Subsurface Structure of Planum Boreum on Mars from Shallow Radar (SHARAD) Soundings

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We have mapped the subsurface structure beneath Planum Boreum using results from the Shallow Radar (SHARAD) instrument, which has acquired sounding observations on more than 1000 orbital passes across the north polar region of Mars since the beginning of its primary science mission in November of 2006. Two-dimensional profiles beneath the instrument's ground track show a series of returns corresponding to dielectric contrasts in the subsurface to depths of 2 to 3 km. Using interactive subsurface-data interpretation software, we have mapped packets of layers within the North Polar Layered Deposits (NPLD) in three dimensions, from the surface down to returns from underlying materials, which are seen as either a diffusely reflective zone (DRZ) or a more coherent basal reflection. The latter presumably represents an extension of the Early Amazonian Vastitas Borealis Interior Unit (Tanaka et al. 2008, Icarus 196, 318) under the NPLD. The DRZ likely corresponds to a Basal Unit identified previously using surface imagery (Byrne and Murray 2002, JGR 107 E6, 5044) and later mapped as the Rupes Tenuis and Planum Boreum cavi units (Tanaka et al. 2008). This radar unit extends under most—but not all—of the main lobe of the NPLD, into Olympia Planum, and also across Chasma Boreale and partly under the Gemina Lingula lobe. These radar results suggest a revised boundary for the Basal Unit that has important implications for its association with the emplacement of Chasma Boreale.

Within the NPLD, four radar units, consisting of alternating packets of strongly reflective layers and quiescent zones that may represent nearly pure water ice, extend into both lobes of the deposits. A fifth radar unit is isolated to eastern Gemina Lingula and occurs between the lower two of the regional units, pinching out below the topographic saddle between the two lobes. The layering associated with the radar units is thought to be the result of variations in dust content within water-ice deposits that are driven by climate cycles (Phillips et al. 2008, Science 320, 1182). With the exception of areas immediately below crosscutting troughs, the thickness of the NPLD is remarkably uniform across both lobes, tapering toward the edges, with most of the topographic difference between the two lobes explained by the Basal Unit residing predominantly under only the main lobe. Also, while there are indications of a few angular unconformities, the layering within and between radar units is typically smoothly varying and quasi-parallel, which contrasts with the more heterogeneous layering seen in the South Polar Layered Deposits (e.g., Seu et al. 2007, Science 317, 1715). These characteristics suggest relatively uniform rates of deposition and erosion across Planum Boreum throughout the history of the NPLD. SHARAD was provided by the Italian Space Agency (ASI) to NASA for the Mars Reconnaissance Orbiter mission.

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