DISTRIBUTION OF STRAIN IN THE FLOOR OF THE OLYMPUS MONS CALDERA. Thomas R. Watters and D. John Chadwick, Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, D.C. 20560, and Michael C. Liu, Department of Astronomy, Cornell University, Ithaca, NY 14853

The Olympus Mons caldera is made up of six coalescing volcanic craters (fig. 1). Based on comparisons with terrestrial volcanoes, such as Mauna Loa, Hawaii (1, 2), the volcanic craters are interpreted to be the result of collapse of a solidified lava lake due to evacuation of the magma chamber during late-stage summit activity (3). The floors of several of the craters are characterized by a large number of deformational features in the form of graben and wrinkle ridges. The largest and oldest of the volcanic craters (crater 6, see 3), approximately 65 km in diameter, has a well developed circumferential graben system in the margins of the floor (fig. 1). Wrinkle ridges are present in the interior of the floor but have been sharply truncated by at least three successive collapse episodes.

The origin of the stresses that generated the observed structures is likely the result of subsidence of the central portion of crater floors (3). Using topography derived by Wu et al. (4), subsidence is evident across the floor of the large crater (fig. 2, 5X vertical exaggeration). The cause of the subsidence is presumed to be loss of support of the caldera floor by withdrawal of the underlying magma, probably the result of flank eruptions. In a finite element analysis, Zuber and Mouginis-Mark (5) have shown that compressive and extensional stresses compatible with the generalized location of the structures can be generated by subsidence. A detailed assessment of the location of the wrinkle ridges and graben relative to the topography is useful in refining such models.

The distribution of the circumferential graben on the floor of large crater is not uniform. Mouginis-Mark (3) notes that the widths of graben are greatest near the crater edge and narrow toward the center of the floor. The most extensive fracturing of the floor is on the southern edge, near the rim of the of crater 3 (fig. 1). The average slope of the floor in the area of these graben is roughly 4° (fig. 2), the largest slopes observed on the floor. On the northern edge, there are fewer graben and the average slope of the floor is less (roughly 3°). Thus, the areas of greatest slope and possibly greatest flexure of the floor correspond to areas with the greatest observed extension. This correlation supports the assumption that the structures are the result of downward displacement of the floor. As noted by Zuber and Mouginis-Mark (5), many of the wrinkle ridges occur in topographic lows. In contrast to the circumferential graben, the ridges are not strongly radially distributed, but are confined to a roughly E-W oriented trough (fig. 2). The most prominent wrinkle ridge on the crater floor is located close to the area of lowest elevation. The average slope of the floor in area of the ridges is $\leq 2°$. Preliminary estimates of the bulk horizontal shortening and extension in the crater floor, using average values of the shortening across the ridges (see 6) and the extension across the graben (see 7), are roughly compatible at 1.5-2.0 km. Based on the topography and the distribution of structures, the subsidence appears to have been asymmetric with greater downward displacement and deformation of the southern half of the floor.

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References Cited:
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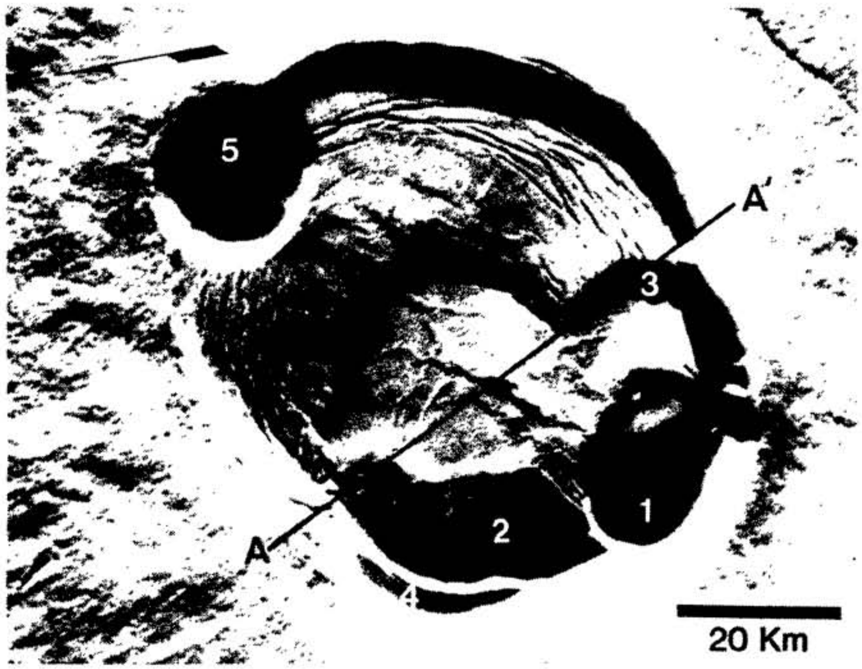

Fig. 1. Nested summit caldera of Olympus Mons.

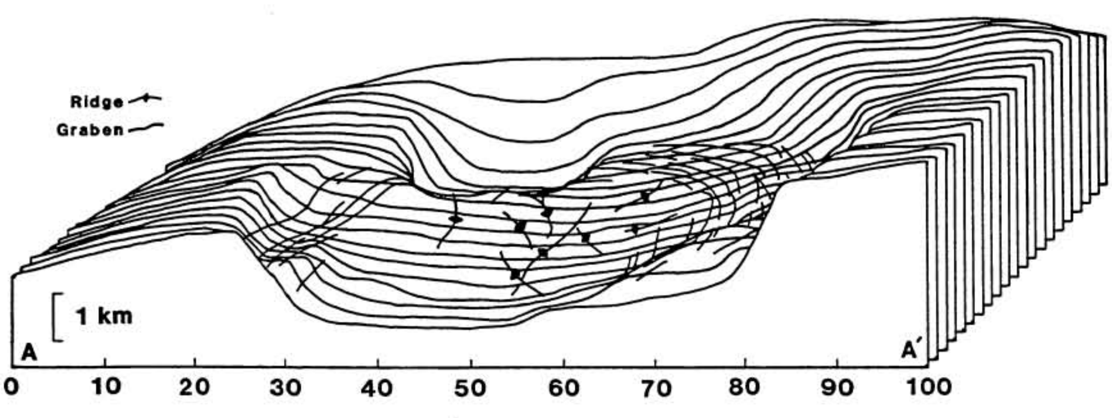

Fig. 2. Topographic profiles of a portion of the caldera with the location of prominent wrinkle ridges and graben.