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Subsurface properties of Lucus Planum, Mars, as seen by MARSIS

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Lucus Planum, extending for a radius of approximately 500 km around 181°E, 5°S, is part of the Medusae Fossae Formation (MFF), a set of several discontinuous deposits of fine-grained, friable material straddling across the Martian highland-lowland boundary. Parts of the MFF have been probed through radar sounding by MARSIS and SHARAD, synthetic-aperture, low-frequency radars carried respectively by ESA's Mars Express and NASA's Mars Reconnaissance Orbiter. They transmit low-frequency radar pulses that are capable of penetrating below the surface, and are reflected by any dielectric discontinuity present in the subsurface.

The dielectric permittivity of the MFF material, estimated from data of both radars, is consistent with either a substantial component of water ice or a low-density, ice-poor material. There is no evidence for internal layering in SHARAD data, despite the fact that layering at scales of tens of meters has been reported in many parts of the MFF. This lack of detection can be the result of one or more factors, such as high interface roughness, low dielectric contrast between materials, or discontinuity of the layers. After more than 10 years of observations, MARSIS has acquired about 240 orbits across Lucus Planum, making it possible to map the presence and depth of subsurface interfaces to a much greater detail than in previous works.

The positions and strengths of subsurface echoes were extracted manually from radargrams and mapped across Lucus Planum, converting echo time delay to apparent depth. The strongest subsurface echoes, resulting from weak internal attenuation, strong subsurface reflectivity, or both, are found within the deposits located NW of Apollinaris Patera, while no subsurface echoes could be detected in the central section of Lucus Planum, in spite of several high-SNR observations. Subsurface reflections are common in the Eastern and Northwestern sectors, in some cases to depths of more than 2000 m assuming a dielectric permittivity of about 3.

The lack of subsurface reflections in the central part of Lucus Planum can be the result of several factors, some of which depend on surface properties. A high topographic roughness at scales comparable to the radar wavelength causes scattering of the impinging pulse, resulting in weaker surface and subsurface echoes. However, surface roughness estimated from MOLA data is higher in the Eastern part of Lucus Planum. Another possibility is that roughness at the base of the deposit is higher in its central part, although there is no indication of such kind of trend in the older surrounding terrains. Because subsurface echoes appear to be closely associated with areas of distinct surface morphology, it is possible that Lucus Planum is in fact laterally inhomogeneous and that the central part consists of denser, more radar-attenuating material.

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