PRELIMINARY GEOLOGIC MAP OF THE MC-23 NW QUADRANGLE, MARS: LOWER MEMBER OF THE MEDUSAE FOSSAE FORMATION. J. R. Zimbelman[1], [1]CEPS/NASM MRC 315, Smithsonian Institution, Washington, D.C. 20013-7012, zimbelmanj@si.edu.

Introduction: Geologic mapping of the MC-23 NW quadrangle of Mars at 1:2,000,000 scale is under way [1] as part of NASA PGG grant NNX07AP42G. This quadrangle includes most of the globally mapped lower member of the Medusae Fossae Formation (MFF). Mapping is being done in ArcGIS, which has involved a very considerable learning curve [1]. Preliminary results derived from the mapping to date include the identification of several outliers of the lower member of MFF [2], which connect to the globally mapped region for this unit [3], indicating that the MFF deposits were at one time considerably more extensive in areal coverage [1-3] than is indicated by the globally mapped unit locations [4, 5]. Separate studies [6-8] have come to the same conclusion, namely, that MFF was once much more extensive than it is at present.

Background: MFF represents a sequence of deposits that currently cover >2 X 10^6 km^2 across the Martian equator [9], in the Amazonis and Elysium Planetiae regions [4, 5, 10]. These enigmatic deposits have generated numerous hypotheses of origin [11], but recent data have tended to favor an ignimbrite origin [9, 12], although an aeolian origin [4] still cannot be excluded. Broad undulations best expressed in the lower member of MFF were interpreted to be similar to polar layered materials, suggesting significant polar wander must have taken place on Mars [13], but a detailed comparison of MOLA topography across MFF and polar layered materials concluded that the MFF undulations were quantitatively distinct from the polar terrains [9]. MARSIS [14] and SHARAD [15] radar sounder data reveal that MFF ranges from many tens of meter (in the west; lower member) to almost 3 km (in the east, upper member) in thickness, lying unconformably on top of northern lowland plains materials.

Methodology: Standard photogeologic mapping procedures [16] are followed, interpreting geologic unit differences from superposition and cross-cutting relationships. To date, MFF has displayed relatively few impact craters, making crater dating difficult, although the deposit as a whole is considered to be ~1.6 Ga [17]. The base map is the latest version of the global THEMIS daytime IR mosaic, released in 2009, which provides 100 m/p resolution coverage [18]. ArcGIS is used to document the on-going mapping.

Results to date: The main result to come out of the early mapping in the MC-23 NW quadrangle [2] was that outliers of a component of the lower member of MFF (Aml2) are present west and south of the globally mapped boundary of MFF deposits (Fig. 1). The most recent version of the global THEMIS mosaiced data now reveal that many of the Aml2 outliers are in fact connected to eachother, as well as to the nearby globally mapped Aml deposit (Fig. 2). These results support other studies that indicate MFF was at one time much more extensive than is preserved in the present severely eroded deposits [3, 6-8]. Recent mapping of the mound of material in the center of Gale crater supports an interpretation that these materials are distinct from

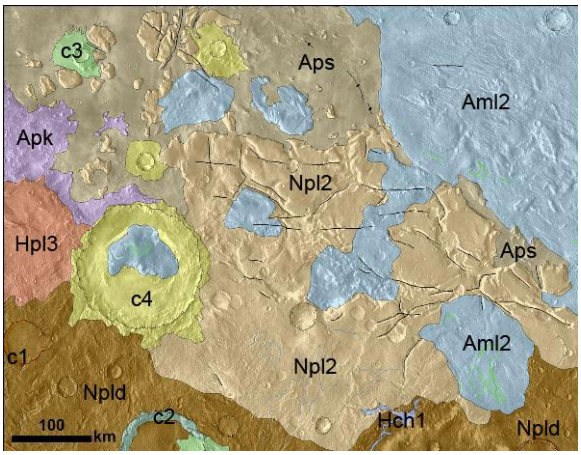

Figure 1. Portion of the 2009 version of the MC-23 NW geologic map, indicating discreet outliers of Aml2 (a subunit of the lower member of MFF). Unit names are derived from those used in global maps [4, 5].

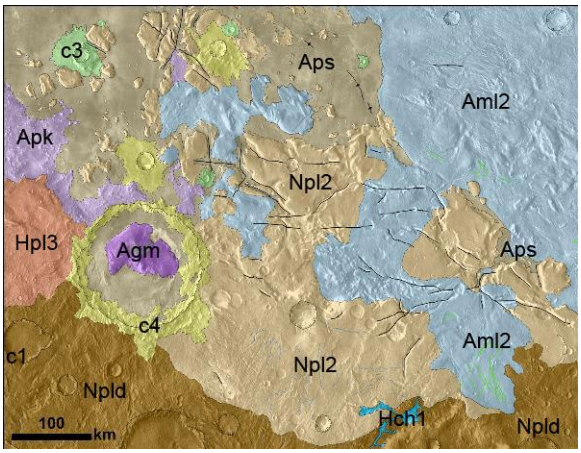

Figure 2. Portion of the 2010 version of the MC-23 NW geologic map, corresponding to the area shown in Fig. 1. The latest version of the THEMIS daytime IR mosaic [18] reveals several of the Aml2 outliers are connected, suggesting an even larger previous extent to MFF than indicated by global mapping [4, 5].

the nearby outliers of Aml2 materials (now shown as unit Agm in Fig. 2), a change from earlier mapping inferences (Fig. 1). No significant changes to the globally mapped units have been observed in either the northern lowlands or the southern highlands. CTX data (6 m/p) show clear contact relationships between the Aml2 outlier deposits, some of which show distinct competency variations as evidenced by etched layers, and the underlying cratered materials (Fig. 3). CTX

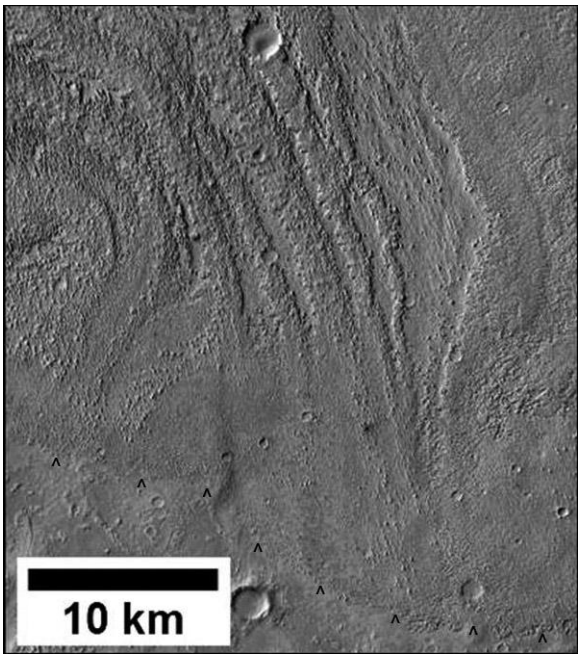

Figure 3. Portion of CTX frame P02_001844_1738 (NASA/JPL/MSSS) showing the southern contact (arrows) of a well-preserved Aml2 outlier. Note layering within the Aml2 materials, likely an expression of variations in material competency within the deposit.

also reveals smaller isolated outliers of Aml2 deposits, which were not immediately apparent in the THEMIS base map (Fig. 4). The new mapping provides strong support for other studies [6-8] that suggest MFF was once much more areally extensive than at present.

Discussion: If MFF is indeed the result of ignimbrite deposits [10, 12], then the evidence of its larger previous extent has important implications for this volcanic emplacement. The Toba eruption (74 ka, 2800 km^3 of deposits [19, 20]) is the largest explosive volcanic deposit yet identified in the terrestrial geologic record. The current volume of MFF [9] would have required 500 Toba-scale eruptions to produce the entire deposit [2], and the evidence that MFF was previously much more extensive suggests that >1000 Toba-scale eruptions would be required to produce the original MFF deposits [3]. It remains problematic that no

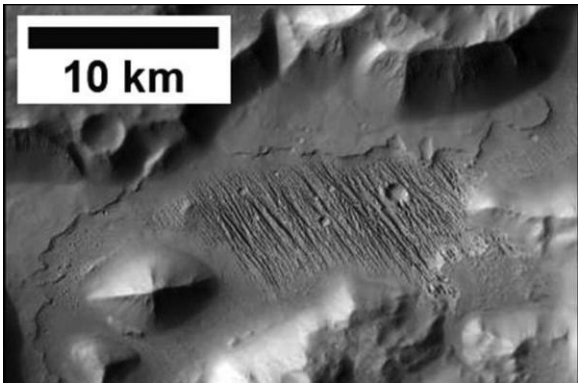

Figure 4. Portion of CTX frame P02_001844_1738 (NASA/JPL/MSSS) showing an isolated outlier of Aml2 material on the floor of a valley within the Npl2 cratered uplands unit.

definitive source calderas have been identified within MFF. Hopefully continued detailed mapping of MFF will provide additional evidence for testing the ignimbrite hypothesis.

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