INFLATED LAVA FLOWS EAST OF MARS' THARSIS MONTES

Abstract 1153

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Introduction

Inflated lava flows are elevated sheets of pahoehoe lava that result from fluid lava being injected into a flow's interior and inflating its rigid outer skin [1]. Previous searches for inflated lava flows on Mars have yielded low percentage results, casting doubt on the prevalence of inflated lava plateaus on the Red Planet. One such study covered a broad region in the Tharsis region and found that only 1.6% of the satellite images examined included portions of inflated lava flows [2]. Recent discoveries of vast inflated plateaus in specific volcanic plain regions [3] have contested the idea that Martian inflated flows are raririties. Inflated lava flows can readily be found on Mars when searching in an appropriate region using suitable satellite images.

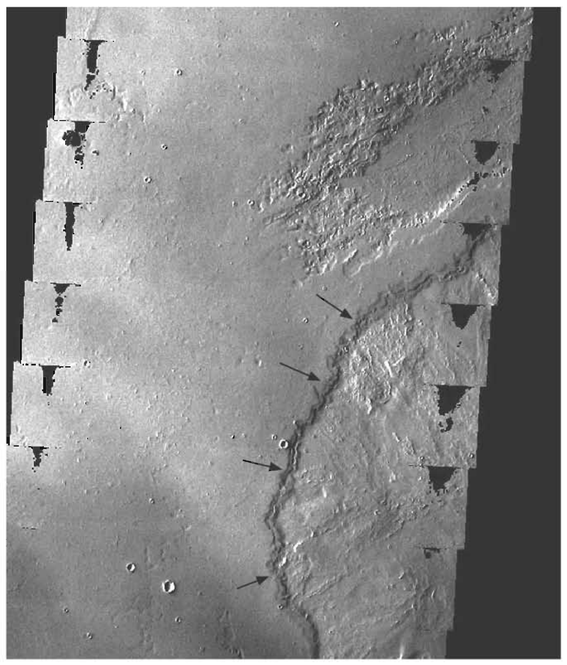

Figure 1: THEMIS image V05209011 includes good candidate inflated lava plateau found near 0.4 N, 253.4 E. Surface is visibly smooth and lacking in obvious texture. Arrows indicate neighboring volcanoes' border, and also point to lava flow's shadowed edge to indicate the relative elevation.

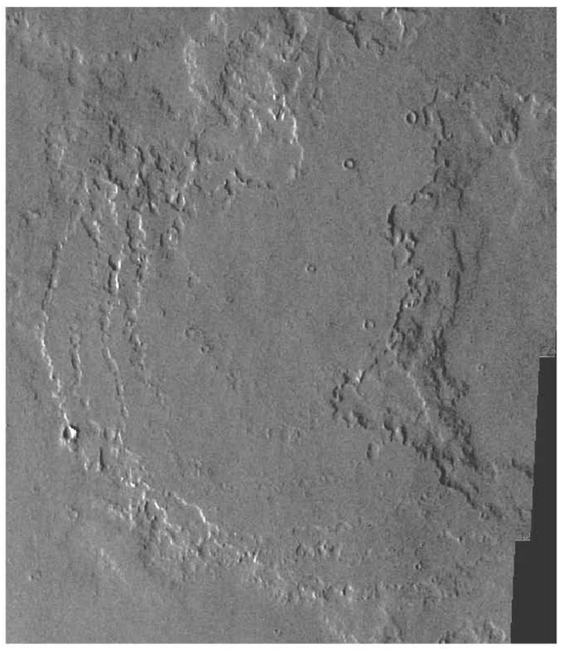

Figure 2: THEMIS image V23731002 includes a good candidate inflated plateau found near 10.0 S, 245.5 E. Contorted shape and irregular margin show that this is a lava flow, as well as a possible example of a terraced lava flow.

Procedure

The area of interest for this inflated flow search was the volcanic plains region east and parallel to the Tharsis Montes and west of the Syria Planum region (14.2 N-19.4 S, 238.9-272.5 E).

Identifying inflated flows via satellite images: To be considered a candidate inflated lava flow, a satellite image must illustrate a feature that meets certain requirements. First, the potential candidate feature must show evidence of an elevated surface. Grayscale aerial views oftentimes cause surface depressions to ressemble surface uplifts. Therefore, an elevated geological feature is detected by comparing the candidate uplift's lighting to that of a nearby crater. A crater's depth is indicated by its shadowed portion and its raised rim wall is indicated by the lighted portion. From this, the location of the Sun can be determined and a similar shadow analysis can be carried out to identify an elevated feature. Second, the elevated geological feature must span a broad region, as lava flows that are longer than they are wide are oftentimes normal pahoehoe finger-deposits [4]. Third, the feature should maintain a uniformly smooth surface, for rough texture is indicative of an a'a flow. Fourth, the lava flow should have an irregular margin, so as to distinguish it from a water-carved feature with a smooth margin. Adjacent volcanoes are also good indicators of candidate regions to look for inflated lava flows.

Instruments: The search was primarily conducted using images from the Thermal Emission Imaging System (THEMIS) aboard the eleven-year-running Mars Odyssey spacecraft [5]. The images used in the study were taken in the visible spectrum from 2002 to present. THEMIS VIS images have a resolution of ~18 meters per pixel. Probable and possible inflated lava regions were subsequently viewed in images from a camera aboard the Mars Reconaissance Orbiter, Context Imager (CTX), which has a ground resolution of 6 meters per pixel [5]. CTX images helped to verify the probable inflated regions and to eliminate 5 contenders previously classified as "possible candidates"; the CTX frames of the "possible candidates" provided a zoomed-in view that revealed a coarse, shell-like surface texture not common on inflated lava flows.

Classificaiton System: THEMIS frames were classified as either "good candidates," "possible candidates," or "not candidates" based on their adherence to the previously stated requirements. "Good candidates" presumably showed inflated lava flows, which were then verified by their corresponding CTX frames. "Possible candidate" images might have shown inflated lava flows, meaning they fulfilled 3/4 of the candidate requirements. The most common reason for a "possible candidate" labeling was a smooth, elevated flow that ran long and thin instead of wide and thick. Some THEMIS frames blurred the texture of geological features, so broad plateaus were dubbed "possible candidates" until CTX confirmed a smooth surface. Frames that were "not candidates" lacked any obvious elevated lava flows, though many did show other notable geographical features, like craters, channels, and graben.

Results

Of the 673 THEMIS images examined in this study, 86 frames were labeled as "good candidates." Therefore, 12.8% of the THEMIS VIS frames observed in this study contained inflated lava flows. Of these 86 strong candidates, 24 of these frames were labeled as "best candidates" because they included exemplary inflated lava flows that strictly cohered to all four requirements. Figures 1-2 provide examples of such frames. Though the "best candidates" were dispersed throughout a broad region (9.5 N-11S), 45.9% of the best candidate frames were concentrated in the region north and east of Arsia Mons (2-11 S). Table 1 provides a quantitative breakdown of the inflated lava flow study and reveals that just under half of the frames (41.3%) could include inflated lava flows. Frames from another orbiter camera, like the Mars Orbiter Camera (MOC), might show some "possible candidates" in more detail, and thereby reclassify them as "good candidates."

Inflated Flow Status	*Number*	*Percentage*
Good Candidate	86	12.8%
Possible Candidate	192	28.5%
Not Candidate	395	58.7%
Total	673	100%

Table 1. Inflated lava flow study in numbers. Inflated lava flows were suspected in over 40% of the THEMIS VIS frames examined.

Discussion

Though 673 THEMIS images were studied in the plains region east of the Tharsis Montes, it is possible that a candidate frame could have been overlooked and went unexamined. Even so, we believe that a 12.8% "good candidate" rate in this specific Tharsis region demonstrates that inflated lava flows are not uncommon on Mars; prevalence of inflated lava flows simply depends on the regions being investigated and the tools used to carry out the investigation. We conducted this search in an attempt to test and improve on a 2011 study [2] that examined random locations throughout the Tharsis region, and found very few inflated lava flows. By comparing the 2011 study to this study, we are more confident that inflated lava flows are not rare on Mars, and that they can be detected over broad regions; the key to locating inflated lava flows on Mars is searching in a lava-plains-rich area. Selecting the right camera to conduct the investigation is also vital to the detection of inflated flows. We found over 673 lava-related THEMIS frames in the eastern Tharsis region, but we could not find many HiRISE frames that were relevant to our study area.

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References: [[1] Garry B. W. et al. (2011) IAG Planetary Geomorphology Working Group, Inflated Lava Flows on Earth and Mars. [2] Graff M. A. and Zimbelman J. R. (2011) LPS LXIII, Abstract #1144. [3] Giocomini L. et al. (2009) Planetary and Space Science, 57, 556-570. [4] Crown D. A. et al. (2010) American Geophysical Union, Fall Meeting, abstract #V21C-2349. [5] http://themis.asu.edu/about