STRATIGRAPHY AND PHYSICAL PROPERTIES OF SOUTHEASTERN AMAZONIS PLANITIA AND THE EASTERN MEDUSAE FOSSAE FORMATION.
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Introduction: The late Hesperian through Amazonian evolution of the plains west of Olympus Mons is a complex mix of volcanic flows, fluvial sediment deposition from the east, and pyroclastics (e.g. the Medusae Fossae Formation). After the formation of the Olympus Mons aureole, lava flows were emplaced from south to north (into the Amazonis basin), presumably from a now-buried source region in southern Tharsis [1]. Later, sediments and lava from Marte Vallis flowed into Amazonis Planitia from the northeast [1]. The Medusae Fossae Formation (MFF) hills of Gordii Dorsum and Amazonis Mensa were also deposited across the dichotomy boundary and overlapping prior volcanic episodes. We use three wavelengths of radar data plus optical imagery to better determine the stratigraphy and to study the physical properties of the volcanic deposits in this region.

Radar Data Products: This is one of the few areas where both of the sounding radars in orbit around Mars detect the same interfaces, offering the possibility of comparing data sets. MARSIS operates at frequencies between 1.3 and 5.5 MHz, has a free-space vertical resolution of 150 m, and can penetrate up to a few km depending on the material [2]. SHARAD operates at 20 MHz and has a free-space vertical resolution of 15 m [3]. Compared to MARSIS, SHARAD does not detect interfaces below a few hundred meters outside of the polar regions, and it is more susceptible to contamination from surface clutter. However, SHARAD can reveal more details of the subsurface topography. We also use ground-based imaging from Arecibo Observatory [4]. These data have a frequency of 2.38 GHz, and can penetrate up to a meter in dry, low-density materials [4]. At this frequency, the radar echo is very sensitive to surface roughness at the centimeter-scale, so radar-bright surfaces are rough at small scales.

Lava Flow Layers: Lava flows originating from the Tharsis area emanate from the base of the Medusae Fossae Formation and flow north (Fig. 1). The flows are too thin to appear in the MARSIS data, but SHARAD detects subsurface interfaces associated with two episodes of volcanism. First, there are interfaces beneath channelized flows near the northern tip of Gordii Dorsum (Fig. 2). Medusae Fossae material is eroding off the flows in this region and exposing a wide channel, which is also visible as a radar bright linear feature in the Arecibo images [4]. At the base of

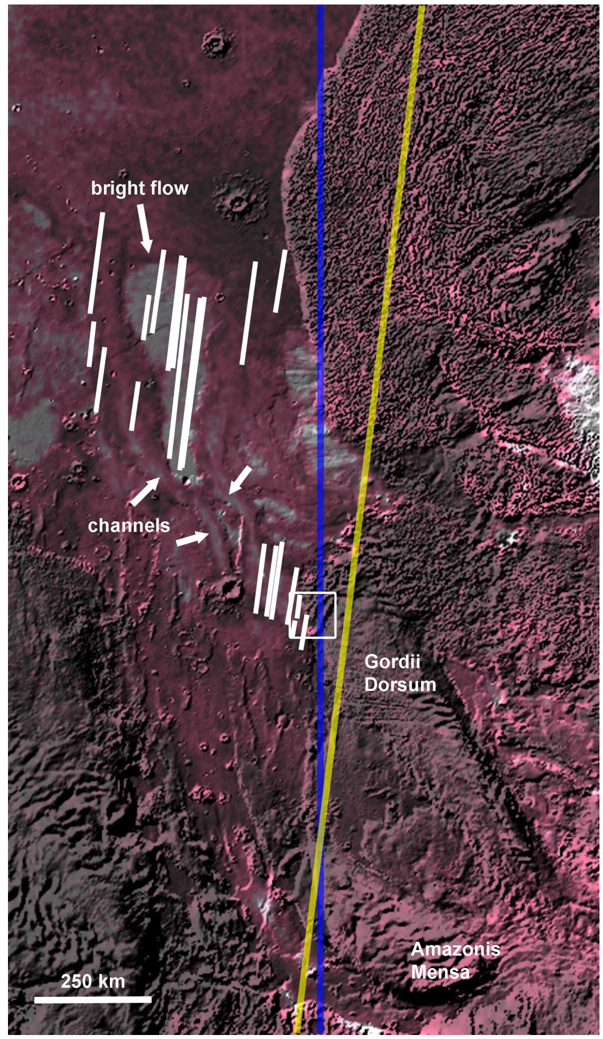

Fig. 1: Eastern Amazonis and the Medusae Fossae Formation, showing the 2.38 GHz radar reflectivity (red) overlaid on stretched topography. Radar-bright channels (arrows) and flows have rougher surfaces. The locations of SHARAD-detected interfaces beneath lava flows are shown in white. A white box marks the location of Fig. 2. The colored lines show the orbit tracks for the Fig. 3 MARSIS (blue) and SHARAD (yellow) data, which intersect over Amazonis Mensa.

Gordii the flow is 60-100 m thick, assuming a relative dielectric permittivity of 6-9. Loss tangent calculations averaged over three similar tracks result in a value of 5e-3 ± 3e-3. This is a low value, but similar to that

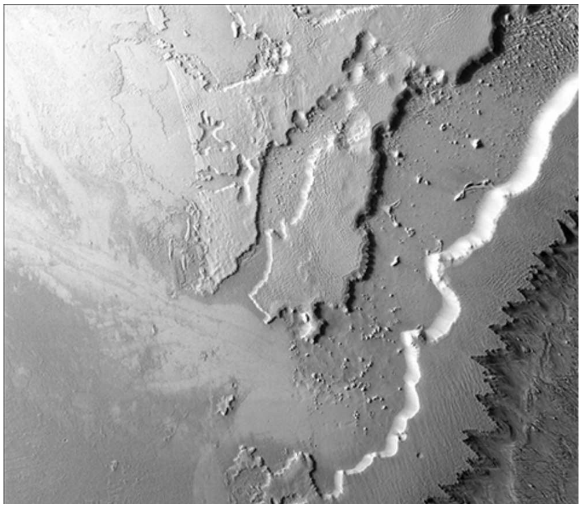

Fig. 2: HRSC (High Resolution Stereo Camera) image (H2965) of the northern part of Gordii Dorsum, showing channelized flow.

measured for other lava flows [5]. The flow is thicker to the west, and then appears to split into two lobes near a large crater. Both lobes have radar-bright channels and hardly any subsurface interface detections. As the flows spread out at the distal ends, SHARAD again detects numerous interfaces.

These channelized flows sit on top of a very radar bright flow that appears to have traveled from a similar source point [4]. This radar-bright flow also has a large number of subsurface interfaces in SHARAD data. Channels are less apparent in this region, and the surface is rougher at centimeter scales than the flows on either side. The flow is also considerably rougher than flows previously studied in western Tharsis near Ascraeus and Pavonis Montes [5]. Despite the different surface texture, SHARAD detects numerous interfaces that have a very consistent depth for hundreds of kilometers. The interfaces terminate very close to the boundary of the radar-bright region.

Medusae Fossae Formation: The Medusae Fossae Formation is of particular interest because of its unknown origins. The MFF is usually considered to be volcanic fall deposits or ignimbrites [6,7], but it has also been suggested that it could be ice-filled relic polar layered deposits [8]. A large amount of prior work has been done on this region; for example, MARSIS has shown that these are low loss deposits with loss tangents of 0.002-0.006 [9]. Both SHARAD and MARSIS have shown that the MFF deposits have dielectric permittivity values close to 3 [9,10], similar to low-density pyroclastic materials or possibly ice.

The addition of many SHARAD rolled tracks, which have higher signal to noise, along with new MARSIS data, offers the opportunity to compare the data sets directly (Fig. 3). An initial comparison of the region revealed that SHARAD detects the upper of two interfaces that MARSIS detects in between Gordii Dorsum and Amazonis Mensa [9, 11]. Further work suggests that the second MARSIS interface may also be present beneath parts of Amazonis Mensa (Fig. 3). We are currently tracking the location of the deeper interface across this region in the MARSIS data.

Summary and Future Work: At the north end of Gordii Dorsum, MFF material lies above lava flows that may create at least part of the subsurface interface MARSIS detects. The lava flows to the north of Gordii Dorsum have different surface morphologies, and appear to have been emplaced in different volcanic episodes. Farther to the south, Gordii Dorsum, Amazonis Mensa, and MFF materials in between lie on top of a boundary that appears very rugged (Fig. 3). MARSIS often detects another layer beneath this. We are currently developing a model that will incorporate the SHARAD and MARSIS subsurface interface information to determine the extent and depth ranges of the layers beneath the eastern MFF hills.

References: [1] Fuller and Head (2002), JGR, 107, 5081. [2] Picardi, G. et al. (2006) *Science*, 310 , 1925. [3] Seu, R. et al. (2004) *Plan. Space Sci*., 52 , 157. [4] Harmon et al. (2012), Icarus, 220, 990. [5] Simon et al. (2014), JGR, 119, 2291. [6] Zimbelman, J. and Griffin, L. (2010), *Icarus*, 205, 198. [7] Hynek, B. et al. (2003), *JGR*, 108 (E9), doi:10.1029/2003JE002062. [8] Schultz, P. and Lutz, A. (1988), *Icarus*, 73, 91. [9] Watters, T. R. et al. (2007) *Science*, 318, 1125. [10] Carter, L. M. et al. (2009), *Icarus*, 199, 295. [11] Carter et al. (2013), 44th LPSC, #2386.

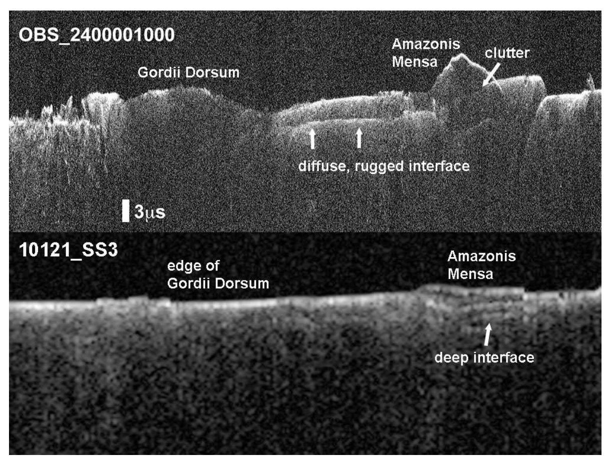

Fig. 3: SHARAD (top) and MARSIS data of Amazonis Mensa, from overlapping tracks (shown in Fig. 1). The MARSIS data has been adjusted to have north on the left to better compare to the SHARAD track. Note that the two tracks intersect in Amazonis Mensa, but do not cross the same terrain (Fig. 1). Therefore, they do not exactly match. A deeper interface is visible in the MARSIS data beneath Amazonis Mensa.