Geophysical Research Abstracts,
Vol. 11, EGU2009-7812, 2009
EGU General Assembly 2009

Thumbprint Terrain in Isidis Planitia, Mars: Geology, Ages, Morphology, and Morphometry

H. Hiesinger, D. Rohkamp, S. Sturm, F. Thiessen, and D. Reiss
Westfälische Wilhelms-Universität, Institut f. Planetologie, Münster, Germany (hiesinger@uni-muenster.de)

The western parts of Isidis Planitia are covered with thumbprint terrain (TPT) consisting of curvilinear ridges of coalesced cones with central depressions or craters [e.g., 1-8]. Thumbprint terrain can be observed in many areas of the northern lowlands [5,9], but it is particularly well developed in the Isidis basin. For this investigation, we have mapped thumbprint terrain in western Isidis Planitia in High Resolution Stereo Camera (HRSC) images. We also used MOLA, MOC, THEMIS, HIRISE and other data to map and characterize the TPT. We have performed extensive morphometric measurements and crater counts in order to constrain the formation of the TPT and its timing and to test the numerous scenarios that have been postulated for the formation of TPT and possible terrestrial analogues, including for example pingos, moraines, shield volcanoes, pseudocraters, and eskers [e.g., 1-8].

On the basis of our map, we recognize spatial variations in the distribution of the TPT. For example, the number of ridges and cones is greater in the northern versus the southern areas of the Isidis floor. Ridges and cones are absent on the ejecta blankets of young rampart craters, which thus postdate the formation of the TPT.

We classified the TPT into six categories, based on the varying lengths of the ridges. Category I includes individual isolated cones, category II consists of 2-3 coalesced cones, category III is characterized by ridges consisting of 4-6 coalesced cones, category IV contains ridges with 7-10 cones, and category V includes ridges with more than 10 coalesced cones. We also mapped ridges without cones, termed “no cone ridges”.

On the basis of our mapping of 8500 ridges/cones, we find that the majority of the investigated features are isolated cones (Cat. I: 43%) and relatively short ridges consisting of 2-3 coalesced cones (Cat. II: 35%). The numbers of ridges with 4-6 (Cat. III: 15%), 7-10 (Cat. IV: 5%), and more than 10 coalesced cones (Cat. V: 3%) are significantly smaller.

Our measurements of the ridge heights revealed that the median height is largest (33 m) for category III. This is similar to the heights of the longer ridges of categories IV (28 m) and V (32 m). The heights of individual cones (13 m) and small ridges with less than 4 cones (21 m) are typically smaller. These heights are comparable to various terrestrial analogues, including pingos, volcanic cones, pseudocraters, and mud volcanoes.

In order to further constrain the formation process of TPT, we plotted the basal diameter of the cones against their basal diameter/crater ratio. Comparing these data to terrestrial monogenetic volcanoes [10], we find the best agreement with cinder cones and pseudocraters and to a lesser extent with maars and spatter cones.

To constrain the formation age of the TPT, we performed crater counts for the geologic units and nearby rampart craters that are superposed on the TPT. Based on these crater counts, we propose that the TPT in western Isidis Planitia could have formed between approximately 2.5 and 3.0 Ga. If unit Aps [11] in the eastern part of the basin has covered the TPT that was originally exposed throughout the basin, its formation can be further constrained to about 2.7 to 3.0 Ga.

On the basis of our study, we conclude that: (1) thumbprint ridges are on average less than 35 m high, but there are a few with heights up to more than 70 m; (2) the occurrence of central depressions associated with the ridges/cones is interpreted as evidence for an explosive origin (e.g., volcanic cones); (3) the basal and central depression diameters are most consistent with terrestrial cinder cones and pseudocraters and to a lesser extent with maars and spatter cones; (4) on the basis of the morphology and morphometry, other origins including various types of moraines, sand ridges, dunes, eskers, drumlins, kames, crevasse fill, beach ridges, berms, table mountains, mud volcanoes, and inverted topography are less likely; (5) TPT was formed sometimes between approximately 2.5 and 3.0 Ga.

[1] Grizzaffi and Schultz, (1989), Icarus 77; [2] Hiesinger and Head, (2003) 6. International Conference on Mars; [3] Hiesinger and Head (2004) LPSC 35; [4] Rohkamp et al. (2008) EPSC 3 [5] Tanaka et al. (2005), USGS SIM 2888; [6] Pithawala and Ghent, (2008), LPSC 39; [7] Pithawala and Ghent, (2008), EPSC 3; [8] Bridges et al. (2003), J. Geophy. Res. 108; [9] Pomerantz and Head, (2003) LPSC 34; [10] Wood (1979) Proc. Lunar Planet. Sci. Conf. 10; [11] Greeley and Guest, (1987), USGS I-1802B.