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Shallow Radar Soundings of the Southern Highlands of Mars

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Observations of relatively smooth areas in the high southern latitudes (poleward of 55°S) by the Shallow Radar (SHARAD) sounder onboard the Mars Reconnaissance Orbiter (MRO) show radar returns at ~0.3–0.5 μs after the surface reflection. These detections are most continuous laterally across the floors of craters and other topographic depressions, such as the craters Mitchel, Secchi, Lamont, and Phillips, and Sisyphi Planum, Pityusa Patera, and Aonia Planum. SHARAD returns of similar delay time and character occur in the higher latitudes of the Northern Lowlands, both at the Phoenix landing site and in many other areas. There, surface and ionospheric sources are discounted, and the returns are thought to originate from depths of ~25–45 m (Putzig et al., 2009, LPSC abstract 2477 and GSA abstract 20-13). The detections track southward to ~61°N–45°N, roughly corresponding to the northern region where ground ice is inferred to be present on the basis of neutron-spectrometer data. Given the geographic distribution and relatively uniform depth of the detections, plausible subsurface sources include shallow ice emplaced by vapor diffusion in the current era (Mellon et al., 2008, JGR 113, E00A25) and an ice-rich mantle emplaced during recent obliquity excursions (Head et al., 2003, Nature 426, 797-802). Since near-surface ground ice is also inferred to be present at the high southern latitudes, the same explanations may apply for the detections identified in the Southern Highlands. However, the returns in at least some of these southern areas may be due to other features. For example, both Pityusa Patera and Mitchel Crater are located within the Circum-Hellas Volcanic Province (Williams et al., 2009, Planet. Space Sci. 57, p. 895–916) and the near-surface layers may represent volcanic flows rather than ground-ice features. Additionally, the detections in Phillips Crater and in Sisyphi and Aonia plana may be associated with materials of the Dorsa Argentea Formation that appear to be ice-rich to greater depths (Plaut et al., 2007, LPSC abstract 2144) and may represent much older materials rather than ice emplaced by equilibrium vapor diffusion or recent obliquity excursions. Further work is needed to rule out observational and processing artifacts and to discriminate between possible subsurface sources.

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