DEGRADATIONAL MORPHOLOGIES OF MID-LATITUDE CRATERS ON MARS. Daniel C. Berman, David A. Crown, and Leslie F. Bleamaster III, Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ, 85719, bermandc@psi.edu.

Introduction: The degradation of craters in ice-rich environments is key to understanding the geologic history of the terrain surrounding the crater, as well as the source of the ice (i.e. ground ice or emplaced from the atmosphere as an ice-rich mantle [1-3]). Features such as arcuate ridges, gullies, and small flow lobes found on crater walls and floors can be used to understand the styles of emplacement, abundance, and distribution of the ice. Previous studies [4] have shown that arcuate ridges and gullies are mainly found in small craters (~2-30 km in diameter); the orientation of these features on crater walls has been found to be dependent on latitude, suggesting that their formation is related to climatic changes driven by obliquity cycles [1-7]. In larger craters (~30-100 km in diameter), potentially ice-rich flow lobes are typically found on pole-facing walls, along with a suite of other degradational morphologies indicative of ice-driven modification processes. In this study, we examined larger craters in detail, noting the potentially ice-rich morphologies present and assessing their relationships to latitude and crater diameter.

Crater Morphologies: ArcGIS was used to integrate available datasets (including Viking Orbiter MDIM 2.1 and THEMIS IR mosaics, MOLA 128 pixel/degree DEM, and selected THEMIS VIS images) to complete surveys of two study regions. Every crater larger than 20 km in each region, as identified in the Barlow martian crater database [8], is being studied in detail for evidence of flow features and related morphological indicators of ice-rich deposits. The geomorphic characteristics of each crater are noted to determine relationships between the observed features and factors such as crater diameter, latitude, and wall slopes. The rims of these craters are typically highly degraded and dissected, in contrast to smaller craters in which arcuate ridges and gullies are typically found. The wall slopes typically range from ~10-20º.

Craters containing lobate flow features also commonly exhibit other features consistent with the presence or flow of water or ice, including valley networks (sometimes with valley floors covered by potentially ice-rich material), gullies (with accompanying fans and alcoves), narrow runoff channels, pitted and/or lineated floor deposits, debris flows, and lobate ejecta. All of the craters found thus far with these features are located between 35º and 60º.

Survey: Two study areas have been selected to examine crater degradational morphologies: one in the northern mid-latitudes in Arabia Terra along the dichotomy boundary (30º-55º N, 0º-40º E) and one in the southern mid-latitudes in the highlands east of Hellas Basin (30º S-60º S, 110º-150º E). Out of 400 craters in the southern study region, as identified by [8], 121 had sufficient image coverage in THEMIS VIS images for more detailed examination. In the northern study region, 116 craters out of 197 were examined. This thorough survey has revealed the presence of a multitude of lobate flow features on the walls of craters throughout both regions, typically on the pole-facing side, with a dependence on latitude and crater diameter. We have identified 24 craters in the south study region and 6 craters in the north study region with lobate flows on their walls, primarily between 35º and 50º, and distributed throughout the region longitudinally. These craters typically contain several such lobes, appearing to flow from near the top of the crater rim, where mantling deposits are present [1-3], to a tapered point as the wall meets the floor. The size and shape of the lobes seem to be controlled by the local topography along the rim. The lobes are bounded by raised ridges, and their surfaces often have a pitted texture.

Nearly all of the lobes are on pole-facing walls, and all of the pole-facing lobes are found below 45º. We have found three craters with lobes on an equator-facing wall, two in the southern study region, and one in the northern region. These craters are found south of 50º in the southern region, and north of 45º in the northern region. This orientation dependence on latitude is consistent with previously determined orientation results for gullies and arcuate ridges [4, 7, 9].

Discussion: A suite of distinct morphologic features is found to be characteristic of mid-latitude craters. These features (e.g., gullies, arcuate ridges, lobate flows, narrow channels, wider valleys, filled and unfilled alcoves, mantling deposits, and debris flows) appear to be related to the deposition and/or accumulation of ice with subsequent erosion due to mobilization of this ice. Which features develop in a crater is a function of latitude, crater diameter, crater wall slope, and crater rim topography. Lobate flows are common in mid-latitude craters larger than 20 km in diameter and are mostly pole-facing in orientation at lower latitudes, and equator-facing at higher latitudes, similar to the relationship between gully latitude and orientation [4]. These interrelationships suggest that cycles of deposition and re-distribution of ice [6, 7, 9] due to obliquity variations [5] are the likely formation mechanism for the observed features.

References: [1] Squyres S. W. and Carr M. H. (1986) *Science, 231*, 249-252. [2] Hartmann W. K. et al. (2003) *Icarus, 162*, 259-277. [3] Arfstrom J. and Hartmann W. K. (2005) *Icarus, 174*, 321-335. [4] Berman D. C. et al. (2005) *Icarus, 178*, 465-486. [5] Laskar J. et al. (2004*) Icarus, 170*, 343-364. [6] Mustard J. F. et al. (2001) *Nature, 412,* 411-414. [7] Costard F. et al. (2002) *Science, 295,* 110-113. [8] Barlow N. G. (2006) *LPSC XXXVII,* Abstract #1337. [9] Christensen P. R. (2003) *Nature, 422,* 45-47.

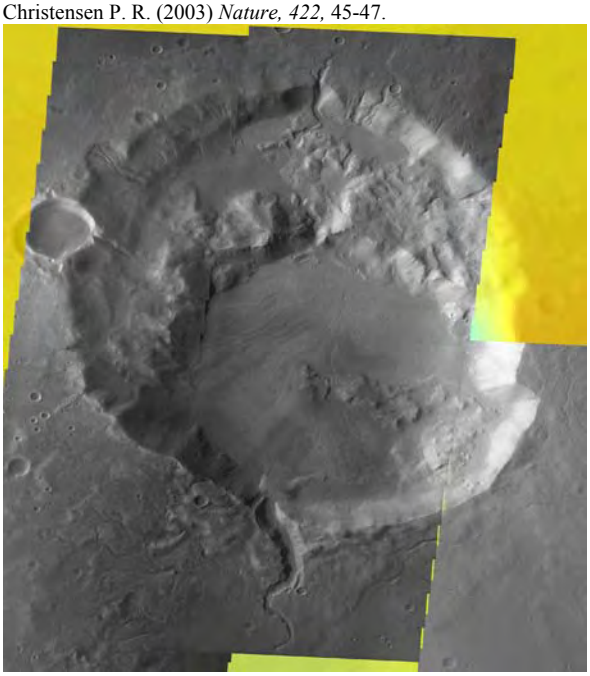

Fig. 1. Crater (41 km diameter; 35.52ºN, 6.59ºE) showing runoff channels on the northern and southern rims and debris flows emanating from the southern, pole-facing wall. THEMIS VIS mosaic merged with MOLA 128 pixel/deg DEM.

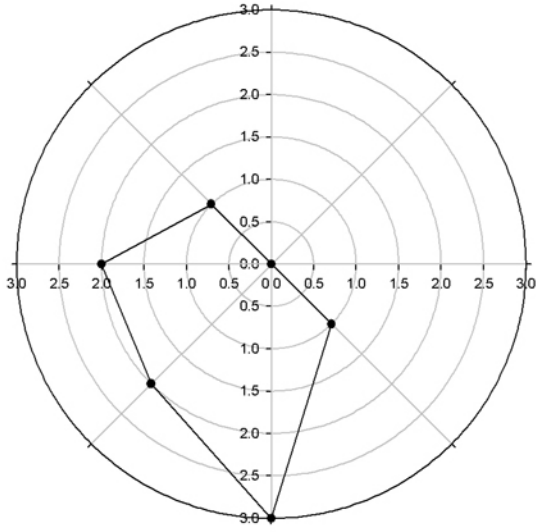

Fig. 2. Number of craters with lobes on walls of each orientation in the southern study region.

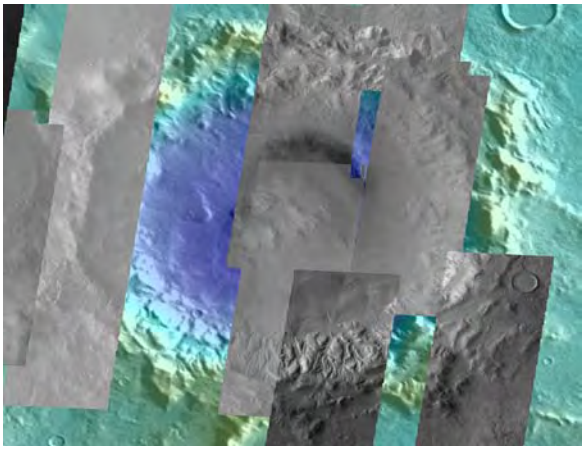

Fig. 3. Crater (70 km diameter; 39ºS., 112.7ºE) showing multiple lobate flows on the northern, pole-facing rim, and filled valleys on the southern, equator-facing rim. THEMIS VIS mosaic merged with MOLA 128 pixel/deg DEM.

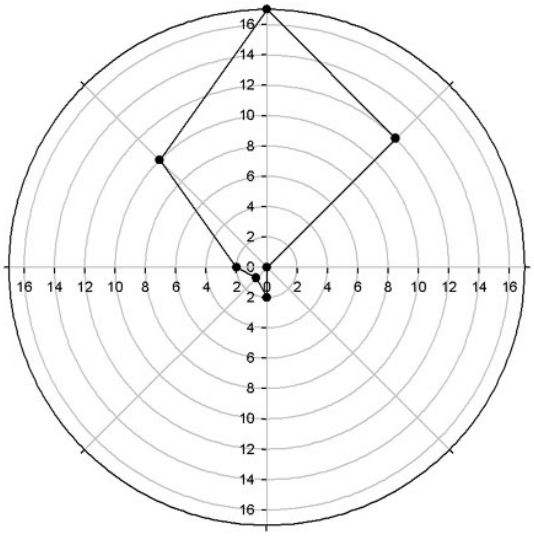

Fig. 4. Number of craters with lobes on walls of each orientation in the northern study region.

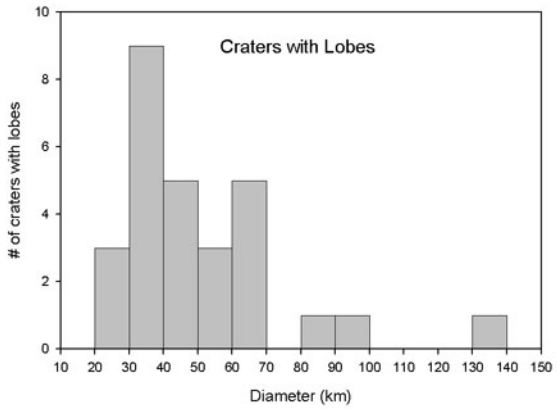

Fig. 5. Number of craters with lobes per 10 km diameter bin.