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Flank terrace morphology of Martian shield volcanoes

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The four giant shield volcanoes on Mars display large bulge-like "terraces" on their flanks. These structures may be the surface expressions of thrust faults, caused by the effects of volcano spreading, lithospheric flexure, or magma chamber tumescence, upon the edifice. We use topographic profiles, slope maps, and contour maps, generated from the USGS MOLA 128-pixel-per-degree gridded dataset, to comprehensively describe terrace morphology and distribution. Our results show that these structures are more complicated than previously described.

Topographic profiles show that terraces are characterised by a flat upper surface whose slope increases towards the terrace base. In plan, terraces are arcuate, and are configured in an overlapping, imbricate manner. Although visible at all elevations on the flanks of Olympus Mons and the Tharsis Montes, terraces are more prominent on those volcanoes with nested caldera complexes (Olympus and Ascraeus Montes). This may suggest that magma chamber inflation and relaxation plays a role in the formation of these structures. MOLA DEMs indicate that terraces are also visible on the flanks of Elysium Mons and Hecates Tholus, indicating that the mechanism of formation is not limited to the four largest shields on Mars. Terrace surface area, relative to edifice surface area, is smaller on these latter volcanoes than on the Tharsis shields.

Olympus, Pavonis, and Elysium Montes, and Hecates Tholus, display terraces arranged in a generally circumferential pattern. We propose that such a pattern develops in response to stress fields intrinsic to the edifice. Ascraeus and Arsia Montes show elongated terraces on their flanks, oriented SW-NE. This orientation matches that of the possible rift underlying these edifices. We suggest that a superposition of edifice- and regional-scale stresses may be responsible for the elongation of terraces on Ascraeus and Arsia Montes.