THE NORTH POLAR LAYERED TERRAIN ON MARS: A VERY YOUNG SURFACE; K. E. Herkenhoff, S. A. Nowicki, and J. J. Plaut, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109-8099, Augustana College, Rock Island, IL 61201-2296.

The Martian polar layered deposits are probably the best source of information about the recent climate history of Mars [1-8], but their origin and the mechanisms of accumulation are still a mystery [9]. The polar layers are sedimentary deposits that most planetary scientists believe are composed of water ice and varying amounts of wind-blown dust [3-5], but their composition is poorly constrained [10]. Interpretation of the observed polar stratigraphy in terms of global climate changes is complicated by the significant difference in surface ages between the north and south polar layered terrains inferred from crater statistics. While no craters have been found in the north polar layered terrain, the surface of the south polar layered deposits appears to have been stable for many of the orbital/axial cycles that are thought to have induced global climate changes on Mars. Further studies of the polar layered deposits should ultimately lead to a better understanding of the climate history of Mars.

Using medium-resolution Viking imagery, Plaut et al. [8] found at least 15 impact craters in the southern layered deposits and concluded that their surface is at least 120 million years old. In contrast, Cutts et al. [2] found no fresh impact craters larger than about 300 meters in summertime images of the north polar layered deposits. Instead of using summertime images, in which differences in surface albedo are difficult to differentiate from shadows cast by topographic features, we studied springtime images. These images show a surface that was covered by a thin blanket of carbon dioxide frost. This effectively removes the albedo differences and makes topographic features like impact craters stand out, as shown in Fig. 1, where impact crater scarps that were obvious in the spring image cannot be seen in the summer image. We found no impact craters on the north polar layered deposits or ice cap. The images studied cover 77% of the layered deposits and ice cap, with resolutions from 20 to 90 meters per pixel. The uniform seasonal frost coverage, clear atmospheric conditions, and excellent resolution of these springtime images make them an ideal dataset for constraining the surface age of the north polar layered deposits. This work is ongoing, but it is clear that the surface of the north polar layered deposits is much younger than that of the south polar layered deposits. Hence, erosional and/or depositional processes have been more active recently in the north polar region than in the south. The greater extent of aeolian erosional features in the south polar layered terrain may be evidence that gradual erosive processes (such as aeolian abrasion) have been more important than rapid ice sublimation in the evolution of the south polar layered deposits. Furthermore, the inferred average surface age of the south polar layered deposits (at least $10^8$ years [8]) is much longer than the timescales of theoretical orbital/axial variations ($10^5$ to $10^6$ years [11]). At least some areas of the south polar layered terrain have therefore not been greatly modified by global climate changes over the last 100 million years or so. New orbital observations of the Martian polar regions from the Mars Global Surveyor and surface exploration by the Mars Volatiles and Climate Surveyor are likely to greatly enhance our understanding of the polar layered deposits and the climate changes that they record.
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Figure 1. Reduced section of USGS Controlled Photomosaic MTM 85040 (I-1834), showing part of Chasma Boreale, centered near 83°N, 46°W. Scale at bottom in kilometers. (a) Northern mid-summer mosaic, $L_s = 134^\circ$, resolution approximately 60 m/pixel. (b) Northern mid-spring mosaic, $L_s = 54^\circ$, resolution approximately 85 m/pixel.

REFERENCES: