EVIDENCE FOR VOLCANISM ON THE WESTERN HELLAS BASIN FLOOR.

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Introduction: With a diameter of 2300 km, Hellas basin is one of the major preserved impact basins on Mars. Its interior has a diverse geology, but displays no evidence for basinwide, plains-forming volcanic activity comparable to the lunar mare. Regional volcanism has been assumed for parts of the western basin [1]. In the course of this study, about two dozen features of probably volcanic origin were identified on the western Hellas floor. Two distinct, mound-like features are presented here in detail.

Data: The investigation uses a variety of available image data sets, with CTX (MRO) data as a near-complete coverage at good resolution, supplemented by HRSC (Mars Express), HiRISE (if available) and THEMIS daytime infrared (Mars Odyssey). As DEMs, both MOLA (MGS) for large areas and HRSC for detailed investigations of smaller features were used.

Image data and derived DEMs unfortunately often suffer from the reduced image quality caused by the atmospheric dust load in the region.

Observations: The two mounds are located on the floor of the deep western trough of Hellas Planitia, which lies at elevations of more than 7000 m below datum. Both are situated in circular depressions and rise to heights well over 1000 m above the surrounding plains.

Mound 1 is located west of the Alphaeus Colles region of central Hellas Planitia (E 53.5° S 36.8°). It is an approximately 1600 m high, conical mountain. The mound is located inside a 200 m deep (MOLA), indistinct depression with a diameter between 50 and 60 km. Flank slopes of the mound as derived from HRSC data exceed 30 degrees. The lower flanks of this mound are covered by several generations of very smooth lobate flows originating near the summit region. The summit region is a horseshoe-shaped half-bowl open to the south. It differs markedly in appearance from the very smooth lower flanks, with a rough, fractured surface and lineations, probably indistinct flow features. Fractures line the southeastern flank and summit, indicating gravitationally induced tectonic deformation of the mound. The depression floor is covered with slightly rougher material, which overlays an older, cratered surface. This material displays rounded circular ridges surrounding the mound. Along the southern margin, the mound's flanks are covered by a >6 km impact crater and its ejecta blanket.

These smooth units appear bright in THEMIS daytime IR. Individual flows display levees, the flow length approaches 7 km (in plan view).

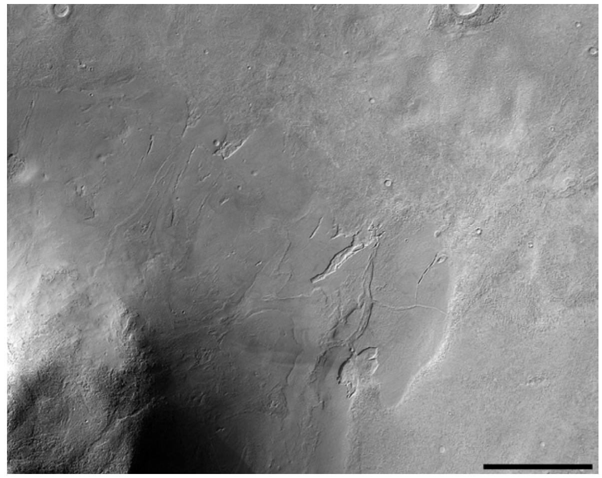

Fig. 1: Smooth flows on the flanks of Mound 1. CTX image CTXP18_008203_1444, north is to the top, scale bar is 3 km.

Mound 2 is situated south of the Alphaeus Colles region (E 55.1° S 45.5°). It is larger than mound 1, with a basal diameter of 32 km and a height of 1800 m. It has the shape of a truncated cone, with a relatively flat, slightly concave summit plateau. The flanks have slopes on the order of 20°, in places exceeding 25° (derived from HRSC DEM). The surrounding depression has a diameter of 47 km and is more sharply defined than in the case of Mound 1.

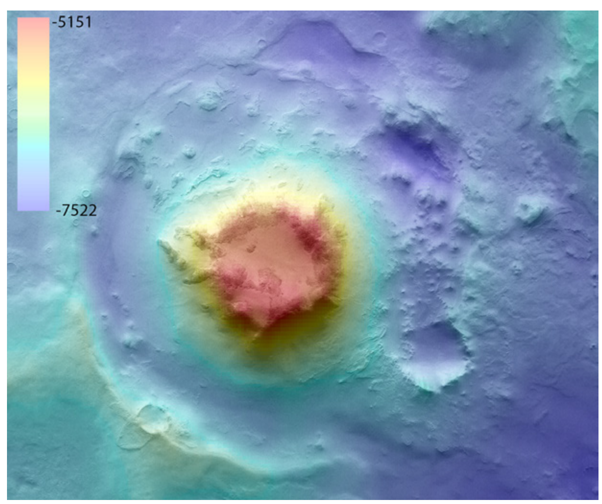

Fig. 2: Mound 2, S of Alphaeus Colles. The depression diameter is 47 km. HRSC orbit 10919 and MOLA color-coded elevation.

The summit plateau consists of a massive cap of rock, which has a surface covered with individual blocks of meter size. To the west, a ramp-like structure reaches from the summit down the flank. Similar but smaller features are observed around the summit plateau. Several domical structures are situated along the plateau rim. These structures show a radial fracture pattern differing noteably from the unordered pattern of the adjacent plateau material. The domical structures are located above the ramp-like features at the flanks.

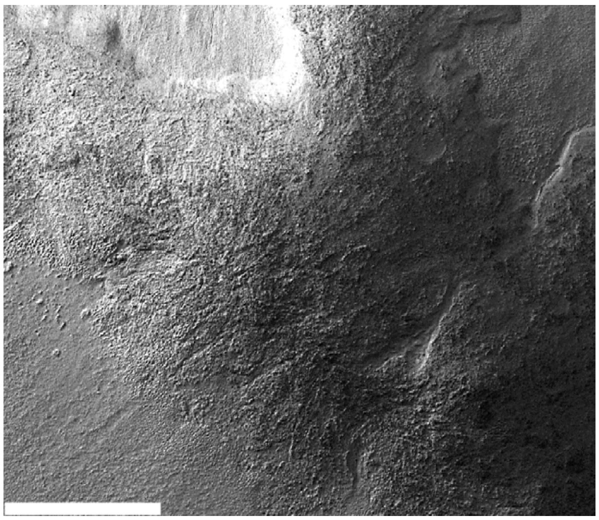

Fig 3.: Domical structure on the northwestern rim of the Mound 2 summit plateau. CTX image P19_008348, scale bar length is 1.5 km.

Depression, mound flanks and the summit plateau's interior are covered with dust mantling deposits common in southern Hellas, which overlie the original land surface.

The depression is bounded by an inward scarp with relatively steep flanks (slope >20°).

Analysis and Interpretation: We compared the diameter-height ratios for the mounds with the values given by Garvin et al. [2,3]. The mounds reach much higher heights than central peaks of impact craters: With a height of 1600 m, Mound 1 is 5.2 times higher than the calculated central peak height for a 55 km impact crater (309 m). The height of of Mound 2 (1800 m) is 6.3 times higher than calculated for an 47 km impact crater central peak (285 m).

Different formation mechanisms have been investigated for the mounds. The evidence for lava flows – and possibly lava domes / cryptodomes – points towards a volcanic origin. The flows observed at Mound 1 indicate low-viscosity material that flowed down the flanks. The ramp-like structure around the summit of Mound 2 can be interpreted as high-viscosity flows, and the associated domical structures as lava domes or cryptodomes, surrounded by talus. A similar structure has been observed by Williams et al (2014) in Argyre Planitia [4].

The circular depressions around both mounds can be explained by volcanic sagging, a process where the weight of the edifice displaces ductile strata in the substratum [4], often in combination with volcanic spreading [5]. This ductile layer may be composed of clay-rich material (as it has been shown for terrestrial volcanoes), or, in the case of Mars, of ice-rich material, where volume loss due to melting may have led to an additional loss of volume. The steep slopes of the mounds and the tentative assumption of lava domes suggest higher viscosity lavas than at shield volcanoes of basaltic composition.

Remnant massifs: An origin as erosional remnants would require the removal of material on the order of > $4x10^5$ cubic km from the floor of Hellas basin beyond the basin rim. This seems unlikely. The occurrence of pedestal craters in the vicinity of Mound 2 shows that deflation at a smaller scale was a process which shaped the basin, but not at the scale required to form the mounds. Deflation at this scale would also be difficult to renconcile with the geologic evidence elsewhere in the region.

Implications: If the features are indeed volcanic, then magmatic processes would constitute an additional factor in shaping the diverse geology of the basin's interior. Mechanisms for magmatic differentiation are required. The occurrence of sagging structures around the mounds indicates a ductile layer in the substratum below a rigid upper layer. This provides insight into the properties of the martian subsurface at the poin of mound formation.

Outlook: We are currently investigating the occurrence of similar features elsewhere on the Hellas floor. A thorough review of our work is currently under preparation.

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