DIFFERENCES BETWEEN SURFACE ICE DEPOSITS AT THE POLES OF MERCURY AND THE MOON: INSIGHTS INTO AGES OF THE ICE. Ariel N. Deutsch[1], James W. Head[1], and Gregory A. Neumann[2], [1]Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, RI 02912 (ariel_deutsch@brown.edu), [2]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA.

Introduction: The poles of Mercury and the Moon both show evidence for water ice, but the deposits on Mercury have a greater areal distribution [1] and a more pure concentration [2]. Earth-based radar observations revealed an estimated ~25,000 m^2 of ice at Mercury's poles [1] that was modeled to be ~95 wt. % pure water ice [2]. Images [3] and reflectance measurements [4] acquired by the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft showed that these deposits are spatially homogeneous within permanently shadowed regions (PSRs).

In contrast to the relatively pure water-ice deposits on Mercury [2], polar deposits on the Moon are rather heterogeneous. For instance, multiple volatiles were detected in the ejecta plume of the LCROSS experiment that impacted into Cabeus at the Moon's south pole, suggesting that the deposits are not pure water ice [5–6]. Additionally, mapping of UV albedo spectra and surface temperature revealed a highly spatially heterogeneous distribution of water frost within PSRs [7].

Here, we explore how these differences in purity and spatial homogeneity of ice at Mercury and the Moon may be related to the ages of the ice.

Methodology: *Mercurian crater statistics.* Using images acquired by the Wide-Angle Camera during MESSENGER's low-altitude campaign [8], we identify small craters in the PSRs that are correlated with high reflectance, suggestive of excavated material. While the majority of craters observed in the PSRs may be pre-existing topography emplaced before the deposition of the ice [e.g., 10], the anomalous small craters associated with high-reflectance material may have formed after the emplacement of the ice. If so, then these small craters superposing the ice deposit can be used to date the ice surface. We estimate the absolute ages of Laxness, Bechet, and Ensor craters using CraterstatsII [11] and chronology and production systems from [12].

Lunar ice heterogeneity measurements. We explore the relationship between the spatial heterogeneity of ice and the age of host craters at the lunar poles. The spatial heterogeneity of a polar deposit is quantified as the percent of the cold trap occupied by ice. We define cold traps as regions with maximum surface temperatures ≤ 110 K, as measured by the Diviner Lunar Radiometer Experiment [13]. To determine what percent of cold traps are occupied, we use maps of anomalously high reflectance measured at 1064 nm, consistent with surface ice detections [14]. Craters are classified into lunar geologic periods through the combined analyses of crater age dating [15], geologic maps [16], and morphological crater classification schemes [e.g., 17].

Results: *Mercurian crater statistics.* The estimated derived ages for the ice surfaces within Laxness, Bechet, and Ensor craters are 48 ± 20 Ma, 91 ± 40 Ma, and 220 ± 60 Ma, respectively. These ages are slightly higher than the 50 Ma predicted by regolith gardening models [18], but consistent with the ice being deposited relatively recently. These ages are also consistent with the ice being delivered by the Hokusai impactor [19].

Lunar ice heterogeneity measurements. We find that for the south pole on the Moon, the youngest ice-bearing craters [14] are the most spatially homogenous, suggesting that age has some control over the spatial distribution of surface ice at the Moon. It is possible that older ice deposits have undergone more space weathering and impact bombardment [20–21], contributing to a more spatially heterogeneous deposit.

Implications: The same impact bombardment and space weathering processes operate on Mercury and the Moon, and Mercury's regolith may be overturned even more frequently than the lunar regolith [22]. Thus, the lack of apparent degradation of Mercury's ice deposits also suggests that these deposits are relatively young. We suggest that the spatial homogeneity and purity of Mercury's polar deposits within a given PSR may be explained by relatively younger ice in comparison to relatively older ice within the Moon's polar cold traps.

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