MGS MOC VIEW OF THE MARTIAN NORTHERN PLAINS. K. S. Edgett and M. C. Malin, Malin Space Science Systems, P.O. Box 910148, San Diego, CA 92191-0148, USA.

Synopsis: Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) images suggest that partly-exposed impact craters of sizes generally <3 km are ubiquitous within the northern plains. In places, the apparent buried crater population resembles that of the more heavily cratered southern highlands at the same scale, although, of course, without the larger craters seen in the south. Boulders are found on the northern plains and in many cases appear to have worked their way to the surface where craters are shallowly buried. The general impression is that the northern plains are only thinly-covered (less than a few 100 m in many places) by material that has locally-expressed layering and is everywhere modified by eolian and/or periglacial processes. In our analysis we have found no clearly volcanic features and no obviously marine or lacustrine landforms on the northern plains.

Background: Although most of the martian northern lowland plains are named the "Vastitas Borealis," they should perhaps have been called "Terra Incognita" instead. Most Mariner 9 and Viking orbiter attempts to image this region were obscured by haze, clouds, or complicated by seasonal frosts. After these missions, Scott and Underwood [1] still found it appropriate to describe the northern plains as "the most ambiguous materials on [sic] all martian images." Most geologic or geomorphic contacts between northern plains surfaces are dashed in the regional map by Tanaka and Scott [2], which is also a reflection of the lack of useful information about these plains. Mariner 9 views showed mottled surfaces in which bright features tended to be craters [3]. Many of the craters seemed to stand above surrounding terrain, earning them the name "pedestal crater" and suggestive of eolian deflation. Despite the occurrence of impact craters, relative to the southern highlands the northern plains were seen as lightly cratered and thus considerably younger than the highlands. Viking images were used by some to propose that the northern plains had once been the site of oceans, seas, and/or glaciers [*e.g.,* 4–5]. Recent Mars Orbiter Laser Altimeter (MOLA) data indicate that the northern plains are relatively flat [6] and some researchers suggest there might be topographic evidence that the region was once the site of an ocean [7].

MGS MOC Images: New images of the northern plains typically have spatial resolutions in the range 1.5 to 15 m/pixel. Hundreds of pictures typically 3 km wide by 18 km long have been taken in 1998 and 1999; many are hazy or somewhat obscured by clouds, but those taken during L_s 100°–160° (Mar.–Jun. 1999) and L_s 240°–270° (Nov.–Dec. 1999) are generally cloud-free and show the surface geomorphology well.

The most striking aspect of the northern plains as seen in MOC images is the impression that there is a surface very similar to that of the southern cratered highlands located "just beneath" the plains surface. In some locations, especially around 48°N, 230°W, in Utopia, there are so many craters evident beneath the thin plains covering that the surface resembles that of many southern highland surfaces at the same scale (Fig. 1). The plains surface material is often thin enough that boulders on buried crater rims and ejecta deposits have worked their way to the surface or were never completely covered (Figs. 2, 3), and sometimes the full crater ejecta morphology can be easily distinguished through this material (Fig. 4). While the northern plains appear to be smooth at the kilometer and 100s of meter scales accessible to the MOLA [*e.g.,* 6, 7], at the meter scale visible to MOC the plains are anything but smooth. Buried topography associated with impact craters and bouldery knobs (Fig. 5) dominate the region. Periglacial processes appear to have modified the upper plains surfaces in many regions, including small polygons observed in the vicinity of the Viking 2 lander site, extremely large polygons on the floors of some craters (Fig. 6), and bumpy and ridged textures that resemble the surfaces of basketballs (Fig. 5) and corduroy fabric at the highest latitudes. In some places, surfaces are pitted, in others they are boulder-strewn. The bouldery surfaces suggest that materials covering the northern plains are not particularly thick—the bedrock is not too deeply buried.

Direction of Future Work: The hundreds of MOC images that sample the martian northern plains will be examined and placed carefully into context. The landforms present are a mixture of the familiar (polygons and impact craters) and the strange (*e.g.,* rugged, pitted surfaces and boulder-covered mounds surrounded by apparently sloughed material). All images acquired to test hypotheses that the northern plains were once the site of oceans, seas, or glaciers have provided negative—if not ambiguous–results [*e.g.,* 8]. Ideally, new images of some resolution intermediate between that obtained by MOC and Viking/Mariner (*e.g.,* as may be possible with the Mars Surveyor 2001 Orbiter with the THEMIS 20 m/pixel visible camera) should be acquired for the entire region when it is cloud- and frost-free in order to provide context for the MOC data and allow regional-scale geomorphic study.

References: [1] Scott and Underwood (1991) *Proc. LPSC, 21*, 627-634. [2] Tanaka and Scott (1987) USGS Map I-1802C. [3] Soderblom et al. (1973) *JGR, 78*, 4197-4210. [4] Parker et al. (1993) *JGR, 98*, 11061-11078. [5] Kargel et al. (1995) *JGR, 100*, 5351-5368. [6] Aharonson et al. (1998) GRL, 25, 4413-4416. [7] Head et al. (1999) *Science, 286*, 2134-2137. [8] Malin and Edgett (1999) *GRL, 26*, 3049-3052.

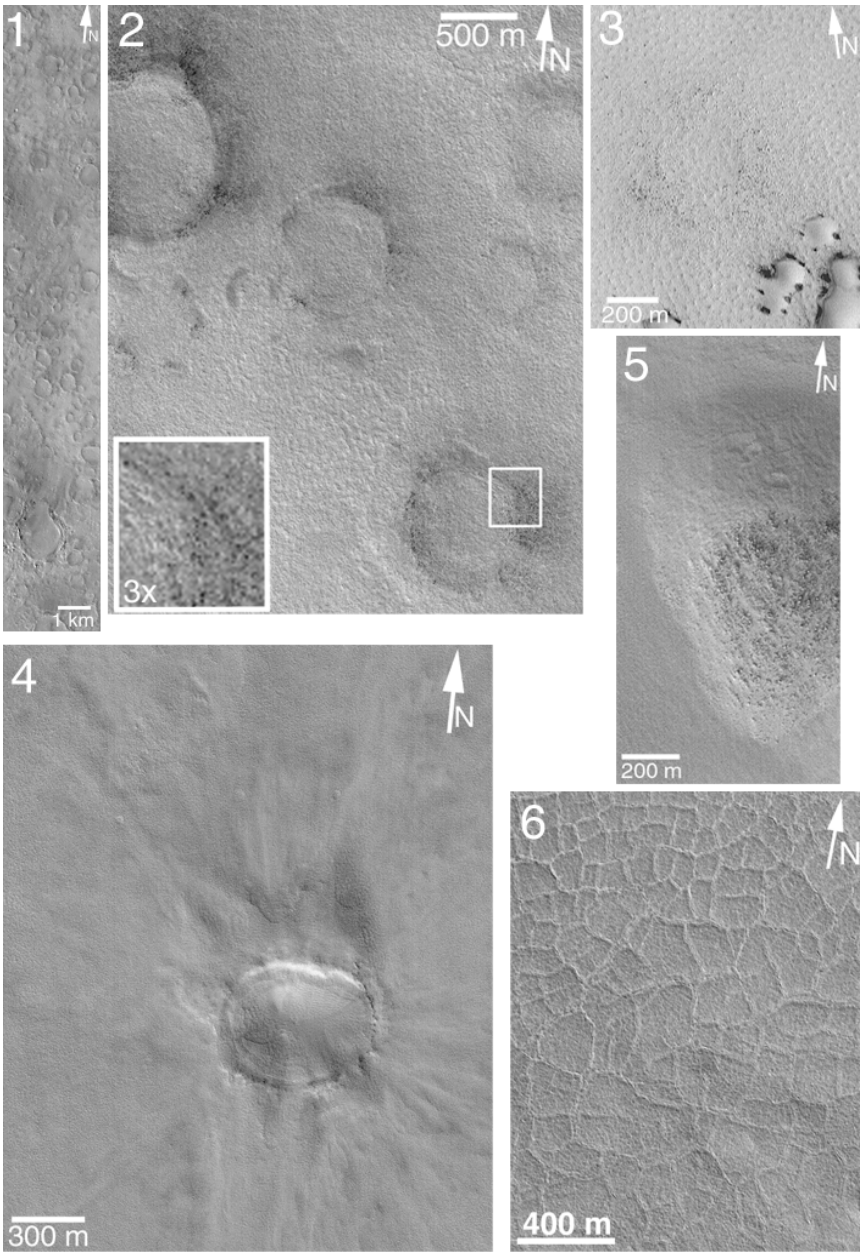

Figure 1. Beneath the northern plains may be a heavily cratered surface. This 3 by 19 km strip in Utopia Planitia shows a surface of many thinly-covered craters. MGS MOC image M02-04189 near 48.0°N, 228.1°W.

Figure 2. Buried and partly buried craters on the northern plains often exhibit small dark spots on their rims and sometimes in the location of their ejecta. These are interpreted to be boulders that have perhaps worked their way to the surface and/or been otherwise exposed through the relatively thin northern plains surface covering. Subframe of MOC image M03-04941 near 68.2°N, 257.9°W.

Figure 3. Rings of dark boulders (center/left) indicating the presence of a buried impact crater near 72.8°N, 7.8°W. Compare with Fig. 2. Here, the crater is more completely buried than those in Fig. 2. Also note basketball-like texture created by numerous, evenly-spaced mounds. Subframe of SP2-53408.

Figure 4. Thinly-buried impact crater and its rayed ejecta deposit near 47.2°N, 227.8°W in Utopia. Subframe of M09-05353.

Figure 5. Example of bouldery knob protruding from northern plains. Boulder surface is only partly exposed (on south side). Note no coastal landforms are evident. Subframe of M09-00978 at 50.3°N, 194.0°W.

Figure 6. Large polygons indicative of ground ice on floor of northern plains crater at 67.5°N, 312.5°W. Subframe of M01-00294.