THE BARCHAN-SHAPED DEPRESSIONS OF THE EQUATORIAL DEPOSITS OF MARS.

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Introduction: The equatorial deposits (Fig. 1), which includes the Eumenides Dorsum formation, may contain possible ice-rich remnants as they are marked by pits and depressions that may be best explained by sublimation of ice [1, 2]. Some argue that the formations are aeolian or volcanic deposits such as ignimbrite in part because equatorial ice deposition seems improbable. However, there is significant latitude regarding the history of Mars climate and unimagined possibilities, which might include incidents and circumstances that can explain how equatorial ice deposition may have occurred. Importantly, the equatorial deposits are comprised of sub-deposits that may have varying origins and compositions and individual sub-deposits may or may not be composed of ice-rich materials.

Barchan Depressions: The equatorial deposits are marked by 100m-to-km scale barchan-shaped depressions (Fig. 2), hereafter barchan depressions, that may be best explained by sublimation and could be indicators of the presence of ice up to at least some 10's to 100's of meters depth. Deposits of ice-rich material may erode or ablate somewhat differently than ice-poor material because water may be removed by melting or sublimation. These additional mechanisms of ablation may be reflected in the geomorphology of remnant landforms that may display pits and larger depressions. With barchan depressions, wind and sublimation are likely most important. This is assuming the nose of the barchan points into the wind by the usual aerodynamic logic, and because it may not be reasonable that all material was removed by wind and that sublimation can presumably explain the lost material.

Ice near concave features may experience enhanced ablation where cracks in collapsing mantle crust expose or reduce the cover over deeper ice. It may be that the steeper slopes of barchan depression walls experience enhanced exposure through slope processes and that non-volatiles are moved and shifted by the prevailing winds. However, while much of the nonvolatile components may be reworked by the wind on the floors of the barchan depressions, some material may be removed by accelerated winds channeled by the outer and central wall or rise of the barchan depression. Naturally, finer material would be more easily removed, while coarser grains would remain.

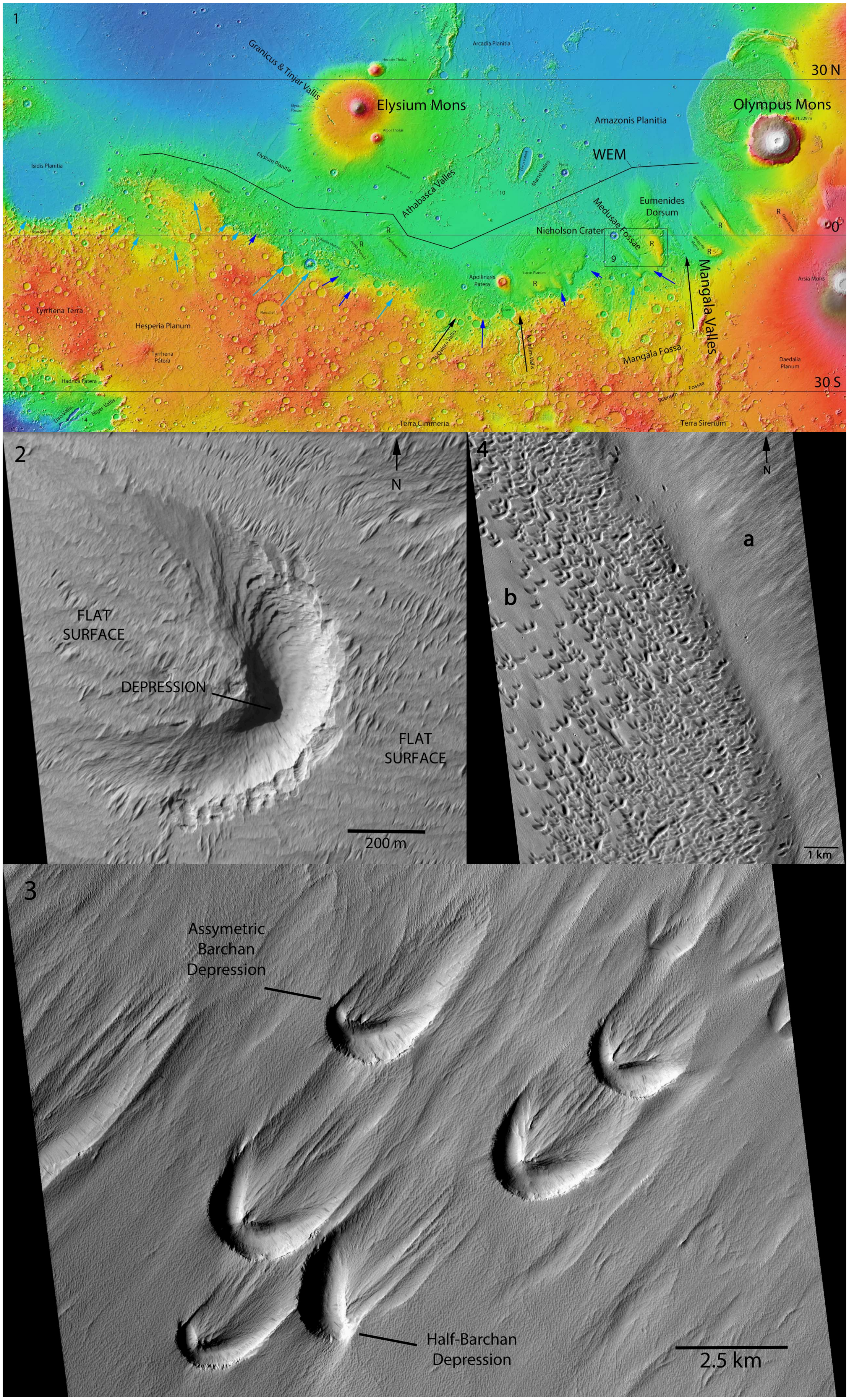
Barchan depressions are common across some sections of the equatorial deposits, while they are absent in other areas. They are oriented in a range of directions but usually develop in groups, all showing similar orientations that may indicate the preferred wind direction. Although barchan depression orientations vary widely, they are usually oriented in particular directions on a given sub-deposit, which suggests that the prevailing winds were different during the periods when the majority of the ablation occurred. Additionally, some groups of barchan depressions on steep slopes at deposit margins are oriented upslope, suggesting the possibility that the deposits may have generated sustained downslope winds at some locations, as with ice caps.

The frequency of barchan depressions in a given area ranges from none to what could be described as saturation (Fig. 2-4). Indeed, the possible ablation seen in Figure 4 has advanced to the degree that an actual terrain has been generated based on barchan depression fragments. Elongation of barchan depressions also occurs (Fig. 3), which suggests that time or conditions resulted in enhanced ablation. In some locations, one side of the barchan has developed to a greater degree to produce asymmetric barchan depressions, including half-barchans depressions (Fig. 3). In some cases, the barchan depressions are more V-shaped or fan-shaped. Not all similar depressions may be classified as differently developed barchan depressions, but many seem related in form and origin. All these types may perhaps differentially form in response to compositional, atmospheric, or orbital variations.

Conclusions: Although it is clear that there is a strong wind element in barchan depression formation, it may be unlikely that all material within these depressions were removed by wind erosion because depressions naturally trap material. Sublimation or melting of ice within the deposit could account for the lost volume. Barchan depressions may be unique in that they are depressions that may have formed by a mechanism other than volcanic, meteoric, isostatic, or structural faulting or collapse. It could be argued that the concave barchan-shaped features found on the equatorial deposits could have only formed through wind-associated sublimation. Further, the equatorial deposits may be partially composed of ice, with the presence of barchan depressions indicating the local presence of ice.

References: [1] J.D. (2012) Comp. Clim. Ter. Pl. Abstract, 8001. [2] DOI 10.13140/RG.2.2.30127.36004.

Figure (page 2): 1: Map view. (R) indicates the equatorial deposits. MOLA. 2: A barchan depression on the western flank of the Nicholson deposit. HiRise: ESP_016874_1800_RED. 3: Well-formed, asymmetric, and a half-barchan depressions. CTX: B16_015977_1792_XN_00S156W. 4: One sub-deposit (b) shows a very high concentration of barchan depressions to the point that a distinct terrain has been generated in some places. CTX: G03_019234_1781_XN_01S157W.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Granicus & Tinjar Valles
Arcadia Planitia
30 N
Elysium Mons
Olympus Mons
Amazonis Planitia
Isidis Planitia
WEM
Athabasca Valles
Eumenides
Dorsum
Nicholson Crater
Medusae Fossae
0°
9
Mangala Valles
Tyrrhena Terra
Hesperia Planum
Mangala Fossa
30 S
Terra Cimmeria
Terra Sirenum
2
N
FLAT
SURFACE
DEPRESSION
FLAT
SURFACE
200 m
4
N
a
b
1 km
3
Assymetric
Barchan
Depression
Half-Barchan
Depression
2.5 km