

MARTIAN CENTRAL PIT CRATERS. E. Hillman and N. G. Barlow, Dept. Physics and Astronomy, Northern Arizona University, Flagstaff, AZ 86011-6010, eah42@dana.ucc.nau.edu, Nadine.Barlow@nau.edu

Introduction: Impact craters containing central pits are rare on the terrestrial planets but common on icy bodies. Mars is the exception among the terrestrial planets, where central pits are seen on crater floors (“floor pits”) as well as on top of central peaks (“summit pits”). Wood et al. [1] proposed that degassing of subsurface volatiles during crater formation produced central pits. Croft [2] argued instead that central pits might form during the impact of volatile-rich comets. Although central pits are seen in impact craters on icy moons such as Ganymede, they do show some significant differences from their martian counterparts: (a) only floor pits are seen on Ganymede, and (b) central pits begin to occur at crater diameters where the peak ring interior morphology begins to appear in terrestrial planet craters [3].

A study of craters containing central pits was conducted by Barlow and Bradley [4] using Viking imagery. They found that 28% of craters displaying an interior morphology on Mars contain central pits. Diameters of craters containing central pits ranged from 16 to 64 km. Barlow and Bradley noted that summit pit craters tended to be smaller than craters containing floor pits. They also noted a correlation of central pit craters with the proposed rings of large impact basins. They argued that basin ring formation fractured the martian crust and allowed subsurface volatiles to concentrate in these locations. They favored the model that degassing of the substrate during crater formation was responsible for central pit formation due to the preferential location of central pit craters along these basin rings.

Recent 2D and 3D modeling by Pierazzo and colleagues [5] has provided some theoretical basis to the idea of central pit creation by degassing of volatiles during crater formation. Pierazzo et al. have modeled asteroid and comet impacts into targets composed of a mixture of soil and water/ice. Their results indicate that the geothermal heat flow gradient causes temperatures to be higher in the central uplift region than in the surroundings. This higher temperature causes vaporization of any preexisting water or ice in this central region. The sudden outgassing of this vapor could produce the observed central pits. Their models also suggest that the higher impact velocities of comets would produce higher central temperatures than asteroid impacts.

Current Study: The acquisition of high resolution multispectral imagery from MOC and THEMIS is re-

vealing impact crater ejecta and interior morphologies in greater detail than was previously available with Viking data [6]. As part of the revision of the *Catalog of Large Martian Impact Craters* [7], we are conducting a new study of the distribution and characteristics of central pit craters. The goal of this study is to obtain an improved understanding of the environmental conditions under which central pits form inside impact craters on Mars.

We have been using THEMIS visible (VIS) and daytime infrared (IR) to identify impact craters containing central pits (Figure 1). Our analysis has thus far covered 465 THEMIS VIS and daytime IR images, where we have identified 176 impact craters containing central pits. The craters range in diameter from 20 to 80 km. Many of these craters were not identified as central pit craters in the previous Viking-based analysis by Barlow and Bradley. Craters containing central pits display a wide variety of preservation, from largely degraded to almost pristine. Many of the fresher craters displaying a central pit are surrounded by a multiple layer ejecta (MLE) morphology. This correlation of central pits with the MLE morphology was previously noted in a regional study of Arabia Terra by Barlow and Dohm [8]. Since both the MLE morphology and central pits have independently been proposed to result from impacts into subsurface volatiles (perhaps excavating into liquid water reservoirs, as proposed by [4]), this suggests that similar environmental conditions might give rise to these two very different crater features. The fact that we also observe central pits in craters ranging in preservation from degraded to pristine indicates that subsurface volatiles have existed in the martian substrate for a large percentage of martian history, including up to recent times.

Future Work: We are working to complete our analysis of the distribution of impact craters containing central pits. Our future work will include measurement of the pit diameters and analysis of how central pit diameter varies with crater diameter for both summit pits and floor pits. We also will compare the distributions of central pit craters with MOLA elevation, GRS water distribution maps, and the distribution of large impact basins and their surrounding rings to determine how these environmental conditions influence the formation of central pits. Our eventual goal is to understand why central pits occur in some craters but not others of similar sizes when ejecta morphologies

suggest that subsurface volatiles are present at the depths excavated by all craters in this size range on Mars.

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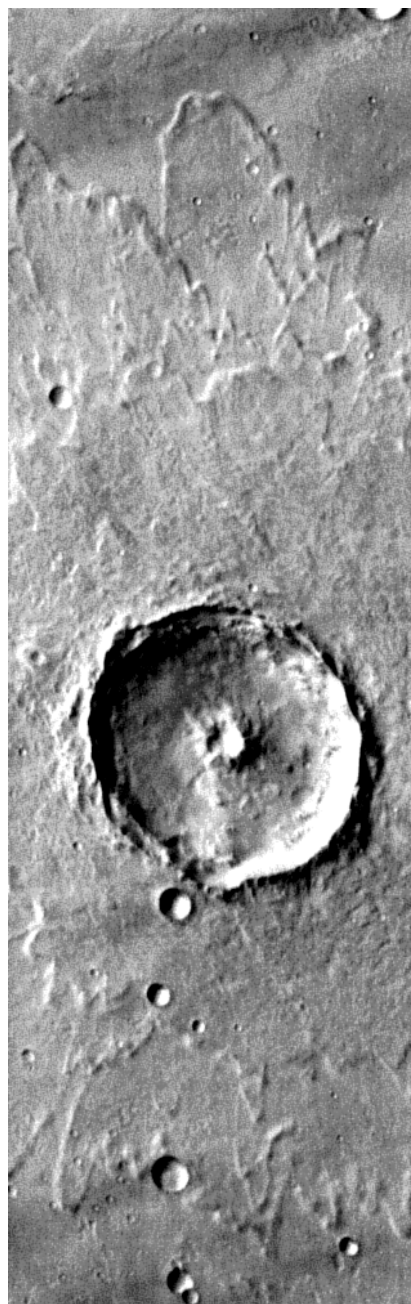


Figure 1: Example of martian impact crater containing a central pit. Crater is 25 km in diameter and located at 6°N 304°E. Note also the multiple layer ejecta morphology surrounding this crater—many fresh central pit craters are surrounded by the MLE morphology. (THEMIS image I03218002).