DISTRIBUTION OF IMPACT MELT ON MERCURY AND THE MOON. Lillian R. Ostrach[1], Mark S. Robinson[1], Brett W. Denevi[2], [1]School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85281; [2]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723. Correspondence: lostrach@ser.asu.edu

Introduction: The surfaces of both Mercury and the Moon show evidence of substantial surface modification from the impact cratering process. Images taken by the Lunar Reconnaissance Orbiter Camera (LROC) and the Mercury Dual Imaging System (MDIS) provide the means to study and compare impact craters. Here we present initial results of a comparison between Mercury and the Moon regarding the distribution and areal extent of impact melt deposits within and around craters with diameters between 8 to 125 km.

Background: Comparisons between lunar and mercurian craters were made following the Mariner 10 flybys [1-6], and many morphologic similarities were observed. Differences were also noted: craters on Mercury form wall terraces at smaller diameters, secondary craters are larger, secondary crater fields are located closer to the crater rim, and the continuous ejecta blanket extends to lesser distances than on the Moon [e.g., 1, 2]. Many of these differences are attributed to greater gravitational acceleration on Mercury (~2.2×) than the Moon [2]. As a result, the average impact velocity is ~2 times higher on Mercury than the Moon [7, 8], which will have little effect on crater morphology but substantially increase the volume of impact melt [2].

Methods: We created 200 m/pixel mosaics from LROC and MDIS wide-angle camera (WAC) images with favorable illumination for morphology (60° to 77° incidence angle). An equatorial band extending ±30° latitude and ±60° longitude, centered at 0°N and 0°E, was defined for analysis with both mosaics. For the Moon, this coverage corresponds to a surface area of 6.3×10^6 km^2 (~17% total surface area), and for Mercury 11.6×10^6 km^2 (~15% total surface area, 2% gores). An 8 km minimum diameter was defined for crater identification because secondaries can be as large as 8 to 10 km on Mercury [9]. ArcGIS and the CraterTools extension [10] were used to identify craters with ponded impact melt and to map the extent of these deposits. For this study, only interior impact melt deposits were included in mapping and area measurements, and area was used as an imperfect proxy for volume until topography data are available.

Identification of impact melt on Mercury is sometimes difficult due to image resolution and/or illumination, so we included only Kuiperian- and Mansurian-aged craters and distinguished impact melt on the basis of morphologic characteristics (smooth, few craters, no embayed craters within the crater interior) and the presence of distinct, visible contacts within the crater. Two labels were used for identification: "positive melt" and "questionable melt" (**Fig. 1**). If the presence of impact melt within a crater was questioned, the crater was categorized as "questionable"; such craters will be the focus of additional study with higher-resolution MDIS narrow-angle camera (NAC) images.

Results: Ponded impact melt deposits were positively identified in 249 lunar craters and 488 mercurian craters, and questionable identifications were made for an additional 40 lunar craters and 209 mercurian craters. The average lunar crater diameter with identifiable interior impact melt deposits was 16 km, with a maximum of 100 km, and the corresponding average mercurian crater diameter was 23 km, with a maximum of 125 km. There is an increase in "positive melt" craters between 8 and 20 km diameter, followed by a gradual decrease that is consistent between Mercury and the Moon (**Fig. 2**).

Both Mercury and the Moon show an increase in melt deposit area with increasing crater diameter (**Fig. 3**), and there is considerable variation in melt pond areas for craters 8 to ~30 km in diameter. Since the volume of impact melt should scale with crater diameter [e.g., 11], we estimated the percentage of the crater area containing ponded impact melt and ignored deposits emplaced exterior to the crater. More melt should be retained in larger impact events [11], and because exterior melt ponds are often smaller than interior ponds, confidently resolving exterior melt ponds was difficult. For the current crater populations, melt-covered interior percentages are largely clustered between 0 to 10% for craters less than ~40 km diameter (**Fig. 3**).

Discussion: We positively identified and mapped interior impact melt deposits within hundreds of craters on Mercury and the Moon, and our results show that for craters ≥40 km diameter, mercurian craters contain larger areal extents of interior ponded impact melt than their lunar counterparts (**Fig. 3**). For larger-diameter craters on the Moon and Mercury, more melt is produced and larger ponded interior deposits formed than at smaller diameters. Smaller craters have a larger range of melt-pond areas that may result from differences in melt distribution (e.g., splashed on the crater walls), crater morphology, and the presence of clasts.

These results for craters ≥40 km diameter are consistent with models [e.g., 2, 7, 11, 12, 13] that predict more impact melt in mercurian craters. Future work will expand the study area to strengthen statistics and explore the apparent increased melt volume for craters above ~40 km diameter on Mercury by including topographic data to quantify crater morphologic comparisons and estimate impact melt volumes, while considering the effects of scaling relations for craters on Mercury and the Moon.

References: [1] Murray B. C. et al. (1974) *Science 185*, 169. [2] Gault D. E. et al. (1975) *JGR*, *80*, 2444. [3] Murray B. C. et al. (1975) *JGR*, *80*, 2508. [4] Gault D. E. et al. (1977) *Ann. Rev. Astron. Astrophys.*, *15*, 97 [5] Guest J. E. and O'Donnell W. P. (1977) *Vistas in Astron.*, *20*, 273. [6] Strom R. G. (1979) *Space Sci. Rev.*, *24*, 3 [7] Wetherill G. W. (1975) *Proc. Soviet-American Conf. Cosmochem. Moon Plan.*, 2. [8] Le Feuvre M. and Wieczorek M. A. (2008) *Icarus*, *197*, 291. [9] Strom R. G. (2008) *Science*, *321*, 79. [10] Kneissl et al. (2011) *Planet. Space Sci.*, *59*, 1243 [11] Grieve R. A. F. and Cintala M. J. (1997) *Adv. Space Res.*, *20*, 1551. [12] Pierazzo E. et al. (1997) *Icarus*, *127*, 408. [13] Cintala M. J. and Grieve, R. A. F. (1998) *MAPS*, *33*, 889.

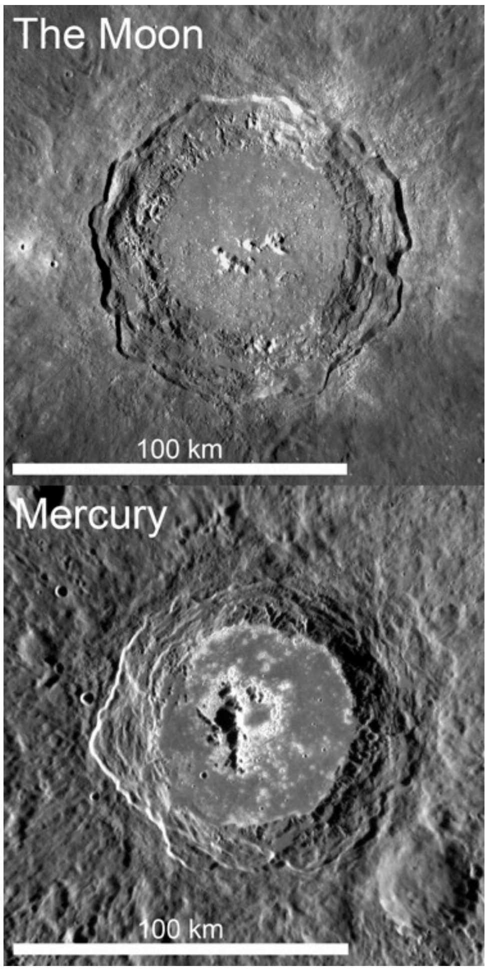

Fig. 1 (left). Craters with extensive interior melt deposits. (Top) Copernicus crater, 93 km diameter (9.60°N, 339.95°E). (Bottom) Unnamed crater, 90 km diameter (7.65°N, 33.19°E). Impact melt deposits are smooth, ponded in crater floors, wall terraces, and regions exterior to the crater, and have a low superposed crater density.

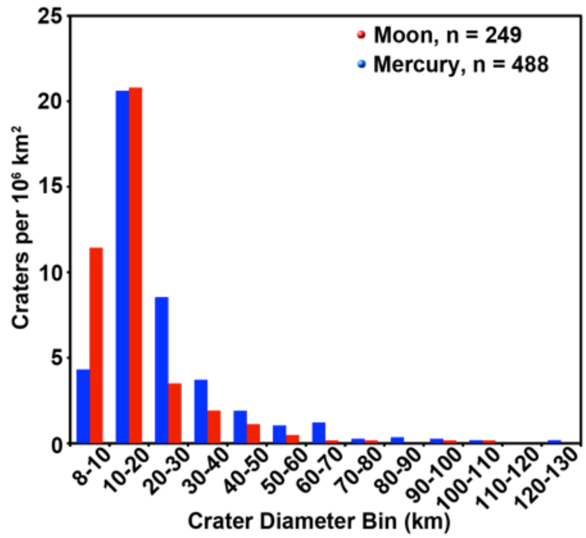

Fig. 2. Craters with interior impact melt deposits.

Fig. 3 (below). (a) Area of melt versus crater diameter. (b) Fractional crater floor area covered by melt versus crater diameter. Many craters ≤40 km in diameter have <10% of interior crater area covered by melt, but craters ≥40 km have ~>15% of interior crater area covered by melt.