SURFACE CHARACTERISTICS OF MARTIAN LOBATE DEBRIS APRONS: INSIGHTS FROM HiRISE IMAGES AND TOPOGRAPHY. E.C.S. Joseph, A.V. Pathare, D.A. Crown, D.C. Berman, and F.C. Chuang, Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719; ejoseph@psi.edu.

Introduction: As lobate debris aprons (LDAs) are significant reservoirs of ancient ice on Mars, the formation and modification of their surfaces provides important clues to Martian climate history. Studies of LDA surface textures [1-5] indicate a complex history, including deposition of ice-rich mantles during the Amazonian Period, and subsequent degradation of the mantle by aeolian modification and ablation of contained ice. Past work evaluated surface textures at the Mars Global Surveyor's (MGS) Mars Observer Camera's (MOC) ~2-12 m/pixel and Mars Reconnaissance Orbiter (MRO) ConTeXt Camera's (CTX) ~5-6 m/pixel resolution [1, 2, 6]. This work extends LDA surface texture analyses to images from MRO's High Resolution Imaging Science Experiment (HiRISE), enabling a more detailed evaluation of surface degradation and modification.

Previous studies [1, 3] identified a topographical component to the surface textures, with degradation of the mantled surface gradually removing material and decreasing the thickness of the apron (Figure 1). The current work incorporates the generation of Digital Terrain Models (DTMs) from stereo HiRISE pairs in order to more precisely study the relationship between LDA surface texture and topography.

Texture Mapping: Figure 2 shows a lobate debris apron in eastern Hellas with surface textures mapped on CTX images [1]. The suite of textures composing the CTX map was interpreted to represent progressive degradation of the mantled apron surface, from Upper Smooth Material (red) to Lower Smooth Material and Lower Knobby (shown in blue and periwinkle, respectively). These textures were observed to be gradational, i.e. lacking sharp contacts. Figure 3 shows a location where the demarcation between the Upper Pitted (UPT) and Lower Knobby (LKB) textures is indistinct.

HiRISE images provide additional evidence of this gradational nature. The black box in Figure 2 denotes the footprint of a HiRISE stereo pair, which was used to create a HiRISE-based texture map in this section of the apron. The majority of textures observed using HiRISE may be characterized as "sub-textures" of the CTX-based textures, as in Figure 4. This portion of the apron was considered to be composed of a single texture (Pitted/Ridge &Valley) when mapped using CTX, but on HiRISE images it is divided into two textures, "Knobby", and "Smooth", where Smooth is interpreted to degrade into the Knobby texture.

Topography: The stereo pair was also used to construct a one-meter DTM (Figure 5) using Socet Set software following the methodology described by [7]. An elevation profile was traced along the violet line in Figure 4 from the northeast to southwest, crossing the Knobby and Smooth textures. The results of the profile (Figure 6) support the interpretation of the Smooth texture, with a higher elevation, degrading into Knobby as material is removed from the apron.

Plan of Work: This method of high-resolution texture mapping and elevation analysis will be applied to a number of LDAs in the eastern part of Hellas basin. Together with flow modeling as described in [8], a clearer understanding of the formation and modification of Martian lobate debris aprons will be achieved.

References: [1] Joseph, E.C.S., Crown, D.A., Chuang, F.C., Berman D.C. (2014) *LPSC XLIV*, abstract no. 2774. [2] Chuang F.C. and Crown D.A. (2005) Icarus, 179, 24-42. [3] Chuang F.C. and Crown D.A. (2012) LPS XLIII, abstract no. 2235. [4] Mangold, N. (2003) JGR 108, doi: 10.1029/2002JE001885. [5] Pierce T.L. and Crown D.A. (2003) Icarus, 163, 46-65. [6] Chuang F.C., et al. (2013) LPS XLIV, Abstract #2512. [7] Kirk, R.L., *et al.* (2008) JGR Planets 113, doi: 10.1029/2007JE003000. [8] Pathare, A.V., *et al.* (2016) LPS XLVII, abstract no. 2563, this volume.

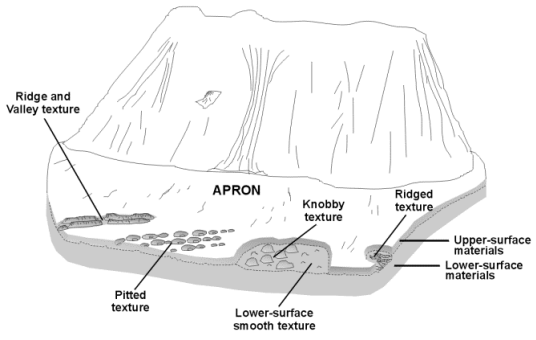

Figure 1: Idealized cross-section of a debris apron showing the types of surface textures identified in analyses of MOC images [from 3]. The upper-surface materials are inferred to be a mantling deposit of ice and debris that overlies thicker lower-surface apron materials. Textures develop within the upper surface material as it degrades. Note: material thickness and textural features not drawn to scale.

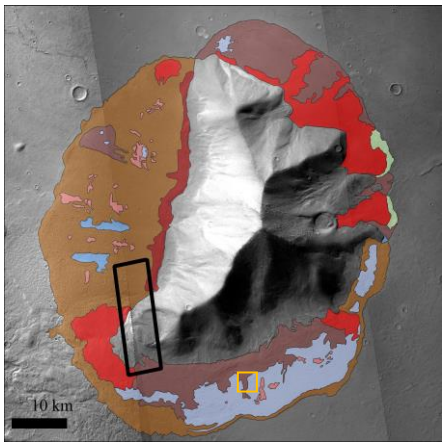

Figure 2: Surface textures mapped on a debris apron in eastern Hellas, 102.9°E and 40.6°S [1]. (CTX images P16_007397_1382, G16_024552_1394, G15_023998_1393; NASA/JPL/MSSS). Unit key: red = Upper Smooth Material, salmon = Upper Pitted, maroon = Upper Ridge & Valley, dark brown = Pitted and Ridge & Valley, brown = Pitted, Ridge & Valley, and Knobby, periwinkle = Lower Knobby, light blue = Lower Smooth, light green = Blocky. The black box indicates the footprint of the HiRISE stereo pair used to generate Figure 5. The orange box shows the location of Figure 3.

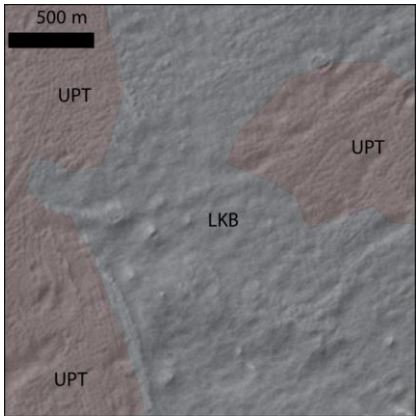

Figure 3: A subsection of the texture map in Figure 2, showing the transition between Upper Pitted Terrain (UPT) and Lower Knobby Terrain (LKB).

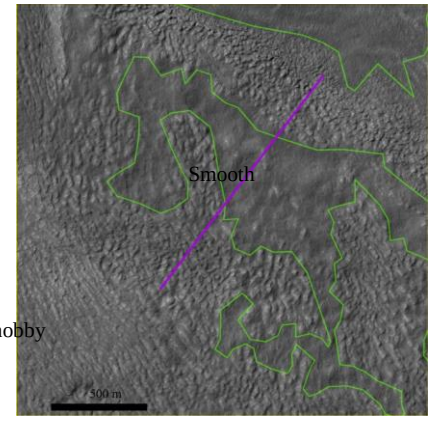

Figure 4: A section of HiRISE image ESP_032978_1390_RED showing Smooth and Knobby textures on the apron's surface. The violet line shows the path of the elevation profile in Figure 6.

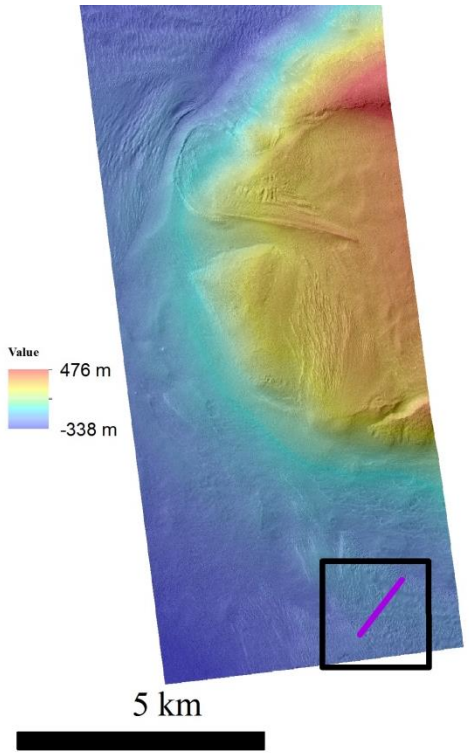

Figure 5: One-meter DTM of the lobate debris apron generated from HiRISE stereo pair ESP_032978_1390 and ESP_033400_1390, showing the location of Figure 4 and the elevation profile shown in Figure 6.

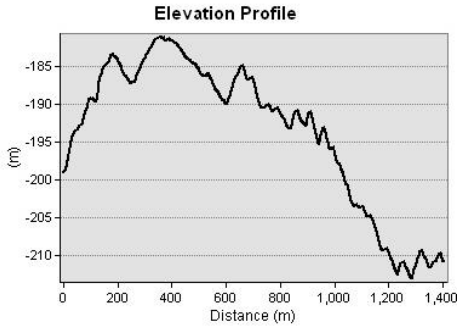

Figure 6: An elevation profile from DTM in Figure 5, following the path shown in Figure 4 (NE-SW**).**