



Tectonic Complexity within Volcanically Infilled Impact Features on Mercury

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Extensional tectonic deformation on Mercury is almost entirely restricted to impact features that host volcanic smooth plains. However, tectonic landforms within such features vary enormously in structural complexity. Here, we describe the progression in tectonic complexity within four representative volcanically flooded impact sites — a “ghost crater,” the Mozart basin, the Rembrandt basin, and the Caloris basin — together with the implications of recent numerical modeling for the Caloris basin in particular, the largest recognized impact feature on the innermost planet.

Ghost craters are volcanically buried impact features marked by a ring of tectonic landforms. Interior to many ghost craters are graben of no preferred orientation that divide the plains infill into polygonal blocks. The 235-km-diameter Mozart basin (centered at 7.8°N, 169.6°E) contains graben and ridges within its peak ring. Wrinkle ridges deform the basin center and are enclosed by an annulus of basin-circumferential graben. Outward from this annulus to the peak ring, mixed-orientation graben form a less-organized pattern. This general tectonic configuration is also observed within the similarly sized Raditladi and Rachmaninoff basins. Rembrandt basin (centered at 33.5°S, 88°E; diameter 715 km) has a basin floor heavily deformed by extensional and contractional structures. Basin-radial graben and ridges form fan-like patterns that are bounded by a mix of circumferential ridges and graben. Local clusters of ridges with mixed orientations lay farther outward on the southwestern and eastern portions of the interior smooth plains.

The greatest tectonic complexity occurs within the 1,640-km-diameter Caloris basin, centered at 30°N, 161°E. A basin-radial graben set termed Pantheon Fossae originates from a point near the basin center and extends over half-way to the basin rim. Here, the Pantheon Fossae graben are bound by circumferential graben that form a near-complete annulus. Outward of this ring, graben display a range of orientations and define a complex pattern of polygonal blocks that decrease in size towards the basin margin. Basin-circumferential and -radial ridges (with the latter being more common) extend two-thirds toward the rim from near the basin center. Farther out, ridges show no orientation preference and so also form a polygonal pattern that becomes less prominent toward the basin perimeter.

The fossae within Caloris and Rembrandt may have formed due to dike propagation, or to flexural uplift of the basin center in response to external volcanic loading or inward flow of the lower crust. Finite-element modeling results for ghost craters and for the Mozart basin indicate that stresses induced by thermal contraction of thick, rapidly emplaced lava flows favor the formation of mixed-orientation graben in volcanic plains. Such models also show that horizontal shortening in response to cooling and contraction of the planet's interior, or flexure due to volcanic loading, was likely responsible for the formation of ridges in these impact features, and that buried basin rings strongly localize radial extensional stress and circumferential graben formation.

Gaben of mixed orientation within Caloris and Rembrandt may thus have formed due to the horizontal extension of rapidly emplaced, cooling lavas, and the decrease in graben size with increasing distance from basin center likely indicates steady lessening of plains thickness and thus original basin depth. The ridges within the basins may primarily be the result of global contraction on Mercury. Finally, if the circumferential graben within these basins reflect extension above a buried basin ring, Rembrandt and Caloris may be multi-ring basins, a class of impact feature not yet clearly documented for Mercury.