Updated Catalogs of Peak-Ring Basins and Protobasins on Mars

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Motivation:

- The morphology of peak-ring basins (exhibiting a rim crest and interior peak ring) in the complex crater basin transition on the Moon and Mercury have been well characterized based on data from recent missions to these planetary bodies [e.g., 1].
- Although global crater catalogs have recently been produced for Mars [e.g., 2], the detailed characteristics of the crater to basin transition on Mars has not been fully re-examined since basin ring catalogs and measurements were produced over two decades ago by Pike and Spudis [3], among others.
- Here, previous basin catalog [3] and the global crater catalog of Robbins et al. [2] are re-analyzed using topographic and image datasets to provide updated catalogs of peak-ring basins and protobasins on Mars.
- These updated catalogs are important for comparisons with other planetary bodies [1], constraining basin formation models, and understanding the original morphology of the abundant degraded craters on Mars.

Findings:

- A total of 16 peak-ring basins and 8 protobasins were identified, ranging in rim-crest diameter from 101 to 446 km (peak-ring basins) and 89 to 298 km (protobasins).
- Nine of these basins are newly added to the catalog and not included in the previous catalog of [3]. Nine basins from [3] are also removed from the present catalogs, as current topography and image data do not support the presence of interior rings within these basins.
- Although it has a larger surface area, Mars has nearly an order of magnitude fewer peak-ring basins than Mercury (N=110), which can be attributed to the planet’s much higher resurfacing and erosion rates.
- Like Mercury, the rim-crest diameters of both complex craters with central peaks and protobasins overlap those of peak-ring basins over a much larger range than on the Moon.
- As noted by previous researchers, protobasins, such as Lyot, occur at anomalously large diameters on Mars compared to Mercury and the Moon. The effect of volcanoes on the basin-forming process is often used to explain this feature, but more modeling work is needed to fully explore this problem.

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References:


I. Global Distribution

Peak-ring basins and protobasins are mainly located within the cratered southern highlands of Mars. Below is an equidistant cylindrical map of MOLA colored topography on a MOLA hillshade basemap.

II. Basin Images

A catalog of craters [2 km on Mars from Robbins et al. [2] was used to survey all craters >80 km on the planet (N=2570) in a manner similar to [3] for the Moon and Mercury. Dataset used included MOLA gridded topography and a global THEMIS daytime IR mosaic [7]. During the survey, each crater was identified as having a rim crest in addition to a single interior ring of peaks (peak-ring basin), an interior ring of peaks plus a central peak (protobasin), a central peak only (complex crater), or no interior structure (unclassified).

III. The Updated Basin Catalogs for Mars

Below: Number of basins and craters with interior structures as a fraction of the total crater populations [2]. Note the low number of craters and basins on Mars with recognizable interior peaks or rings due higher erosion and resurfacing rates on the planet. This is most evident when compared with the Moon and Mercury (below).

Peak-ring and/or central-peak diameters versus rim-crest diameters for peak-ring basins and protobasins on Mars only. Data from Pike and Spudis [1] (PS87) are shown for comparison.

IV. Comparisons with the Moon and Mercury

Table of basin summary statistics, comparing the Moon [1],5], Mercury [1,5] and Mars. Mars has the lowest proportion of preserved peak-ring basins even though it has the greatest surface area. Protobasins also occur at anomalously large diameters on Mars.

Below: Number of basins and craters as a fraction of total crater populations [1]. A) Peak-ring diameters versus rim-crest diameters for peak-ring basins and protobasins on Mars, the Moon [1,5], and Mercury [1,5]. The data fall along a similar power-law trend. Ratios of peak-ring diameter to rim-crest diameter for peak-ring basins and protobasins on the Moon (B) and Mercury (C). Note the similarly increasing ratios with basin size, suggesting a continuum in process forming protobasins and peak-ring basins.