EVIDENECE FOR THE ROLE OF VOLATILES ON MARTIAN IMPACT CRATERS AS REVEALED BY HIRISE.
L. L. Tornabene[1, 2], A. S. McEwen[1], J. A. Grant[3], P. J. Mouginis-Mark[4], S.W. Squyres[5], J. J. Wray[5], and the HiRISE Team[1], [1]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721, [2]livio@lpl.arizona.edu, [3]Smithsonian Institution, National Air and Space Museum, Center for Earth and Planetary Studies, Washington DC 20560, [4]Hawaii Institute of Geophysics and Planetology, SOEST, University of Hawaii, Honolulu, HI 96822, [5]Department of Astronomy, Cornell University, Ithaca, NY 14853.

Introduction: Direct evidence of the role of volatiles on Martian craters has been elusive in the past. The debate has especially intensified with respect to the mode of emplacement of "fluidized" or rampart ejecta. Specifically, as to whether the morphology of such ejecta is a direct consequence of volatiles in the subsurface [e.g., 1], atmospheric influences [e.g., 2] or a combination thereof.

Recently, alluvial fans were discovered in Mojave crater (D_a ~60 km) in Xanthe Terra (7.6ºN, 327ºE) by the Mars Orbiter Camera (MOC) [3, 4]. These alluvial fans were interpreted to have formed from either atmospheric or groundwater fed surface run-off released during the crater-forming event. Their morphologic complexity, as well as the apparent rarity (no other instances were found in >75K MOC images covering ~3% of Mars), of the Mojave crater alluvial fans led to the conclusion that they formed under most unusual circumstances on Mars [3, 4]. Impact–induced precipitation was evoked to explain these features, which may have been a consequence of the impact event liberating confined subsurface ice [3, 4] or from the impact of a "live" volatile-rich comet [5].

Meter to sub-meter resolution images (0.25-1.3 m/pixel) from the High Resolution Imaging Science Experiment (HiRISE) camera have revealed that these features, may not be exclusive to Mojave crater. Images of Mojave alluvial fans (hirise.lpl.arizona.edu), and other fluid abetted features in relatively well-preserved and youthful craters are currently being investigated to determine the processes responsible for their formation. Results from this study may yield further insight into the role of subsurface volatiles on the formation of Martian impact craters.

Approach: A close inspection of Mojave crater in visible and THEMIS nighttime thermal infrared (TIR) images strongly suggest that Mojave crater is a relatively well-preserved and youthful crater. Our reasoning, if these fluid-abetted features are related to the crater forming event, then they are likely to be preserved in relatively young, unmodified craters that lack substantial deposition and burial. One obvious class of relatively fresh Martian cratersis the large rayed craters, including Zunil (D_a = 10.1), Tomini (= 7.4), Gratteri (= 6.9) and Zumba (= 3.3) [6, 7]. Tooting crater (D_a ~29 km), west of Olympus Mons, has also been identified as one of youngest and the best-preserved craters on Mars [8]. These craters are currently being extensively surveyed with HiRISE data to identify Mojave-like features or other potential water-related morphologies.

Observations: As of writing this abstract, we have identified potential fluid-abetted erosional and mass wasting features in Tooting, Zunil and Zumba craters. Gratteri and Tomini craters do not appear to have any clear indication of such features. However, these craters may have been of insufficient size to sample reservoirs of subsurface volatiles, or there may have been a paucity of subsurface volatiles in the regions in where these craters occur. Also, at the time of writing this abstract, the ejecta blankets of these two craters were not extensively imaged (January 2007).

Tooting crater possesses high-order channelized features and debris (mud?) flows within the terraces in the southern wall (Fig. 1). While, Zunil possesses some exquisitely preserved debris flows associated with the central uplift (Fig. 2). Zumba crater, on the other hand, possesses streamlined morphologies with some similarities to Mohave alluvial fans, although much smaller in scale and concentrated within the continuous ejecta blanket (Fig. 3).

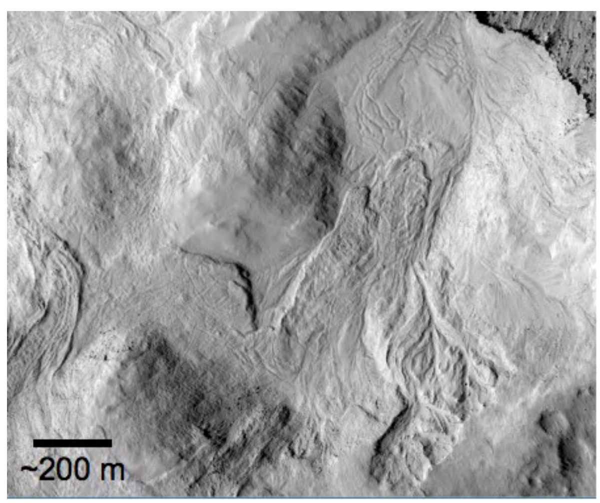

Figure 1. HiRISE subimage (PSP_001538_2035) Fluid-abetted debris (mud?) flow and third order tributary channels in Tooting crater (D_a ~29 km). North is up.

Discussion and Conclusions: Our preliminary observations suggest that the Mojave alluvial fans may not be as rare as previously suggested. In addition, the central uplift of Mojave crater appears to lack alluvial fans observed on the wall/terraces, rim and ejecta [4]; this seems at odds with the precipitation hypothesis, as rain and run-off should have dissected all topographic features uniformly across the crater and potentially should have included surrounding topographic features in Xanthe Terra as the system moved off the crater.

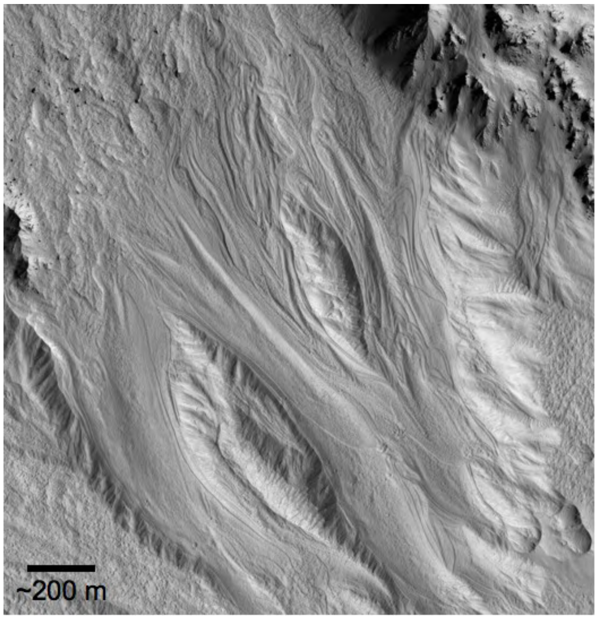

Figure 2. HiRISE subimage (PSP_001764_1880) of putative fluid-abetted debris (mud?) flows off the central uplift of Zunil crater (D_a ~10.1 km). North is up.

We conclude that these may be surface water-related features indicative of surface run-off, but the fluids involved most likely originates from groundwater sources and not precipitation. Crater- excavated and uplifted volatile-rich subsurface lithologies, when suddenly relieved of overburnden, could have catastrophically release volatiles. In addition, our preliminary observations appear to indicate that these processes may have also included dewatering of impact melt sheets. However, Mojave crater may have been large enough to produce effects not seen in the smaller craters discussed here.

These features may be direct evidence for the role of volatiles on the impact process on Mars. Such features may have been common in many craters on Mars, but overprinting, degradation, erosion, and burial may have destroyed them or disguised their presence.

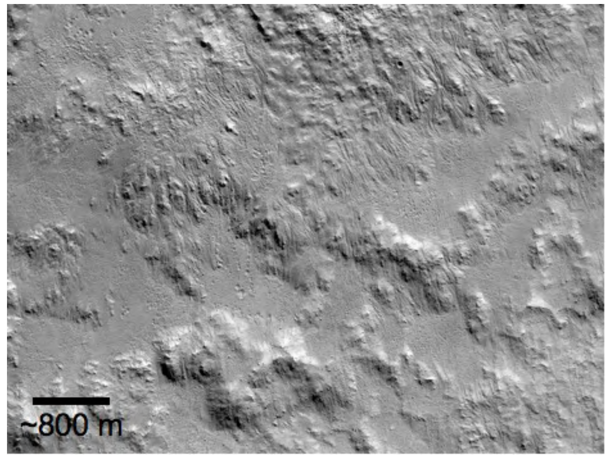

Figure 3. HiRISE 4x4 bined (~1.2 meter/pixel) subimage (PSP_001630_1510) of the eastern ejecta blanket of Zumba crater (D_a ~3.3 km). North is to the right.

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