STRATIGRAPHIC DIVERSITY OF THE NORTH POLAR LAYERED BASAL DEPOSITS ON MARS. K. L. Tanaka[1], J. A. P. Rodriguez[2], J. A. Skinner, Jr.[1], C. M. Fortezzo[1, 3], and E. J. Kolb[4]. [1]U.S. Geological Survey, Flagstaff, AZ 86001, [2]U. Arizona, Tucson, AZ 85721, [2]Planetary Science Institute, Tucson, AZ, 857053, [3]Northern Arizona U., Flagstaff, AZ 86011, [4]Google, Inc., Mountain View, CA 94043.

Introduction:

The Mars north polar region (Fig. 1) has among the planet's densest coverage of released data from orbiting spacecraft. Thus, many new findings are being gleaned regarding its complex geologic history [e.g., 1-8]. Previous workers identified a single basal unit for Planum Boreum (PB) [1-4]. Our geologic mapping [9] reveals that the base of PB consists of **three** geomorphologically distinct geologic units. Stratigraphically from bottom to top these include: (1) the Rupes Tenuis (RT) unit, (2) the PB cavi unit (PBC), and (3) the Planum Boreum 1 unit (PB1) (see Fig. 2).

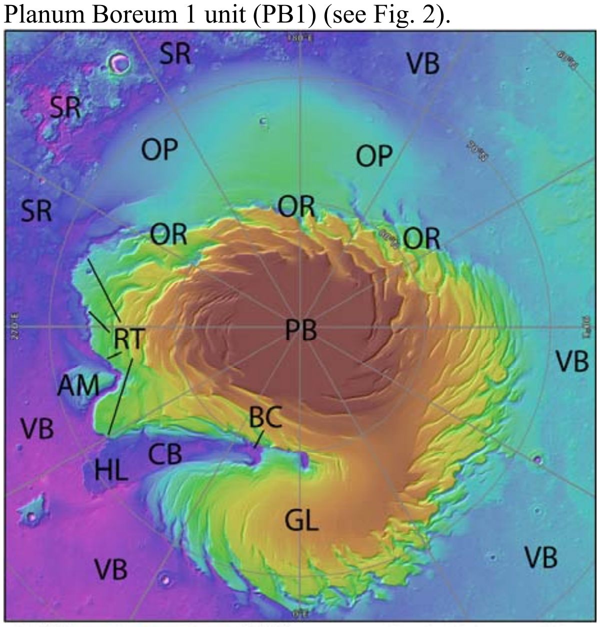

Fig. 1. North polar region of Mars showing locations of geographic features (abbreviated names; see text). (MOLA shaded-relief base; polar stereographic projection.)

Datasets. Our mapping includes consideration of the following datasets: (1) topography based on Mars Orbiter Laser Altimeter (MOLA) data; (2) images acquired by the Thermal Emission Imaging System (THEMIS) in the visual range (VIS), the Mars Orbiter Camera (MOC) at narrow-angle resolutions (NA), the Context Camera (CTX), and the High Resolution Imaging Experiment (HiRISE); (3) multispectral water-ice and mineral mapping obtained by Observatoire pour la Minéralogie, l'Eau, les Glaces, et l'Activité (OMEGA) and Compact Reconnaissance Imaging Spectrometer for Mars (CRISM); and (4) regional-scale color images from Mars Color Imager (MARCI).

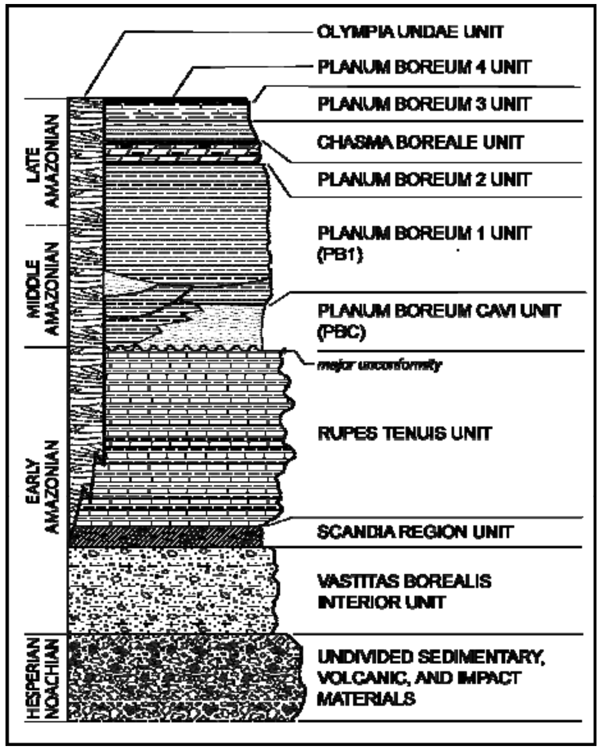

Fig. 2. Schematic stratigraphic column for the north polar region of Mars showing the interpreted vertical relationships of the mapped units (some units not discussed here; adapted from [9]). Relative thicknesses of units are only approximately shown; those of thinnest geologic units are exaggerated for emphasis. Note uncertain placement of the boundary between the Middle and Late Amazonian relative to PBC and PB1.

The Rupes Tenuis unit: The Rupes Tenuis (RT) unit makes up much of PB along the RT scarp (as much as 1000 m high) west of Chasma Boreale (CB) and the floor of CB, which includes the tongue-shaped, ~300-m-high plateau of Hyperborea Lingula (HL). In addition, the unit also appears to make up the base of Olympia Planum (OP).

The RT unit is deeply eroded but preferentially preserved beneath multi-kilometer-diameter impact craters and their ejecta. We find that the unit has a N(5) = 143±54 (cumulative no. craters >5 km diameter per 10^6 km^2) crater density. This corresponds to a middle Hesperian age, but the unit rests on the Early Amazonian Vastitas Borealis (VB) interior unit. Thus preferential preservation of the unit where covered by large craters may account for the increased N(5) value.

The RT unit consists of layers tens to ~100 m thick. Its origin may be related to the episodic coldtrapping of volatiles and fine lithic particles sourced from the nearby Early Amazonian Scandia region (SR) unit [3], which appears to be deeply eroded. The RT unit thus is likely Early Amazonian—perhaps ~1 to 3 billion years old [10].

How the RT unit's pedestal craters formed is not understood. Armoring by ejecta and aeolian erosion of surrounding material is one mechanism previously proposed for such landforms [e.g., 11]. We also suggest that the generation of thermal anomalies by large impact craters could lead to extensive heating and volatile migration focused on the periphery of impact craters. In turn, this activity could cause the precipitation of salts as matrix-forming cements in the RT unit in these zones, such that regional resurfacing events would preferentially erode out the uncemented peripheries of the larger impact craters.

The Planum Boreum cavi (PBC) and 1 (PB1) units: The PB cavi unit gets its name from the fact that its most prominent exposures occur in the cavi depressions along the margins of PB and Abalos Mensa (AM). PBC includes dark layers that may be sand rich. In fact, recent erosion of the unit appears to have led to the formation of dark dunes [1-3].

The unit's layering is locally even, uneven, and cross-bedded [1-3, 9, 12]. We also find that PBC is transgressive in Boreum Cavus (BC) with regularly-layered brighter sequences of PB1 (Fig. 3). In troughs above western Olympia Rupēs (OR), we find what we interpret to be outcrops of PBC forming lenses within PB1 (CTX images P01_001593_2635 and P01_001646_2639). They are dark, with irregular, furrowed surfaces similar to those of "marker beds" in stratigraphically higher parts of the PB1 unit [13-14]. These relations collectively indicate that PBC and PB1 at least locally had con-current deposition and thus must have some overlap in age. PBC onlaps the Rupes Tenuis unit in Chasma Boreale and along Olympia Rupēs. However, above RT and in the Gemina Lingula (GL) lobe, PBC may be largely absent. There, PB1 directly rests on the VB interior unit and thus forms a local, basal unit of PB.

Small craters superposed on PB1 in the spiral troughs of PB indicate a surface age of only a few million years [3]. However, we find that beneath its <100-m-thick cover of dunes and PB1, Olympia Planum consists mainly of PBC. Two craters >5 km in diameter on Olympia Planum and uncertainty in the resurfacing history of the planum suggest a surface N(5) between about 5 and 50, or a model crater age of ~100 Ma to ~2 Ga for these deposits.

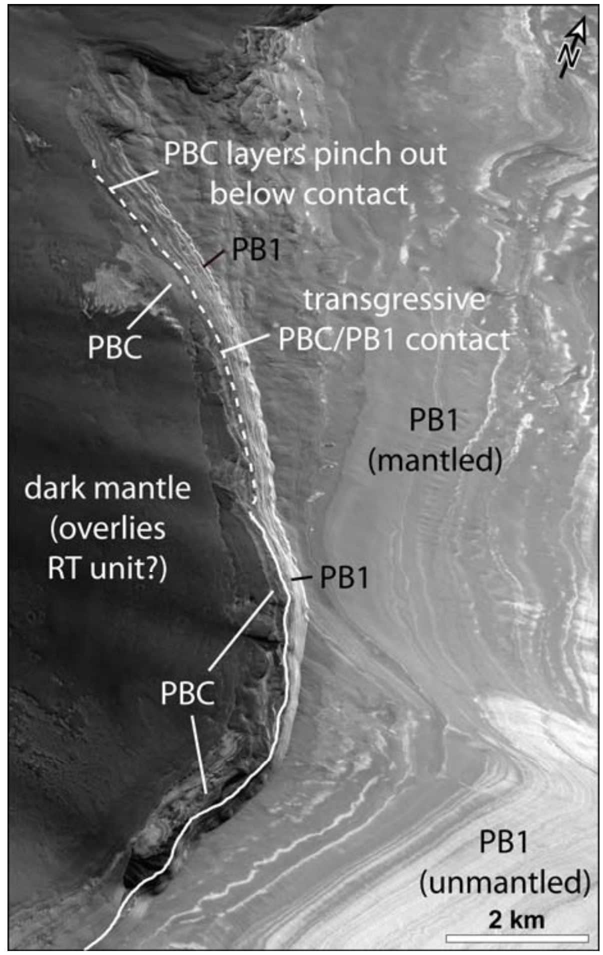

Fig. 3. View of area at head of Chasma Boreale of dark floor of eastern Boreum Cavus (left) underlain perhaps by the Rupes Tenuis unit. The cavus is flanked by Planum Boreum (right) made up of PBC overlain by PB1. Note that toward the northwest, PB1 grades into PBC above the transgressive contact. (Part of CTX image P01_001334_2644;6 m/pixel; illumination from lower left; scale bar is approximate.)

References: [1] Byrne S. and Murray B. (2002) *J. Geophys. Res. 107*(E6). [2] Fishbaugh K. and Head J. (2005) *Icarus 174*, 444-474. [3] Tanaka K. (2005) *Nature 437*, 991-994. [4] Tanaka K. L. et al. (2005) *USGS Sci. Invest. Map SIM-2888*. [5] Milkovich S. and Head J. (2005) *J. Geophys. Res. 110,* doi:10.1029/2004JE002349. [6] Milkovich S. and Head J. (2006) *Mars 2*, 21-45. [7] Levrard B. et al. (2007) *J. Geophys. Res. 112,* doi:10.1029/ 2006JE002772. [8] Rodriguez J.A.P. et al. (2007) *Mars 3*, 29-41. [9] Tanaka K. L. et al. (in review) *Icarus*. [10] Hartmann W. (2005) *Icarus 174,* 294-320. [11] Arvidson R. E. et al. (1976) *Icarus 27,* 503-516. [12] Russell P.S. et al. (2007) *LPSC 38,* Abs. #1930. [13] Kolb E. and Tanaka K. (2001) *Icarus 154,* 22-39. [14] Malin M. and Edgett K. (2001) *J. Geophys. Res. 106*, 23429-23570.