SHALLOW RADAR SOUNDINGS OF THE NORTHERN LOWLANDS OF MARS

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At the Phoenix landing site, the Shallow Radar (SHARAD) sounder onboard the Mars Reconnaissance Orbiter (MRO) has obtained radar returns at ~0.5 μs after the surface reflection that likely originate from depths of ~25 to 45 m. Weaker returns of similar appearance and delay time occur in many other areas across the Northern Lowlands. We build confidence in a subsurface explanation for the returns by discounting surface and ionospheric sources through comparisons with synthetic radargrams generated from topography data, use of processing that suppresses side lobes, and selection of observations from a wide range of solar zenith angles (ionospheric effects vary with time and solar zenith angle). These measures support subsurface interfaces as the source of the returns, both in the 'Green Valley' where the Phoenix lander resides and elsewhere in the Northern Lowlands. The detections track southward to ~61°N on the slopes of Alba Patera and as far south as 45°N in other regions, latitudes encompassing the region where ground ice is inferred to be present on the basis of neutron-spectrometer data.

Other studies have suggested that ice-rich materials may occur as layers within the Vastitas Borealis Formation, lags in Late-Amazonian mantles, dust-rich ice emplaced atmospherically during recent obliquity excursions, and shallow ice lenses and layers emplaced by vapor diffusion. An equilibrium condition such as this last possibility may dominate, given the relatively uniform depth of the detections. We test this idea with a numerical model and find that the base of ground ice ought to be at a depth of ~15 to 30 m, increasing to ~20 to 40 m if the present geothermal heat flow is 5 mW m^{-2} K^{-1}, a low value implied by the recent finding of unexpectedly low flexure beneath Planum Boreum [Phillips et al., 2008, Science 320, 1182]. The weak signal strength suggests either lower ice content in the near surface or a gradual transition at the base from ice rich to ice poor, rather than an abrupt interface with a large dielectric contrast, since SHARAD typically obtains a strong reflection in the latter case.

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