CENTRAL PIT CRATERS WITH INTERIOR VALLEY NETWORKS ON MARS: CHARACTERISTICS AND FORMATION PROCESSES. S. E. Peel[1] and C. I. Fassett[1], [1]Dept. of Astronomy, Mount Holyoke College, 50 College Street, South Hadley, MA 01075. (peel20s@mtholyoke.edu).

Introduction: Central pit craters are impact craters with central depressions, either in the floor of the crater or superposed on a central rise [1]. Examples are broadly distributed geographically on Mars [1]. Hypothesized pit formation mechanisms generally involve interaction of crater formation with water-rich crust at the sub-impact point, which lead to vaporization, melt drainage or structural collapse of a central peak [2-4].

In images from the Mars Reconnaissance Orbiter Context Camera (CTX) [5] and High Resolution Stereo Camera (HRSC) on Mars Express [6], a variety of central pit craters were observed with valley systems on their interiors that drain into the central pit. In some instances, these valleys have associated sedimentary deposits. Many of the central pit craters that host valley networks appear relatively young (Hesperian to Amazonian).

The goals of this study are to characterize the morphology and morphometry of the valleys associated with pit craters, assess the hydrology and formative conditions of these valleys, and understand whether valley initiation related to pit crater formation itself. Examples of five such craters have been included in this initial study (Fig. 1).

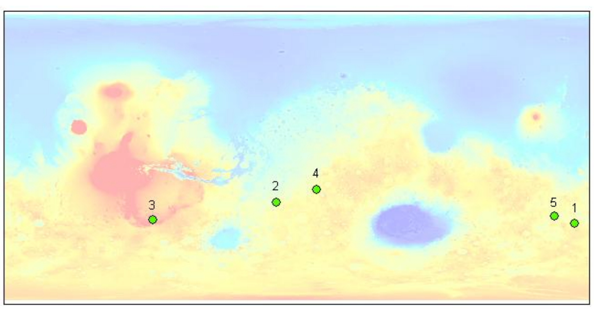

Fig. 1: Map of the positions of the craters investigated.

Observations: *General Observations*. We have mapped valleys and related features using CTX images and digital terrain models (DTMs) from the Mars Orbiter Laser Altimeter [7]. In addition, higher resolution topography from HRSC stereo DTMs [6] were used for craters 3 and 4, and a CTX stereo DTM created with the Ames Stereo Pipeline [8] was used for crater 1. We find typical valley widths are ~100–450 m and depths are ~15-20 m; typical widths of internal channels are ~50-200 m. Most of the investigated pit craters (at least 4/5) have valley systems with tributaries that extend from the pit at least partially up the walls of the crater. In several instances, the pit craters have valleys outside their rim as well on their interior. Valley features are sometimes preserved in inverted relief (crater 4).

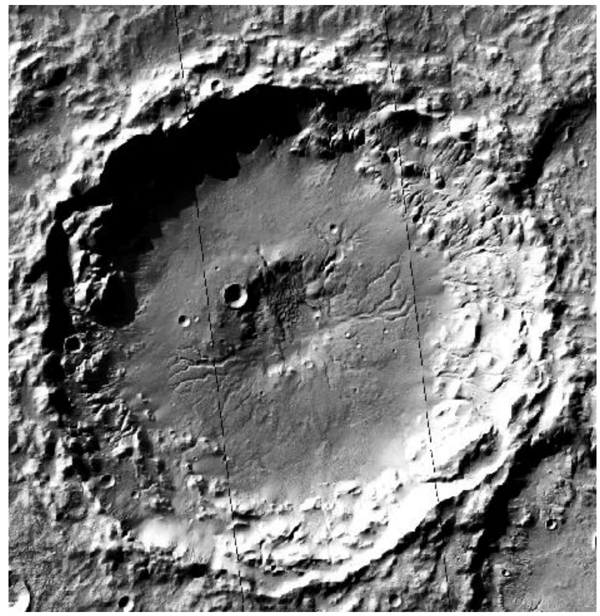

Fig. 2: Image of crater 5 (diameter D~40 km for scale). The central pit is clearly visible, as are the valleys that drain into it.

Specific Example. We describe one crater in detail (Crater 5, location: 36.3S, 158.2E; Fig. 2). It has prominent terraces near its rim, typical for a complex crater in this size range. An extensive valley system drains into its central pit (Fig. 2) and extends back to these terraces. Much of the crater interior is moderately mantled, as is common at this latitude [9]. Adjacent to the crater walls are a complex systems of tributaries, which lead to alluvial fans (many forming bajadas) on the crater floor (ex: northeast crater rim and floor) (Fig. 3). The toes of the alluvial fans partially super-impose the valleys on the crater floor. This suggests that either these alluvial fan systems formed after the valleys, or that they developed concurrently with the valley system and remained active after activity in the main valley system had ended.

It is evident that there were multiple episodes of erosion within Crater 5, as it is possible to recognize older valley segments that were abandoned and cutoff by younger valley segments (Fig. 4). Much smaller features (<100 m wide) interpreted as the youngest channels remain. Within the central pit itself, these valleys terminate at a depositional feature that has a distinct fan shape; this depositional feature may have formed as a delta or as an alluvial fan that was then substantially modified.

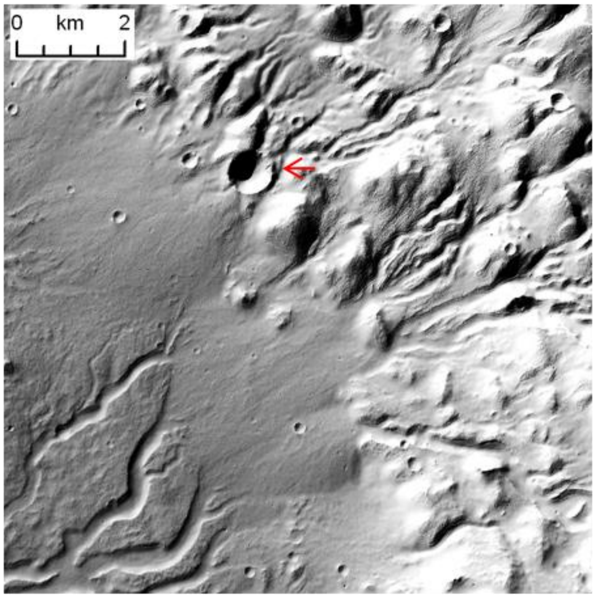

Fig. 3: Image of alluvial fans located in the NE of crater 5. Red arrow points to a ~800 m diameter crater with a small valley entering from the NE and exiting from the SW.

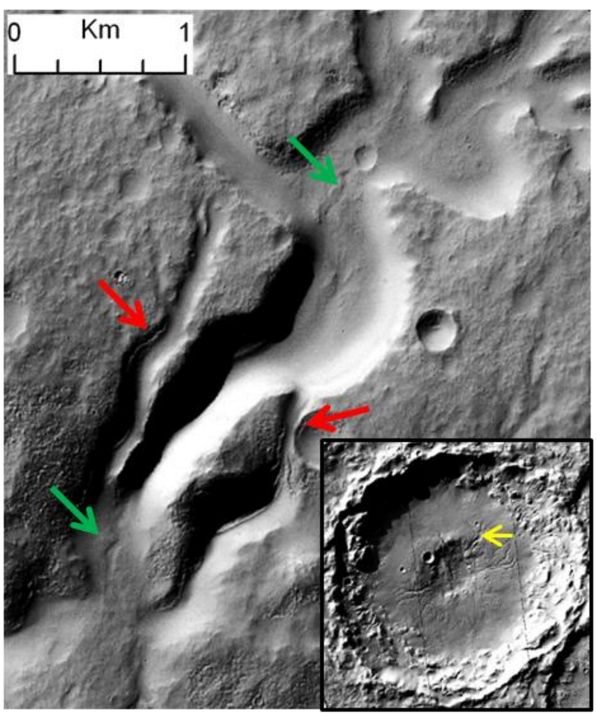

Fig. 4: Multi-generational valley system in Crater 5. The red arrows point to abandoned valley systems that have been superimposed by the younger, wider valley. The green arrows point to small (<100 m wide), late stage valleys. Inset: Full image of Crater 5; yellow arrow points to the valley system in the main image.

To the northeast of the central pit, a ~800 m crater has an apparent valley cutting through it (Fig. 3). This crater is interpreted as a possible paleolake, since water flowing into it would have to have ponded in the crater in order to overtop and erode the notch at its opposite end.

Discussion: The valleys superimposed on these pit craters appear to be multi-generational, and have evolved over a considerable time after crater emplacement. In addition, the presence of a cross-cut ~800 m crater on the interior of Crater 5 further suggests that valley formation occurred well after the initial pit crater formed. Thus, if the valley systems are in fact related to the pit crater formation process, conditions that allow them to remain active must have persisted for a substantial period of time.

Most morphological characteristics of these valley systems suggest that precipitation of snow or rain is favored as a source of fluid for these features rather than groundwater. The headwaters of the valleys are distributed within the craters and not restricted to a single elevation or locale. This is also supported by the observation that, in some instances, valleys are apparent both on crater interiors and exteriors and dense tributaries are recognized on some of the crater walls.

Additional research is being pursued to further determine how these valley features may reflect on the origin of pit craters and their subsequent modification.

References: [1] Barlow N. G. (2010) *GSA Sp. Pub, 465,* 15-27. [2] Wood C. A. et al. (1978) *Proc. Lunar Planet. Sci. Conf., 9th*, 3691-3709. [3] Elder C. M. et al. (2010) *LPSC 41*, abs. No. 2519. [4] Croft S. K. (1981) *LPS XII*, 196-198. [5] Malin M.C. et al. (2007), *JGR*, *112*, E05S04. [6] Neukum et al. (2004), *ESA Sp. Pub. 1240*, 17–36. [7] Smith D. E. et al. (2001) *JGR*, *106*, 23,689. [8] Moratto Z.M. et al. (2010), *LPSC 41*, abs. no. 2364. [9] Mustard J.F. (2001), *Nature, 42*, 411–414.