MAPPING AND CHARACTERIZATION OF SUBSURFACE DEPOSITS IN PLANUM BOREUM, MARS, USING RADAR SOUNDING AND THERMAL INVERSION TECHNIQUES. M. Willis-Reddick and S. Nerozzi[1]. [1]Lunar and Planetary Laboratory, The University of Arizona, Tucson, AZ. (mwillisreddick@arizona.edu)

Introduction: The Planum Boreum of Mars is the host to the North Polar Layered Deposists and the basal unit, two of the largest water ice reservoirs on the planet [1, 2]. The southern fringe regions of Planum Boreum are characterized by enigmatic subsurface reflectors detected by the Shallow Radar (SHARAD, [3]) on Mars Reconnaissance Orbiter (Fig. 1). Depending on their composition, the deposits could reach as far as ~150 m of depth. There has not been extensive research on the specific occurrences of water ice and sediment deposits at these sites and their relationship to the lack of variable topographical features in this area. Our hypothesis is that these deposits are made of an ice and lithic sediment mixture with low radar signal attenuation characteristics, possibly a remnant of ancient ice caps. In this study, we test this hypothesis by mapping each occurrence of these subsurface reflectors in SHARAD profiles and applying inversion techniques to obtain an estimate of the complex dielectric permittivity of the deposits. Additionally, we aim to constrain the thermal characteristics of the shallowest portion (up to 1 m depth) of these materials by performing thermal inertia measurements and modeling. Our study addresses the following key guiding questions about these deposits:

- What is the lateral and depth extent of these reflectors?
- What is the composition of the overlying materials and what are their thermal characteristics?
- Is there a relationship between the occurrence of these reflectors and surface roughness?

Methods: In this study, we integrate the use of radar sounding, high-resolution imagery and thermal emissions spectroscopy to provide answers to the guiding questions listed above.

Radar sounding. SHARAD is an orbital sounding radar with a vertical resolution of ~8.4 m in water ice [3]. The comprehensive and extremely dense coverage of radar sounding in Planum Boreum, with a total of over 3000 profiles available in the PDS (~500 used in our study) [4] enables high-detail mapping of enigmatic deposits. First, we performed a quick survey based on SHARAD profiles to determine the spatial occurrence of the subsurface deposits around Planum Boreum (Fig. 1). Then, we began detailed mapping across a region just outside Gemina Lingula by examining over 500 SHARAD profiles (example in Fig. 2) using the Seisware interpretation suite. We tested the accuracy of our reflector interpretations against off-nadir "clutter" by using in-house simulations [5].

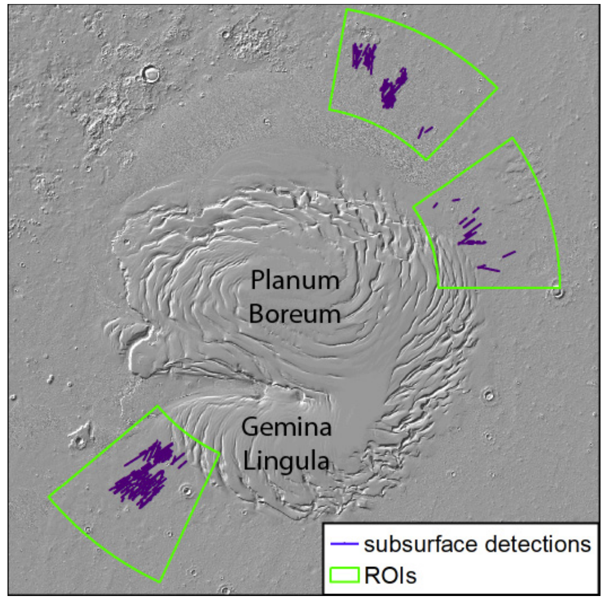

Figure 1: Overview of the preliminary survey of subsurface reflectors found in the outskirts of Planum Boreum. The shaded relief basemap was constructed from Mars Orbiter Laser Altimeter (MOLA, [13]) data. Note that the subsurface reflectors are clustered in three separate regions of interest (ROI).

High-resolution imagery. In conjunction with SHARAD imagery, we utilize high-resolution images acquired by the High-Resolution Imaging Science Experiment (HiRISE [6]) and Context Camera (CTX [7]). We use visible imagery to look for surface morphologies and/or changes in composition that would impact the propagation of SHARAD signals in the subsurface, thus hampering the detection of dielectric interfaces below the surface.

Thermal emission spectroscopy. Information from Thermal Emissions Spectrometer (TES [8]) and Thermal Emission Imaging Spectrometer (THEMIS [9]) are used to infer the surface mineralogy and thermophysical properties of the shallow subsurface (up to 1 m depth). After selecting the highest quality THEMIS images in JMARS [10], we employed the thermophysical models available in MARSTHERM [11] to obtain two-layer and single lateral mixed layer

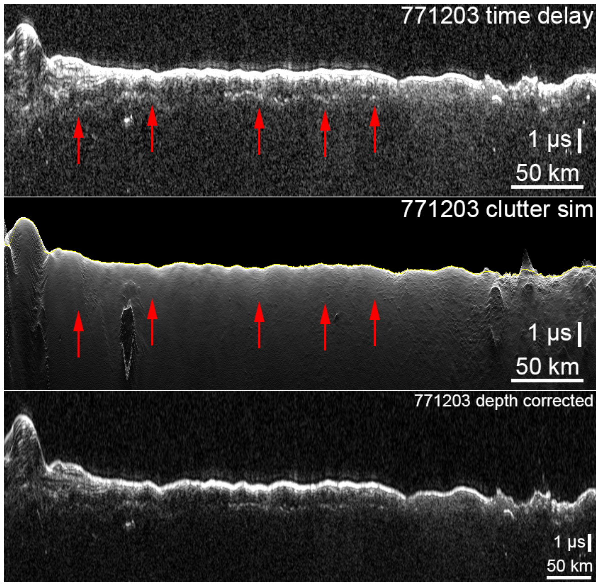

Figure 2: Example of SHARAD profile showing a subsurface reflector just outside Gemina Lingula. Note that no clutter appears in the simulation (central panel). The bottom panel is the depth corrected version of the same profile shown above using ε'=3.1.

fits of the thermal inertia measurements acquired during northern spring summer.

Preliminary results: We found that the subsurface reflectors in the region near Gemina Lingula span an area of ~35,000 km^2. By applying depth conversion using a real dielectric permittivity of ε'=3.1 for water ice [12], we find that subsurface reflectors characterized by time-delays apparently anti-correlated with surface became flat. This suggests that these deposits are largely composed of water ice or a mixture of lithic materials with significant pore space filled by air [13]. Thermophysical modeling in MARSTHERM of dune-free areas in these regions is best fit by cm-thick icy materials.

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