DEBRIS APRONS IN THE TEMPE/MAREOTIS REGION OF MARS. F. C. Chuang and D. A. Crown, Planetary Science Institute, 1700 East Fort Lowell Rd., Suite 106, Tucson, AZ 85719-2395 (e-mail: chuang@psi.edu).

Introduction. Martian debris aprons are part of a suite of features attributed to the progressive down-slope creep of ice-rich material [1]. Lobate debris aprons, along with concentric crater fill and lineated valley fill, are found in mid-latitude regions on Mars [2]. Their distribution is consistent with model predictions of near-surface ground-ice [3,4,5]. Because these features are considered to be geomorphic indicators of ground ice, they are important in understanding the climate and volatile inventory on Mars. Their presence suggests storage of ice in the Martian regolith, either currently or in the recent geologic past. Recent studies of aprons have focused on two regions, eastern Hellas and Deuteronilus/Protonilus Mensae [6,7,8]. However, there are several other locales that have significant populations of aprons [9,10]. We have initiated a new study of aprons located along the northern lowlands-southern highlands boundary in the Tempe Terra/Mareotis Fossae region (43-55 N, 274-294 E). Comparison of apron populations from different parts of Mars will allow us to evaluate regional geologic controls and potential climatic differences on apron development.

Data and Methods. In this study, we use datasets from the Viking, Mars Global Surveyor, and Mars Odyssey missions. These data include Viking Orbiter mosaics (256 pxl/deg), gridded MOLA topography (128 pxl/deg), individual MOLA tracks (~300 m/shot point), MOC narrow-angle images (2-7 m/pxl), and THEMIS daytime and nighttime IR images (~100 m/pxl) and daytime VIS images (~19 m/pxl). The data have been imported into ESRI ArcView 8.3 Geographic Information Systems (GIS) software for georegistration, analysis, and the eventual generation of map products. The individual datasets are stored as layers and then further manipulated to produce accurate measurements (e.g., areas and lengths) and to examine slopes of different textural regions on apron surfaces.

Regional Geology. The Tempe/Mareotis study area lies along the Martian crustal boundary. In this region, the boundary has features typical of fretted terrain, a transitional region between smooth lowlands plains to the north and rugged mid-latitude highlands to the south [11]. Relief along the Tempe/Mareotis boundary reaches 4 km in places, particularly along escarpments to the north. In general, the Tempe/Mareotis region is geologically diverse with abundant volcanic (domes, fissures, and flows) and tectonic (grabens) features [12,13]. A synopsis of the Tempe/Mareotis geologic history is provided in [12].

Apron Complexes. We have identified 65 debris apron complexes using Viking Orbiter images. This number is slightly less than our initial survey due to a re-assessment of complexes using MOC and THEMIS images [14]. Apron complexes generally consist of one or more lobate deposits that surround individual massifs or small knobs, but have also been observed along the base of escarpments and inner crater walls. The Tempe/Mareotis aprons have a similar planimetric morphology to those observed in east Hellas and other areas on Mars [6,7]. Apron surfaces at Viking scale generally lack craters.

Surface Textures from MOC. Four distinctive textures are observed on apron surfaces in narrow-angle MOC images: a) smooth, b) pitted, c) ridge and valley, and d) knobby. The textures are commonly observed along mid-to- lower apron slopes and represent different stages of preservation of the top surface. The modification of this surface may occur by one or more processes including ice sublimation, melting of ice, and aeolian activity.

Smooth texture. This upper-most surface is generally featureless with a lack of craters and erosional features. However, there are several geomorphic features that are observed within smooth areas including longitudinal cracks, individual and multiple broad ridges circumferential to the bases of scarps and massifs, and elongated depressions.

Pitted texture. Individual semi-circular to elliptical-shaped pits can be as small as a few meters across and up to 135 m long and 70 m wide. When multiple pits form in close proximity to one another, they often coalesce into chains that can extend up to a few hundred meters.

Ridge and valley texture. Adjacent rows of pit chains develop an undulating topographic pattern where the linear to curvilinear depressions are valleys and the remnant materials form ridges. Ridges can reach up to several hundred meters in length. The spacing between sets of ridges is often regular, with distances between 30 and 90 m.

Knobby texture. Individual or clusters of knobs up to 100 m across are located between lower-standing degraded areas. Degraded areas typically exhibit smooth or ridged surfaces. Overall, this texture has a hummocky appearance.

Apron Profiles from MOLA. MOLA profiles across many of the Tempe/Mareotis aprons show a convex-upward shape similar to those observed in eastern Hellas and Deuteronilus/Protonilus Mensae. However, not all apron profiles have such shapes and many have a linear slope or only a slightly convex-upwards shape. Thus, it is not clear if all Tempe/Mareotis aprons formed by the same geologic process or combination of processes. Convex-upward shapes have been produced in finite-element models of ice+rock mixtures under current Martian conditions [15]. Aprons are generally tens of meters thick and sometimes more than 100 m.

Surface Properties from THEMIS. THEMIS infrared (IR) images allow identification of dusty and rocky areas and visible (VIS) spectrum images provide high-resolution views of surface features. Nighttime IR images reveal temperature differences of 5 to 11 K between apron surfaces and massif surfaces. The cool apron surfaces appear to be fine-grained dust whereas massif surfaces are probably exposed rock partially covered by dust. A dust-blanketed apron surface is consistent with our observations of an upper-most smooth-textured surface with subdued topographic features. VIS images reveal areas of active mass-wasting along massif slopes and the accumulation of debris along their bases.

Apron Surface Degradation Sequence. The four textures observed on apron surfaces represent different stages of progressive surface degradation. The sequence begins with an unmodified upper-most smooth surface which then develops pits. The pits coalesce to form chains and any remnant high-standing material between the depressions forms ridges (Fig. 1). Continued degradation causes the ridges to pinch-off, forming isolated knobs that indicate a textural transition from ridge and valley to knobby. However, there are cases in which a direct transition from pitted to knobby is observed. Also, we do not find a complete degradational sequence on every apron or every part of an apron surface.

We believe the preserved textures in this degradational sequence occur on an upper dust+ice mantle that overlies a lower rock+ice mixture (the apron mass). Morphologic indicators of viscous flow are less prominent in Tempe/Mareotis than in eastern Hellas, suggesting differences in the emplacement and/or preservation of the mantling deposit. The overlying dust+ice mantle may be the same material that has been found globally throughout the mid-to- high latitudes (30-70 N) of Mars [16]. The dissected appearance of this global 1-10 m thick mantling layer is morphologically similar to our pitted and ridge and valley textures.

Degradation of the dust+ice mantle by ice sublimation would disaggregate dust, forming a lag deposit on the apron surface. Unless this lag is consistently removed by aeolian activity, it may become sufficiently thick to arrest ice sublimation. However, lag deposits that form on the slopes of pits, ridges, and knobs may also be transported downslope to lower-standing erosional surfaces by gravity or wind activity. Continuous or periodic removal of the lag would allow sublimation degradation to continue. Erosional surfaces typically appear smooth or ridged (Fig. 1). However, it is not clear if the erosional surfaces are exposed portions of older mantle deposits or of the apron mass.

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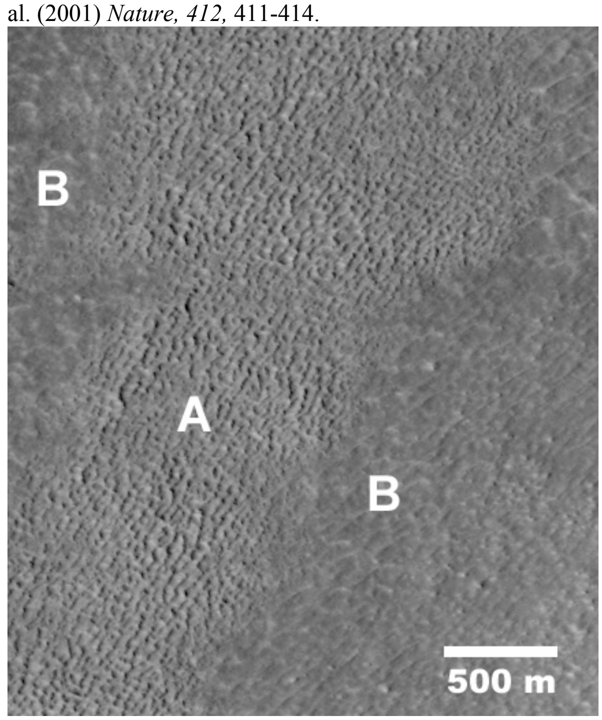

Figure 1. Example of (A) transitional terrain with *pitted* and *ridge and valley* textures that overlies lower-standing (B) *ridged* texture on apron surfaces. Portion of MOC image E0300481 (NASA/JPL/MSSS).