WAXING AND WANING OF THE NORTH POLAR LAYERED DEPOSITS OF MARS. K. L. Tanaka, U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ 86001, USA, ktanaka@usgs.gov;

Introduction: New geologic mapping of the north polar region of Mars (>60°N; see Fig. 1 for locations of features in brackets { } in text) based mainly on Mars Orbiter Laser Altimeter (MOLA) and Mars Orbiter Camera (MOC) images reveals evidence showing potentially widespread growth and retreat of polar deposits during the Amazonian Period. This geologic record indicates that over this broad span of time, the stability and perhaps composition of polar deposits has been sensitive to changing climatic conditions brought on perhaps by obliquity variations and to the availability and abundance of volatiles and surficial fines (dust, silt, and sand).

Regional Geologic Setting: The Late Hesperian/Early Amazonian Vastitas Borealis Formation (VBF) [1] covers nearly the entire north polar region. New regional geologic mapping indicates that the unit most likely represents a terrain homogenized in surface morphology by periglacial reworking of outflow-channel sediments and other older materials [2]. Thus the lack of recognized, pre-Amazonian polar deposits may be a result of this reworking, or such deposits did not form. In either case, only the Amazonian record of north polar deposits appears to be preserved.

Early to Middle Amazonian polar deposits. MOC images and MOLA shaded-relief maps indicate a sequence of lower polar layered deposits (LPLD) in Planum Boreum that underlie the uncratered upper polar layered deposits (UPLD) [3-4]. The LPLD is characterized by what appears to be cross bedding in MOC images [3]. It is clearly superposed by two large impact craters (18 {a} and 24 km {b} rim diameters at 81.4 °N, 254.7 °E and 79.2 °N, 60.5 °E) whose ejecta blankets are visible, and by a 6-km crater {c} (82.3 °N., 290.5 °E.) that may be partly buried and/or degraded. Another indication that the LPLD is fairly old is that outcrops between 30-90 °E {e} have a subtle hummocky appearance in the 1/128° resolution MOLA shaded relief that is similar to that of the adjacent VBF surface. Presumably, the process that formed hummocky surface in the VBF operated on the LPLD at about the same time.

The LPLD approaches 1000 m in thickness west of the mouth of Chasma Boreale, where it forms an abrupt scarp {f}. This scarp apparently formed by extensive backwasting, and the unit likely extended southward across perhaps hundreds of kilometers of the adjacent plains.

Beyond Planum Boreum, mapped outcrops of material form either outliers of LPLD or perhaps polar deposits of different age and/or origin, as follows. (1) About 200 km south of Chasma Boreale, a 23-km-diameter crater {g} (77.0 °N., 304.8 °E.) rests on an isolated plateau about 600-700 m high that may be an outlier of the LPLD. (2) Another broad outlier of possible LPLD {h} occurs at 76-82 °N., 105-145 °E. A few small craters within this outcrop may be resting on LPLD or perhaps on the underlying VBF. (3) The dunes of Olympia Planitia form a thin layer resting above layered deposits [5]. Exposed outliers show a smooth, layered surface characteristic of LPLD. However, a well-preserved, 20-km crater {i} (81.7 °N., 190.0 °E) in the middle of Olympia Planitia is superposed on layered deposits; since craters are rare on the UPLD, the LPLD probably underlies this crater indicating that the UPLD is very thin in this region. (4) Scandia Colles {j} forms what appears to be a broad band of degraded deposits >1000 km across and 20 to 200 m thick roughly between Alba Patera and Olympia Planitia (<60-77 °N, 200-275 °E.). (5) Numerous small pedestal craters (several indicated by {k}) supposedly overlie blankets of material that have come and gone across the plains; perhaps these blankets include the LPLD. Most of the pedestals occur near the topographic divide between north polar and Utopia basins (60-75 °N, 60-110 °E.). These various outcrops suggest a potentially rich history of waxing and waning of polar deposits, but it remains unclear whether all of the outcrops are layered and were formed by true polar deposition.

Late Amazonian polar deposits. The upper layered deposits (UPLD) form the primary record of youthful, finely preserved layers as viewed in MOC images. The deposit may easily exceed 2000 m in thickness, if the underlying LPLD does not thicken underneath. The surface of UPLD appears generally smooth in the MOLA 1/128° DEM. Outliers of apparent LPLD occur >300 km south of the main, continuous Planum Boreum/Olympia Planitia UPLD as crater fill {K} (e.g., within 84-km diameter Korolev crater at 73 °N., 164 °E.) and as an irregular mound {m} at 74.5 °N., 98 °E.). Thus the UPLD apparently was at one time considerably more extensive than at present.

Figure 1. North polar region of Mars showing MOLA shaded-relief, color-scale elevation map. PB, Planum Boreum; CB, Chasma Boreale; OP, Olympia Planitia; AP, Alba Patera; K, Korolev crater. Locations referenced in text shown by letter symbols.