SURVEY OF MID-LATITUDE MARTIAN CRATERS: VOLATILE-DRIVEN DEGRADATIONAL MORPHOLOGIES. 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: Recent geomorphic [1], remote sensing [2], and atmospheric modeling studies [3] have shown evidence for potentially large amounts of ground ice deposits in the Martian mid-latitudes. Numerous potential ice-rich flow features have been identified in these regions in the Viking Orbiter dataset [4] as well as in more recent high resolution images. Arcuate ridges at the bases of the walls of small (2-30 km diameter) craters in the mid-latitudes (Fig. 1, feature "a") have been interpreted as glacial features [1,5,6]. Potentially ice-rich lobes, such as the one found on the wall of the ~70 km diameter crater east of Hellas Basin [5], are commonly found on the walls of craters with diameters between ~30-100 km in southern mid-latitude regions (Fig. 2). These features typically have distinct morphological characteristics, which appear similar to terrestrial debris-covered glaciers [6].

Figure 1. Crater (at bottom) with gullies and arcuate ridges (feature "a") nested within a larger crater with lobate flow features on its northern wall (at top, shown by arrows). THEMIS VIS image V07798008.

Background: The degradation of craters in ice-rich environments provides clues to regional geologic history, as well as to the source of the ice (i.e., whether it was present as ground ice at the time of impact, or if it has since been emplaced from the atmosphere [7,8,9]). Features such as arcuate ridges, gullies, and flow lobes can be used to understand degradational history and constrain the distribution and abundance of ground ice. Previous studies 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 also been found to be dependent on latitude [1,10,11], suggesting that their formation is related to climatic changes driven by obliquity cycles [3] and deposition of an ice-rich mantle [7,8,9]. Larger flow lobes are typically found in larger craters without an association with gullies, although they do often show drainage patterns beneath them.

Crater Morphologies: Craters containing lobate flow features also commonly contain other features consistent with the flow of water or ice, including trough-like valley networks (sometimes filled with potentially ice-rich material), gullies (with accompanying fans and alcoves), narrow runoff channels in and around the crater, mantled floor deposits, and lobate ejecta. Crater diameter and latitude seem to be the strongest controls on these features and their interrelationships. All of the craters found thus far with these features have been found between latitudes 35º S and 60º S.

Survey: Two study areas have been selected to identify and examine these features; one in the northern mid-latitudes in Arabia Terra along the dichotomy boundary (30º-50º N, 0º-40º E) and one in the southern mid-latitudes in the highlands east of Hellas basin (30º -60º S, 110º-150º E). A preliminary survey of THEMIS VIS images of the southern region has revealed the presence of a multitude of lobate flow features on the walls of craters throughout the region, typically on the pole-facing side, with a dependence on latitude and crater diameter. We have thus far identified 16 craters with lobate flows on their walls, primarily between 35º and 50º S, and distributed throughout the region longitudinally. These craters typically contain several such lobes, extending from near the top of the crater rim, where mantle-like deposits are present [7,8,9], 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 (See Figs. 1-3) as well as the size of the crater. The lobes are bound by raised ridges, and their surfaces often have a pitted texture. The crater wall slopes where lobes are found typically range from ~10-20º.

Nearly all of the lobes are on pole-facing walls; however, these are found only as far south as ~45º. We have thus far found two craters with lobes on an equator-facing wall (Fig. 3); these craters are found south of -50º. This orientation dependence on latitude is consistent with previously determined orientation results for gullies and arcuate ridges [1,10,11].

Future work will include use of ArcGIS to integrate available datasets to complete the surveys of the designated regions. Every crater in each region larger than ~5 km will be studied in detail for evidence of flow features and related morphological indicators of ice-rich deposits. The geomorphic characteristics of each crater will be noted to determine relationships between the observed features and factors such as crater diameter, latitude, and wall slopes. The rims of these craters may be highly degraded and dissected, in contrast to the smaller craters in which arcuate ridges and gullies are typically found.

References: [1] Berman D. C. et al. (2005) *Icarus, 178*, 465-486. [2] Boynton W. V. et al. (2002) *Science, 297*, 81-85. [3] Laskar J. et al. (2004*) Icarus, 170*, 343-364. [4] Squyres S. W. and Carr M. H. (1986) Science, 231, 249-252. [5] Hartmann W. K. et al. (2003) *Icarus, 162*, 259-277. [6] Arfstrom J. and Hartmann W. K. (2005), *Icarus, 174*, 321-335. [7] Mustard J. F. et al. (2001) *Nature, 412,* 411-414. [8] Costard F. et al. (2002) *Science, 295,* 110-113. [9] Christensen P. R. (2003) *Nature, 422,* 45-47. [10] Bridges N. T. and Lackner C. N. (2005) *LPSC XXXVI*, Abstract #1764. [11] Heldmann J. L. and Mellon M. T. (2004), *Icarus, 168*, 285-304.

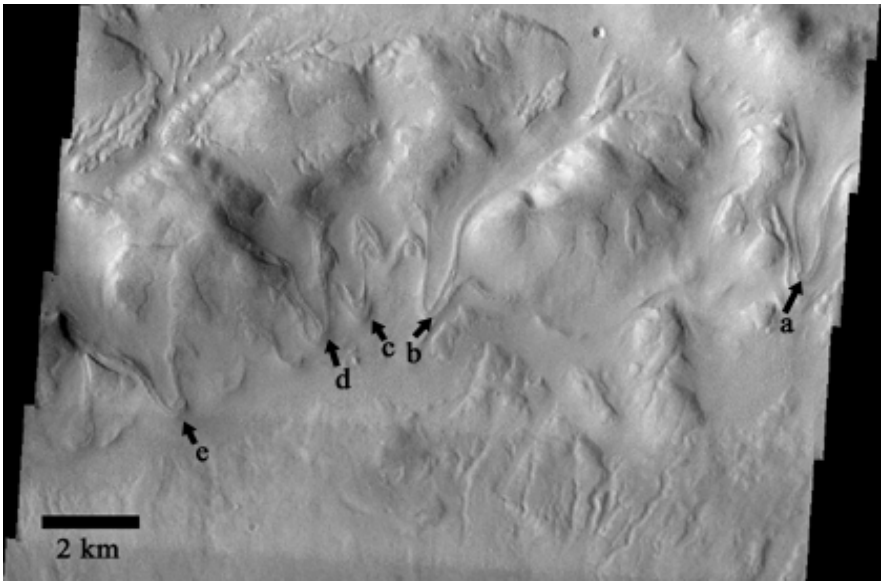

Figure 2. Northern wall of crater at 39º S, 113º E, with multiple lobes extending down crater wall. THEMIS VIS image V08298002.

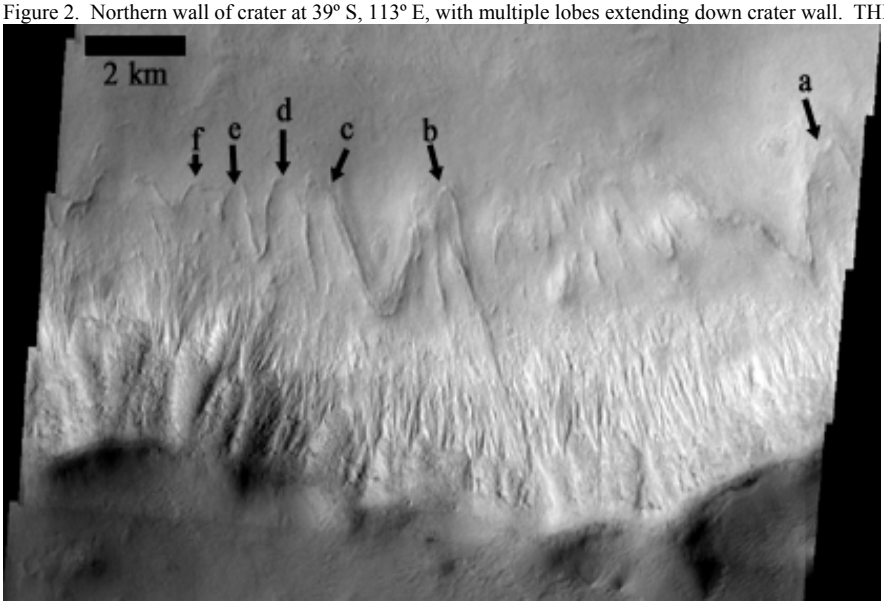

Figure 3. Southern wall of crater 50º S, 140º E showing multiple lobes on equator-facing crater wall. THEMIS VIS image V09570003.