HIGHLAND FRETTED “DEPOSITS” OF THE MARTIAN PLAINS ARE REALLY ANCIENT TERRAIN.
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Within the highland plains of Mars, several localized zones of what appeared to be rough, equant sided hummocks at Viking resolution have been interpreted to represent zones of more friable, weakly consolidated materials, perhaps formed as sediments within an internal drainage basin or local slack water zone of fluvial transport [1,2,3]. While sifting through hundreds of MOC images of the highland plains searching for evidence for or against sedimentary deposits, we have found many examples of these features that at MOC resolution of 2-5 m/p, that now show incontrovertible evidence of ancient cratered terrain exposed through, and surrounded by plains units. In the Margaritifer Sinus and Iapygia quadrangles, these patches of ancient terrain are in various states of exposure and infilling, ranging from pristine looking, heavily cratered terrain with only patchy aeolian dune cover, to a modified, highly cratered surface with curvilinear ridges marking the rims of ancient craters. In contrast to the sedimentary origin interpreted in the past, such zones may have formed by incomplete plains cover or by erosional stripping of the plains. MOLA profiles along these exposures support both modes of origin.

The record of volcanic and possible sedimentary plains formation is preserved in the martian equatorial highlands, yet is difficult to decipher photogeologically because of the non-descript morphology of each of those types of surfaces after billions of years of impact gardening, aeolian erosion and deposition, and lateral mixing of the surface. In prior work, small patches of fretted and fractured hummocky terrain a few kms to 10’s of kms across appeared to be depositional, based on their occurrence in interior drained basins [1,2] and within areas whose crater age relations suggested a sedimentary origin [3,4]. We have continued work on the highland plains to utilize MOC and MOLA data to look for small scale evidence of the origin of individual plains units, concentrating in the Margaritifer Sinus and Iapygia quadrangles, where the effects of aeolian blanketing and Hesperian volcanism are minimized. While searching through the MOC collection of plains images, we noted with increasing frequency those areas that were probable lacustrine deposits targeted by the MOC team, and that with only few exceptions, the high resolution view was not consistent with what had been interpreted in the past. In fact, of the 15 images of such “lacustrine deposits” in Margaritifer Sinus, only three of them show under high resolution what appears to be a horizontally layered, fractured material. All the other images display a highly cratered surface surrounded by smooth plains (not so smooth at MOC resolution). Obviously, the interpretations at Viking resolution are mistaken, and these units are not consistent with a depositional origin, but are the opposite: windows through the plains units into some of the oldest terrain on Mars.

As noted in prior work, “these deposits [sic] are not simply the remnants of once more extensive airfall deposits since they are preferentially located in the central parts of drainage basins and in some cases within craters that would favor interior drainage” [5]. The comment on the geologic setting of these units remains accurate; although the interpretation is wrong. In both highland quadrangles studied, these exposures are typically located up against one side of a degraded crater, whose rims are embayed by the surrounding plains. Exposures not related to crater rims are in areas of plains with lobate or linear markings - possible flow fronts or fracture trends. Of the four exposures where we have derived boresighted MOLA profiles, all show that the exposures are in regional low areas of the plains, although the highly cratered and ridged terrain may protrude 40-80 m above the average level of the surrounding plains.

The old terrain within these exposures has a range from distinct craters at saturation in the 200-500 m diameter range to larger, more degraded curved crater rims that cut through images at MOC resolution, yet are not apparent in Viking or MOC context images. In some of these exposures, craters are sparse, and linear to curvilinear sharp-appearing ridges represent the highest topographic features. Others display no distinct ridges per se, but do have linear, positive-relief trends a few 10’s of meters wide that criss-cross the surface. These features may be dikes (clastic or intrusive volcanic?) reflecting a fracture system in the older terrain. The patterns are not apparent on lower resolution images, and do not appear in the surrounding plains.

These exposures are located within craters and other low areas, so presumably there had to be an episode of crater fill during the early Noachian high impact crater flux that formed the substrate. In addition, there is no obvious evidence of terminal volcanic flow lobes at the contact of the plains with the cratered exposures. Given their geologic and topog-
Fig. 1. Context and MOC image (M02 03372) at 11°W, 15.8°S of highland plains and exposed cratered terrain in the Margaritifer Sinus quadrangle.

with the occurrence of linear fractures and sharp dike-like ridges, the interpretation of sedimentary plains within the martian highlands is not yet confirmed.

Exposures of these materials within the highlands have several implications, a) where we look for aqueous “deposits” [5,6,7] may now be suspect in light of the recognition of these old cratered units as well as other evidence for ancient terrain [8], and b) the highly cratered terrain that makes up these exposures may be some of the oldest volcanic or impact generated debris on the planet not in situ. If the underlying terrain is volcanic, it would extend internal heating models of Mars back to the mid (or early?) Noachian. These areas would be fascinating landing sites to explore both the early history and plains formation episodes of Mars.

Fig. 2. Context and MOC image (M02 04772) at 9.9°W, 17°S with cratered remnants of terrain underlying the highland plains.