1:200,000-SCALE GEOLOGIC MAP OF OLYMPUS MONS CALDERA, MARS.

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Introduction: The martian volcano Olympus Mons (18.65˚N, 226.20˚E) is the highest and most prominent shield volcano in the Solar System. It is ~600 km in diameter and rises ~22 km above the northwestern edge of the Tharsis rise [1, 2]. The summit displays a nested series of pits ("paterae"), which collectively comprise the summit caldera [3]. Via formal geologic mapping at a scale of 1:200K (Fig. 1), details of the summit geology and topography of the caldera provide key insights into the relative timing of collapse episodes, as well as the post-emplacement deformation of the summit.

Geologic Mapping: HiRISE [4] and CTX [5] images were used for mapping and elevation data were obtained from MOLA [1] and the HRSC [6]. For this area, the HRSC data have a resolution of 100 m/pixel, and a vertical accuracy of 10 m. A subset of topographic data were derived from CTX images covering parts of the caldera floor at a spatial resolution of 24 m/pixel and vertical accuracy of ~3-5 m [3]. As is conventional for terrestrial shield volcanoes, the individual paterae have been given formal names by the International Astronomical Union (Fig. 2). They are named after the Greek Olympian gods who were believed to habit Mount Olympus, the highest mountain in Greece and purported to be the seat of the gods by Homer, the legendary Greek author of the Iliad and the Odyssey. This map includes Pangboche crater (10.4 km in dia.), which offers the opportunity to study the effects of cratering with minimal influence from the thin Martian atmosphere and the lack of volatiles in the target [7].

Physical Volcanology: Within the 80 x 65 km diameter structure, the chronology of the six nested paterae (Fig. 3) indicates that the preserved summit has undergone multiple collapse episodes, flooding by lava, and subsequent deformation [3]. Numerous tectonic features on the caldera floor have been interpreted to have formed by compression (wrinkle ridges) and extension (graben), believed to have been associated with subsidence associated with magma chamber deformation [8].

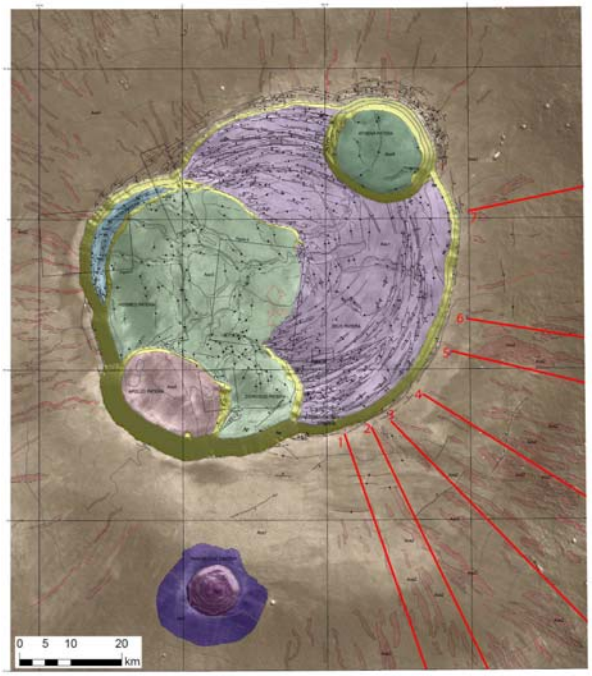

Fig. 1: Top: Submitted 1:200,000 scale map of the summit caldera. Red lines (accentuated here) show profiles identified in Fig. 4.

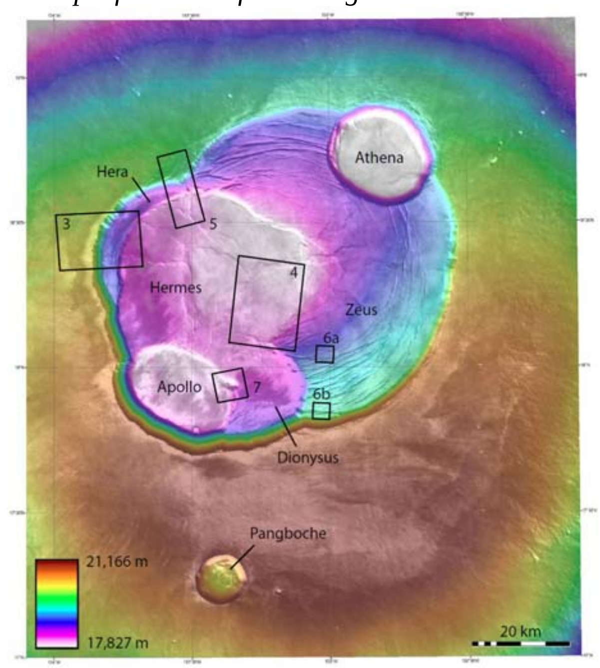

Fig. 2: MOLA topography of summit, showing the paterae names and the locations of detailed images used in the submitted geologic map. See Fig. 3 for the correlation of map units.

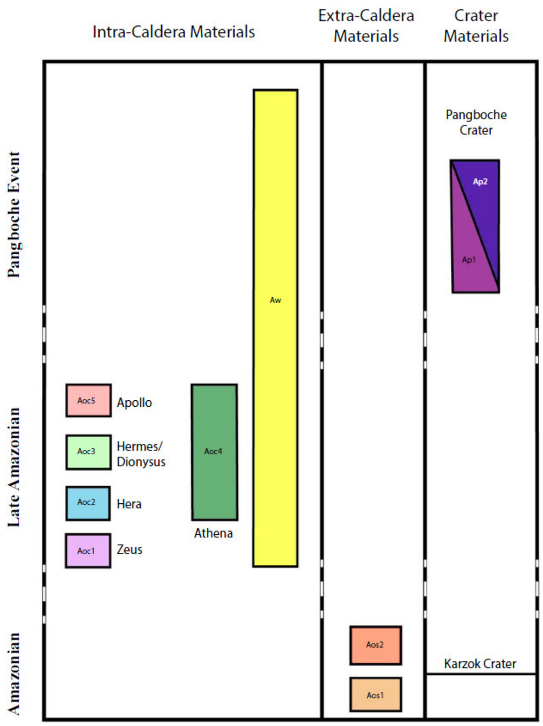

Fig. 3: Correlation of map units for summit area.

Mapping at 1:200K allows the distribution of 351 lava flows to be identified at the summit. Correlating these flows with the current topography from MOLA, numerous flows south of the caldera rim appear to have moved uphill [9]! This disparity is most clearly seen to the south of the caldera rim, where the elevation increases by >200 m along the apparent path of the flow (Fig. 4). Additional present day topographic anomalies have been identified, including the tilting towards the south of the floors of Apollo and Hermes Paterae within the caldera, and an elevation difference of >400 m between the northern and southern portions of the floor of Zeus Patera. It is inferred that inflation of the southern flank after the eruption of the youngest lava flows is the most plausible explanation [9]. This implies that intrusive activity at Olympus Mons continued towards the present beyond the age of the youngest paterae, which may be <200 Myr [6, 10].

Conclusions: It is proposed [9] that intrusion of lateral dikes to radial distances >2,000 km is linked to the formation of the individual paterae at Olympus Mons. Two specific dikes to the SE of the volcano are inferred to have volumes of ~4,400 km^3 and ~6,100 km^3, greater than the volumes of individual calderas and implying triggering of both caldera collapse and lateral dike injection by the arrival of large inputs of magma from the mantle. A comparable disparity between lava flow direction and current topography, together with a tilted part of the caldera floor, has been identified at Ascraeus Mons [9], opening the opportunity for new research via additional mapping of this Tharsis volcano at higher resolution than is currently underway [11].

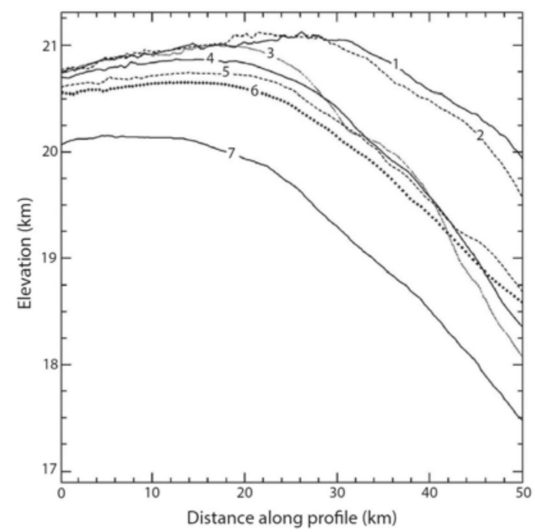

Fig. 4: Topographic profiles (derived from gridded MOLA topography) along specific lava flows on the southern and eastern flanks of the caldera, showing that some now appear to have been emplaced by moving uphill. Numbers refer to profiles on the geologic map (Fig. 1).

References: [1] Smith, D.E. *et al*. (2001). *JGR* 93(B12), 14,773 – 14,784. [2] Plescia, J.B. (2004). *JGR* 109 (E03), doi: 10.1029/2002JE002031. [3] Mouginis-Mark, P.J. (2018). *Chemie der Erde* 78, 397 – 431. [4] McEwen, A.S. *et al*. (2007). *JGR*, doi: 10.1029/2005JE002605. [5] Malin M.C. *et al*. (2007). *JGR* 112(E5), doi:10.1029/2006JE002808. [6] Neukum, G. *et al*. (2004). *Nature* 432, 971 – 979. [7] Mouginis-Mark, P.J. (2015). *MAPS* 50(1), 51 – 62. [8] Zuber, M.T. and P.J. Mouginis-Mark (1992). *JGR* 97(E11), 18295 - 18307. [9] Mouginis-Mark, P.J. and L. Wilson (2019). *Icarus* 319, 459 – 469. [10] Robbins *et al*. (2011). *Icarus* 211, 1179 – 1203. [11] Mohr, K.J. *et al*. (2018). Planet. Geol. Mappers Mtg., *LPI Contr. 2066*, abs. #7007.