THE NEW MARS OF MGS MOC: RIDGED LAYERED GEOLOGIC UNITS (THEY'RE NOT DUNES).

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Synopsis: Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) high resolution images (1.4–15 m/pixel) reveal a planet often unlike anything ever seen. Some features are familiar to our Earth-trained eyes, such as windblown dunes, but other features defy ready explanation. One class of landforms that has emerged as being rather important are geologic units consisting of fields of closely-spaced ridges that, at first glance, seem to resemble small eolian bedforms but in fact are not. These ridges are not yardangs (formed by wind erosion), either. Their relative importance is underscored by the fact that some correspond with the hematite surface identified by the MGS Thermal Emission Spectrometer (TES) team in Terra Meridiani, and by their relevance to difficulties in finding future sites for Mars Surveyor landers. The ridged units generally appear to be indurated if not completely lithified. This paper represents our first attempt to put into words the characteristics and occurrences of these ridged forms. It is possible that different ridged surfaces have been generated by different processes; it is also possible that they require materials of similar physical properties.

Descriptions: Most of the ridged units in question are found in the equatorial latitudes of Mars. They are nearly always exposed as an upper layer in a layered sequence of 2 or more materials. Many examples have lower albedos than surrounding terrain, although this is not always the case. Ridges are nearly always closely-spaced (a few 10s of meters, at most) and apparent ridge heights (or groove depths) are generally equal from one to the next. Figure 1 shows a range of examples. Fig. 1a is a representative example from the unit within Terra Meridiani mapped by MGS TES as having abundant hematite. We find that the ridge-forming unit corresponds exactly with the hematite surfaces, although in some MOC images the material appears to have only incipient ridges/grooves. The strongest TES hematite signatures seem to correspond to the largest ridges/widest grooves, suggesting that the hematite abundance is connected to the state to which ridge/groove formation has progressed. Fig. 1a shows that the ridged material is confined to a specific layer that in this case is topographically and stratigraphically higher than an intermediate-toned layer which overlies a darker, smooth layer (down center of 1a). Fig. 1b (top) shows a ridged unit in Ius Chasma, again illustrating that the ridges are confined to specific geologic units (dunes would cross geologic contacts). Fig. 1c shows a crater being exhumed from beneath a layer that has been eroded to a ridged form—dunes would deflect around the crater whereas these ridges pass through it. Figs. 1d and 1e show craters superposed on a ridged unit, again indicating the hard, rock-like (rather than loose sand) character of the ridged material. Fig. 1f shows remnants of a dark layer (expressed as a ridged unit) that has been stripped from a brighter substrate on the plain SW of Nirgal Vallis. Fig. 1g shows a case in Schiaparelli Basin where large dark ridges may owe their form to the brighter, underlying unit. Taken together, Figs. 1a-g establish the rock-like nature of ridged units in a variety of martian locales and contrasts these ridges from eolian bedforms. They are also unlike eolian yardangs, which would show classic "inverted boat hull" morphologies rather than the sharp-crested, nearly symmetric appearance of this particular type of ridged unit.

Discussion: The ridged units appear to be an erosional form. They appear to be confined to specific layers exposed at or near the martian surface. Some of them occur in the cap rock atop large mesas like those in Ophir and central Candor chasms. Some occur in dark mesa-forming units (Fig. 1j). Some appear to owe their form to an underlying ridged unit (Fig. 1g), but most do not. In many cases, ridges are parallel to or radial to local slopes (*e.g.,* buttes, buried craters). Sometimes there are superposed layers that are smooth and/or have formed mesas and buttes, indicating that some of the ridged units were formerly buried. Whatever process brought these layers to the martian surface, something about their physical properties when exposed to the surface environment has caused them to form ridged/grooved patterns. Perhaps something is removed via deflation or sublimation, as might be the case for a possible analog surface on the south polar residual cap (Fig. 1h). This type of surface is extremely rare on the polar caps, however, and its origin is likewise unknown. A mesa in Melas Chasma may shed some light on the evolution of these terrains (Figs. 1i-j). Note that the scene in 1i-j is illuminated from the upper left, thus the linear features on the mesa top are grooves and pits. The mesa appears to be developing grooves that are spaced and aligned in a manner similar to the ridges on the surrounding plain. Perhaps this mesa is in an early state progression toward the type of ridged surfaces seen elsewhere in Fig. 1j and 1a-g.

Figure 1: Examples, characteristics, and configurations of ridged, eroded units. Figs. are subframes of the MOC images indicated, north is toward upper right and illumination from left except where noted, latitude and longitude are approximate. **(A)** Ridged upper layers corresponding to TES hematite unit, M04-03468, 3.6°S, 2.7°W. **(B)** Ridged unit (top) in Ius Chasma, M02-01296, 8.0°S, 78.9°W. **(C)** Ridges in relation to partly-exhumed crater in Schiaparelli Basin, M02-03362, 2.4°S, 344.0°W. **(D, E)** Ridges in relation to superposed craters, Candor Mensa, M02-02913, 6.1°S,

23.8°W. **(F)** Dark, ridged remnants on bright substrate SW of Nirgal Vallis, M10-00406, 28.4°S, 47.9°W. **(G)** Ridge texture possibly imposed by subjacent unit, Schiaparelli Basin, M00-02181, 1.1°S, 346.1°W. **(H)** Possible analog on south polar residual cap, illumination from lower right and north toward bottom, M08-01792, 86.3°S, 57.5°W. **(I)** Expanded view of grooves developed in mesa shown in **(J)**, which is grooved/pitted mesa surrounded by ridges in Melas Chasma, FHA-01277, 8.8°S, 76.9°W. Box shows location of Fig. 1i.