CRATER RETENTION AGES INDICATE A HESPERIAN AGE FOR WESTERN AND CENTRAL PORTIONS OF THE MEDUSAE FOSSAE FORMATION, MARS. J. R. Zimbelman[1] and S. P. Scheidt[1], [1]CEPS/NASM MRC 315, Smithsonian Institution, Washington, D.C., 70013-7012; zimbelmanj@si.edu.

Introduction: The Medusae Fossae Formation (MFF) is a complex, intensely eroded deposit adjacent to the dichotomy boundary on Mars [1, 2], between ~130° and ~230° E longitude and ~15° S to ~15° N latitude. This enigmatic deposit has had numerous published hypotheses of origin (summarized in [3]), but the favored interpretation at present is that MFF materials were emplaced by ignimbrite eruptions [4, 5]. Geologic mapping of two 1:2M quadrangles, including western and central MFF exposures, was supported by NASA PGG grant NNX07AP42G. Crater counts on the MFF units within these two quadrangles provide results that have important implications for the overall history of MFF.

MC-23 NW Quadrangle Results: Global geologic mapping (1:15 M scale) identified three members within MFF; upper, middle, and lower, all identified as Amazonian in age [1, 2]. Mapping in MC-23 NW has subdivided the lower member into two components, with AHml1 superposed by Aml2 [6] (Fig. 1).

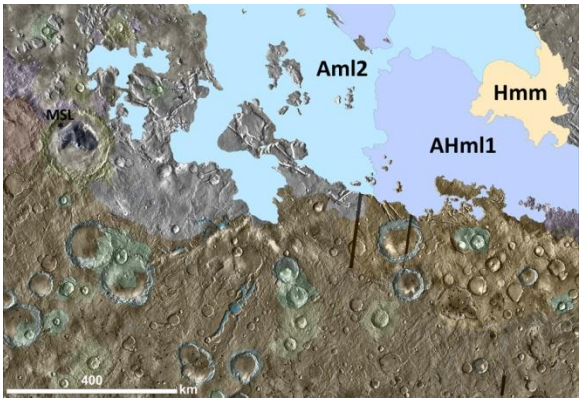

Figure 1. MC-23 NW quadrangle map, with MFF units in solid color, labeled based on cratering results. MSL targeted landing site is inside Gale crater (left).

Figure 2 shows the age dating results from crater counts for the three MFF subunits within MC-23 NW, and one MFF unit from MC-16 NW. Ages of the MFF subunits were determined based on crater counts obtained using ArcGIS, plotted using Craterstats [7]. The stratigraphic upper component of the lower member (ml2) has an early Amazonian age, while the stratigraphically lower component (ml1) is near the Amazonian-Hesperian boundary. Curiously, the portion of the middle member (mm, from global mapping) within MC-23 NW has a Hesperian age, older than both ml units. These results suggest that the crater retention

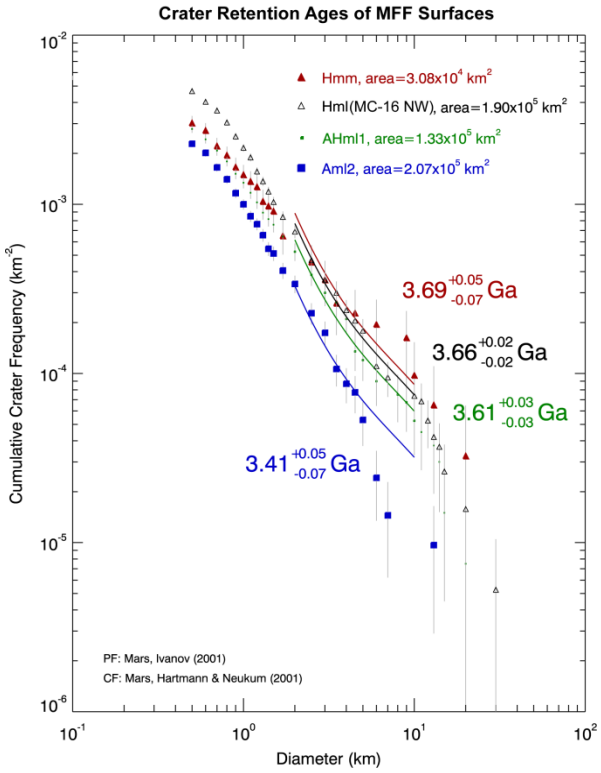

Figure 2. Cumulative crater frequency data for MFF units in MC 23-NW and unit Hml from MC-16 NW (black symbols). Ages are derived from fitting craters in the 2 to 10 km diameter range [7]. PF = production function [8]. CF = chronology function [9].

ages represent surface exposure ages; lower member units experienced erosion into the Early Amazonian, even though they are stratigraphically beneath (older than) the middle member (unit mm, which has an Hesperian-aged surface). Thus, a substantial amount of material has been eroded from the ml units, and the emplacement of all MFF units in MC-23 NW occurred prior to at least the late Hesperian. This result is consistent with previous work that indicated a Hesperian age for at least portions of MFF [8, 9], but our results suggests that all of the lower and middle members were emplaced much earlier than indicated by previous global studies [e.g., 1, 2, 12]. Unit Aml2 may be related to the topmost unit on the Gale Crater mound (see "MSL" location in Fig. 1), which has layering unlike the lower portions of the mound [13, 14]. The topmost Gale mound layering [14] appears to be similar to layering within portions of Aml2 [Fig. 5 of 3]. MSL is targeted to explore the Gale mound starting in

late 2012; Curiosity could eventually reach materials on top of the Gale mound during an extended mission.

MC-16 NW Quadrangle Results: Three units of the MFF (lower, middle and upper) were previously mapped as Amazonian on a global scale [1] in the MC-16 NW quadrangle, south of Nicholson crater and east of Apollinaris Patera. Using the latest THEMIS base maps, these units were separated into eight subunits based on geomorphologic contacts, stratigraphic relations, textures and layering expressed in the erosion of the MFF materials [15] (Fig. 3). New age dating results provide clues to the relative timing of MFF subunit material emplacement and erosion, including resurfacing events [7] (Figs. 2 and 4).

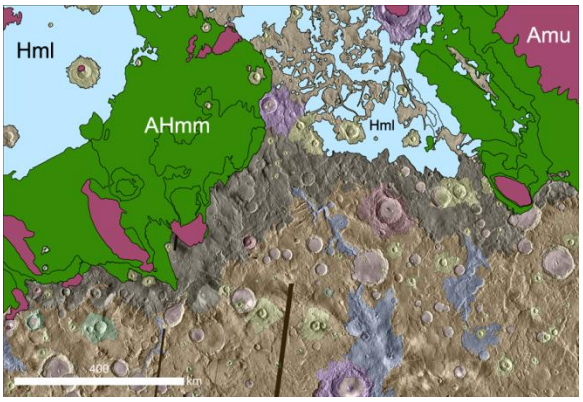

Figure 3. MC-16 NW quadrangle map, with MFF with in solid colors are grouped together by similar ages.

The lowest three subunits (Aml1, Aml2 and Aml3), were previously considered Amazonian, but here they are grouped together as Hml and placed robustly in the Hesperian based on similar crater counts. If craters between 1 and 2 km are included, the unit might only date to the very beginning of the Early Amazonian. Hml exhibits little evidence of resurfacing (Fig. 2). This unit is stratigraphically lower than other MFF units and has a high preservation of small craters. It is possible that overlying MFF units have been preferentially eroded away here, exposing a preserved Hml surface and the age of Hml and crater preservation could also suggest that this unit is actually older Hesperian lava [11]. An interfingered Aps unit among Aml2 remnants in the middle of the map has a younger Early Amazonian age (3.34 ± 0.22 Ga), probably due to the mantling of eroded MFF material. Hml is predated by Hesperian channeled (Hch) and adjacent dissected terrain (Npld) at 3.8 ± 0.015 Ga. Resurfacing events may cause underestimations of surface formation ages [5], but resurfacing is distinguishable in the cumulative crater distributions of all middle and upper

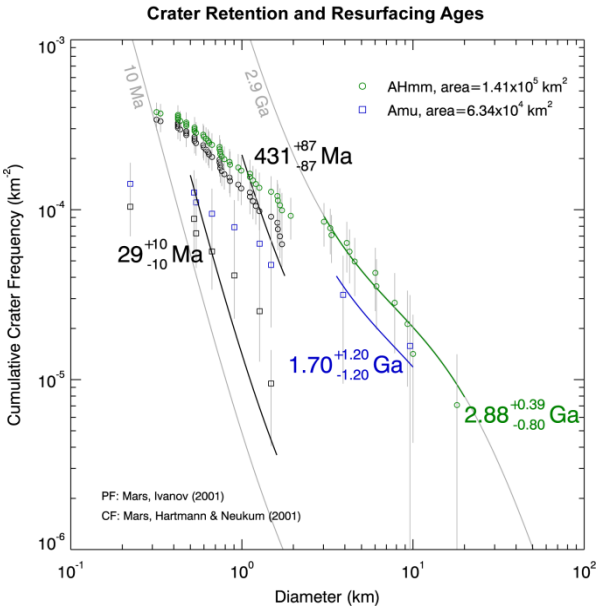

Figure 4. Cumulative crater frequency data for grouped MFF units in the MC-16 NW. Resurfacing events are each unit are indicated by black symbols.

MFF units by a downward step that deviates from the isochron of the surface formation age (Fig. 4).

Cratering ages were similar for units Amm1, Amm2, Amu1, and Amu2 when accounting for resurfacing of craters between 1-2 km, so these units were grouped together here as AHmm, giving the surface a formation age in the Late Hesperian (2.89 Ga) with resurfacing beginning in the Middle Amazonian (409 Ma). The youngest subunit in the map area (Amu3) exhibits very few craters, a smooth undulose terrain and scour pits (probably the early growth stages of yardanges). The crater retention age for the Amu surface indicates an Amazonian age (1.7 ± 1.2 Ga). A resurfacing age determined from craters in the 1-2 km range is 266 ± 130 Ma, but a better fit to an age of 29 ± 10 Ma includes craters less than 0.5 km.

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