A PROGRESSION OF INDURATION IN TRANSVERSE AEOLIAN RIDGES: EVIDENCE FOR ANCIENT AEOLIAN BEDFORMS AND EXTENSIVE REWORKING IN THE MEDUSAE FOSSAE FORMATION. L. Kerber and J. W. Head, Brown University Department of Geological Sciences. 324 Brook Street, Box 1846, Providence, RI 02912, Laura_Kerber@brown.edu

Introduction:

The Medusae Fossae Formation: The Medusae Fossae Formation (MFF), is a fine-grained, friable unit of uncertain origin located near the equator of Mars (130°-230°E and 12°S-12°N), which displays evidence of intensive aeolian erosion [e.g. 1,2, Fig. 1]. There are several hypotheses for the formation of the MFF, including a variety of volcanic processes [1-7], accumulation of aeolian debris [1,8,9], paleopolar deposits [10], and obliquity-driven deposition of ice and dust [11].

Although the MFF has been traditionally mapped as an Amazonian-aged deposit [1,8,12], recent work has suggested that deposition of the MFF began at the latest in the Hesperian, and that it has undergone erosion, redeposition, and induration since its primary emplacement [7].

The surface morphology of much of the MFF is dominated by erosional features such as yardangs, leading researchers to propose that the formation used to be much more voluminous than it is today [13]. It has been suggested [9] that given the extensive erosion present in the Medusae Fossae, a corresponding volume of loose material should be present within or around the MFF as sand seas (ergs). The absence of these ergs was cited as evidence that the deposit was dominated by dust-sized particles which could be eroded and then carried to great distances [9]. Given the already large current volume of the MFF, the inference that it was originally much larger places important constraints on any possible formation mechanisms [13].

In order to assess the likelihood of the proposed formation mechanisms for the MFF, it is helpful to determine how much of the deposit (if any) retains the morphology of its primary emplacement. To achieve this goal, it is necessary to examine both how the formation is eroded as well as what happens to the loose material which has been eroded.

Martian Aeolian Bedforms: Aeolian erosion and transport is hypothesized to be an important geomorphological process on Mars. Dunes and transverse aeolian ridges (TARs) are present over large portions of the martian surface. TARs are depositional features, thought to be either small dunes or large, coarse-grained, aeolian ripples, such as those found at the Spirit landing site [14, 15, 16]. Recent work has shown that some dune fields on Mars are active today [15, 17]; however, the majority of martian dunes that have been observed over time have shown no evidence of growth or translation [18, 19]. TARs appear to be even less mobile than the better documented large sand dunes, almost always stratigraphically below them where they appear together [14]. Some dunes with low levels of activity may be indurated, either by chemical cementation or seasonal ices [20].

Despite this apparent lack of movement, however, only a few martian dune fields appear to be old enough to have accumulated craters or other indications of degradation and erosion [21].

Observations: A survey was conducted of images of the MFF taken with the High Resolution Science Experiment (HiRISE) on the Mars Reconaissance Orbiter (Fig. 1). Images taken by the Mars Orbiter Camera (MOC) on the Mars Global Surveyor spacecraft were also consulted. Images that contained aeolian bedforms were noted. It was found that depositional aeolian bedforms are common in the MFF at MOC and HiRISE resolution (Fig. 1), though their mass does not appear sufficient to account for the "missing" mass implied by the extensive erosion of the MFF.

However, unlike TARs found elsewhere on Mars, which normally appear morphologically fresh, the TARs found within the MFF display a range of morphologies, from fresh-looking forms with crisp crests and well-defined secondary bedforms to cratered and eroding remnant ridges, with flattened or crenulated crests and muted secondary bedforms (Fig. 2). Fresher-looking TARs were found superposed on or grading into more degraded bedforms, indicating several generations of TAR formation and induration (Fig. 3). Some TARs within the MFF are cratered at HiRISE and MOC scales, suggesting that they are better indurated or older than aeolian bedforms studied elsewhere (Fig. 2). Both fresh and indurated aeolian bedforms are more common in the western parts of the MFF and near its edges; fresh bedforms are more common than indurated bedforms in the westernmost part of the MFF (Fig. 1).

Conclusions: The variety in degradational states observed in MFF TARs suggests that aeolian bedform formation, induration, and degradation is a significant and ongoing process within the MFF. The recycling of loose material through many cycles of induration and erosion may reduce the need for a large "missing" volume of material from the MFF. The presence of degraded and cratered bedforms, a relatively uncommon occurrence on Mars, may indicate a difference in the level of induration or a more ancient age of the TARs in the MFF compared to those found elsewhere on the planet.

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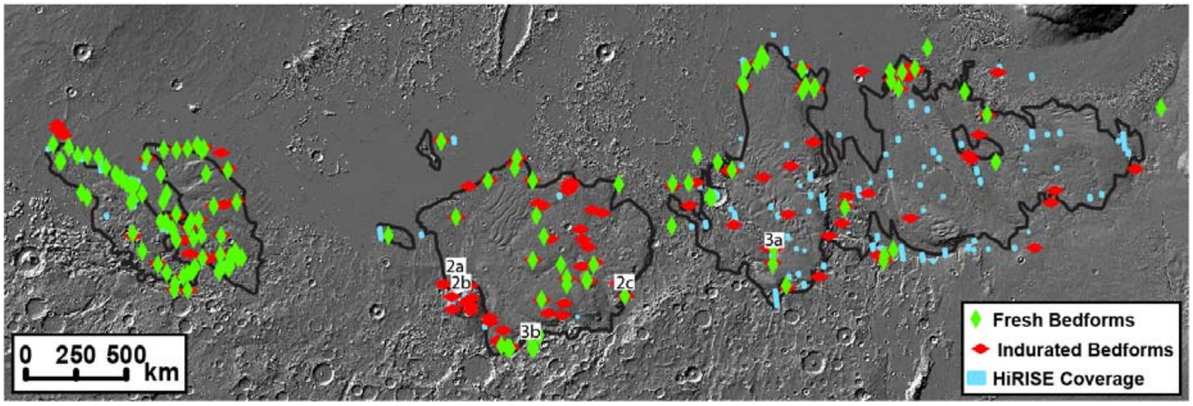

Figure 1. A regional view of the MFF (outlined in black). HiRISE images included in the survey (blue) containing fresh bedforms (green) or indurated bedforms (red). The locations of the other figures are indicated. Aeolian bedforms are more common in the western part of the MFF. Global MOLA data overlain on a MOLA hillshade map.

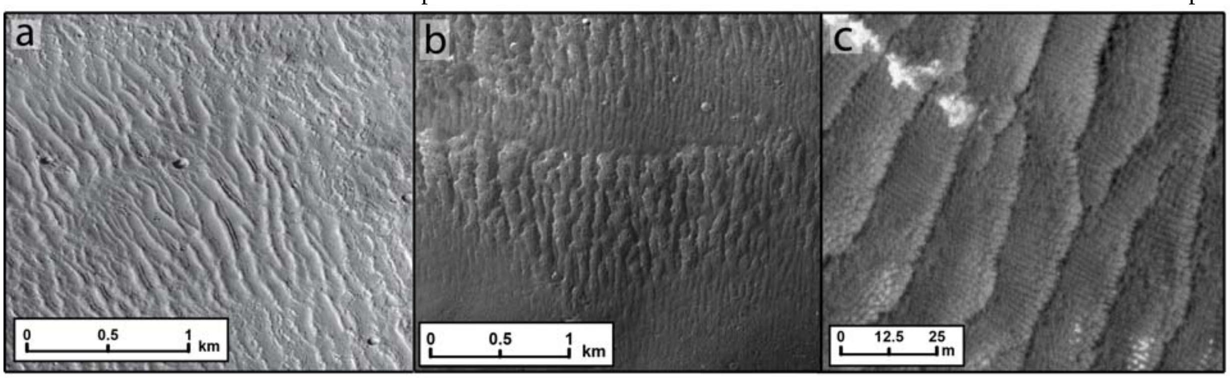

Figure 2. Heavily eroded, etched, and cratered TARs in Lucus Planum. a) TARs north of Apollinaris Patera. Note rounded crests and subdued topography (MOC image M1301069). b) Eroded TARs with flattened crests. Smaller, secondary bedforms are also eroded and cratered (MOC image M1003186). c) Indurated and eroded TARs in eastern Lucus Planum, with rough and discontinuous crests (HiRISE image PSP_006273_1715).

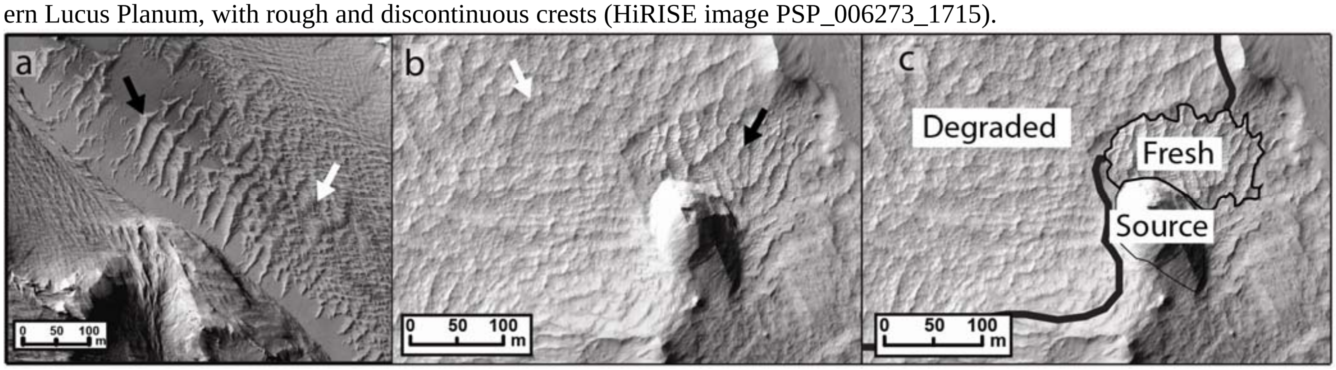

Figure 3. The transition from recognizable aeolian bedforms to degraded terrain. (a) Distinct complex TARs (black arrow) grade into complex terrain (HiRISE image ESP_017098_1745). b) A patch of fresh aeolian bedforms (black arrow), likely eroding from the knob at center right, is superposed on older, indurated bedforms with subdued crests (white arrow) (HiRISE image PSP_009398_1685). (c) A sketch map outlining the units discussed in (b).