EARLY HiRISE OBSERVATIONS OF FRACTURED MOUNDS. C. M. Dundas[1], C. Okubo[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: The High Resolution Imaging Science Experiment (HiRISE) camera [1] is producing hundreds of images of the Martian surface with resolution as good as 0.25 m/pixel. These images have shown fractured circular rises at several locations in the midlatitudes. These may be Martian pingos, as they have some morphological similarities with terrestrial pingos. Since pingos indicate freezing of near-surface liquid water, this may have important implications for water on Mars.

Background: Pingos are ice-cored mounds produced when a solid permafrost layer is raised by freezing of subsurface liquid water. They are subdivided into hydraulic and hydrostatic pingos, sometimes called open and closed system pingos, based on the source of the freezing water (e.g. [2-3]). In the hydrostatic case, freezing of an unfrozen zone (typically below a shallow lake) surrounded by frozen ground leads to expulsion of water, producing a dome on the surface; hydraulic pingos are morphologically similar but the pressure is provided by flow down a hydraulic gradient [2-3].

Pingos are typically a few hundred meters across and a few tens of meters high [e.g. 2-5], with substantial variation. Slopes are typically near the angle of repose of loose material but may exceed it. The thickness of the layer of frozen ground above the ice core is typically a third to half of the pingo height, and the ice core extends below the surrounding terrain [6]. Pingos typically have a summit dilation crack, frequently intersected by several additional radial cracks. These form due to stresses induced by flexure of the overburden as it domes upwards [7]. Concentric cracks are rare, but have been observed [3].

Martian pingos have been suggested at a number of locations [8-13], based on morphologies seen in Viking and MOC NA images. Radial cracks may be ambiguous or unresolved at these scales; HiRISE images will help resolve the uncertainty. Cracked features of the appropriate size are of interest as possible pingos. HiRISE images suggest that features from the Cerberus Plains/Athabasca Valles region are in fact volcanic rootless cones rather than pingos [14].

HiRISE Observations: Several HiRISE images show fractured, roughly circular rises in the northern midlatitudes (Figs 1-4). In the least degraded examples the flanks have a roughly constant slope, with a relatively flat summit, but the example in Fig. 3 has a summit pit. The features appear to have both radial and concentric cracks or depressions. Fig. 4 shows a non-circular fractured rise at the base of a gullied slope. The surface texture appears similar to surrounding material. Each image covers terrain where water may have been involved in the formation in some form; PSP-001438-2160 covers lineated valley fill in Choloe Fossae, PSP-001503-2180 shows northern plains near the rim of a large crater with a subdued rim, and PSP-002036-2205 is in the interior of a gullied crater.

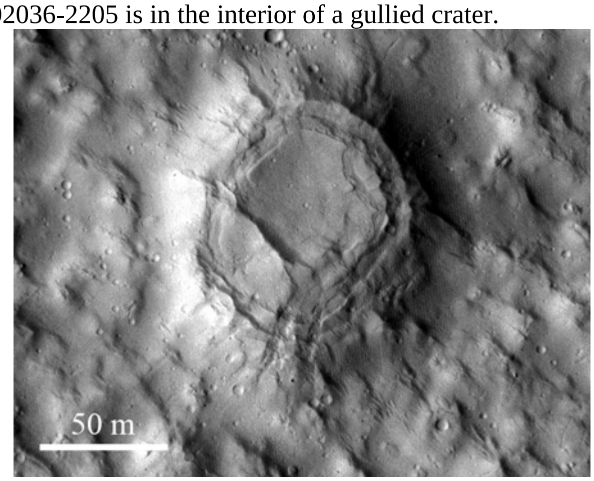

Figure 1: Subsection of HiRISE image PSP-001438-2160, showing a fractured rise on lineated valley fill from Choloe Fossae (35.6°N, 56.6°E). Illumination is from the left. The scale and fractures are both similar to terrestrial pingos.

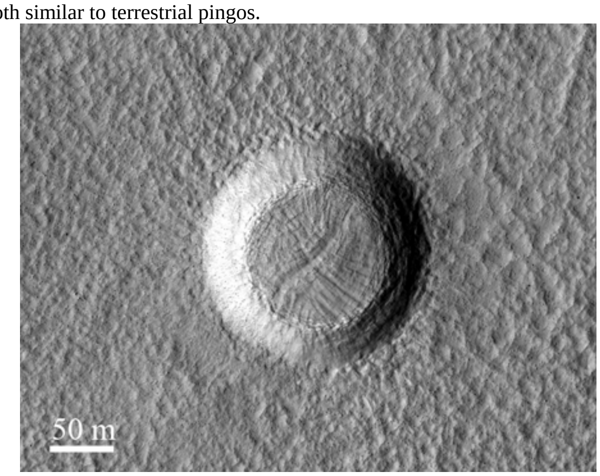

Figure 2: Subsection of HiRISE image PSP-001503-2180, showing a fractured rise in Utopia near the hemispheric dichotomy boundary (37.5°N, 82.8°E). Illumination is from the left.

The mounds shown here appear cracked in places; in Fig. 1 there appears to be concentric cracking, and in Fig. 2 the cracks are confined to the flat summit. The cracks are shallow, possibly due to erosion or infill by wind-blown dust. Fracturing in the rise in Fig. 4

is irregular, as is the shape of the rise, but many examples (Figs 1-3) are circular.

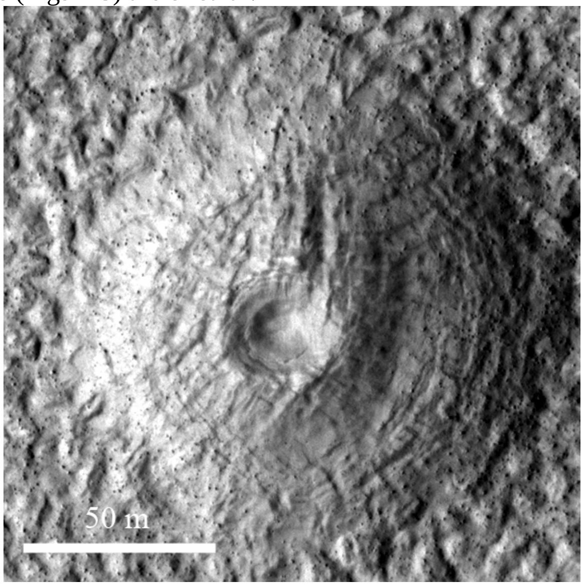

Figure 3: Another subsection of HiRISE image PSP-001503-2180, in this case showing a mound with a summit pit. Illumination is from the left. This feature is ~2 km from Fig. 2.

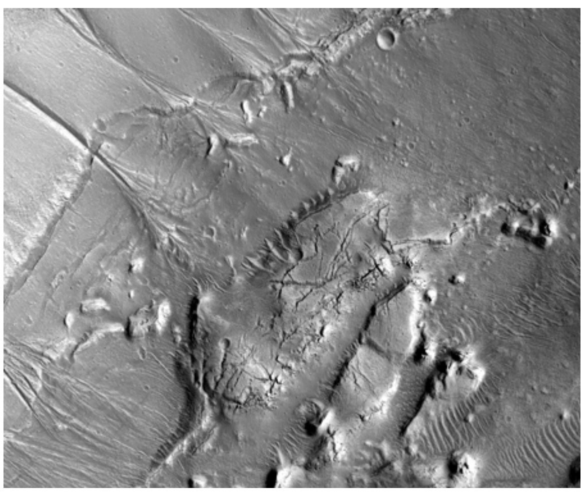

Figure 4: Subsection of HiRISE image PSP-002036-2205 (40.0°N, 296.6°E), showing a fractured rise at the base of a gullied slope. Image is ~600 m across; illumination from the right (not map projected).

Discussion: The qualitatively similar surface roughness and boulder density indicates that these features are likely composed of the same material as the surrounding level terrain, modified only in topography. There are no large boulders or other obvious indicators of a resistant layer which could produce this morphology by differential erosion. The sharp morphology of some features (e.g. Fig. 2) also suggests that these are not some form of pedestal crater, even though many examples are circular.

These may be examples of Martian pingos, although several questions remain. If these are pingos, the cause of the localization of water is unclear, although the feature in Fig. 4 is at the base of a gullied slope and so may be an example of a hydraulic pingo. The fracture patterns are also somewhat different than terrestrial pingos. For instance, in Fig. 2 the fractures do not extend down the flanks past the break in slope, the source of which is uncertain.

Summary: Early HiRISE images show several mounds in the Martian midlatitudes which are similar in scale to terrestrial pingos and show evidence of cracking. Continued HiRISE imaging of similar regions will be used to search for more of these features. A broader range of examples will allow better characterization of the morphology and determination of the mechanism of formation.

References: [1] McEwen A. S. et al. (2007) *JGR*, in press. [2] Müller, F. (1963) *Nat. Research Council Canada Tech. Trans. 1073*, 127 p. [3] Mackay J. R. (1998) *Geogr. Phys. Quat. 52*, 271-323. [4] Gurney S. D. (1998) *Prog. Phys. Geog. 22*, 307-324. [5] Pissart A. and French H. M. (1976) *Can. J. Earth Sci. 13*, 937-946. [6] Mackay J. R. (1962) *Geogr. Bull. 18*, 21-63. [7] Mackay J. R. (1987) *Can. J. Earth Sci. 24*, 1108-1119. 8] Judson S. and Rossbacher L. (1979) *NASA Tech. Memo 80339*, 229-231. [9] Parker T. J. et al. (1993) *JGR 98*, 11061-11078. [10] Cabrol N. A et al. (2000) *Icarus 145*, 91-107. [11] Soare R. J. et al. (2005) *Icarus 174*, 373-382. [12] Burr D. M. et al. (2005) *Icarus 178*, 56-73. [13] Page D. P. and Murray J. B. (2006) *Icarus 183*, 46-54. [14] Jaeger W. L. et al. (2007) *LPS XXXVIII*, Abstract #1955.