Shallow Radar soundings of the four candidate landing sites for MSL *Curiosity*

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To search for subsurface interfaces and characterize surface roughness, the Shallow Radar (SHARAD) sounder onboard the Mars Reconnaissance Orbiter has observed the 4 final landing-site candidates for the Mars Science Laboratory (MSL) *Curiosity*. Images and altimetry data at the sites show layered sequences 100s of m thick extending over 10s to 100s of km—large enough for SHARAD subsurface detections, provided sufficient dielectric contrast between layers. The relative power of surface returns depends on surface roughness, an important element of assessing landing safety and trafficability.

At Gale Crater, the single SHARAD observation crossing the proposed landing ellipse shows tentative evidence for near-surface returns at a delay of ~0.3–0.5 μs from the surface (i.e., depths of 16–43 m for materials with a dielectric constant of 3–8). Elsewhere on the floor of Gale, stronger evidence for subsurface returns occurs at a delay of ~1.0–2.0 μs (depths of 53–170 m). While surface images clearly show layering within Gale's central mound, SHARAD shows no strong evidence of subsurface layering therein. But present radar coverage is sparse, and observing geometries may limit the ability to image beneath the mound's sloping surface. Of the 4 MSL sites, Gale shows the highest-power surface returns, indicating a relatively smooth surface. However, the returns are not nearly as strong as those from the Mars Exploration Rover site at Meridiani, which is exceptionally smooth at radar wavelengths (~15 m). At Holden Crater, the single SHARAD observation of the landing ellipse has first returns from the crater wall and no nadir surface return. Just east of the ellipse, observations at more favorable geometry show moderately high-power returns from the surface but no evidence of subsurface interfaces. At Eberswalde Crater, we see no evidence of subsurface returns despite more extensive coverage (10 observations of the ellipse). Here, the crater walls yield extensive off-nadir returns, and the use of simulated radargrams is critical in identifying late returns as surface clutter. Nadir returns have lower power than those at Gale and Holden, and thus Eberswalde is likely rougher at the 15-m scale. The Mawrth Vallis sites are elevated above their surroundings, thereby minimizing surface clutter. Even so, we see no indications of subsurface returns at the 2 of 4 landing ellipses with SHARAD observations. Surface returns here are much more diffuse and have the lowest power of the four MSL sites, suggesting a significantly rougher surface.

Where potential detections are not hindered by surface clutter, a plausible explanation for a lack of subsurface returns is that layers seen in imagery and altimetry have feeble dielectric contrasts—likely due to low contrasts in density, perhaps a result of similar composition and structure. Another possibility is that features of the material [e.g., adsorbed water; Stillman and Grimm, LPSC XLI #2143, 2010] are attenuating the SHARAD signal. It is notable that an exhaustive SHARAD survey of Meridiani Planum found no firm evidence of subsurface layers.

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