MERCURY CRATER STATISTICS FROM MESSENGER FLYBYS: IMPLICATIONS FOR STRATIGRAPHY AND RESURFACING HISTORY. Robert G. Strom[1], Maria E. Banks[2], Clark R. Chapman[3], Caleb I. Fassett[4], Jeffrey A. Forde[5], James W. Head[4], William J. Merline[3], Louise M. Prockter[6], and Sean C. Solomon[7]. [1]Lunar and Planetary Lab., University of Arizona, Tucson, AZ 85721 (rstrom@lpl.arizona.edu); [2]Center for Earth and Planetary Studies, Smithsonian Institution, Washington, DC 20013; [3]Southwest Research Institute, Boulder, CO 80302; [4]Dept. of Geological Sciences, Brown University, Providence, RI 02912; [5]Microsoft Corp., Redmond. WA, [6]Applied Physics Lab., Laurel, MD 20723; [7]Dept. of Terrestrial Magnetism, Carnegie Inst. of Washington, Washington, DC 20015.

Introduction: The primary crater population on Mercury has been modified by volcanism and secondary craters. For a given-size crater or basin, secondaries appear to be larger than on any other planet or satellite in the solar system, affecting the crater statistics at diameters as great as 20 km. Volcanic emplacement of intercrater plains during the period of Late Heavy Bombardment (LHB) markedly altered the cratering record in many areas [1]. Volcanism near the end of or shortly after the LHB is typified by the smooth plains interior and exterior to the Caloris basin [2]. These two types of volcanic units may be samples of more or less continuous volcanism early in Mercury's history. The youngest age of volcanism cannot yet be determined, but at least small areas of smooth plains, e.g., within the Rachmaninoff basin [3], appear to be younger than the plains associated with Caloris.

Variations in the Crater Size/Frequency Distribution: For any given region the crater size-frequency (SFD) distribution depends on three factors: 1) the abundance of plains and their emplacement history, 2) the proximity to large craters and basins, and 3) the age of the surface. The formation of both intercrater plains and smooth plains obliterated some fraction of the smaller craters in a region, steepening the slope of the SFD on an R plot. Secondary impact craters can cause the slope of the SFD to lessen and turn upward at diameters <20 km. On the youngest surfaces the primary crater SFD flattens out to an approximate differential –3 slope characteristic of the post-LHB crater population. The shape and vertical position (relative age) of the SFD thus provide insights into the resurfacing history of the planet.

An R plot comparing the crater SFD for two regions on the approach side of Mercury during MESSENGER's first flyby (M1) with that for the lunar highlands is shown in Fig. 1. The SFD for the region labeled Areas 1 and 2 on the Mercury curve is similar to that for the lunar highlands at diameters greater than about 25 km, but below that diameter there has been an apparent loss of craters due to younger plains formation. The region directly south (Areas 3 and 4) has extensive intercrater plains but is adjacent to the 643-km-diameter Beethoven basin. Here the crater SFD is well below the lunar curve at diameters less than about 70 km due to plains formation during the LHB, but at diameters less than about 25 km the curve turns upward due to secondaries from Beethoven.

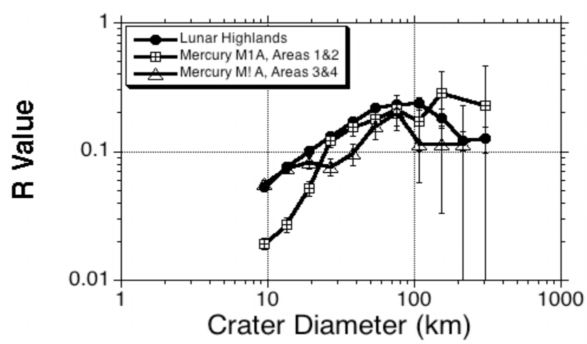

Fig. 1. R plots for two regions on the approach side of Mercury during M1.

A comparison of the SFD for a large area on the departure side of Mercury during MESSENGER's second flyby (M2) with that for the lunar highlands is seen in Fig. 2. The entire curve for diameters less than about 120 km is well below that for the lunar highlands due to extensive intercrater plains formation during the LHB. The upturn at about 10 km is due to secondaries from the largest craters.

The average SFD for seven Mercury highland areas of heavily cratered terrain seen during M1 and M2 and during the Mariner 10 flybys is compared with that for the lunar highlands in Fig. 3. On average, Mercury highlands are deficient, relative to the Moon, in craters with diameters less than 100 km, but the SFD is virtually identical to that for the lunar highlands at greater diameters. This difference indicates that in general the Mercury surface has been greatly affected by intercrater plains formation during the period of LHB. In particular, plains formation has removed craters having diameters less than 100 km, but the larger craters have been largely preserved.

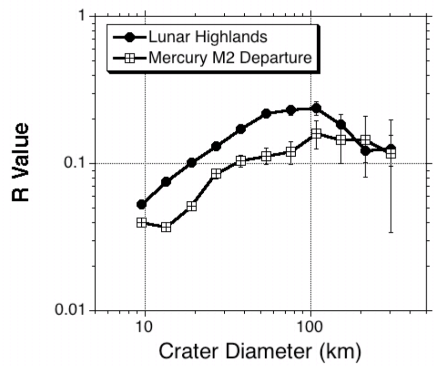

Fig. 2. R plot of the crater SFD for a region on Mercury's departure side during M2.

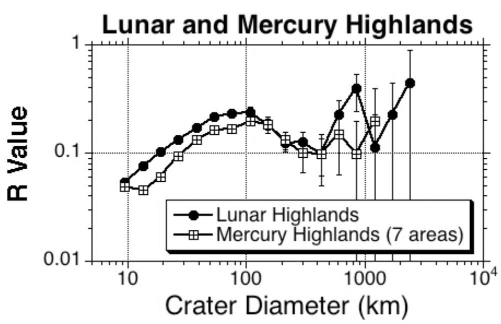

Fig. 3. R plot of the average crater SFD for seven highland regions on Mercury.

Summary: The crater size-frequency distribution on Mercury shows pronounced regional variations that are primarily the consequence of differences in the extent and age of volcanic plains formation. Also, the formation of large craters and basins has produced large secondaries that have affected the SFD at diameters less than about 20 km. In some areas plains formation has obliterated a sufficient number of craters to steepen the crater curve at smaller diameters. In other areas, almost the entire curve has been lowered as a consequence of extensive volcanism that resurfaced the region during the LHB. This epoch was followed by re-cratering, raising the crater curve but to a density still lower than unaffected areas. There are variations among regions in all of these factors indicating a rather complicated history of volcanic plains formation.

References: [1] R.G. Strom et al. (2008) Science, 321, 79-81. [2] J.W. Head et al. (2008) Science, 321, 69-72.[3] L.M. Prockter et al. (2010) Science, 329, 668-671.