Petr Brož[1,2] and Ernst Hauber[3] present:

Small-scale post-Noachian Volcanism in the Martian Highlands? Insights from Terra Sirenum

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Introduction:

Volcanism was globally widespread on Mars in the early history of the planet, but focused with ongoing evolution in Tharsis and Elysium [1]. Evidence for post-Noachian (<3.7 Ga) volcanism in the Martian highlands is rare (e.g., Tyrrhenus and Hadriacus Montes) and, to our knowledge, few, if any, younger volcanic edifices have been reported so far. Here we focus on two spectacular cones with outgoing flows and three dome-like structures surrounded by flow units, that might change this view.

The study area is located in Terra Sirenum (Fig. 1), a highland region which was included by [2] as part of the large Eridania paleolake, a possible source for the formation of the Ma'adim Vallis outflow channel during the Hesperian/Noachian period [2].

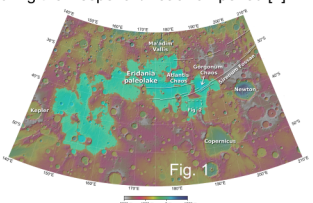
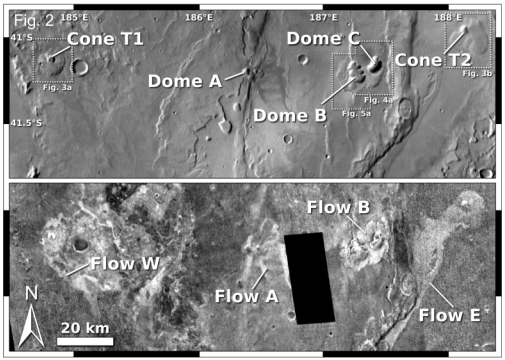


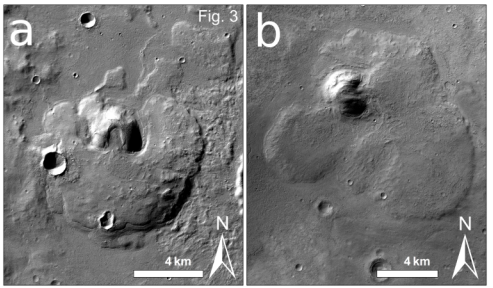
Fig. 1

Thermal characteristics

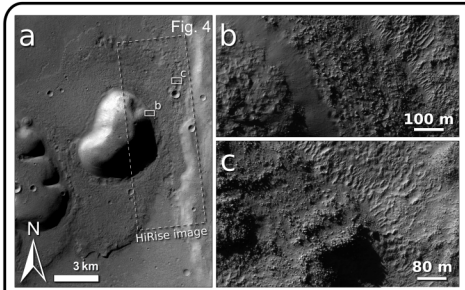


Themis-IR day-time (upper image) and night-time (bottom) of the study area reveal several areas of relatively higher thermal inertia. These regions correspond to landforms (Fig. 3, 4 and 5) associated with flow-like structures (marked as flows).

Morphology: cones



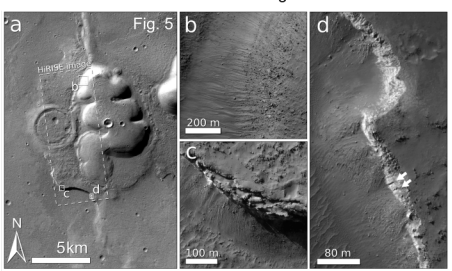
Two cones (a – cone T1, b – cone T2) are associated with flows that partly cover the cones themselves. Overlapping flow margins suggest a repetitive process of their formation. The edges of the flows seem to be relatively steep, based on MOLA measurements, reaching values between 4° (for eastern cone T2) up to 20° (for western cone T1). The flows originated from the breached cone's centers, not from their flanks. Flow E seems to originate beneath cone T2. CTX images.



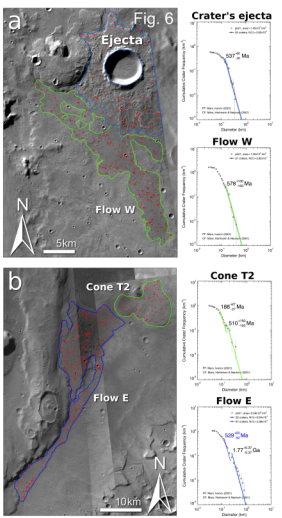
Morphology: domes

Two investigated domes are covered by CTX and HiRISE images (Dome B and C), enabling observations of small details. The domes stand between 390 m and 530 m above the surrounding plains and have steep flanks with slopes between 17° and 23.5°. Topographic data also reveal sloping heights, decreasing in southern direction.

HiRISE images reveal that the edifices and associated flows are composed of boulders up to several meters large (up, Fig. 4b, c). A significant scarp (right, Fig. 5a) with vertical offset around 80 m is situated at the southern margin of Dome B. At the foot of this scarp is talus with a low amount of large boulders (Fig. 5c). The exposed material is layered and shows signs of ongoing erosion (Fig. 5d).



Ages



Conclusions

The observed cones may represent Martian small-scale volcanic edifices with associated lava flows, but they are different in morphology to previously observed Martian scoria cones [3, 4] or tuff rings/cones [5]. The steep-sided morphology suggests that highly viscous lava formed them. The material exposed by scarp might be fine-grained volcanic ash resulting from fragmentation of highly viscous lava and explosive eruption(s). Based on our observations and the similarities to terrestrial obsidian flows, we interpret these features as probably volcanic in origin and post-Noachian in age (Fig. 6). If so, volcanic edifices composed of evolved magmas may not only be present in the northern lowlands [6], but also in the 'middle of nowhere': in the southern highlands far away from any known volcanic centers.

We currently have no explanation why such evolved volcanism might have occurred in those regions and how such magmas were generated. But our finding may expand our knowledge about evolved magmas on Mars, which seem to be more widespread than previously thought [7-10]. The cones and flows in Terra Sirenum might represent ideal candidates for spectroscopic observations.

References

[1] Grott et al. (2013), Space Sci. Rev. 174, 49-111 [2] Irwin et al. (2004), J. Geophys. Res. 109, E12 [3] Meresse et al. (2008), Icarus 194, 487-500 [4] Brož and Hauber (2012), Icarus 218, 88-99 [5] Brož and Hauber (2013), JGR-Planets 118, 1656-1675 [6] Rampey et al. (2007), JGR-Planets 112, E6 [7] Wray et al. (2013), Nature Geosci. 6, 1013-1017 [8] Meslin et al. (2013), Science 341, 6153 [9] Sautter et al. (2014), JGR-Planets 119, doi: 10.1002/2013JE004472 [10] Carter and Poulet (2013), Nature Geosci., 6, 1008-1012.