**HOLLOWS ON MERCURY: NO GEOGRAPHIC TRENDS IN REFLECTANCE.** M. S. Phillips[1], J. P. Emery[1], and J. E. Moersch[1] [1](Planetary Geosciences Institute, Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, Tennessee 37996-1410, USA, mphill58@vols.utk.edu).

**Introduction:** Mercury is host to unique, sub-kilometer-scale, rimless depressions known as hollows [1]. These irregularly-shaped features have distinctive flat floors, steep walls, high-reflectance and high UV to visible color-ratio values. Possible mechanisms for hollow formation include loss of volatiles due to sublimation or space weathering [1, 2], which is inconsistent with early estimations and predictions of the volatile content of Mercury [e.g., 3, 4], but consistent with more recent volatile-content estimations from MESSENGER [e.g., 5, 6, 7].

Thomas et al. [8] completed a global survey of hollows mapping 445 groups and finding an anomalously high concentration of these features between longitudes -60 and -40 °E. Their work supports the hypothesis that hollows form via sublimation and that a likely source for the volatile component is associated with low-reflectance material on Mercury [8]. However, neither an over-abundance of low-reflectance material nor an elevated rate of space-weathering due to higher solar flux is sufficient to explain the concentration of hollows between -60 and -40 °E [8]. Additionally, Thomas et al. [8] found a negative correlation between the areal extent of hollows in craters and the degradation state of the host crater. If hollows form near the time of impact, and impacts throughout time have had equal potential for creating equal areal extents of hollows, then the observation that more-degraded craters harbor fewer hollows implies that the areal extent of hollows decreases with time. Furthermore, it has been suggested that bright surface materials on Mercury degrade over time due to surface weathering processes, such as micrometeoroid impacts, accumulation of nanophase iron, and impact gardening, such that brighter surfaces become less reflective with time [9, 10]. This implies that hollow brightness could be correlated with how recently hollows have formed. We hypothesize that the anomalously high abundance of hollows in the area between -60 and -40 °E may be a consequence of hollows in that region forming more recently than elsewhere.

**Methods:** To test this hypothesis, 30 areas of size 20° longitude by 5° latitude were chosen across Mercury using the global map of hollows created by Thomas et al. [8]. With the Planetary Image Locater Tool (PILOT), we searched NASA's Planetary Data System (PDS) for MESSENGER images in the 30 preselected hollow-bearing areas. Images were obtained from the 1.5° field-of-view Mercury Dual Imaging System Narrow Angle Camera (MDIS NAC). Images were selected from longitudes that contained hollows at latitudes 0 to 5° N, 20 to 25° N, and 40 to 45° N. By selecting areas of longitude that contained hollows at all three latitudes, we were able to test for longitudinal and latitudinal variations independently. Images south of 0 °N were excluded due to the low spatial resolution of images from the southern hemisphere, and images north of 45° N were excluded because at high latitudes, high incidence angles preclude the identification of hollows inside craters and inhibit the efficacy of the photometric correction. One image was randomly selected from all hollow-bearing NAC images in the PDS for each sample area.

*Data Collected.* Images were converted to raw ENVI files with the Geospatial Data Abstraction Library (GDAL) software package. Hollows were defined by their halos, and, in the absence of a halo, they were defined by their distinctive sharp edges. The reflectance value of host material was sampled surrounding the hollows, and shadows were excluded to avoid artificially lowering the values. Average values and standard deviations were derived for each area with the ROI statistics tool in ENVI.

**Results and Discussion:** The average hollow reflectance and the ratio of average hollow reflectance to average host material reflectance are shown in figure 1. Error bars represent a 90 % confidence interval. The average reflectance value for the hollow material is 1.54 times brighter than the average reflectance value of the host material.

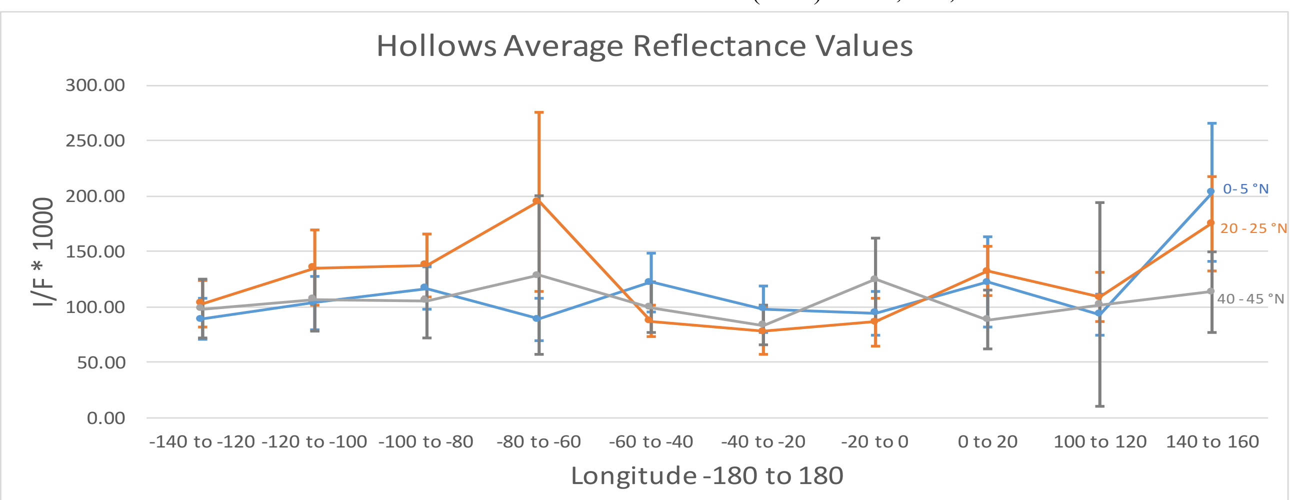
*Longitudinal and Latitudinal Variation.* Hollows between longitudes -60 and -40 °E are not brighter than hollows from other longitudes of the planet. This result does not support the hypothesis that the hollows of this region have formed more recently than hollows elsewhere on the planet. Additionally, there does not appear to be any statistically significant longitudinal variations in reflectance.

Similarly, variations in hollow reflectance across latitude are not observed; hollows at a specific latitude do not appear consistently brighter than hollows of another latitude. These data do not support the idea that special conditions associated with specific latitudes or longitudes are necessary for hollow formation (e.g., hot poles or equatorial regions). Rather, this result further supports the findings of Thomas et al. [8], that the conditions for hollow formation are ubiquitously met on the Hermean surface. Additionally, it implies that hollows at all latitudes and longitudes have a similar age of most recent activity "freshening" their reflectance, or that the rate of darkening is longer than temporal variations in formation.

*Anomalous Regions.* Although no universal latitudinal or longitudinal trends are found, some anomalous regions are observed. Hollows at longitude 140 to 160 °E and latitudes 0 to 5 °N and 20 to 25 °N have a higher average reflectance than several other areas of hollows. Additionally, hollows observed between -80 to -60 °E and 20 to 25 °N are more reflective than hollows at the same longitude at 0 to 5° N latitude. The higher reflectance could mean that hollows in these areas are more recently active, but it is more likely that the higher reflectance is an artifact of high incidence angles in these images and, consequently, an unreliable photometric correction [11]. The ratio values for these same areas prove uninteresting, which supports the interpretation that the unusually high average reflectance is not a real characteristic of the hollows, but a consequence of extreme viewing geometry.

**Conclusions:** We find that hollows show no significant variations in reflectance values at 747.7 nm. This implies a similar age of most recent activity "freshening" hollow surfaces, or that the rate of darkening is slow compared to temporal variations in hollow formation. Additionally, this supports the idea that conditions for hollow formation are commonly met on the Hermean surface.

**References:** [1] Blewett, D. T., et al. (2011) *Science 333 (6051*), 1856-1859. [2] Xiao, Z. Y., et al. (2013) *Journal of Geophysical Research-Planets 118(9),* 1752-1765. [3] Benz, W., et al. (1988). Icarus *74(3),* 516-528. [4] Lewis, J.S., in *Mercury*, ed. by F. Vilas, C.R. Chapman, M.S. Matthews (1988) University of Arizona Press, Tucson, pp. 651–667. [5] Head, J. W., et al. (2008) *Science*, *321(5885)*, 69. [6] Kerber, L., et al. (2009) *Earth and Planetary Science Letters, 285(3),* 263-271. [7] Kerber, L., et al. (2011) *Planetary and Space Science, 59(15),* 1895-1909. [8] Thomas, R. J., et al. (2014) *Icarus, 229,* 221-235. [9] Blewett, D. T., et al. (2007) *Journal of Geophysical Research-Planets, 112(E2).* [10] Lucey, P. G. and S. K. Noble (2008). *Icarus, 197(1),* 348-353. [11] Domingue, D. L., et al. (2015) *Icarus, 257,* 477-488.



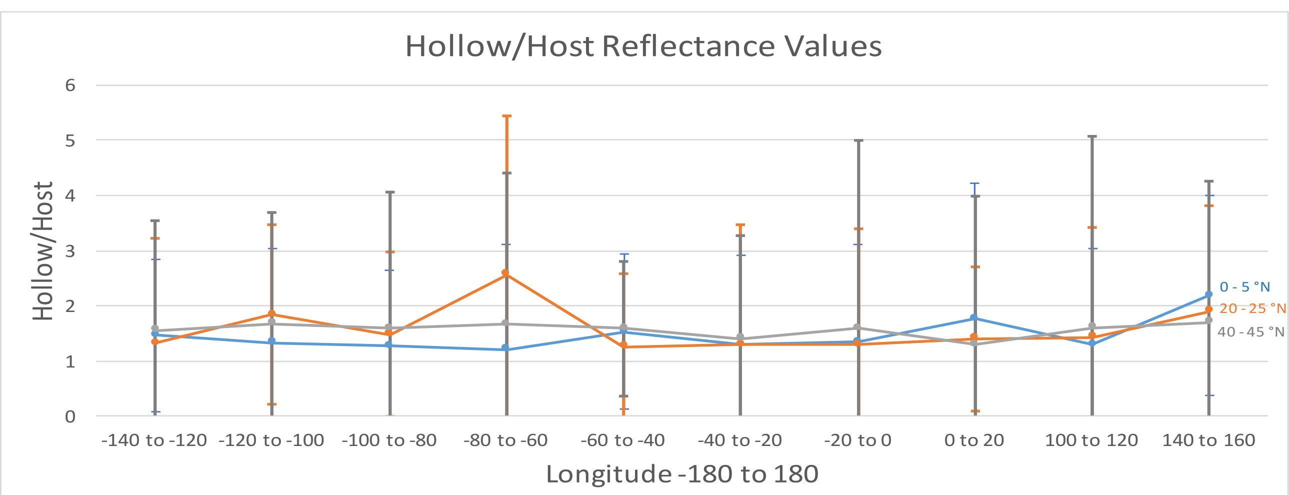




**Figure 1**: Plots of the average hollow reflectance value (bottom) and hollow/host material reflectance ratios (top). Error bars represent 90 % confidence intervals for the values calculated from ± 1.645 standard deviations. Reflectance (I/F) is multiplied by 1000.