CRATER DEGRADATION ON MERCURY: A GLOBAL PERSPECTIVE. Mallory J. Kinczyk1, Paul K. Byrne1, Louise M. Prockter2, Hannah C. M. Susorney3, Olivier S. Barnouin4. 1Planetary Research Group, Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University, Raleigh, NC 27695, 2The Lunar and Planetary Institute, Houston, TX 77058, 3Department of Earth and Planetary Sciences, The Johns Hopkins University, Baltimore, MD 21218, 4The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723.

Introduction: Impact craters are the most ubiquitous geological feature in the Solar System. Manifest in numerous shapes and sizes, all impact craters are affected by the erosive forces acting upon their host body. From water and wind to viscous relaxation and micrometeorite bombardment, these processes work to subdue the crater form on geologic timescales. This results in an assortment of crater morphologies that can shed light on a planet’s geological history and evolution. With the global image dataset collected by the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft, it is now possible to characterize impact crater morphology across the entire surface of Mercury.

Global Classification: In this study, we developed a globally consistent degradation classification scheme for Mercury’s craters [1] by reviewing previous descriptions of crater classification [e.g., 2,3] (Fig. 1). This approach labeled the most degraded craters as “Class 1” and the best preserved craters as “Class 5.” We utilized multiple global monochrome image mosaics with a variety of viewing and illumination conditions, complemented with topography derived from stereophotoclinometry, to classify all craters ≥40 km in diameter. We also subdivided observations based on initial crater diameter and morphology [4]. This subdivision is a key aspect of the analysis because, although this particular crater property was not incorporated in previous classification systems, it has been recognized that size contributes to the overall appearance of crater features at varying degrees of degradation [3,5].

Roughness of Crater Ejecta: In addition to the visual classification system described above, we sought to identify whether surface roughness—the scale-dependent measure of topographic change [6]—could be used as a proxy for crater degradation. Using Fourier transform analysis, altimeter tracks acquired by the Mercury Laser Altimeter (MLA) were analyzed to determine whether a measureable, quantitative difference exists in surface roughness at the kilometer scale of continuous ejecta deposits [7]. By comparing roughness measurements across Class 3 and Class 4 craters (Fig. 1), we searched for differences that may represent further evidence of a morphological change over time, and to test the basis by which these craters were classified in the first place [1].

Results: Our results provide the first comprehensive assessment of how craters of various states of degradation are distributed across Mercury and, therefore, a characterization of the planet’s impact cratering history. We find fewer mid-sized (i.e., ~40–100 km-diameter) craters of the most degraded (and thus presumably oldest) class than expected, implying that the earliest record of impact bombardment of Mercury’s intercrater plains is only partially preserved [8].

In addition, we find that there is no statistically resolvable difference in roughness between Class 3 and Class 4 craters even with the highest-resolution MLA tracks. The upcoming ESA/JAXA BepiColombo mission will provide an excellent opportunity for further investigation into crater roughness at a range of scales.


Fig. 1. Crater degradation in a subset of Mercurian craters [1]. Fresh craters have crisp rims, continuous ejecta, and a continuous field of secondary craters. Heavily degraded craters have little to no topographic relief and are heavily overprinted by subsequent primary and secondary craters.