CRATERING ON MERCURY: INSIGHTS FROM THE MESSENGER FLYBYS

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Introduction: During its three Mercury flybys, MESSENGER imaged most regions unseen by Mariner 10 and viewed some previously seen regions under more favorable lighting. The surface density of impact craters and basins on Mercury with diameters D>200 km is comparable with that of the Moon, though possibly there are fewer large basins. The largest basin mapped from Mariner 10 (Borealis) has not been reliably recognized in MESSENGER images. Two smaller peak-ring basins (Raditladi and Rachmaninoff) are comparatively young. Large craters and basins have numerous secondary craters, which generally dominate Mercury's crater populations at D<10 km. Extensive volcanism apparently modified Mercury's crater populations at D <100 km, to variable degrees in different regions, but was as powerfully destructive of craters D<40 km as the many degradation processes that affected Martian highlands.

Large Craters and Basins: The morphologies of dozens of peak-ring basins have illuminated the transition from smaller complex craters to basins. Caloris and Rembrandt basins are fairly well preserved and formed during the later part of the Late Heavy Bombardment (LHB); craters on their rims follow the Population-1 size-frequency distribution (SFD) characteristic of LHB cratering throughout the terrestrial planet region (believed to be the result of direct scattering of main-belt asteroids). Volcanic plains formation within Caloris ended well after the basin formed, close to the end of the LHB: its interior plains are dominated by the later Population-2 craters typical of near-Earth asteroids today, chiefly derived from the main belt by size-dependent processes such as the Yarkovsky effect. Volcanic plains formation exterior to Caloris continued afterwards, based on a lower density of almost purely Population-2 craters. These plains clearly postdate formation of the Caloris basin by a substantial interval and are not ejecta deposits like the lunar Cayley Plains, as had been hypothesized after Mariner 10.

SFD's for Mercury's craters with D>10 km in various cratered regions of Mercury differ widely, more than was appreciated from Mariner 10. In some regions, voluminous intercrater plains obliterated all craters with D>100 km, whereas elsewhere plains buried only smaller craters so that many with D>40 km remain from older eras. Intercrater plains and younger, often more spatially restricted, smooth plains both formed by volcanic emplacement.

Small Craters, Secondaries, and Young Plains: In some places (e.g. in regions near Raditladi) Mercury's craters are dominated by secondaries for D<20 km. In general, the upturn of the SFD at smaller sizes occurs at D<8 km, a much larger diameter than the few km typical on the Moon and Mars. Perhaps larger secondaries are formed on Mercury than on other bodies. The temporally sporadic and spatially clustered nature of secondaries hinders studies of relative ages of small and/or recent units. Nevertheless, the extremely sparse densities of small craters within Raditladi and Rachmaninoff suggest that these basins are unusually young. In the case of Rachmaninoff, volcanism continued within its inner plains until comparatively recently, long after basin formation, and thus those plains cannot be impact melt.