DISTRIBUTION AND MORPHOLOGY OF MARTIAN FRACTURED MOUNDS. C. M. Dundas[1], A. S. McEwen[1], and the HiRISE Team, [1]University of Arizona, Department of Planetary Sciences, Tucson, AZ, 85721 (email: colind@lpl.arizona.edu).

Introduction: Pingos are frost mounds with substantial icy cores which form when water freezes under pressure. Identification of pingos provides information about near-surface water and ice and its history. The identification of pingos on Mars would thus provide important information about the habitability and geologic history of the planet. Features observed in Viking and Mars Orbiter Camera-Narrow Angle (MOC-NA) images were interpreted as pingos [e.g. 1-6]. However, relevant morphological features such as surface fractures were difficult to resolve with these cameras, and in several cases further examination supported different origins [7-9].

The High Resolution Imaging Science Experiment (HiRISE) camera [10] has imaged fractured mounds in the mid-latitudes of Mars. These features appear morphologically similar to pingos on Earth in several ways, and appear to be confined to the mid-latitudes, in a band where gullies are also common [11]. This latitudinal dependence is of particular interest since one model of gully origin on Mars is similar to the formation mechanism of some pingos on Earth [12]. However, since initial HiRISE areal coverage was very limited, this distribution was based on MOC imagery of mounds with a particular flat-topped morphology and focused on the Utopia basin. Here we discuss some initial results of a broader-scale survey using only HiRISE imagery.

HiRISE Image Survey:

Survey Parameters: The purpose of this survey is to assess the distribution of fractured mounds on Mars, in order to characterize their properties and test models of their origin. Much of the surface of Mars has fissures or fractures, often superimposed on topographic features; however, they are often unrelated. Therefore, we look for mounds where fractures are confined to the mound surface or emphasized there, in order to isolate instances where they may be of related origin. We exclude hills covered with polygonal thermal contraction cracks and outcrops of jointed rock.

HiRISE obtained some images during the transition orbits of the Mars Reconnaissance Orbiter (MRO), and began Primary Science Phase imaging on orbit 1330. We have analyzed 932 HiRISE images obtained up to MRO orbit 3100. Through orbit 2150, images from all latitudes were examined (these images are biased towards the northern hemisphere due to seasonal illumination constraints but include a few images as far south as 74º latitude); subsequently, only images from latitude 20º-60º of each hemisphere were included.

Mound Distribution: Through orbit 3100, a total of 41 images of 32 sites (nine are stereopairs) with mounds meeting the criteria described above have been found. These sites show a distinct latitudinal dependence: 23 lie between latitudes 35º-40º in either hemisphere, and 31 lie between latitudes 33º-45º. The lone outlier from this group is at 28.3º N, and the fractured mounds there have a distinctly anomalous morphology. The most common geologic settings are floors of several-km-diameter impact craters, particularly in the southern hemisphere, and areas of lineated valley fill.

Morphology: A variety of fractured mound morphologies have been observed. The shape and fracture pattern are often irregular (e.g. Fig. 1). At some locations, mounds are isolated and quite distinct from their surroundings (e.g. Fig. 2), while elsewhere fractured mounds are part of clusters of hummocks, occasionally with pitted summits (e.g. Fig. 3). In some of these clusters fractured mounds appear to be substantially larger than the small hummocks, suggesting different origins. Fractured mounds are also observed partially filling small pits or impact craters in some images.

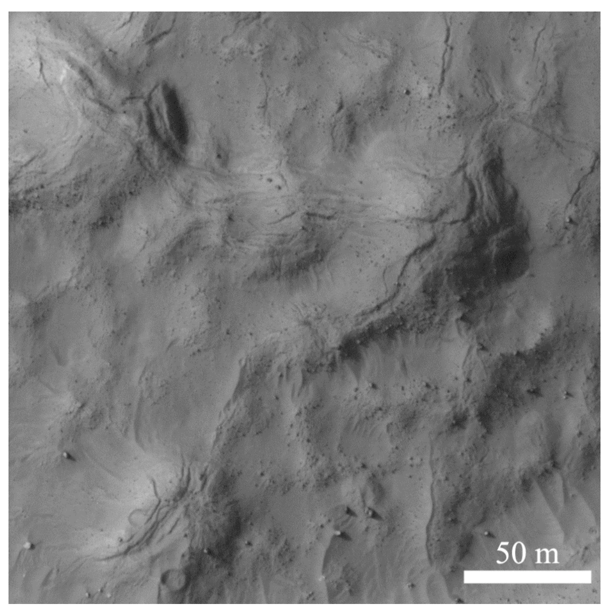

Figure 1: Section of HiRISE image PSP_002040_1435 (36.3º S, 198.3º E) showing fractured mounds on the floor of a gullied crater where recent activity has been suggested [13]. At this site the surrounding terrain shows some evidence of fracture, but the mounds are distinctly more frac-

tured. In this and other figures north is up and illumination from the left.

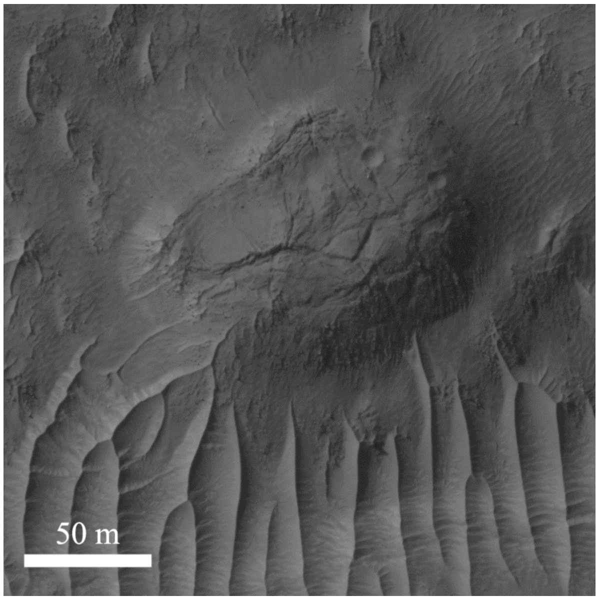

Figure 2: Section of HiRISE image PSP_001578_1425 (37º S, 207º E).

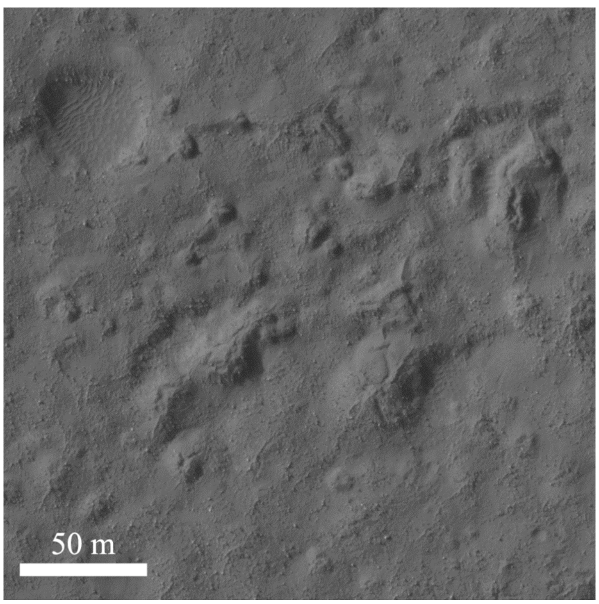

Figure 3: Section of HiRISE image PSP_001816_1410 (38.7º S, 194º E). In this image some larger fractured mounds occur along with many small pitted knobs and troughed ridges ~10 m wide; the relationship of the two is uncertain.

Discussion: Preliminary results of this survey suggest that the latitudinal dependence of flat-topped mounds discussed in [11] extends to a broader region and group of features. This latitudinal control suggests a role for water or ice in the formation of these features, particularly since the latitudes of fractured mounds are in the range where gullies, thought to be formed by liquid water, are most abundant [e.g. 14]. The occurrence of several examples on the floors of gullied craters allows a related origin and may offer clues to the hydrology of each. A number of mounds are relatively isolated features with scale and fractured nature similar to pingos on Earth.

Pingos are expected to uplift, stretch and crack the overlying ground as they grow [15]. The observed fractures are consistent with some extension and uplift of the mound surface. Fracture also indicates brittle behavior, which is expected for frozen ground if there is not sufficient time to relax stresses.

Although relatively steep sides and flatter summits are sometimes observed in both pingos on Earth [16] and Martian fractured mounds, the distinctive trapezoidal profile of some mounds [11] does not appear to be common. The best examples of this observed to date, with distinct near-radial fracturing, all occur in Utopia. This morphology might be related to properties of the near-surface material.

The definition used in this survey is broad, and may include features formed by multiple processes. We use this for completeness, as the fractured mounds may divide into several categories. The observed morphologic diversity may ultimately allow such classification. For instance, some of the features on lineated valley fill have dish-shaped summits and may be inverted craters as described by [17], but this is unlikely to be the general explanation since many examples are not in pits and show no indication of resistant layers or summit depressions. More examples will help clarify the relations between different features and illuminate the range of settings and morphologies.

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