PITTED DEPOSITS IN FRESH MARTIAN IMPACT CRATERS, Joseph M. Boyce[1], Peter J. Mouginis-Mark[1], Livio Tornabene[2] Christopher W. Hamilton[1], John Allen[3], and Lionel Wilson[1]; [1] Hawaii Institute for Geophysics and Planetology, University of Hawaii, Honolulu, [2] Smithsonian Air and Space Museum, Washington DC, and [3] Department of Engineering, University of Hawaii, Honolulu 96822; Corresponding author: Jboyce@higp.hawaii.edu.

Introduction: Thin deposits of heavily pitted material are common on the floors, interior terraces blocks, and ejecta blankets near rims of well-preserved impact craters on Mars (Fig. 1) [1, 2]. This pitted material shows evidence of flow during its emplacement,

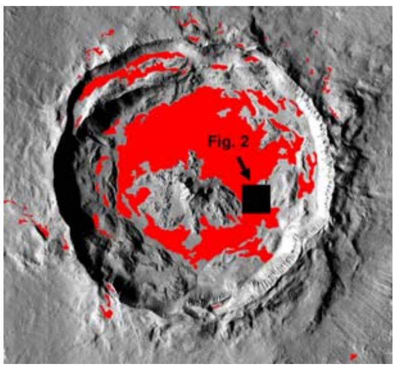

Fig. 1: Distribution of pitted material (in red) within Tooting crater, which is ~29 km in diameter.

and although there are places where this material is smooth, flat and lacks pits at HiRISE resolution, typically it contains closely-spaced clusters of pits whose individuals share relatively narrow, raised rims (Fig. 2).

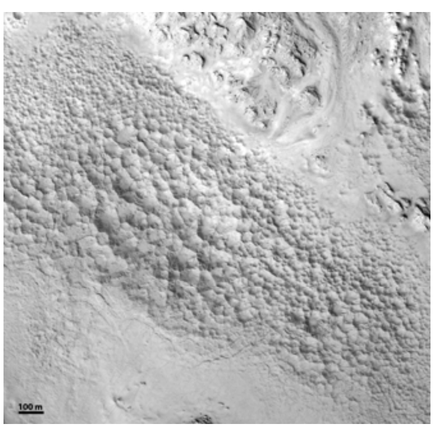

Fig. 2: Pits in the NE floor of Tooting crater. HiRISE scene is ~ 1.75 km across.

Tornabene et al [3], *Mouginis-Mark and Garbeil,* [4], McEwen et al [2], and *Morris et al* [5] have suggested that the pitted material is either volatile-rich suevite, or impact-generated, fine-grain sediment, and that the pits formed by collapse caused by escape of water or ice initially contained in the deposit. Alternatively, [6] suggest the pits may be ice sublimation features caused by escape of volatiles form the pitted material. However, the morphology of the pits is inconsistent with these interpretations, with pits commonly exhibiting low-relief rims, and a close-pack, froth-like pattern suggestive of simultaneous formation of the pits through a process that builds rims, instead of destroying them. Consequently, because of these morphologic traits and that the pitted material appears to be an ejecta facies, we suggest that the pits formed through a process that is more akin to the rapid degassing of the suevite at the Reis crater, but with the release of about an factor of 2 to 4 times more water (vapor) over the same short time period [*7*, 8].

Proposed Mechanism of Pit Formation: We suggest that of the most evidence indicates the Martian pitted material is suevite derived from relatively water-rich target rock (i.e., megaregolith). Based on this assumption, we propose that the pits are formed through the same degassing mechanism proposed by [7] for the suevite at Reis crater. However, because of the expected higher water content of the Martian target material and effects of the Martian environment (e.g., lower gravity and atmospheric pressure) the pressure and escape velocity of the water vapor from the pitted material should be substantially higher than from the suevite at the Reis crater. Preliminary calculations based on the approach of [7] (adjusted to Martian conditions and assuming the pits are the location of major degassing pipes of at least 1 m diameter) suggest that the superficial gas velocities of escaping water vapor from pitted material in Martian craters of equivalent size of Ries crater, are high enough for ejection of particles and vigorous fountaining. For the Martian crater Tooting (Fig. 1), a fresh Martian crater of similar size as Reis, this is ~ 16 m/sec. (+/- ~ 5 m/sec) compared with ~ 13.8 m/sec. required to launch particles on ballistic trajectories in order to form its average size floor pits (~ 100 m). In addition, [7] suggested that because of elevated temperature, initial degassing of the impact melt and hot crystalline particles in the Reis (fallout) suevite occurred over ~ 2 hours, producing the observed degassing pipes in a manner found in experiments of degassing of ignimbrites [9, 10]. While short, this is a reasonable time period for degassing of suevite even on Mars considering the rate of diffusion of water out of particles with the mean grain size in suevite at its initial temperature at depsotion (i.e., ~ 750 ˚C) (8, 11, 12). It also should be noted that the calculations of [7] for degassing of the Reis suevite were based on a mean water content of the Reis parent rock of ~ 1.4 wt %, but more detailed work indicates that this value is ~ 6 wt % [13]. This is still a factor of 2 to 4 times (per unit) less than the Martian target rock (i.e., the megaregolith) [see 14, 15, 16].

While this simple preliminary approach suggests that pits plausibly can be produced by high velocity escape of steam from rapidly degassing suevite on Mars, recent advances in industrial study of high-temperature gas escaping through poorly sorted particulate materials can provide more insight into Martian pit formation [e.g., see, 17, 18, 19]. These studies show a progression of behavior of deposits composed of poorly sorted coarse particules with increased gas escape velocity. In lower-velocity escaping gas the particles show no effects, but with increasing gas velocity the friction of the escaping gas first reaches a point where it equals the weight of the particles causing fluidization. At higher velocity, bubbles form, leading to the formation of degassing pipes that become the main conduits for the escape of the bulk of the escaping gas, like those in the Reis suevite [e.g., see,17]. . As gas velocity increases spouting and fountaining occurs at the surface through the degassing pipes. Here, friction with the escaping high velocity gas entrains particles and propel them away from the vent (how far is dependent on the velocity of the gas and physical characteristics of the particles (e.g., see,*17*, *19*). We plan to further develop our model for pit formation based on the mechanics developed by these previous studies.

References: [1] Mouginis-Mark, P., et al., 2003, 4 th Int. Mars Conf, abs. #3004; [2] McEwen, A. et al., 2007 Science, 317, 1706-1709; [3] Tornabene, L., et al., 2007, 7th Inter. Conf. on Mars. abs. 1353; [4] Mouginis-Mark, P. and Garbeil, H., 2007, MAPS, v. 42, p. 1615 – 1625; [5] Morris, A et al 2010 ;Icarus, 209, 369-389; [6] Hartmann, W., et al., 2010 Icarus, doi: 10.1016 /j.Icarus. 2010. 03.030; [7] Newson, H. E., et al., 1986., JGR, v. 91, no. B13, p E239-E251; [8] von Engelhardt et al., 1995, Meteoritics, 30, 279-293; [9] Wilson, C., 1980, J. Volc. Geotherm. Res., 8, 231-249; [10] Wilson, C., 1984, J. Volc. Geotherm. Res. 20, 55-84; [11] von Engelhardt, W. 1972, Contrib. Mineral. Petrol., 36, 265-293; [12] Stoffler et al., 1977, Geol. Bavar., 75, 163-190; [13] Osinski, G., 2004, Earth Planet Sci. Lett., 226, 529-543; [14] Clifford, S.,1993. *JGR*, 98, 10, 973-11, 016; [15] Boynton et al., 2008, The Martian Surface Cambridge U Press, 105-124; [16] Ming, D. et al., 2008, The Martian Surface Cambridge U Press, 519-540; [17] *Kunii and Levenspiel*, 1969, Wiley & Sons, NY; [18] Goossens et al 1971, Chem. Eng. Prog. Symp. Ser. 67, 38-45; [19] Olazar et al., 2006, Powder Tech., 165, 128-132.