A WIDESPREAD RADAR-TRANSPARENT LAYER DETECTED BY SHARAD IN ARCADIA PLANITIA, MARS. J. J Plaut[1], A. Safaeinili[1], B. A. Campbell[2], R. J. Phillips[3], N. E. Putzig[3], D. C. Nunes[1], R. Seu[4]. [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109 (plaut@jpl.nasa.gov), [2]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, D.C. 20560, [3]Southwest Research Institute, Boulder, CO 80302, [4]INFOCOM Department, University of Rome "La Sapienza," 00184 Rome, Italy.

Introduction: Arcadia Planitia is a transitional terrain between the Amazonian volcanic terrains associated with Tharsis and Elysium volcanism, and the northern plains assemblage dominated by the Vastitas Borealis Formation [1,2]. Observations by the Shallow Radar (SHARAD) on the Mars Reconnaissance Orbiter indicate that much of Arcadia Planitia is covered by a layer up to ~100 m thick that is transparent to the SHARAD radar signals. Here we discuss the radar signatures of this terrain, its geologic setting, and implications for the composition of this enigmatic mid-latitude deposit.

Observations: The terrain of interest occurs within the latitude range 38°-50°N, and longitude range 180°-225°E. The radar-transparent layer consists of a continuous E-W patch about 2000 km by 500 km, and several outliers, mostly to the north (Figure 1). From the west, the layer appears northwest and then just due north of the cratered terrain remnant known as Erebus Montes. It straddles the 40°N latitude line and ends to about 200 km NW of Acheron Fossae. An outlier patch is observed north of Acheron Fossae, near 225°E longitude. The layer covers a total area of approximately 700,000 km^2.

An example of the detection of the lower boundary of this layer is shown in a radargram in Figure 2. Typically the interface can be distinguished from the surface return after ~0.3 μsec of delay. The maximum roundtrip delay observed after the surface echo is slightly more than 1 μsec. The interface is generally flat, and occasionally discontinuous. Gaps in the detection of the interface may be due to scattering at the surface due to roughness. In the north (left) portion Figure 2, the transparent layer appears pitted in the MOLA data, possibly partially eroded, while it is more continuous to the south. The intensity of the subsurface interface reflection is variable, and not obviously dependent on depth. This intensity may be controlled as much by surface scattering as by the dielectric contrast at the interface and the attenuation within the layer itself.

In some areas (e.g., north and northeast of Erebus Montes), a second deeper interface is detected. This appears to be a continuation of the boundary interpreted by [3] to be the base of the Vastitas Borealis Formation beneath a veneer of Amazonis Planitia lavas. In the vicinity of Erebus, this interface is seen at time delays up to 2 μsec, deeper than any reported in [3]. However, these detections are consistent with the observation of [3] of a deepening of this interface with latitude.

Geologic Setting: The radar-transparent layer is mostly contained within the boundaries of the Amazonian volcanic unit "AAa1n" mapped by [2]. This corresponds closely to the Hesperian "proto-Olympus flow" unit of [4]. Both [2] and [4] interpret the terrain to be volcanic in origin, with sources in the Olympus Mons area, though there is some disagreement on the formation age. [2] note that the surface of the unit is rugged, with flows with rampart margins, depressed interiors, and dissection by channel systems. Our examination of image and topographic data from recent missions indicates that the area is also characterized by numerous features likely related to the presence of ground ice. Lobate debris aprons, similar to those found to be predominantly water ice based on SHARAD observations [5,6], occur within Erebus Montes. Many impact craters within the mapped boundaries of the radar-transparent unit contain concentric fill and/or other thick deposits on crater walls. The unit occurs entirely within the band noted by [7] to contain a latitude-dependent mantle, hypothesized to indicate the presence or former presence of ground ice. Numerous examples of surfaces exhibiting this patchy, dissected appearance occur within the boundaries of the unit.

Interpretation: The radar data may eventually provide firm constraints on the composition of the layer, but for this preliminary report we assume only that the dielectric constant is within the range expected for materials on Mars, of 3 (pure ice or low-density sediments) to 8 (dense basalt). Within this range the maximum round trip time delay to the lower boundary of the layer of 1 μsec corresponds to a maximum thickness range of 50-90 m. Careful examination of MOLA or higher resolution topographic data of pitted or other marginal areas of the unit may allow firmer constraints on the true thickness and thus the dielectric constant. The attenuation behavior of the layer is not easily observed, as the echo strength of the interface depends on geometric, as well as electrical properties. However, the signal does not seem to fade with depth, so we can at least state qualitatively that the layer does not strongly attenuate the signal. These properties should help us distinguish among several hypotheses for the composition of the layer: strictly volcanic material, sediments related to aqueous or aeolian activity, or a ground-ice-rich deposit several 10s of m thick. The presence of numerous geomorphic indicators of ice tends to favor the latter hypothesis, but at this time the radar data do not require an ice-dominated composition.

References: [1] Scott, D.H and K.L. Tanaka (1986) *USGS Map I-1802-A*. [2] Tanaka, K.L et al. (2005) *USGS Map I-2888*. [3] Campbell et al. (2008) *JGR 113,* E12010. [4] Fuller, E.R. and J.W. Head (2002) *JGR 107*, 5081. [5] Holt, J.W. et al. (2008) *Science 322*, 1235. [6] Plaut, J.J. et al. (2008) *GRL 35*, in press. [7] Mustard, J.F. et al. (2001) *Nature 412*, 411

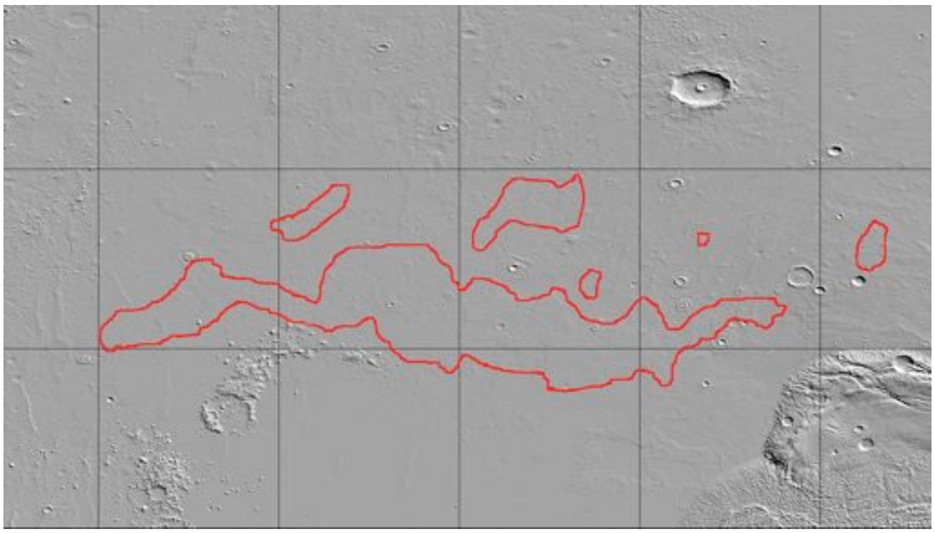

Figure 1. MOLA map of part of Arcadia Planitia showing occurrence of the radar-transparent layer. Map is centered at 45°N, 200°E. Grid spacing is 10°. Erebus Montes are in the lower left center and Archeron Fossae and the Olympus Mons aureole are in the lower right. Milankovic Crater (D=110 km) is in the upper right.

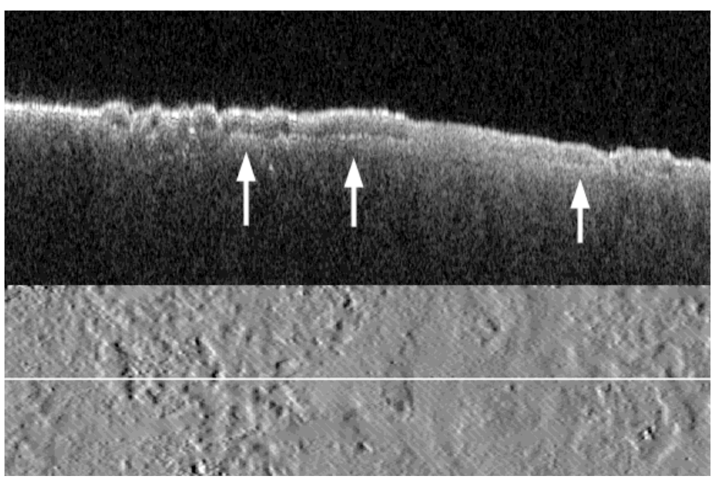

Figure 2. SHARAD radargram of Arcadia Planitia. Arrows show subsurface interface detections. Radargram is in time delay; maximum roundtrip delay to the interface is about 1 μsec. This corresponds to a depth of 50-90 m, depending on the assumed dielectric constant. MOLA topography is shown in lower panel. Image width is 300 km. Centered at 42.7°N, 201.0°E. North is to the left.