INSIGHTS INTO THE FORMATION OF MARTIAN CENTRAL PIT CRATERS AND IMPLICATIONS FOR THESE CRATERS ON OTHER SOLAR SYSTEM BODIES.

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Introduction: Central pit craters display a depression either on the crater floor or atop a central rise (Fig. 1). A pit is classified as a floor pit when the pit floor lies below the crater floor and as a summit pit when the pit floor lies above that of the crater. Central pit craters are abundant on Mars, Ganymede, and Callisto, which led to the proposal that target volatiles are involved in the formation of these features [1, 2]. However, central pits also have been reported on Mercury and the Moon, although they are much less abundant on these more volatile-poor bodies [3-5], leading to the question of whether volatiles are required for central pit formation.

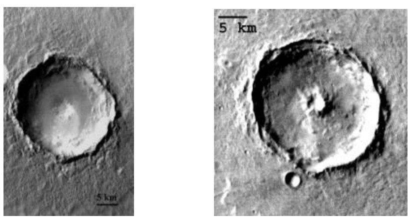

Figure 1: Examples of Floor Pit (left) and Summit Pit (right) craters. Floor pit crater is 24.8 km in diameter and located at 0.77°N 356.06°E (THEMIS image I11284045). Summit pit crater is 22.2 km in diameter and centered at 5.73°N 304.64°E (THEMIS image I03218002).

Four models have been proposed to explain the formation of central pit craters but here we only focus on the two leading models. Central peak collapse involves the inability of weak target materials to retain a central peak and thus the peak collapses to form a pit [2, 6]. The melt drainage model proposes that temperatures reached under the center of the transient cavity create a liquid "plug" which later drains away through subsurface fractures to leave a pit [6-8]. We are conducting a detailed study of central pit craters on Mars in an effort to better understand the conditions leading to the formation of these structures both on Mars and elsewhere in the solar system. Here we report on results for central pit craters in the northern hemisphere of Mars.

Central Pit Characteristics: The revised *Catalog of Large Martian Impact Craters* [9] lists 14,239 impact craters in the Martian northern hemisphere and includes 566 floor pit craters and 333 summit pit craters. Thus ~6% of all impact craters in the northern hemisphere of Mars are classified as central pit craters. Floor pit craters range in diameter from the lower-diameter cut-off of the *Catalog* at 5 km to 114.0 km. The pits range in diameter from 0.3 km to 17.8 km with a median of 2.4 km. The ratio of the pit diameter (D_p) to the crater diameter (D_c) ranges from 0.02 to 0.48 with a median of 0.15. Summit pit craters range in diameter from 5.5 to 125.4 km and their pits range from 0.3 to 13.9 km in diameter (median 1.9 km). Summit pit D_p/D_c ranges from 0.03 to 0.29 with a median of 0.12. Thus although summit pits are seen in craters of similar size and within a similar latitude range as floor pits, summit pits tend to be smaller relative to their parent crater than floor pits.

Floor pits sometimes display a raised rim along the edge of the pit while other times a rim is absent. We are currently dividing floor pits into three categories (rimmed (R), partially rimmed (PR), and non-rimmed (NR)) for a more detailed analysis of differences between these subclasses. A preliminary analysis [10] suggests that the difference between R, PR, and NR floor pits is a function of pit diameter and terrain.

Implications for Formation Models: The presence of floor pits, summit pits, and central peak craters in the same geographic regions on Mars suggests that pit formation is not simply the result of a transition to material too weak to support a central peak. Melt drainage model predictions are consistent with D_p/D_c ratios and the presence of central pits in craters of only a certain diameter range, and are in the direction expected as target volatile content changes (i.e., larger D_c and D_p/D_c for higher ice concentrations [8]). Although the original description of the melt drainage model for lunar central pit craters suggested weaker core material which did not require volatiles [7], recent numerical modeling finds that this mechanism does not work for silicate melts [11]. A detailed comparison study of central pits on volatile-richer bodies and volatile-poorer bodies is needed to determine whether the same formation mechanism can be applied everywhere.

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