MAPPING INFLATED LAVA FLOW MARGINS NORTHWEST OF ELYSIUM MONS, MARS.

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Introduction: Emplacement of a pāhoehoe lava flow onto a surface with a relatively shallow slope can cause irregular cooling that leads to inflation. In this process, the exposed outer surface of the flow cools to form a ductile crust while still-molten lava is able to flow in the interior. Continued injection of lava over weeks or months causes the flexible crust to expand until it ruptures and produces a new lava lobe [1]. The resulting tabular flows can create extensive, connected lava plateaus.

Previous remote sensing surveys have shown that the inflation process also occurs on the surface of Mars [2]. Much of this work has focused on the area surrounding the Tharsis Montes, however, recent searches northwest of Elysium Mons have shown an abundance of flows exhibiting characteristics of inflation [3, 4]. This region has a gradient averaging 0.001 where it descends towards Utopia Planum, making it an ideal surface for the inflation of a pāhoehoe flow. This work has also shown the advantages of using Mars Reconnaissance Orbiter Context Camera (CTX) images when searching for inflated flows as they offer a threefold improvement in resolution over Mars Odyssey Thermal Emission Imaging Spectrometer Visible Light (THEMIS VIS) data.

Methods: There are several characteristics that can be used to identify an inflated lava flow from orbital images. These flows are flat and smooth at scales of several meters and have rougher margins than features formed through phreatomagamatic and glacial processes. On Earth, inflated flows can also be identified by fracturing along their margins and the presence of lava-rise pits. These pits are understood to be parts of the flow that did not inflate, leaving a depression of concentric fractures. Inflated margins may also be terraced, whereby breaching of the flow front produces a short series of thinner flows [5, 6].

Our study was carried out using the freeware GIS application JMARS (Java Mission-planning and Analysis for Remote Sensing) and an online MRO data viewer. CTX images were examined for candidate inflated margins within smaller search areas that were then cataloged in Excel with notes on the flow characteristics for these sub-surveys. Images from the High Resolution Imaging Science Experiment (HiRISE) that covered flow margins were also examined.

Criteria for identifying and describing flows in the study area were (1) the flatness and extensiveness of the flow including the degree to which it is broken up by surrounding topography; (2) the relief, clarity, and texture of the margin; and (3) the presence of fractures and candidate lava-rise pits. A number of the flows identified were ranked according to how well they fit these criteria and their locations were outlined (Fig. 1). Instances of margin fractures, terracing, and possible lava-rise pits were also mapped.

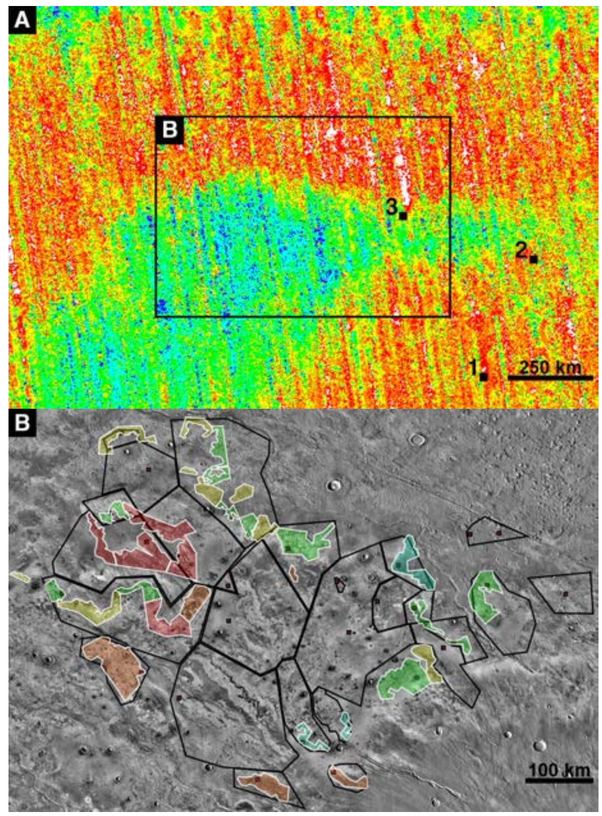

Figure 1. (A) TES dust cover index heat map showing areas with low dust cover in blue and high dust cover in red. Shows locations of (1) Elysium Mons, (2) Hecates Tholus, and (3) Galaxius Mons. (JMARS) (B) View of the mapped area centered at 136.187E, 34.656. Black lines demarcate sub-surveys with points marking characteristic flows for each area. Colored polygons outline flows rated on a scale of 5 indicating the strength of inflated flow characteristics displayed, with a 5 given to the best candidates (1 = red, 2 = orange, 3 = yellow, 4 = green, 5 = blue). Overlaid on THEMIS Day IR mosaic base layer. North is up in both images.

Findings: A variety of different flows and inflation features were observed in the study area. Narrow, low-relief, heavily cratered flows are especially common near the Elysium Rise; they tended to be given the lowest rating. Broad, high-relief margins have the best examples of fractures but tend to be heavily broken up by underlying topography; the three flows given the highest rating of 5 belong to this type. Flows with raised margins abutting surrounding topography are common in the northern part of the study area and may be indicative of mud flows.

Previous studies have not identified the characteristic fracturing of terrestrial inflated margins on Martian flows. CTX images used for our study revealed examples (Fig. 2) with a range of clarity that roughly corresponds to the relative dust cover in this region observed by the Mars Global Surveyor Thermal Emission Spectrometer (TES). The best examples were found in the region of low dust cover to the west of Hecates Tholus (Fig. 1).

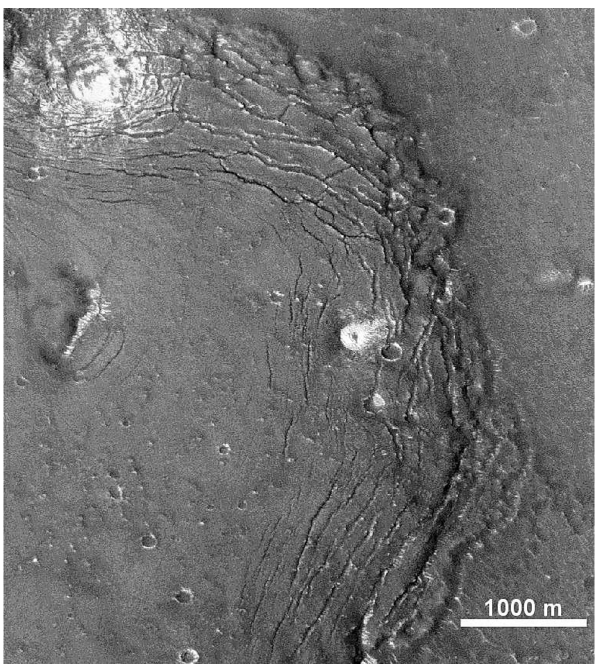

Figure 2. The best example of flow margin fractures found in the study area. Possible terracing can be seen in the lower right. Located at 137.685E, 31.373. Subset of CTX B03_010652_2100_XN_30N222W. North is up.

The best candidates for lava-rise pits previously caught the attention of the HiRISE imaging team in part because of their anomalous thermal signatures in THEMIS IR data. A number of good candidates near Galaxius Mons were imaged by HiRISE (Fig. 3) and interpreted as depressions formed by collapse of part of a mud flow or of a sub-glacial lava flow [7, 8]. More study is needed to determine the processes that formed these features.

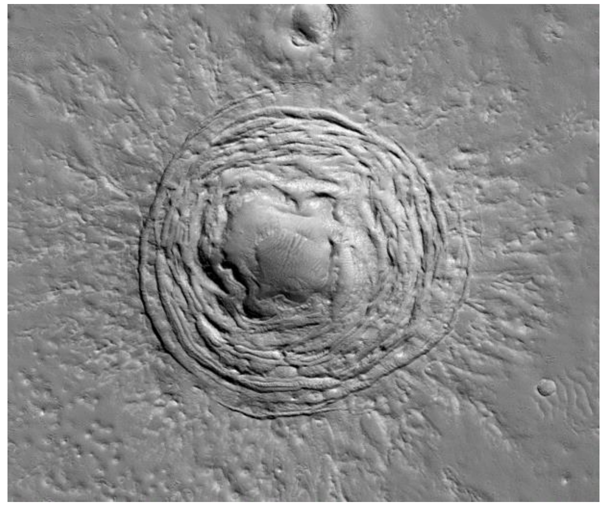

Figure 3. Example of a candidate lava-rise pit measuring 2.5km wide and located at 141.828E, 34.804. HiRISE PSP_005813_2150; anaglyph from stereo pair available. North is up.

Our survey shows that Elysium Mons remains a promising location for the study of inflated Martian lava flows. It also shows that CTX images, with their near-global coverage and excellent resolution, are the ideal data through which to carry out further studies. These studies should look for inflated flows in areas where low dust cover may allow margin fracturing and other inflation features to be clearly seen.

References: [1] Giacomini L. et al. (2009) *Planet. Space Sci., 57,* 557. [2] Garry B. W. et al. (2011) IAG Planetary Geomorphology Working Group, *Inflated Lava Flows on Earth and Mars.* [3] Wood K. L. and Zimbelman J. R. (2014) *LPS XLV*, Abstract #2359. [4] Venzke A. C. and Zimbelman J.R. (2016) *LPS XLVII*, Abstract #1486. [5] S. P. Scheidt et al. (2014) *LPS XLV*, Abstract #1491. [6] J. R. Zimbelman et al. (2012) *LPS XLIII*, Abstract #1831. [7] http://hirise.lpl.arizona.edu/PSP_005813_2150 [8] Morris A. and Mouginis-Mark P. (2005) *Icarus, 180*, 335-347