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Thickness Estimate of Ice-Rich Mantle Deposits on Malea Planum and the Southern Hellas Basin, Mars

M. Zanetti, H. Hiesinger, and D. Reiss

Institut für Planetologie, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany (mikezanetti@yahoo.com)

Latitude-dependent ice-rich surface deposits of dust have been observed to mantle the middle and high latitudes of the Martian surface. Based on observations from previous work from [1], mantle deposits on the southern wall of the Hellas Basin appear significantly thicker than those on Malea Planum. We have attempted to quantify the thickness of the mantle in this region using the measured crater diameter/rim height relationship of partially and completely buried 'ghost' craters. This method has been successfully used in the past for estimations of mare lava thickness on the Moon [e.g., 2], and dust mantles on Mars [e.g., 3]. Because the dust-ice mantles represent a significant reservoir of presumably H2O ice, quantifying their volume is important for under-standing the current ice budget of the planet, as well as current and paleoclimate depositional re-gimes.

The study region is located in Malea Planum and the southern Hellas Basin from ∼56°E to 70°E and ∼52°S to 70°S. High Resolution Stereo Camera (12.5 m/pxl resolution) and CTX (5 m/pxl resolution) images in this area were examined for mantled impact craters. Where craters appeared to have been completely buried by mantle deposits, or where their crater rims appeared to be just barely visible through the deposit, their crater diameter was measured, and their loca-tion recorded. Crater rim heights (the expected average height of the crater rim above the sur-rounding plains elevation) were calculated from these diameters using the relationship for simple craters of h=0.04D̂0.31 from [4]. 3829 craters (diameter range: 0.081km - 5.8 km) were found to be mostly or completely buried. A gridded isopach map was produced based on the calculated rim heights. The method required that certain assumptions be made regarding the craters: 1) Craters are simple, bowl-shaped, and unmodified; 2) Craters formed prior to the emplacement of the mantle; 3) Craters are entirely buried or their rims are barely discernable from the surrounding terrain. These assumptions carry a few caveats. Specifically, we do not take into account possible degradation of the crater rim following the impact, but before deposition. Also, we do not ac-count for impacts that may have formed on pre-existing mantle deposits that were subsequently buried by later depositional phases. Using this method, caution has been exercised for the follow-ing reasons. Craters that are completely buried by mantle material probably represent an underestimation of the total thickness of the deposited material, as the thickness of the overlying material is not known. Additionally, if any given impact occurred after the deposition of mantle material began, the calculated depth would not be consistent with the depth to the basement surface, and would be an underestimation of total mantle thickness at that point. Complicating the estimations further are craters that are not completely mantled to their respective rims. For these examples, the calculated rim height would represent an overestimation of the amount of mantling material, and the difference between the crater rim and mantle layer should be subtracted. However, in many instances this is not possible due to the small size of the craters and the spacing of individual MOLA measurements. Resolution and atmospheric effects that influence image quality are additional sources of error. Many of the problems with these assumptions have been noted by previous researchers [e.g., 5].

Preliminary mantle thicknesses derived from crater rim height calculations range from ∼13 m to ∼39 m. The thinnest areas of mantle are found on the highland plains of Malea Planum, with isolated areas of thicker smooth mantling, and some areas where dust has accumulated in topographic lows. The interpolation in the isopach map overestimates mantle thickness in thin areas where no data points were collected and visual inspection shows that the mantle is in some places can be thinner than indicated by the map. The thickest areas of deposited material are found on the southern slope of the Hellas Basin, where craters are often completely mantled and no rim is seen. These were identified by concentric fractures in the mantle which mark the approximate outline of the buried rim. Mantle in these regions is typically smooth and continuously seen draped over the topography. Our results

indicate distinct thickening of ice-rich deposited material north of $\sim$58°S on the southern wall of the Hellas Basin, compared to the plains of Malea Planum. The mantle on the plains is probably thinner than what is indicated due to the overestimation of values caused by partially buried craters. Similarly, the mantle on the slope of the basin is probably thicker than represented due underestimation caused by complete burial of many craters. [1] Zanetti et al., 2009, Icarus, in review. [2] DeHon, R.A., 1974 Proc. Lunar Sci. Conf., 5th, 53. [3] Bleacher, J.E., et al., 2003, JGR, JE001535. [4] Garvin et al., 2003, 6th Intl. Conf. on Mars, Abs. #3277. [5] Head, J.W., (1982), Moon and Planets, 26, 61-88.