A SEARCH FOR INFLATED LAVA FLOWS ON MARS. M. A. Graff[1,2] and J. R. Zimbelman[2], [1]Brown University Geological Sciences, 324 Brook St., Box 1846, Providence, RI 02912, michelle_graff@brown.edu; [2]CEPS/NASM MRC 315, Smithsonian Institution, Washington, D.C. 20013-7012, zimbelmanj@si.edu.

Introduction: Previously held theory regarding crustal formation on both the Earth and Mars supports the concept that fast-flowing, rapidly-cooling aa lava is primarily responsible for the formation of basaltic plains. Recent discoveries of inflated pahoehoe flows [1, 2] have begun to challenge the notion of very rapid emplacement and instead suggest that the inflation of pahoehoe flows has been, and continues to be, both an important and a common process in the formation of volcanic plains on both Earth and Mars [3]. New orbital imaging data provide a means for evaluating the prevalence of inflated lava flows on the lava plains of Mars.

Methods: Possible candidate inflation flows were located using Context Imager (CTX) images (with a resolution of 6 m/pixel), an instrument aboard the Mars Reconnaissance Orbiter (MRO) from 2006 to the present [4]. The area of interest for this project was the volcanic plains surrounding Tharsis Montes and Olympus Mons, (30S-30N, 210-270 E). Regions which were determined to contain portions of inflated lava flows were then examined using different images taken by the following cameras: the High Resolution Imaging Science Experiment (HiRISE) camera on MRO (resolution to 0.25 m/pixel) [5], the Mars Orbiter Camera (MOC) on Mars Global Surveyor (resolution 1.6 to 6 m/pixel) [6], and the Thermal Emission Imaging System (THEMIS) on Mars Odyssey (both visible light and daytime IR images were used, with a resolution of 19 and 100 m/pixel, respectively) [7]. These images were then rendered in JMARS (Java Mission-planning and Analysis for Remote Sensing) [8] in order to obtain a more complete picture of each flow. JMARS additionally allowed the measurement of the shadows cast by the margins of each lava flow. The height of the flow margin was then calculated using the shadow length and the angle of incidence (solar angle) at the time the image was taken.

Results: Of the 314 CTX images examined in this study, five of the CTX frames contained portions of candidate inflated lava flows; therefore, inflated flows were identified in 1.6% of the CTX images examined. The candidate inflated flows are located at the following approximate center latitudes and longitudes: (22.1 S, 227.0 E), (23.9 S, 226.2 E), (3.6 N, 239.9 E), (5.2 S, 239.7 E), and (19. 7 S, 229.3 E). In addition, some flows not originally located through examination of CTX images were found through analysis of MOC images (the precise number of MOC images looked at for this purpose was not recorded). Three additional candidate inflated flows were found through this method, located at: (15.7 S, 226.7 E), (7.8 S, 225.6 E), and (19.3 S, 227. 7 E).

Figures 1-3 provide three examples of the candidate inflated flows that were found during this study, and they exemplify the three characteristics used to identify possible inflated flows. Candidate flows have an irregular margin (more consistent with lava than some other type of geologic flow), they are generally broad as compared to their length (that is, they are not narrow, finger-like deposits), and the surface displays a smooth texture at CTX resolution and lacks a visible central channel (both attributes are more consistent with pahoehoe rather than aa lava). The calculated heights of the candidate inflated flow margins ranged from 20.2 m to 150.9 m, though most flow thicknesses were within the more restricted range of 20.2 m to 39.8 m. Figure 4 shows an example of what we interpret to be an aa lava flow texture at CTX resolution; such a flow was excluded from the list of candidate inflated lava flows for this study.

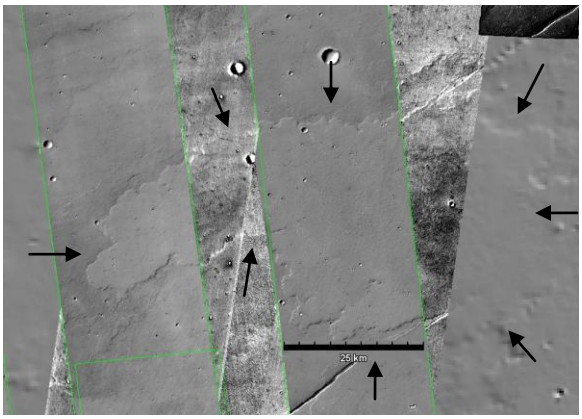

Figure 1. Candidate inflated lava flow found near (23.9 S, 226.2 E), indicated by arrows. Individual frames visible in this mosaic include P13_006008_1577 (CTX), I07695002 (THEMIS), I05092005 (THEMIS), B17_016451_1565 (CTX), and I05086002 (THEMIS) (left to right), overlain on THEMIS day IR mosaic base. Scalebar is 25 km long.

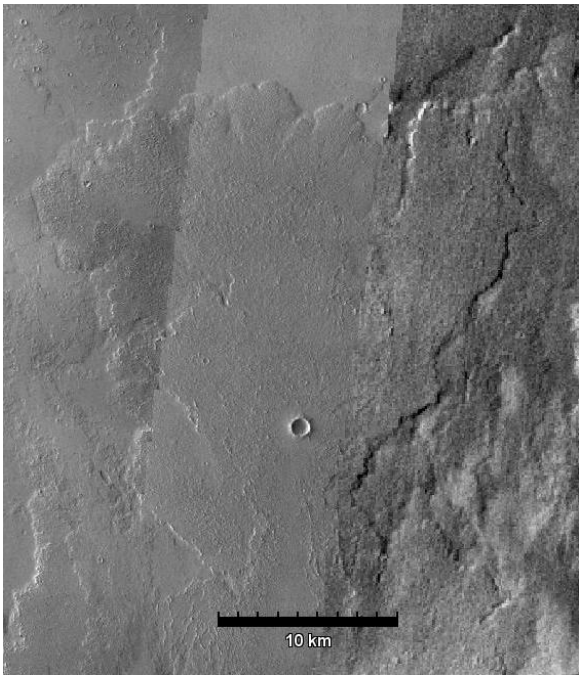

Figure 2. Candidate inflated lava flow located near (3.3 N, 239.9 E). Note the delta shape for the distal end of this flow. Individual THEMIS frames visible in this mosaic include, from left to right, V11625004 (VIS), I36158028 (day IR), and V14071010 (VIS), overlain on THEMIS day IR mosaic base. It is possible that this flow overlays another inflated lava flow just north of the visible flow margin; a portion of this buried flow is visible in the upper right of the image. Scalebar is 10 km long.

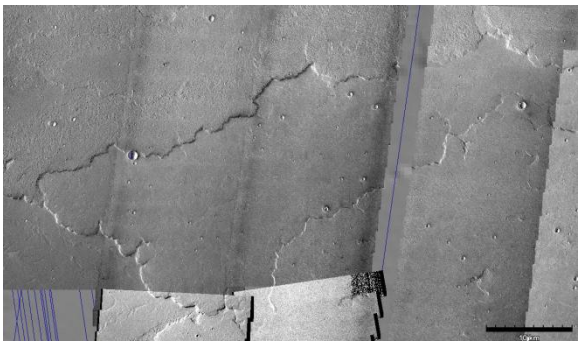

Figure 3. Candidate inflated flow located near (22.1 S, 227.0 E). The inflated pahoehoe flow (center) is buried on both sides by two aa flows. Thus, the flow may be much broader than visible here, due to superposition by the later aa flows. THEMIS VIS frames visible in this mosaic include: V26814006, V17654007, V24393004, V27388008, V15807005, and V23769003 (left to right), overlain on THEMIS day IR mosaic base. Scalebar is 10 km long.

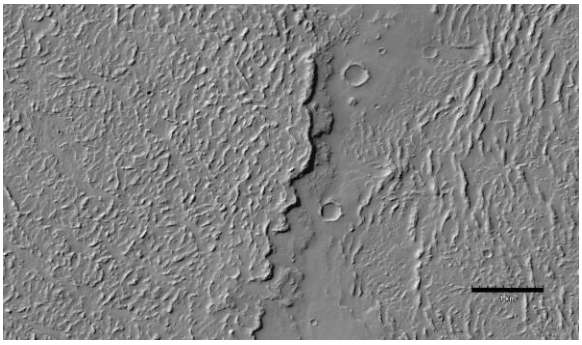

Figure 4. Portion of CTX frame B19_017097_1541, showing a close-up view of aa lava texture at CTX resolution. Flows displaying this texture were excluded from the list of candidate inflated flows. Scalebar is 1 km long.

Discussion: The images examined were randomly selected, and, thus, it is possible that not every frame with a candidate inflated lava flow was viewed. However, we are still confident that the value of 1.6% is an accurate representation of the prevalence of inflated lava flows randomly investigated from all lava flows present in the Tharsis region of Mars. This low percentage of inflated lava flows is likely due to large (>1°) regional slopes in several portions of the study region around the Tharsis Montes, which are not favorable for inflation of pahoehoe lava flows. Most of the candidate inflated lava flows were found in Daedalium Planum, where the average regional slope was calculated to be .077°, a slope small enough to allow lava flows to inflate.

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References: [1] Walker, G.P.L. (1991), Bull. Volc. 53, 546-558. [2] Hon, K. et al (1994), Geol. Soc. Am. Bull. 106, 351-370. [3] Self, S. et al (1998), Ann. Rev. Earth Planet. Sci. 26, 81-110, 10.1146/annurev.earth.26.1.81. [4] Malin, M.C. et al. (2007), J. Geophys. Res. 112, E05S04, 10.1029/2006JE002808. [5] McEwen, A.S. et al. (2007), J. Geophys. Res. 112, E05S02, 10.1029/2005JE002605. [6] Malin, M.C. et. al. (1998), Science 279, 1681-1686. [7] Christensen, P.R. et al. Sp. Sci. Rev. 110, 85-130. [8] http://jmars.asu.edu/