GULLIES OBSERVED ON FROST-COVERED POLEWARD DUNE FACES IN THE SOUTHERN MID-LATITUDES OF MARS: POTENTIAL TARGETS FOR HI-RISE AND CRISM. J.L. Dickson and J.W. Head, Dept. of Geological Sciences, Brown University, Providence, RI 02912, jdickson@brown.edu.

Introduction: Gullies have been observed along the flanks of a variety of surfaces in the mid/high-latitudes of Mars including crater and valley walls [1], and isolated topographic surfaces like central peaks, mesas, knobs, and raised crater rims [2]. Among the most striking of these features, however, are ones found along the slopes of dunes. Due to their small volume and lack of impermeable rock layers, dunes are problematic locations for groundwater accumulation and release, one of the candidate formation hypotheses proposed for martian gullies [1,3,4]. This has led other workers to conclude that gullies on dunes are triggered by surface accumulation of snowpacks that undergo melting to carve the observed channels [5], an hypothesis that has been offered to account for all gullies on Mars [6,7].

The apparent youth of martian gullies has led to debate as to whether or not they can be formed at ideal locations under current climatic conditions. Since obtaining data of these features is difficult due to their small size, focus has been given to models that simulate the current martian climate [6, 8]. *Hecht* [6] concluded that the lack of heat provided by the thin martian atmosphere is balanced by increased direct solar insolation, and that liquid water can exist transiently at nearly any location on the martian surface. Therefore, if gullies on Mars are formed by accumulation and melting of surface snow deposits, they would be expected to form where ice is most stable: poleward slopes in the mid/high-latitudes of each hemisphere, where ice would not receive enough direct sunlight to increase the temperature sufficiently to sublimate.

While orientation measurements show that gullies indeed form on poleward slopes in the mid-latitudes of the southern hemisphere [4,9], little work has been done to decipher a geologic association between surface snowpacks and gullies based on available data. *Christensen* [7] presented evidence for a remnant snowpack within a suite of gullies on the poleward wall of Dao Vallis in Mars Orbiter Camera (MOC) image M09/02875, but images of this region show similar deposits at all seasons (e.g. M03/07529), implying that gully formation at this site is no longer active. In this contribution we document a set of channels incised into dunes in the presence of a seasonal frost deposit in the southern mid-latitudes and discuss implications with regard to gully formation and the stability of liquid water on present-day Mars.

Observations: MOC image M04/03432 shows a dune field found on the central peak of an 80 km diameter crater at 52°S, 33°E (Figure 1a). The southernmost of these dunes show distinct frost deposits on their pole-facing slopes, with no deposits observed on the equator-facing slopes. This image, with a resolution of 2.77 m/px, was acquired at L_s = 195.04°, which corresponds to the beginning of spring in the southern hemisphere. A detailed examination of one of the dunes (Figure 1b) reveals a set of small linear features trending downslope from the zone of frost accumulation towards the base of the dune (Figure 1d). Similar features of the same length and width are observed on neighboring dunes in the same orientation and geometry, and lighting from the northwest reveals these features to be channels incised into the dune face. These channels are no more than 10 m wide and they extend for no more than 175 m from the lower margin of the frost deposit towards the base of the dune, and they frequently terminate before reaching the floor. The easternmost of the channels in Figure 1b shows a high-albedo deposit at its terminus, presumably frost.

MOC image E17/00566 (Figure 1c) shows the same dune face, but in a different season. This image, with a resolution of 4.36 m/px, was acquired at L_s = 24.74°, which corresponds to the beginning of autumn in the southern hemisphere. The frost deposits observed in the spring are no longer present, revealing an undulating topography to the underlying terrain. This texture is only present on poleward slopes, where frost is found in the spring. The channels observed in the spring are present, though they are at the limit of this image's resolution and are barely visible.

The only other high-resolution data available of this dune field is THEMIS image V09998003, which shows the dunes at L_s = 5.392°, also at the beginning of southern autumn. The resolution of this image (35 m/px) is insufficient to observe the channels, but it is important to note that no frost deposits are found on the poleward or equatorward slopes of the dunes.

Discussion: Despite the difficulties in analyzing the precise morphologies of the observed channels at limited resolutions, these features appear similar to well-documented larger gullies found on other dunes in the mid-latitudes of Mars [5]. Unlike gullies carved into other surfaces, gullies on dunes do not emanate from broad alcoves, they maintain very consistent narrow and straight courses, and frequently terminate before reaching the base of the dune [5]. Additionally, these features frequently form well-defined ridges at their terminus instead of depositing debris fans [5]. Higher resolution data will be necessary to study the channels in question in detail, but the visible morphology suggest that they are similar in nature to larger channels incised into dunes.

We feel that the association between frost deposits on pole-facing slopes and the occurrence of channels exclusively on the same slopes is suggestive that these channels have formed from the melting of these frost deposits. Efforts to model the present-day martian climate [6] have predicted that poleward slopes in the mid/high-latitudes of Mars are where gullies would form if they are active, and this location meets those criteria. Frost on poleward slopes at this latitude remains stable on the surface, while frost on equatorward slopes is exposed to greater direct solar insolation, increasing the temperature enough to induce sublimation. By early spring, when Figure 1b was obtained, the frost is still stable and is potentially beginning to melt and carve the channel. By the beginning of autumn, when Figure 1c was obtained, the frost has all been removed to reveal the underlying terrain.

Due to resolution constraints, the most important unanswered questions with regard to these features cannot currently be addressed. The composition of the frost deposits is unknown and the resolutions of TES and OMEGA are insufficient to obtain accurate spectra for the target. CRISM, part of the Mars Reconnaissance Orbiter (MRO) instrument payload, will obtain spectra at a spatial resolution as high as 18 m/px, which will be sufficient to determine the composition of the frost. Additionally, any seasonal

modification of the channels cannot be observed at MOC resolution. HiRISE, also part of the MRO instrument payload, will obtain visible wavelength images at a resolution as high as 30 cm/px. We feel that seasonal monitoring of this site could provide critical information with regard to frost deposition in the mid/high-latitudes, channel formation on dune faces, and the stability of liquid water on the present-day martian surface.

References: [1] Malin, M.C. and Edgett, K.S. (2000), *Science*, 288, 2330-2335. [2] Dickson, J.L. and Head, J.W. (2005), LPSC 36, #1097. [3] Mellon, M.T. and Phillips, R.J. (2001), *J. Geophys. Res.*, 106 (E10), 23,165-23,180. [4] Heldmann, J.L. and Mellon, M.T. (2004), *Icarus*, 168, 285-304. [5] Reiss, D. and Jaumann, R. (2003), *Geophys. Res. Lett.*, 30 (6), 10.1029/2002GL016704. [6] Hecht, M.H. (2002), *Icarus*, 156, 373-386. [7] Christensen, P.R. (2003), *Nature*, 422, 45-48. [8] Haberle, R.M. et al. (2001), *J. Geophys. Res.*, 106 (E10), 23,317-23,326. [9] Berman, D.C. et al. (2005), *Icarus*, in press.

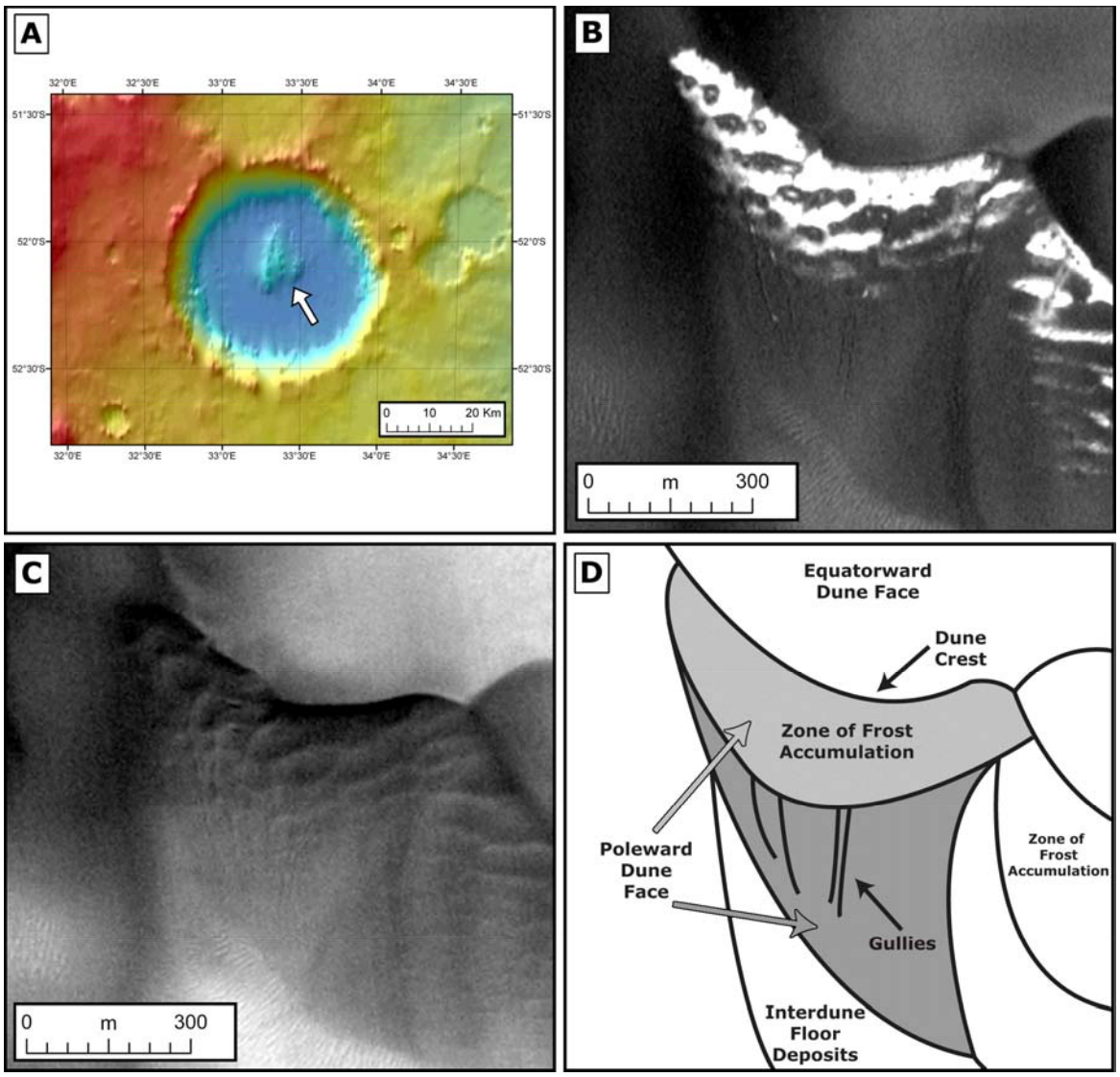

Figure 1. a) MOLA context map showing the host crater. Arrow refers to location of Figures 1b-d. b) Subframe of MOC image M04/03432 showing a frost-covered dune with channels running downslope in early spring. c) Subframe of MOC image E17/00566 showing the same dune in early winter. d) Sketch map for Figure 1b.