MAPPING MEDUSAE FOSSAE MATERIALS ON THE SOUTHERN HIGHLANDS OF MARS.

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Introduction: The Medusae Fossae Formation (MFF) is an extensive deposit (2.2 x 10^6 km^2, [1]) of wind-eroded material of widely debated origin which unconformably overlies a considerable area of the crustal dichotomy boundary on Mars. The MFF shows a variety of layering patterns, erosional styles and channel-like forms. We aim to constrain the origins and post-emplacement processes of this formation.

Background: Morphologically, the Medusae Fossae Formation materials are typified by a discontinuous, highly eroded appearance (Fig. 1), and it is commonly agreed that they are fine grained and friable in nature [1, 2, 3, 4]. They have been mapped into five main outcrops and into three geological members according to exposure and stratigraphy [4, 5]. Away from these outcrops, there are numerous examples of materials across the Northern lowlands that have surface morphology and erosional characteristics similar to MFF material [6, 7] but few studies have examined the possibility of MFF outliers on high ground south of the dichotomy boundary. This study presents evidence for newly found outliers I nthis region.

Approach: A preliminary transect survey revealed apparent outlying MFF materials in the southern region of the Mangala Valles area of Mars. A more thorough study of MOC NA images across this region revealed many examples of materials similar to the MFF.

Results: Fig. 2 shows the occurrence and spatial extents of the outlier MFF materials south of the dichotomy boundary. These materials are typified by yardang fields, a patchy and discontinuous nature, and are very similar to materials found in areas of the upper member of the MFF (Fig. 1). The characteristics of the outliers indicate that they drape the underlying terrain for they appear widely in dips, craters and topographic lows. Most have yardang orientations consistent not only across this area but also with the dominant orientation of the main MFF outcrops.

Discussion: It can be seen from the extent data (Fig. 2) that the outliers are widespread but concentrated to the north of the study area. In the more southern areas there are often only tiny outcrops or traces. If the outliers represent the remnants of a once continuous layer, the Medusae Fossae Formation might once have extended up to 870 km south of the crustal dichotomy boundary, although these areas have since been heavily eroded.

Elevation data shows that the maximum, minimum and mean elevations of the newly discovered outliers are closest to those of the upper member of the MFF. That the outliers share morphologic characteristics with a subset of the upper member materials, together with these elevation trends, suggest that the outliers are more likely to be remnants of the upper member than the middle or lower members.

Conclusions: Our observations show that there are MFF-like deposits on the southern highlands. We suggest that there might be two possible explanations for these outliers:
1) The MFF had a much greater pre-erosional extent than previously estimated, or
2) Materials from the main MFF lobes were eroded and then blown south to accrue in the highland areas, where they were subsequently reworked.

At this time, we believe that the first option is the more likely and briefly present a "breaching" layer-cake model for deposition. In this hypothesis, approximately horizontal stacks of sediment built up south of and against the dichotomy boundary until they reached the topographic level of the highlands. Further materials (that went on to become upper-member MFF material and outliers) were then deposited across a wider area, including south of the dichotomy. Severe erosion then removed much of this material.

We conclude that the MFF was therefore emplaced by airfall deposition of fine sediments. Previously presented formation mechanisms that match this conclusion include episodic ignimbrites [8, 9] or ice-rich deposits laid down during periods of high obliquity [10].

References: [1] Bradley et al., 2002, JGR 107. [2] Bridges et al., 2007, LPSC Abstract #2098. [3] Kerber & Head, 2009, doi: 10.1016/j.icarus.2009.10.001. [4] Zimbelman et al., 1996, LPSC Abstract 1495-1496. [5] Tanaka & Scott, 1986, USGS Map I–1802–A. [6] Watters et al., 2007, Science 318. [7] Keszthelyi et al., 2008, LPSC Abstract #2420. [8] Hynek et al., 2003, JGR 108. [9] Kerber et al, 2008, LPSC Abstract #1881. [10] Head & Kreslavsky, 2004, LPSC Abstract #1635

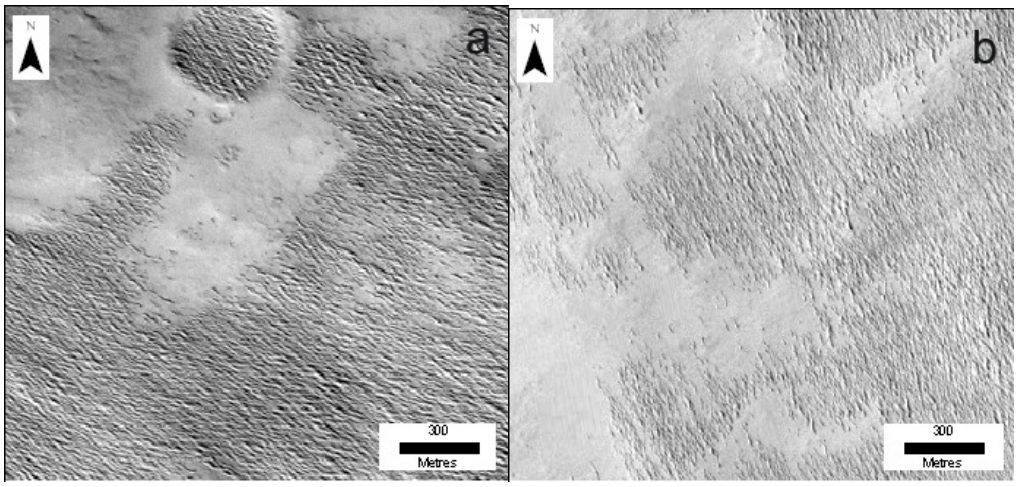

Figure 1: Comparison of degraded upper member materials on lobe D (a – MOC NA image E11/01999) with an example of the outlier materials (b – MOC NA image R11/04489). Both show a rough SE-NW directional trend in the yardang ridge features and preferentially occur in topographic lows. Image credits: NASA/ MSSL.

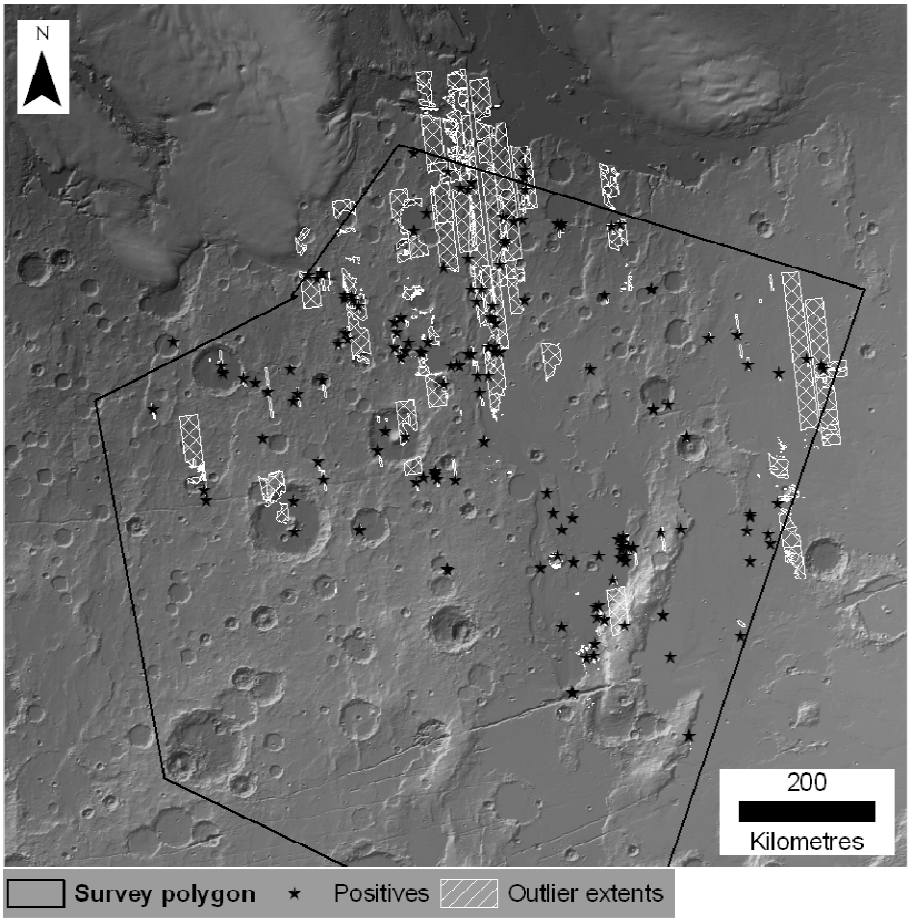

Figure 2: Map showing the positive occurrences of MFF outlier materials and the spatial extents of these examples. The stars also represent extents which are too small to be represented at this scale.The largest continuous extent can be seen in the north of the study area and extending above it, between lobes D and E of the main formation, with other the main occurrences clustered in the north west of the area. Towards the south of the study area, the extents become considerably smaller and more widely spaced. Image credit: NASA/MSSL/USGS.