Numerous Martian impact craters have pits at their centers and thus exhibit a crater-in-crater configuration. Characteristically, the pits are relatively small (e.g., 10 to 12 km across in a 50 to 60 km crater) and are surrounded by raised blocky rims and hummocky debris, separated from the main wall of the crater by smooth or hilly floor materials. There appears to be a progression from craters whose pits are about the expected diameters of central peaks (e.g., crater Tu, Oxia Palus Quadrangle, lat 24° N, long 33° W, Viking image 034A87) to small basins like Lowell with peak rings, and to craters with peripheral shelves, exemplified by Green (lat 53° S, long 6° W), in which a central peak also occurs.

The raised rims around some small central pits, usually deeper than the surrounding crater floor, strongly suggest that material was ejected from the core of a central peak; thus they appear to be excellent analogs of Gosses Bluff (Australia), as interpreted by Milton, et al. (1), who proposed that the eroded, doughnut-shaped bluff formed as a central peak whose center was excavated during floor rebound. The excavation was facilitated by the lithology of the deepest rocks exposed at the center, which were less resistant than the sandstone that formed the surrounding bluff. The discovery on Mars of these well-preserved small end members in an apparently gradational series (not so well delineated on the Moon) adds credence to the hypothesis that peak rings of two-ring basins -- such as Schrödinger on the Moon and Lowell on Mars -- are expanded central peaks whose centers have been evacuated during excavation (2,3,4,5,6).

On the Moon the transition from central peaks to arcs and circles of peaks appears to be partly related to increasing crater size, although there are exceptions in which the peaks of relatively small craters (e.g., King) approach a ring morphology. A cursory overview of Viking images indicates that on Mars, however, the central pit craters may be geographically localized, suggesting that, as at Gosses Bluff, the lithologies of the substrate materials influence the development of this crater configuration. Thus the crater Tu (Oxia Palus Quadrangle) may have penetrated rocks at depth that were less resistant than an immediately overlying layer, resulting in the central peak with evacuated center. Had the kinetic energy of impact been greater, or the depth to the weaker layer less, the raised rim of the central pit would, according to this hypothesis, have expanded to become the peak ring in a basin like Lowell. As proposed earlier for the Moon (2,3), intersection of yet another stratigraphic discontinuity at depth could result in a second peak or peak ring, thus producing the concentric rings of multi-ring basins. If geographic localization of central pit craters is found to be systematic on Mars, inferences about the lithologic and stratigraphic nature of the martian substrate may be possible.

References:
CENTRAL PIT CRATERS ON MARS.

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