]. Inflated lava flows form as the cooled exterior of a lava flow flexes outward from the pressure of the still molten lava interior [3]. This often happens in pahoehoe flows. Such inflated flows have been identified by their typical lobate plateaus. In Tharsis, 1.6% of CTX images contained evidence of inflated flows [4]. In Syria Planum, 12.8% of THEMIS images had such flows [5]. And in the Elysium area, 30.9% of THEMIS images had inflated flows [6]. The higher abundance of inflated flows near Elysium Mons is thought to be related to the particularly shallow slopes of that area, typically less than 0.06°.

A further step in understanding pahoehoe lava flows is to obtain their high-resolution topography in order to identify additional small-scale flow features. The global MOLA data set only has a few hundred meter horizontal resolution, with cross-track spacing of up to a couple of kilometers at the equator being the limiting factor. This scale will miss small topography features, which may also be hard to identify in visible images. Spatial resolution can be improved upon locally by using stereo photogrammetry. Stereo photogrammetry utilizes changes in the viewing angle to derive elevation information. In this work, we present topography derived from CTX stereo image pairs corresponding to the inflated flows identified in THEMIS visible images near Elysium Mons [6].

Methodology: We identified multiple CTX (6 m/pixel) image pairs within study area (so far no HiRISE pairs are available). Pixel resolution, incidence angle, emission angle, and sub solar ground azimuth parameters were compared to make appropriate pairs. These pairs were then processed using USGS-provided scripts to translate planetary data into a format readable by the ©BAE SO CET SET software. USGS scripts also prepare surrounding MOLA track points and DEM grid for import into SO CET SET.

After import, the images were orientated relative to each other through the use of multiple tie points. Elevation data was added with the MOLA tracks and DEM. The tracks were further used to tie the images to their absolute horizontal orientation. Gridded MOLA DEMs were used to seed the initial generation of the stereo-derived DEMs, which is an iterative process. The best possible spatial resolution of stereo-derived DEMs is equivalent to 3 times the average of the individual image resolutions. For CTX these equates to a resolution of 15-20 meters. The generated DEMs occasionally need further manual modification. For example, the program may not interpolate a shadowed area correctly.

The final stereo-derived DEM was used to create an orthorectified photo. Both the DEM and orthophoto were export to ArcGIS for topographic analysis.

Results: Two DEMs have been created over flows northeast of Elysium Mons that represent inflated flows and leveed lava channels (Fig. 1 and 2). The stereo-derived DEMs vastly improve the spatial resolution of topography, allowing for the identification of features only a few meters high (Fig. 3 and 4). In particular, Fig. 1 only has an elevation change of about 300 meters. Cross-section profiles of the lava channel show a steepening of the channel wall on the north side and levees that are built higher on the same wall (Fig. 3). This could have to do with the underlying topography, an obstruction causing a lava build up, or another cause. The high resolution DEMs can be used to interrogate this, including calculating more accurate thicknesses and volumes of flows.

The second DEM (Fig. 2) contains a portion of a large lava flow with evident surface features. The new DEM can be used to map the elevation changes on this flow (Fig. 4). The profile perpendicular to the direction of motion shows a number of ripples in the flow that have approximately 10-50 meters change in elevation. This site also represents an area where impact crater ejecta have interacted with the lava flows. The DEM demonstrates more clearly the relationship of the ejecta blankets and lava flows, including thicknesses and superposition.

Future Work: Additional DEMs will be created with the goal of have merged regional topography of the flows of interest. Topography will also be examined to identify additional pahoehoe flow features. Higher-resolution DEMs, 1 meter, will be created for HiRISE pairs in this area.


Figure 1. Stereo-derived topography (resolution 15 m) overlaying orthophoto (5 m) of CTX pair B12_014344_2191_XN_39N220W and G06_020436_2191_XN_39N220W. The lower left inset is the same area of the global MOLA hillshade map. While the MOLA topography has the large-scale features, the stereo-derived topography shows a significant greater spatial resolution in topography including lava channel overflows and other elevated terrain (Fig. 3).

Figure 2. Perspective view (5x vertical exaggeration) of stereo-derived topography (resolution 15 m) of CTX orthophoto pair B17_016164_2168_XN_36N226W and B18_016797_2171_XN_37N226W with inset MOLA gridded topography. The few 10s of meter ripples parallel to the direction of flow are profiles in Fig. 4. The height, and inferred thickness, of the flow can be interpreted from the DEM.

Figure 3. Profile across the lava channel in Fig. 3 demonstrates the asymmetry in the lava channel and levees.

Figure 4. This profile highlights the smaller scale ripples in the inflated lava flow of Fig. 2.