CUT CRATERS ON MARS: A STUDY OF IMPACT CRATERS EXPOSED IN CROSS SECTION. B. J. Thomson[1], [1]Lunar and Planetary Institute, 3600 Bay Area Blvd, Houston, TX 77058 (thomson@lpi.usra.edu).

Introduction: The subsurface structure of impact craters on the Earth is typically accessible only through drill core data and geophysical surveys [e.g., 1, 2]. On Mars, some 20 impact craters have been identified in this study that have been cut by a combination of tectonic activity and erosion and are partially exposed in cross-section. Many of these cut craters lie along the walls of the Valles Marineris canyon system, which extends over 4000 km in length and has relief in excess of 9 km in places.

To the author's knowledge, no comparable terrestrial impact structures that have been exposed in a similar fashion are available for study. Examining Martian craters in cross section provides a unique opportunity to directly investigate many aspects of crater morphology, including the crater excavation depth, depth of layer disruption, ejecta thicknesses, and other cratering parameters. Given the wide range of crater degradation states on Mars, these craters may also provide constraints on weathering and degradation processes. Finally, cut craters may provide insight into the material properties of the target canyon wall rock, the exact nature and formation mechanism of which remains uncertain [e.g., 3]. This abstract reports the initial analysis of a 7.75 km diameter cut crater in Coprates Chasma (Figure 1).

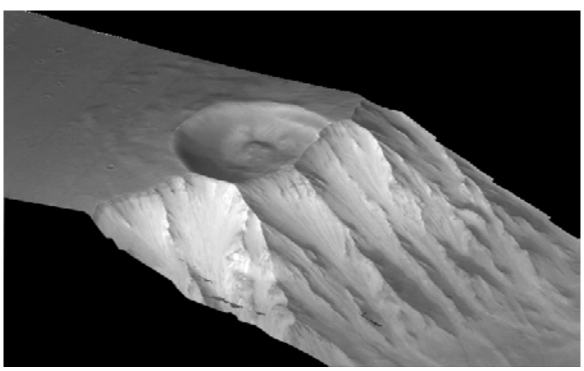

Figure 1. Oblique 3D perspective view of cut crater (7.75 km diameter) in northern wall of Coprates Chasma. Portion of THEMIS visible image V06831002.

Methods: Structural elements of cut craters were observed with high-resolution images from the Thermal Emission Imaging System (THEMIS) and the Mars Orbiter Camera (MOC). Precise topographic measurements of small structural elements (i.e., decimeter-thick layers) cannot be obtained using the 128 pixels per degree gridded Mars Orbiter Laser Altimeter (MOLA) topographic data, which have a resolution of 463 m at the equator. Instead, elevations were determined using individual MOLA profiles that crossed the study region. MOLA elevation points have a diameter of 168 m and the shot-to-shot center spacing is about 300 m [4].

First, MOC and THEMIS images were registered to a network of individual MOLA points. Second, linear elements of crater and wall rock geology were mapped using the images in a GIS software package. Third, tie points were extracted from intersection of MOLA ground tracks with mapped structures (Figure 2). Elevation values of these intersection points were obtained from linear interpolation between adjacent MOLA points along a given profile. Finally, all tie points were projected onto a single vertical plane to construct a true cross-section that facilitated interpretation (Figure 3). Note that this vertical plane does not bisect the crater; it was instead positioned to minimize the projected horizontal distances and thus reduce the uncertainty introduced into the projection.

Observations: *Crater characteristics.* This unnamed cut crater has a rim-to-rim diameter of 7.75 km. Erosion has removed approximately 23% of the crater as measured in plan view. The crater floor juts out into the chasma, suggesting that the floor is more resistant to erosion than the crater wall material. Rim heights average ~160 m above the surrounding terrain, and the rim-to-floor depth is 1.39 km. The steepest wall slope measured within the crater is 19.0° (as calculated between adjacent MOLA topographic points).

Hummocky ejecta deposits on the flat-lying upper surface of the chasma wall are subdued but still discernable. Three MOC images in the vicinity of this crater have been released (Figure 2), though none have targeted the areas where the crater rim meets the chasma wall. Thus, although an overturned flap of ejecta is expected to be present, it remains unresolved in the THEMIS visible image (spatial resolution = 19 m/pixel).

Wall material properties. The chasma wall has a spur-and-gully morphology with ridges of exposed material separated by talus-covered alcoves. Talus obscures much of the stratigraphy except along the uppermost portions of the wall and along the spines of spurs downslope. Wall rock slopes average ~19° down to the chasma floor, although local slopes exceed 30° in many places.

The uppermost layer visible in the cliff face is a thin, dark-hued layer that occurs about 100 m below the upper chasma surface. As measured in MOC images, this layer is about 10 m thick. Outcrops of this layer occur along on either side of the crater. Beyer and McEwen [3] mapped the elevation, dip, and horizontal extent of this layer along eastern Coprates Chasma and found it to be laterally extensive–it may underlie much of Ophir Planum (a plains region that borders the northern edge of the chasma).

Interaction between crater and wall layering. No continuation of this thin, dark-hued layer is evident beneath the crater floor. Outside the crater rim, the thin layer appears to mimic the slope of the upper surface and slopes gently away from the crater on both sides. Apparent dip angles are 1.8° on the west side of the crater and slope 3.8° in the opposite sense in the eastern exposure.

A different, thicker packet of dark-hued layers is visible below the crater floor. The top of this horizon is about ~400 m below the edge of the floor. Several subhorizontal layers have been mapped with an apparent dip of <1.0°. It is unclear if this layer is contiguous with a similar lower packet of dark-hued layers "at least 200 m thick" identified by [3]. Since this packet lies nearly a kilometer below the pre-impact target surface (~2300 m, Fig. 3), it is unlikely to represent a lens of fallback breccia.

Conclusions and implications for future work: The cut crater initially analyzed for this study appears to have disrupted a thin, laterally extensive layer in this region. Crater excavation did not extend down to a deeper packet of dark-hued layers identified beneath the crater floor. Proposals for layer origin include volcanic [e.g., 5], fluvial [e.g., 6], and diagenetic processes [7]. Although [3] interpret the disruption of the this layer by the crater as evidence that it was not formed by diagenesis, the possibility that this layer was formed by diagenetic activity that ceased before the crater formed cannot be completely discounted.

Cut craters provide a unique opportunity to directly investigate the subsurface structure of craters. Of particular interest are the interaction between craters and layers in the chasmata walls. Given that the interaction of craters with layers of disparate strength at depth produce distinct alterations in crater profiles [e.g., 8], the complete analysis of the cut craters identified for this study may help place constraints on the mechanical properties of layers encountered.

References: [1] Keiswetter D. *et al.* (1996) in *GSA Spec. Pap.*, *302*, 105-113. [2] Lana C. *et al.* (2006) *Geology*, *34*, 9-12. [3] Beyer R. A. & McEwen A. S. (2005) *Icarus*, *179*, 1-23. [4] Smith D. *et al.* (1999) NASA PDS, MGS-M-MOLA-3-PEDR-L1A-V1.0. [5] McEwen A. S. *et al.* (1999) *Nature*, *397*, 584-586. [6] Malin M. C. & Edgett K. S. (2000) *Science*, *290*, 1927-1937. [7] Treiman A. H. *et al.* (1995) *JGR*, *100*, 26339-26344. [8] Quiade W. L. & Oberbeck V. R. (1968) *JGR*, *73*, 5247-5270.

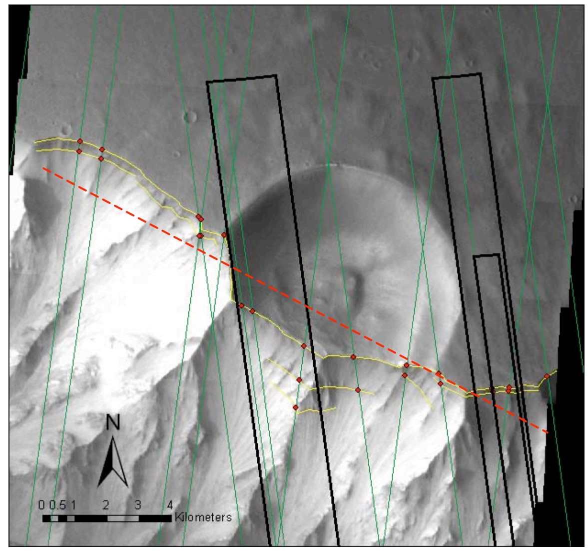

Figure 2. THEMIS visible image V06831002 with cut crater substructure mapped in yellow. Red points indicate intersections of mapped linear structures with MOLA profile ground tracks (green lines). Red dashed line is position of vertical plane used to create cross-sectional view (Fig. 3). Black outlines indicate positions of MOC narrow-angle images.

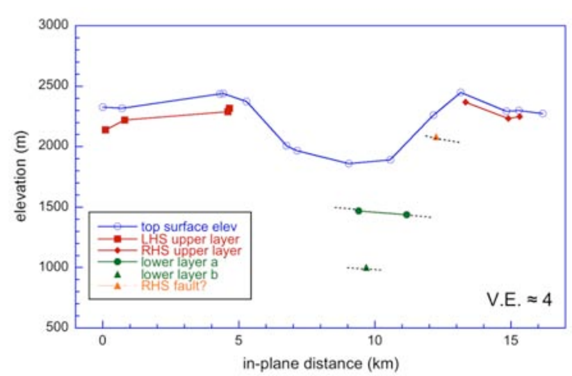

Figure 3. Cross-sectional view created by projecting intersection points given in Figure 2 into a vertical plane. Dashed lines are used to indicate extrapolations between MOLA profiles.