areas that are periodically sunlit (Vasavada et al., 1999), but perhaps the specific topography and location of Prokofiev create a thermal regime that can maintain subsurface ice even though the surface periodically reaches temperatures too high for the preservation of the low-reflectance organic-rich volatile material.

In the lower-latitude craters, the fact that the low-reflectance deposits display sharp boundaries that extend to the edges of the shadowed and radar-bright regions (Fig. 4) contrasts with the 3 km offset of such boundaries observed in Prokofiev and indicates that lateral mixing has not moved the boundary of low-reflectance material inward. This observation implies that the low-reflectance deposits formed geologically recently or as part of an ongoing process. However, if impact gardening of a low-reflectance deposit tens of centimeters thick exposed or thermally disturbed underlying water ice, any water ice exposed at the surface would quickly sublimate (1 m in 10^6 yr at 130 K; 1 m in 10^3 yr at 150 K; Vasavada et al., 1999; Paige et al., 2013). A stable configuration would rapidly be restored, perhaps resulting in the formation of new lag deposits of low-reflectance material. Thus, by continually disturbing and reforming the edges of the low-reflectance deposits, the impact gardening process potentially could keep the boundaries sharp and well matched to those of the radar-bright and permanently shadowed regions.

The total amount of ice at Mercury's poles is substantial, with estimates of $\sim 10^{16}$–10^{18} g (Moses et al., 1999; Lawrence et al., 2013). The upper estimate is comparable to the water volume of Lake Ontario (North America; $\sim 1.64 \times 10^{18}$ g) and consistent with delivery by external sources to Mercury and subsequent thermal stability over billions of years (Moses et al., 1999; Paige et al., 2013). However, in addition to lateral mixing, other processes have been suggested that would disrupt exposed volatile deposits on Mercury within geologically short time scales. Models of vertical mixing by impact gardening (Crider and Killen, 2005) indicate that ice would be buried at a rate of 4×10^{-9} m/yr; destruction by Lyman alpha photodissociation may limit the lifetime of exposed ice (Morgan and Shemansky, 1991); and organic synthesis within ice bombarded by galactic cosmic rays, such as in Prokofiev, may darken the ice on time scales of tens of millions of years (Crites et al., 2013). Moreover, although laser reflectance measurements at 1064 nm have yielded higher reflectance values for permanently shadowed regions at the lunar poles, indicative of modest amounts of water frost or a reduction in the effectiveness of space weathering (Lucey et al., 2014), visible-wavelength imaging of permanently shadowed craters on the Moon (Haruyama et al., 2008; Speyerer and Robinson, 2013) has not revealed surfaces with anomalously high or low reflectance similar to those seen in WAC broadband images of Mercury. One explanation for differences between the Moon and Mercury could be that the volatile polar deposits on Mercury were recently emplaced. If Mercury's currently substantial polar volatile inventory is the product of the most recent portion of a longer process, then a considerable mass of volatiles may have been delivered to the inner Solar System throughout its history.

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