THE MARTIAN NORTH POLAR CAP: SEDIMENTARY ASPECTS. K. S. Edgett and M. C. Malin, Malin Space Science Systems, P. O. Box 910148, San Diego CA 92191-0148, USA.

Synopsis: The polar layered terrains of Mars exhibit many of the characteristics common to sedimentary rocks and deposits on Earth, including groups of similar beds (*i.e.*, 'formations'), continuity of beds over 100s of kilometers distance, beds of differing thickness and resistance to erosion, deformed beds, and erosional unconformities. Many of these features are readily apparent in the north polar cap, the subject of this brief report, in 1.5–12 m/pixel images acquired by the Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) in the past 2 years. The sedimentary and stratigraphic properties described here attest to the presence of a complex geologic record that, with adequate field work, could one day be deciphered.

Introduction: 'Laminated terrain' or 'polar layered deposits' have been known since the Mariner 9 mission. The layered nature of the polar material led to immediate speculation that these units are a type of sedimentary deposit, most likely a mixture of silicates (largely in the form of dust settled from atmospheric suspension) and, owing to their presence near the poles, ice. The layered expression was interpreted to indicate that a record of past climate change is present, as changes in the depositional environment, processes, and/or materials would lead to changes in bedding style and properties. The apparent similar thickness and repeatability of layers visible in Mariner 9 and Viking orbiter images suggested that these might be the result of climate-induced control on a cyclic or episodic basis. Here we report on new observations regarding the sedimentological character of polar layers; earlier MOC images and discussions were described in [1].

Data: MGS has been orbiting Mars since September 1997. Because of the spacecraft aerobraking schedule and seasonal darkness (*i.e*, winter), the north polar region has only been adequately viewed by MOC in July–September 1998 and March–August 1999. The focus here is upon the properties of layers exposed in the broad, shallow slopes of troughs or 'dark lanes' within the Planum Boreum (residual north polar cap). MOC has viewed these surfaces from orbit in a nadir-pointed orientation, thus each image represents a vantage point "looking straight down" upon a banded slope in the north polar terrain.

More Beds; Beds of Differing Properties; and Unconformable Beds: Figure 1 shows a slope in a north polar trough that has dozens of layers and groups of layers of differing thickness and resistance to erosion. Layers that form ridges are more resistant than those that are recessed. The layers in Fig. 1 include a set in the upper 1/4 of the image that appears to pinch-out from left to right, perhaps representing the location of an erosional unconformity. As was suspected before the MGS mission, MOC images reveal that there are many more—and thinner—beds than were visible in Viking and Mariner 9 orbiter images. This observation suggests that there could be even thinner beds, down to scales of centimeters or less, and that such beds would be accessible to landed spacecraft.

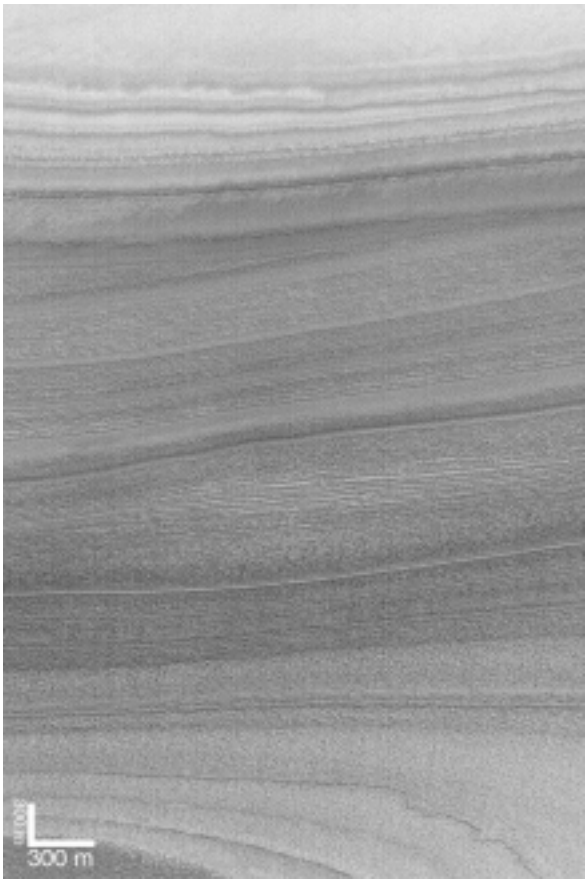

Figure 1. North polar layer outcrop. Sub-frame of MOC image M02-04374, near 81.1°N, 287.4°W, illuminated from top/upper right, acquired 27 June 1999.

Stratigraphy and Continuity: Individual beds within the north polar cap can be traced over distances greater than 100 km, and whole groupings of beds—perhaps better described as geologic 'formations'—can be traced over 100s of kilometers, as well. Figure 2 shows three views of the walls of a single trough; each image is spaced 10s of km from the other, yet many beds can be seen to be continuous over this distance. The feature labeled "MB" in Fig. 2 is a

marker bed that is also found in other troughs throughout the north polar region and will perhaps be useful in the stratigraphic correlation efforts that are just beginning. Figure 3 also exhibits the promise of stratigraphic studies in the north polar region. The two images in Fig. 3 are located on escarpments located ~280 km apart in different polar troughs, yet they have the same stratigraphic sequence including a slightly jumbled, platy, dark terraced unit overlain by a lighter-toned, thick, flat-lying, evenly-bedded unit. The contact between the two units might be an unconformity.

Deformed Beds: Several examples of folded or otherwise deformed beds have been identified in the north polar strata; Fig. 4 provides one example, others were shown in [1]. The folded beds in this case might represent soft-sediment deformation rather than a tectonic process, because they are bounded above and below by more regular, horizontal beds with no apparent unconformity between them.

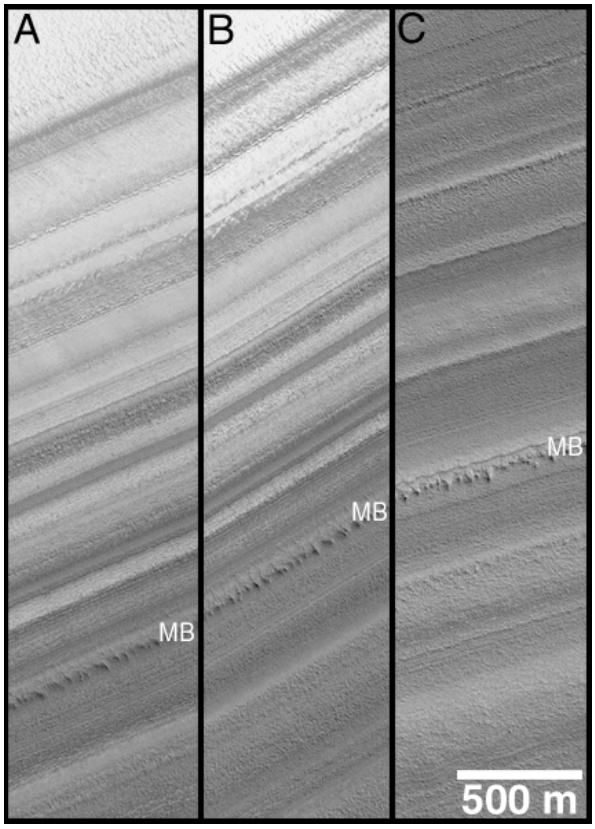

Figure 2. Continuity of polar layers over >100 km distance. Sub-frames of MOC images (A) M00-01754 near 86.5°N, 281.5°W, (B) M00-02100 near 86.4°N, 278.7°W, and (C) M00-02072 near 85.9°N, 257.9°W. All illuminated from the upper right, all acquired in April 1999.

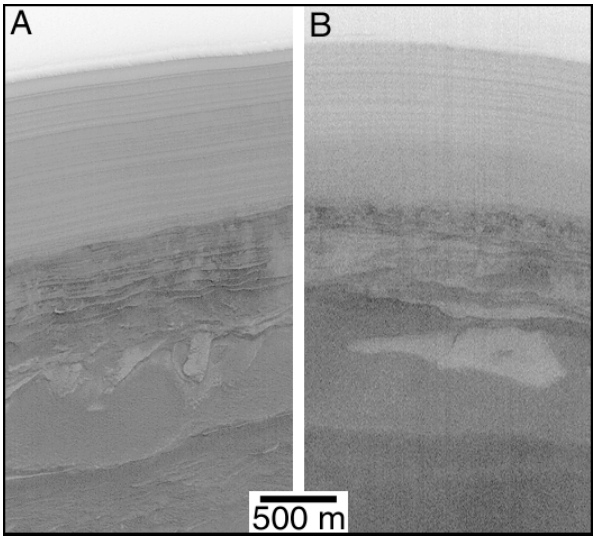

Figure 3. North polar stratigraphy. Ice (top) is underlain in both cases by a sequence of light-toned, horizontally-bedded material, which itself is underlain by a darker, platy layered unit. The images are located ~280 km from each other on two different escarpments. (A) Sub-frame of M02-01676 near 85.4°N, 167.9°W, illuminated from the right, 14 June 1999. (B) Sub-frame of M03-04769 near 85.0°N, 357.7°W, illuminated from top/upper right, 24 July 1999. Both scenes are partly obscured by late-summer haze.

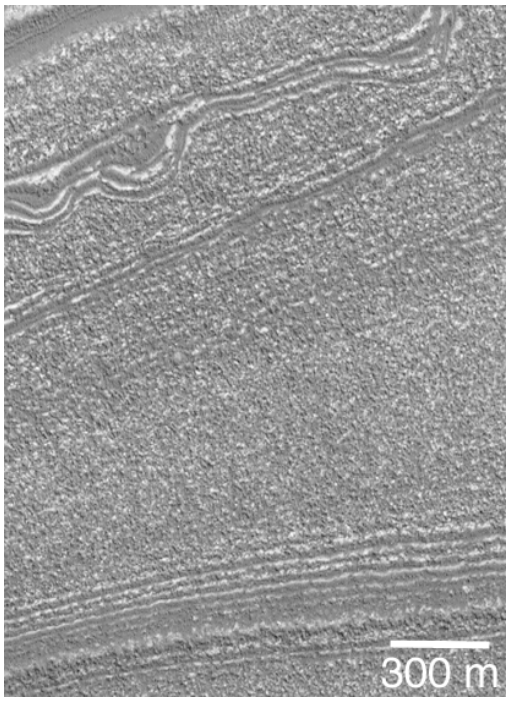

Figure 4. Deformed beds in a north polar trough slope (upper 1/4 of image). Sub-frame of M00-01925 near 81.4°N, 273.1°W, illuminated from the upper right, 12 April 1999.

Reference: [1] Edgett K. S. and Malin M. C. (2000) *LPS XXXI*, abstract #1068.