DEFINING THE MATERIAL PROPERTIES OF THE DORSA ARGENTEA FORMATION USING MARSIS RADAR SOUNDER DATA. J. L. Whitten[1], B. A. Campbell[1], and J. J. Plaut[2], [1]Center for Earth and Planetary Studies, Smithsonian Institution, MRC 315, PO Box 37012, Washington, DC 20013 (whittenj@si.edu), [2] NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA.

Introduction: Two deposits in the south polar region of Mars may hold important information about the climate during their periods of emplacement, the South Polar Layered Deposits (SPLD) and the Dorsa Argentea Formation (DAF). The SPLD preserve an Amazonian-aged record of the south polar climate and the DAF may contain a Hesperian-aged record. There is not agreement on the processes responsible for the DAF emplacement. Its origin has been variously attributed to volcanic activity, debris flows, aeolian deposition, and glacial activity [1–8]. However, if the DAF is an ancient ice-rich deposit, it has the potential to provide an even older climate record for the south polar region.

The DAF is areally extensive, covering ~1.5 million km^2 in the south polar region of Mars. It is primarily concentrated between 270°E and 30°E, though there are outlier deposits in Prometheus basin, and is located north of the SPLD, extending as far north as 55°S. The DAF contains a variety of geologic features, including sinuous ridges, pitted terrain, and pedestal craters, and is Hesperian in age [1].

The age of the DAF, and its potential ice-rich character, may preserve critical information about the climate history of the south polar region. Here, we use radar sounder data to characterize the extent, morphology, and possible material properties of the DAF subsurface materials. The goal of this research is to better understand the dominant DAF emplacement process.

Methodology: Radar sounder data from the MARSIS instrument on ESA's Mars Express spacecraft [9] were used to map subsurface radar reflectors in the south polar region of Mars. MARSIS operates at four different frequencies (1.8, 3.0, 4.0, and 5.0 MHz) and has a bandwidth of 1 MHz. The along-track resolution of the data is 5–10 km and the cross-track resolution is 10–30 km. Compared with SHARAD, MARSIS has a lower resolution, but is able to penetrate more deeply into the subsurface.

Here, MARSIS data collected at 4.0 and 5.0 MHz and processed using the technique of [10] are used to identify and map the distribution of subsurface reflectors that correspond to the mapped extent of the DAF [1, 11]. Loss tangent values were calculated for certain MARSIS tracks using a technique commonly applied to SHARAD data [e.g., 12, 13], measuring the power of the surface and subsurface reflectors and using the change in these values with depth to determine the loss tangent. This technique is employed when the thickness

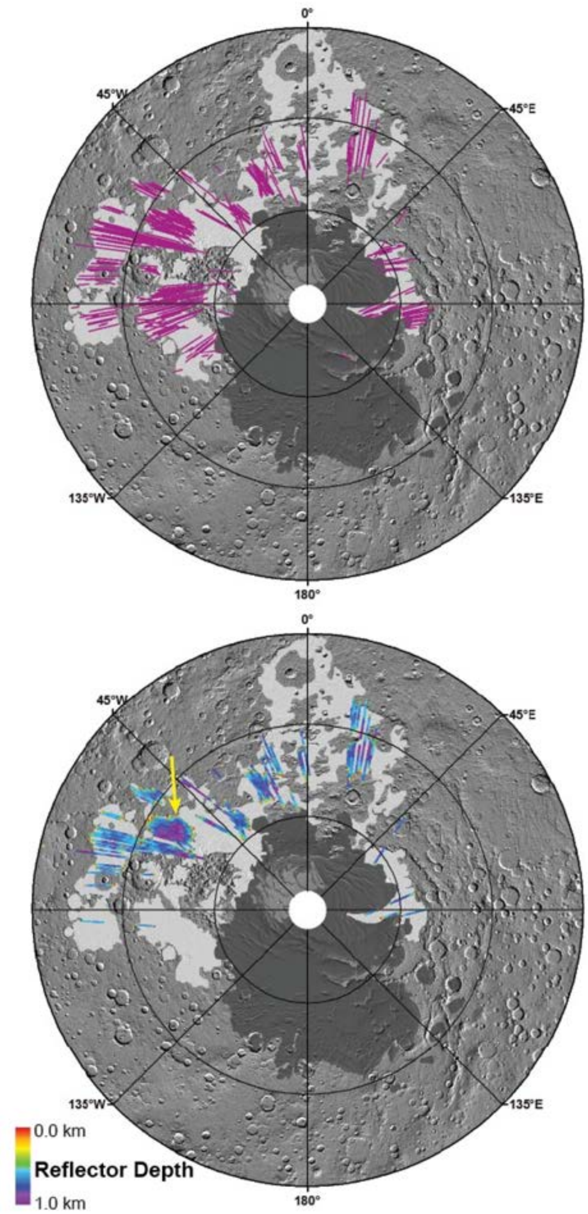

Figure 1. (Top) Location of sub-sections of MARSIS tracks with evidence of subsurface reflectors (magenta lines). (Bottom) Thickness calculations, assuming water ice, for a subset of the mapped MARSIS reflectors. Yellow arrow points to buried crater. The DAF is shown as transparent white polygons and the SPLD are shown as transparent black polygons. MOLA 128 ppd hillshade.

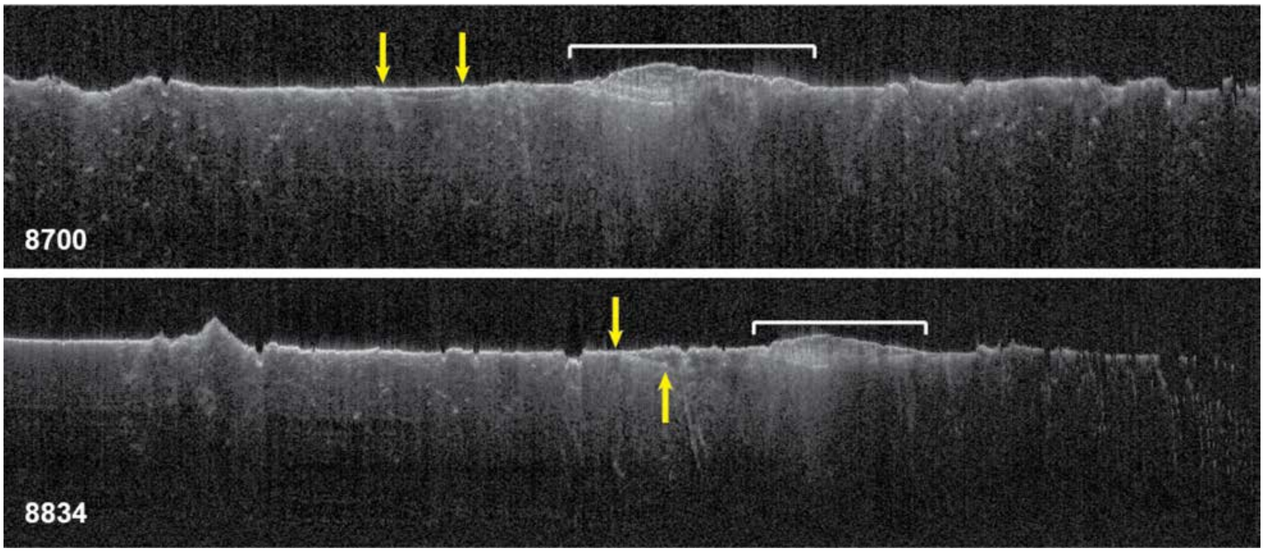

Figure 2. Subset of MARSIS radargrams showing the subsurface reflector correlated with the DAF. (Top) Example of reflector that starts and ends at the surface interface. (Bottom) Example of a reflector where one end begins at the surface interface and the other end stop abruptly below the surface. Yellow arrows show beginning and end points of reflectors. Location of the SPLD is noted by the white brackets in each radargram.

of the deposit is unknown. The calculations are made assuming a homogeneous layer of material between the surface and subsurface radar reflectors.

Preliminary Results: Subsurface MARSIS reflectors were identified in the region around the SPLD in 260 tracks (Fig. 1, top). In most cases, one end of the reflector originates at the surface interface as the reflector dips into the subsurface. Sometimes the other end of the reflector trends back up toward the surface interface (Fig. 2, top), and in other cases the reflector ends in the subsurface (Fig. 2, bottom). Almost all of these identified reflectors overlap with the mapped extent of the DAF from [1]. No indication of layering within this material was identified. If the DAF deposits are largely made of water ice [see 8, 14], the average deposit thickness is ~0.5 km. In certain regions of the DAF the local variation in thickness indicates the presence of a buried impact crater (Fig. 1, bottom). In these MARSIS data there is no clear evidence to suggest that any of the subsurface reflectors continue underneath the SPLD.

A subsection of MARSIS track 2474 shows a subsurface interface with obvious reflected power loss with increasing time delay (and thickness of the overlying material) (Fig. 3). A preliminary estimate for this one segment suggests a maximum loss tangent of ~0.03, much larger than expected for water ice. The uncertainty on this value is quite high, but it may suggest that the DAF has both ice-rich [14] and ice-poor regions. More work is required to constrain these loss tangent values across the DAF.

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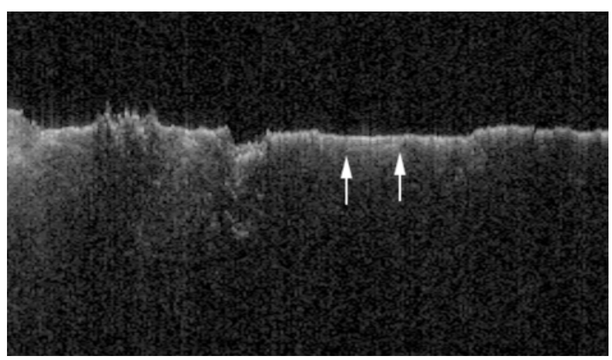

Figure 3. Example of dipping subsurface reflector displaying a loss in power with depth; reflector darker on the left and brighter on the right. Subsection of MARSIS track 2474, band 4. Arrows indicate the start and end of the reflector.