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Mapping Subsurface Interfaces in Eastern Amazonis Planitia Using SHARAD Data

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Abstract

The SHARAD instrument on Mars Reconnaissance Orbiter detects multiple sets of buried interfaces in Eastern Amazonis. The interfaces extend for hundreds of kilometers and are generally horizontal or slightly dipping, with the exception of one area that may be a filled depression. These interfaces may represent the base of lava flow units that lie on a less-dense material such as regolith or porous volcanic deposits.

1. Introduction

The eastern portions of Amazonis Planitia consist of flat plains of middle Amazonian age [1]. This region, mapped as AAa2n and AAa2s [1], is covered in lava flow textures and features such as channels and lobate flow boundaries. The area is bordered on the east by Olympus Mons and on the south by the Medusae Fossae Formation, and therefore links these major volcanic provinces with the flat lava flows and sediments of the rest of Amazonis Planitia. Understanding the nature and stratigraphy of the lava flows that cover this border region is important to establishing a timeline and evolutionary history for this portion of the Martian plains.

The SHARAD radar on Mars Reconnaissance Orbiter has detected buried interfaces in many northern plains regions. In central Amazonis, SHARAD penetrates through 100-170 m of low-to-moderate loss tangent (0.005-0.012) sediments and likely reflects from the base of the Vastitas Borealis Formation [2]. SHARAD also detects interfaces beneath portions of the low-density, low-loss Medusae Fossae Formation (MFF) [3,4], and thin (~50 m) lava flows west of Ascraeus Mons [4]. The Ascraeus-area lava flows have permittivity values of ~11 and loss tangents of 0.01-0.03, consistent with terrestrial basalts and different from the more SHARAD data across eastern Amazonis can be compared to the Ascraeus-area lava flows and to the sediment packages in central Amazonis to better understand the nature of the materials and stratigraphy in this region.

2. Summary of SHARAD Data

The SHARAD radar operates with a central frequency of 20 MHz and has a free-space vertical resolution of 15 m [5], which corresponds to a 5-10 m vertical resolution in common geologic materials. The lateral resolution of SHARAD is 3 to 6 km depending on surface roughness, reducible to ~1 km in the along-track direction with synthetic aperture focusing [5].

SHARAD has acquired numerous tracks over Eastern Amazonis and detects four distinct sets of apparent subsurface reflectors within and just outside the unit mapped as AAa2s (Fig. 1) [1]. SHARAD data are

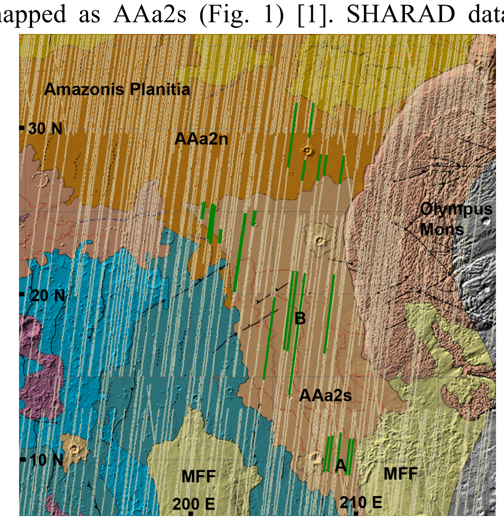

Figure 1: SHARAD orbital tracks in eastern Amazonis overlaid on geologic map from [1]. Green tracks show areas where subsurface interfaces are present. Areas A and B are shown in Fig. 2.

sensitive to wavelength-scale topographic features that contribute off-nadir surface clutter to the radargrams; however these echoes are not present in surface clutter simulations performed using MOLA topographic data. The subsurface reflectors are most likely generated by dielectric boundaries between different stratigraphic horizons; for example, between dense lava flows and regolith or low-density volcanic materials.

3. Discussion

The four sets of interface detections mapped in Fig. 1 are not spatially overlapping and have different physical properties. The interfaces mostly fall within the boundaries of mapped geologic units, with the exception of the northwest corner of AAa2s where interfaces overlap both the AAa2n and AAa2s units. Here we focus on two sets of reflectors that lie completely within the AAa2s unit. Examples are shown in Fig. 2.

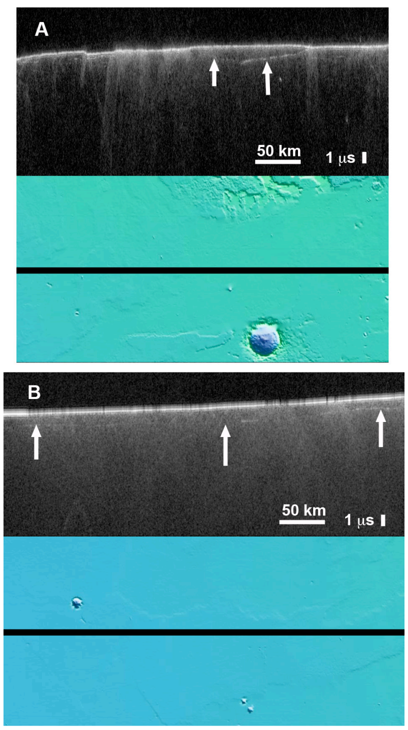

Figure 2: A.) SHARAD radargram showing subsurface interface marked as A in Fig. 1. B.) SHARAD radargram showing long subsurface interface (marked B in Fig. 1) in central part of unit AAa2s. Orbit tracks are marked on corresponding MOLA topography below both radargrams.

The first set of subsurface interfaces (marked A in Fig. 1) occurs just to the west of Gordii Dorsum and appears to be a filled shallow depression or discrete flow unit ~120 km in along-track length. The depression is 1.6 µs in round-trip time delay at its deepest point, corresponding to ~80-100 m. The interfaces are first visible in SHARAD tracks immediately west of the Medusae Fossae Formation material. A crater marks the western side of the depression. THEMIS images reveal lava flow textures including lobate flow boundaries.

The second set of interfaces (marked B in Fig. 1) occurs in the middle of the AAa2s unit and extends along-track for ~400 km. The interfaces are typically faint and are not visible along the entire length in any given orbit track. The maximum depth is ~1.4 µs, corresponding to 70-90 m for permittivity values of 6-9. These interfaces extend across the longitudinal width of the AAa2s unit and have a very consistent time-delay, which implies a very extensive and uniform interface.

The eastern Amazonis reflectors described here are more spatially extensive than the Ascraeus-area flows, and the interfaces are visible at somewhat greater time delays, suggesting slightly lower loss tangents. Future work will focus on the relationship between the Amazonis and southeast Amazonis reflectors, and possible differences in material properties between the two regions.

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