THE NATURE OF LAYERED OUTCROP EXPRESSION IN THE MARTIAN POLAR LAYERED TERRAINS. M. C. Malin and K. S. Edgett, Malin Space Science Systems, P.O. Box 910148, San Diego, CA 92191-0148, USA.

Synopsis: Outcrops within the polar layered terrains differ radically between the two martian polar regions. Layers in the south are most commonly expressed as cliff-bench topography; those in the north have ridged-and-grooved relief. Differences may be related to the nature of the permanent ice caps.

Observations: The Mars Orbiter Camera (MOC) aboard the Mars Global Surveyor (MGS) spacecraft has provided substantial new information about the nature of layered outcrops within the martian polar layered terrains. Hundreds of images with scales of better than 10 m/pixel of both polar layered terrains have been acquired during spring, summer, and fall conditions.

Layers are expressed in two types of outcrops in the layered terrains: outcrops within the regions of the permanent ice caps (often occurring as broad channels with asymmetric transverse sections or monoclinal escarpments), and outcrops away from the permanent caps. Layered escarpments in the south polar region display a characteristic stair-stepped appearance with steep, narrow risers separated by broad flats (Figure 1). Escarpments in the north show little or no evidence of the stair-stepped relief. Rather, groups of layers stand out together as ridges or troughs (Figures 2 and 3), with the individual layers expressed geomorphically either as albedo patterns or as differences in texture associated with pits and knobs only a few tens of meters across. In the north, only equatorward facing slopes show such features. Those facing poleward are usually smooth and featureless.

The north-south difference between layered outcrops is quite dramatic. Much of the north polar layered terrain occurs within the boundaries of the residual cap, and stair-stepped expression is extremely rare. In the south, only a small portion of the area of layered terrain is covered by perennial ice; the ridged-and-troughed morphology is much less common. Although other features sometimes obscure the detailed morphology of layers in outcrops within the south polar cap, for the most part stair-steps remain visible.

Interpretations and Speculations: There is no clear reason why a hemispheric difference between layered outcrop expression should exist. Several alternative explanations can be posited:

1) the composition of the layers may be different;
2) the mechanism by which the layers are formed may be different;
3) the mechanism by which the layers are exposed may be different;
4) the environments under which (2) and (3) may occur are different.

Discussion: One possibility is that the composition of the two polar deposits are different. The pitting, banding and sensitivity to solar orientation seen in the north may reflect a higher volatile content, while the ability to maintain steep risers with little accumulation of debris on the subjacent flats might suggest less volatile materials within the southern unit.

The number and thickness of layers seen in the south is different from that inferred from the bands, ridges and pits seen in the north. There appear to be more, smaller layers in the south and fewer, often appreciably thicker, layers in the north. It may be that such differences represent a different mechanism of formation--for example, materials may be metamorphosed in one polar region but not the other.

Even if compositional differences in and of themselves might not lead to the type of morphological differences seen, the way they respond to the erosional processes may. For example, variations in the durations of seasons, and the amount of isolation received during the seasons, may manifest themselves in enhanced or retarded erosion.

Directions for Future Research: The very presence of layered materials in the martian polar regions means that something changes. It is not clear whether the layers represent compositional variations, changes in the environment of deposition, or periods of erosion. To this mystery must now be added the hemispheric differences in the expression of the layers. Is there any way to determine what's going on? Careful correlation of relief relationships within the deposits with morphology may provide some clues. The search for additional variations in expression may also lead to new insights. Ultimately, it may be particularly difficult to solve these mysteries without detailed, *in situ* observations of the type that can only be performed by skilled field scientists.

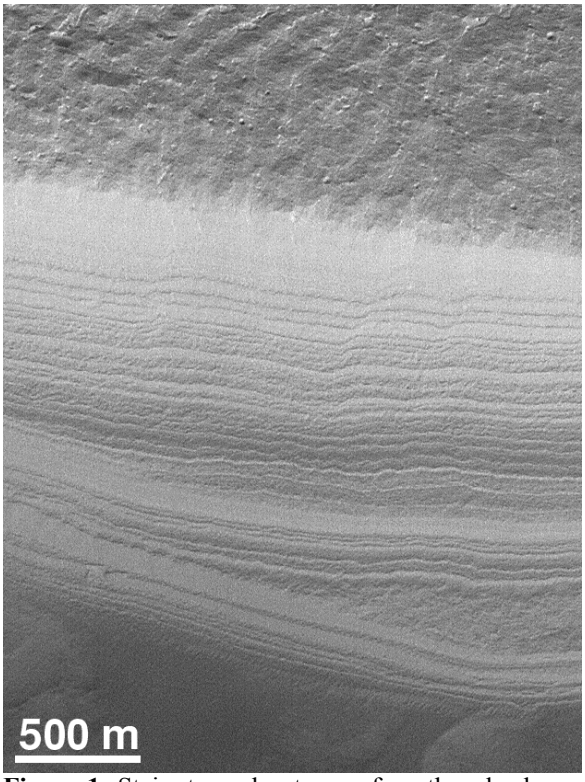

Figure 1. Stair-stepped outcrop of south polar layered terrain in an area outside the perimeter of the residual cap. Subframe of MOC image M07-05953, near 72.1°S, 217.3°W.

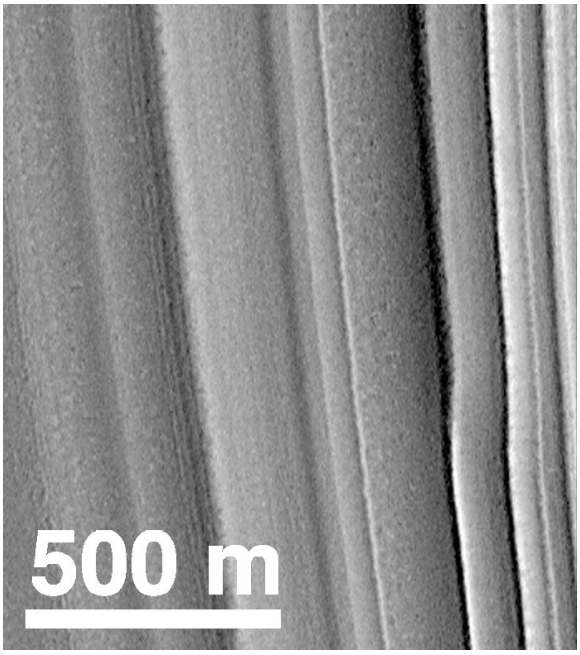

Figure 2. North polar layers expressed as series of ridges and troughs. Illumination from right. Subframe of MOC image SP2-52406, near 86.3°N, 199.0°W.

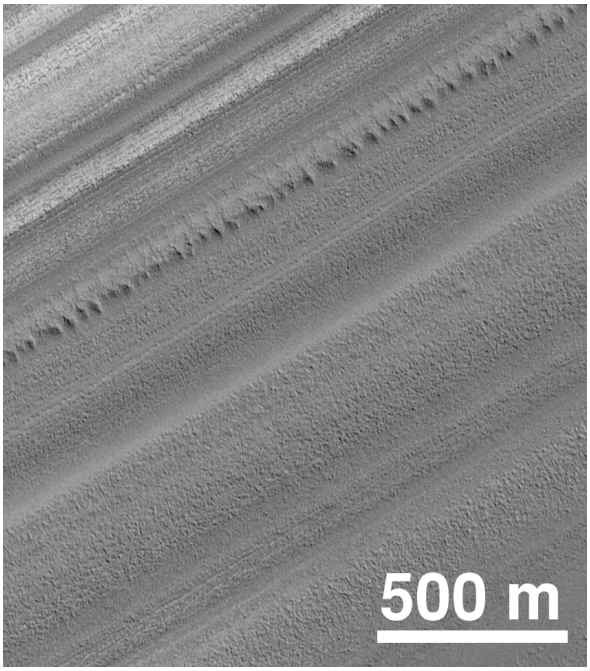

Figure 3. North polar layered escarpment within the perimeter of the residual cap, showing that layers are expressed as ridges, troughs, aligned pits, knobs, and albedo patterns with only rare resistant layers showing stair-stepped relief. Subframe of MOC image M00-02100 near 86.4°N, 278.7°W.