A NEW MODEL FOR PEDESTAL CRATER FORMATION. N. G. Barlow, Dept. Physics and Astronomy, Northern Arizona University, NAU Box 6010, Flagstaff, AZ 86011-6010 Nadine.Barlow@nau.edu.

Introduction: Pedestal craters are unique landforms on Mars where both the crater and ejecta blanket are elevated above the surrounding terrain (Fig. 1). The distributions and characteristics of these craters indicate that they form within a fine-grained layer. Traditionally, eolian deflation of the surrounding material has been the proposed formation mechanism [1]. However, new models of the latitudinal distribution of ice-rich mantles suggest that pedestal craters may result from sublimation of the surrounding ice-rich material.

Pedestal Crater Characteristics and Distributions: Pedestal craters are typically <5 km in diameter and occur in fine-grained deposits which often correlate with the high-H_2O-content regions identified by the Mars Odyssey Gamma Ray Spectrometer (GRS). Although most pedestal craters are found at high latitudes, particularly in the north, we have also identified pedestal craters in near-equatorial regions such as on the floor of Gusev crater [2].

Ejecta extent is quantified using the ejecta mobility (EM) ratio [3]:

$$EM = (\text{maximum extent of ejecta})/(\text{crater radius})$$

Single layer ejecta (SLE) craters poleward of ±40° latitude have average EM values of 1.8 in the north and 1.6 in the south. Double layer ejecta (DLE) craters north of +40° latitude have an average EM of 1.5 for their inner lobe and 3.5 for their outer layer. Corresponding values for the region south of -40° latitude are 1.4 and 2.8, respectively. Pedestal craters have the highest EM values of any ejecta morphology measured, with an average EM of 3.7 for those north of +40° and 3.8 for craters south of -40° latitude.

Ejecta sinuosity is measured through a parameter called lobateness (Γ) [4, 5]:

$$\Gamma = (\text{ejecta perimeter})/[4\pi(\text{ejecta area})]^{1/2}$$

$\Gamma = 1$ indicates a circular ejecta pattern while larger values of Γ indicate an increasing degree of sinuosity. SLE craters have average lobateness values of 1.12 for latitudes > +40° and 1.15 for latitudes < -40°. The inner layer of the DLE craters has an average Γ of 1.09 versus 1.14 for the outer layer. Lobateness values for pedestal craters display a large variation, ranging from 1.0 to 1.8, but the average $\Gamma = 1.12$.

New Observations: The higher resolutions of the Mars Orbiter Camera (MOC) and Thermal Emission Imaging System--Visible (THEMIS VIS) cameras have revealed many more Pd craters than were previously known from Viking analysis. These higher resolutions also permit identification of finer-scale features than previously seen. Although most Pd craters seem to be surrounded by one ejecta layer, we do see a few examples of a double layer structure (Fig. 2). We typically see the DLE-type structure for the larger pedestal craters, suggesting that resolution effects might limit the detection of an inner layer for the smaller craters.

One of the most interesting correlations that we see is between the distribution of Pd craters and the regions of high-H_2O content as revealed by the GRS instrument. This correlation strongly suggests that near-surface volatiles play a role in the formation of the Pd morphology. In addition, the highest concentrations of pedestal craters are found in the same regions where ice-rich mantles have been proposed to occur, based on geomorphic observations and modeling of past obliquity cycles [6, 7].

Discussion: Our analysis of the distribution of pedestal (Pd) craters finds that they often occur in the same regions as DLE craters. Because Pd craters also disply similarities to the EM and Γ values of the outer DLE layer, we propose that these morphologies form in a similar manner. It is entirely possible that Pd craters are the small crater versions of larger DLE craters. We propose that the easily identifiable ejecta layer of Pd craters is the same as the outer ejecta layer of DLE craters.

Formation Hypothesis: Pd craters have been known to be concentrated in fine-grained materials since the first analysis of Viking data. Several models were proposed to explain Pd formation, but the favored model is the eolian deflation model [1]. This model argues that the ejecta blanket somehow becomes armored during its emplacement. Subsequent eolian deflation of the region removes the surrounding fine-grained material, leaving the crater and its ejecta blanket perched above the surroundings.

One of the major problems with this model is the symmetrical shape of the pedestal crater—one must invoke a changing preferential wind direction over the entire 360° to produce such a symmetrical pedestal. With the new information indicating that Pd craters form not just in fine-grained materials but in ice-rich fine-grained materials, we propose a new formation mechanism. We propose that Pd craters result from small impacts which do not excavate entirely through the fine-grained mantle. Some (currently unknown) mechanism armors the ejecta deposit. During periods of lower obliquity, the ice in this mantling material sublimates, lowering the surrounding terrain and leaving the pedestal crater and its ejecta elevated. Other geologic evidence of the sublimation of an ice-rich mantle has been reported in these same regions [6]. Sublimation also would occur more symmetrically around the pedestal, removing the major problem with the eolian deflation model.

References: [1] Arvidson, R. E., et al. (1976) *Icarus, 27*, 503-516. [2] Cabrol N. A. et al. (2003) *JGR, 108*, 10.1029/2002JE002026. [3] Mouginis-Mark, P. (1979) *JGR, 84*, 8011-8022. [4] Kargel, J. S. (1989) *4th Intern. Conf. Mars*, Tucson, Univ. AZ, 132-133. [5] Barlow, N. G. (1994) *JGR 99*, 10927-10935. [6] Mustard, J. F. et al. (2001) *Nature, 412*, 411-414. [7] Head J. W. et al. (2003) *Nature, 426*, 797-802.

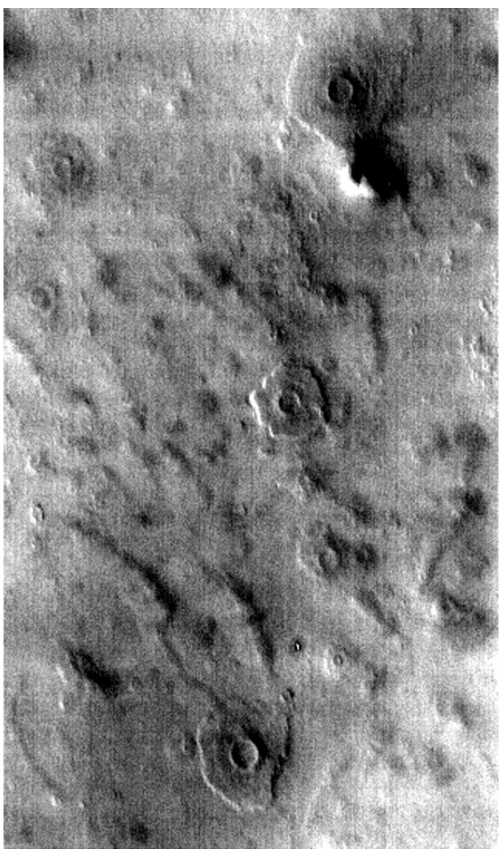

Figure 1: A field of pedestal craters. All craters are less than 2 km in diameter. (THEMIS image I04916007)

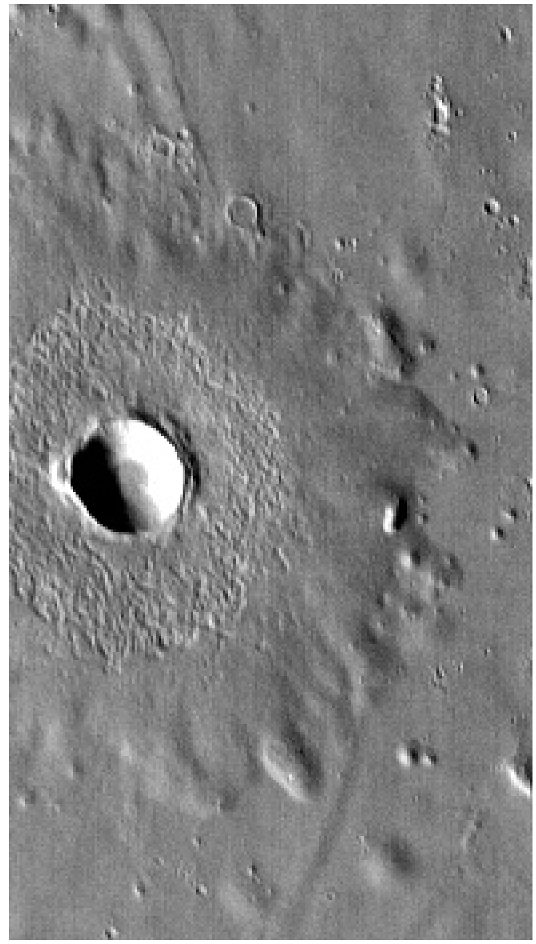

Figure 2: 3.9-km-diameter pedestal crater showing a double layer morphology. Crater is located at 35.90°N 147.78°E. (THEMIS image I10293012)