TOPOGRAPHIC, COMPOSITIONAL AND TEXTURAL VARIATIONS IN BASAL INTERFACES BENEATH THE SOUTH POLAR PLATEAU OF MARS FROM MARSIS RADAR SOUNDING.

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Introduction: Subsurface radar sounding by the MARSIS (Mars Advanced Radar for Subsurface and Ionospheric Sounding) and SHARAD (Shallow Radar) has allowed views inside the martian polar deposits that reveal their gross properties (volume, composition), details of internal structure (layer continuity, unconformities) and relationships to underlying and surrounding terrains. A key target for MARSIS has been the "basal interface" of the south polar layered deposits (SPLD, or Planum Australe), which is the contact of the icy sediments with the underlying, presumably lithic, substrate. Detection of this interface allows measurements of the the thickness and volume of the overlying deposits, and characterization of the pre-depositional landscape morphology. Beneath the south polar plateau, unusually strong basal reflections have been detected by MARSIS [1-2]. Modeling of the propagation of the radar signals suggests that a highly reflective material, possibly including liquid water, occurs in certain limited areas of the basal interface [2]. In this paper, three-dimensional radar sounding image compilations of MARSIS data for south polar region are used to examine the variable properties of the basal interface.

Data sets: MARSIS has been collecting subsurface sounding data since 2005. It operates simultaneously at 2 of 4 frequency bands (1.8, 3.0, 4.0 and 5.0 MHz) with a 1 MHz bandwidth. The compiled polar data sets consist of about 2000 orbits at each pole, taken in the 3 higher frequency bands. Key features of the 3D radar imaging volumes are: voxel (volume pixel) dimensions 1.5 km x 1.5 km (horizontal) x 50 m (depth); depth correction is applied in the subsurface using a wave speed in pure water ice; overlapping echo frames from different orbits are averaged; empty voxels are filled with horizontally applied nearest neighbor interpolation; volumes are constructed for bands at 3, 4 and 5 MHz separately, and as combined products; slices are extracted for all vertical and horizontal planes in each volume for individual study and animations.

Discussion: The 3D volumes of the south polar region provide new insights on the deepest structure below the layered deposits of Planum Australe. Several distinct regions of the basal interface display widespread, unusually bright reflections. These include areas under the thickest sections of the SPLD, at depths >3.5 km. Moreover, this reflective surface extends to the margin of the SPLD, where shallow thermal conditions should be similar to the surface in this, one of the coldest regions of Mars. The area identified in [2] is generally bright, but the regional signature does not distinguish this area from the others. The small (~30 km) highly reflective patch was only detected with high resolution raw echo data [2] which are not used in the 3D volume compilations due to limited coverage. The patch and its surroundings seem to be responsible for a rarely observed (in MARSIS) "multiple," in which a ghost image of the reflector appears at twice its depth due to a secondary round-trip ray path from the base to the surface and back. Analysis of early MARSIS data Planum Australe [1] suggested the presence of discontinuous reflectors at surprisingly great depths, as much as 1 km beneath the generally planar basal interface. These deeper reflectors are well-delineated in the 3D volumes; some are detected strongly only in the lowest frequency (3 MHz) of the studied bands. Many deep reflectors are associated with the Cavi Angusti "pitted" terrain, which implies that intervals of debris deposition and erosion occurred prior to the deposition of the Planum Boreum SPLD. Characterization of the south polar basal interface provides insight into the geological and climatic evolution that has affected the region. Further analysis of MARSIS data should better constrain the origin of the enigmatic highly reflective signatures.

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References: [1] Plaut et al., 2007 Science 315, doi: 10.1126/science.1139672 [2] Orosei et al., 2018, Science 361, doi: 10.1126/science.aar7268