THE INTERACTION OF IMPACT MELT, IMPACT-DERIVED SEDIMENT, AND VOLATILES AT CRATER TOOTING, MARS.

P. Mouginis-Mark[1] and J. Boyce[1], [1]HIGP, Univ. Hawaii, Honolulu, HI 96822. <pmm@hawaii.edu>

We are producing a 1:200K geologic map of Tooting crater, Mars. This work has shown that an incredible amount of information can be gleaned from mapping at even larger scales (1:10K – 1:25K) using CTX and HiRISE data. We have produced two new science papers (Morris et al., 2010; Mouginis-Mark and Boyce, 2010) from this mapping, and additional science questions continue to arise from our on-going analysis of Tooting crater:

1) What was the interplay of impact melt and volatile-rich sediments that, presumably, were created during the impact? Kieffer and Simonds [1980] predicted that melt would have been destroyed during impacts on Mars because of the volatiles present within the target – we seek to understand if this is indeed the case at Tooting crater. We have identified pitted and fractured terrain that formed during crater modification, but the timing of the formation of these materials in different parts of the crater remains to be resolved. Stratigraphic relationships between these units and the central peak may reveal deformation features as well as overlapping relationships.

2) Morris et al. [2010] identified several lobate flows on the inner and outer walls of Tooting crater. It is not yet clear what the physical characteristics of the source areas of these flows really are; e.g., what are the sizes of the source areas, what elevations are they located at relative to the floor of the crater, are they inter-connected, and are they on horizontal or tilted surfaces?

3) What were the details of dewatering of the inner wall of Tooting crater (Fig. 1)? We find evidence within Tooting crater of channels carved by water release, and the remobilization of sediment (which is inferred to have formed during the impact event). Sapping can be identified along the crest of unit 8 near the floor of the crater (Fig. 2a, 2b). This unit displays amphitheater-headed canyons that elsewhere on Mars are typically attributed to water leaking from the substrate [Laity and Malin, 1985; Malin and Edgett, 2000].

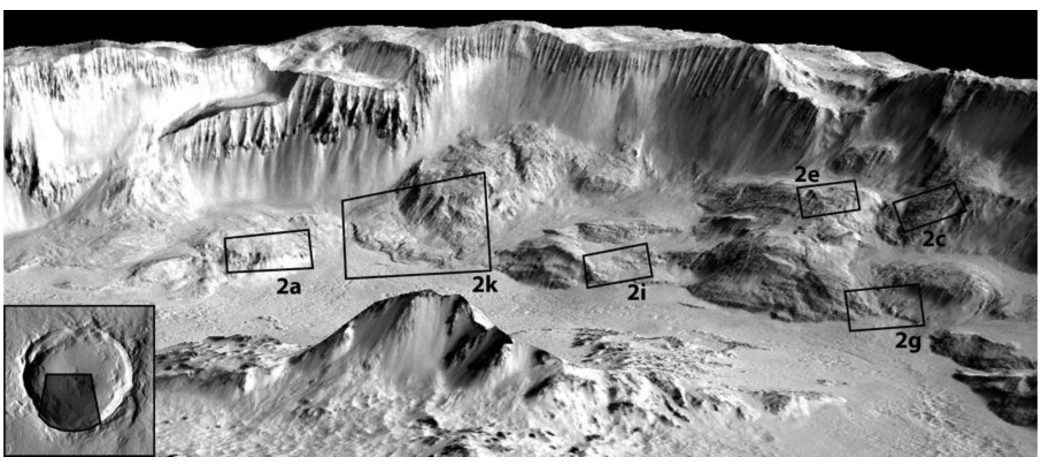

Figure 1: Oblique view looking south at the interior of Tooting crater. The kilometer-high central peak is in the left foreground. Boxes delineate the locations of the HiRISE subscenes presented in Fig. 2. Base image is CTX frame P01_001538_2035, vertical exaggeration is 1.9x. Height of rim rises ~2,100 m above the crater floor. Shaded area within insert at lower left shows the large image location within Tooting crater.

Canyons in Tooting crater are the source of debris that is superposed on the pitted terrain on the crater floor (Fig. 2a), and hence post-dates its formation, whereas in other places (Fig. 2c) the chronology is the opposite with canyons carved before pitted terrain formed. Slump blocks reveal several episodes of water release, with theater-headed canyons pre-dating the formation of some units of pitted material (Fig. 2c, 2d), and channels within other blocks (Fig. 2e, 2f). At several levels on the inner wall, we find evidence for the mobilization of sediments. For example, based on their superposition relationships, there is a sequence of three episodes of flow lobes emplaced on top of pitted terrain on the floor of Tooting crater (Fig. 2g, 2h). These flow lobes (units 2-4 in Fig. 2h) are confined by two terrace blocks and are the distal portions of the leveed-flow described by Morris et al. [2010]. The mobilization of sediment deposits fed smaller (<500 m-long) discrete flows at the edge of terrace blocks (Fig. 2i, 2j). Some of these terrace blocks (unit 7, Fig. 2l) have also slumped during cavity modification; a series of thick (35 - 55 m) flow lobes extend toward the crater floor and appear to pre-date the formation of sediment flow units 3 and 4 because these flow lobes do not disrupt the sediment flow units.

References: Kieffer, S.W. & C.H. Simonds (1980) The role of volatiles and lithology in the impact cratering process. *Rev. Geophys. Space Phys*. 18: 143 – 181. Laity, J. E., & Malin, M. C. (1985) Sapping processes and the development of theater-headed valley networks on the Colorado Plateau: *GSA Bull*. 96: 203 – 217. Malin, M.C., & Edgett, K.S. (2000) Evidence for recent groundwater seepage and surface runoff on Mars: *Science* v. 288, p. 2330 – 2335. Morris, A.R., Mouginis-Mark, P.J., & Garbeil, H. (2010) Possible impact melt and debris flows at Tooting crater, Mars, in press, *Icarus*. Mouginis-Mark, P.J. & J.M. Boyce (2010) Protracted dewatering of the cavity of Tooting crater, Mars. Submitted to *Geology*.

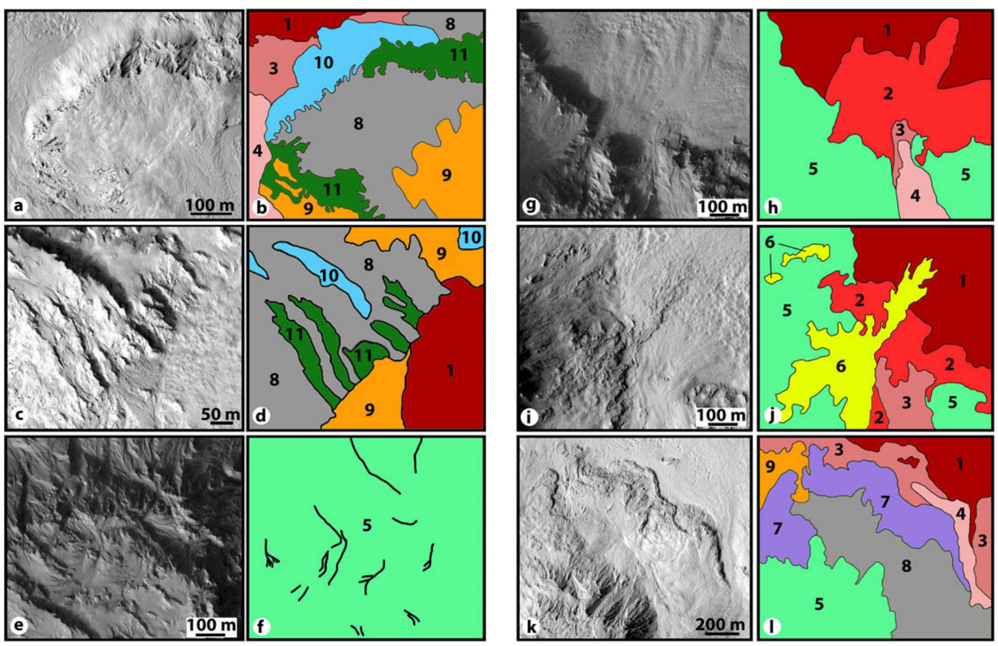

Figure 2: Left two columns, examples of erosion on wall blocks suggestive of water release, along with interpretive sketches. North is towards the top of each image and the illumination is from the left in all images. Locations are indicated in Fig. 1. Numbered units in figures b, d, f, h, j and l are morphologically similar in all images: “1” pitted terrain; “2,” “3” and “4” sediment flows; “5” eroded terrain blocks; “6” flow originated from terrace block; “7” massive flow units; “8” sediment plateaus; “9” smooth units with channels carved into surface cut; “10” scree slopes; and “11” canyonlands. Attributes to note are: (a) scarps with sapping headwalls cut into sediment plateau to produce canyons. HiRISE image PSP_001538_2035; (c) theater-headed canyons (unit “11”) that pre-date the pitted terrain unit “1.” HiRISE image PSP_003569_2035; (e) braided channels within wall block. HiRISE image PSP_005771_2035. Right two columns, examples of features interpreted to be sediment flows generated by up-slope dewatering, along with interpretive sketches. Key attributes to note are: (g) multiple episodes of sediment fans spreading out of pitted terrain. HiRISE image PSP_005771_2035; (i) single lobe superposed over sediment fan which is itself on top of pitted terrain. Central portion of lobe is 55 m thick, eastern margin is 35 m thick. HiRISE image PSP_007406_2035; (k) massive flow lobes from terrace block. HiRISE image PSP_001538_2035.