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Moderately to Poorly Welded Tuff, Bishop, California: Broadband Performance of Ground- Penetrating Radar

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GPR performance was assessed in an arid volcanic environment to understand the controls on radar attenuation and depth of investigation. Our ultimate goals are better prediction of the performance of planetary sounding radars and characterization of the subsurface using these instruments (e.g., MARSIS and SHARAD). We collected GPR data spanning 12.5-900 MHz (100 MHz and above in 2006, remainder in 2004 [see Grimm et al., JGR 111, 2006], for the latter). The GPR profiles are dominated by signatures of subvertical cooling joints consistent with mapped surficial features and by discontinuous subhorizontal reflectors - also probably weathered joints - that likely mark primary cooling and/or secondary unloading (see Dinwiddie et al., this session). The depth of investigation was a weak function of frequency, log z(m) = 1.9 - 0.46 log f(MHz). The effective attenuation - determined analogously to seismic coda Q - increased only from 1.0 dB/m at 12.5 MHz to 1.8 dB/m at 200 MHz. Constant loss tangent would produce attenuation proportional to frequency and therefore radar penetration strongly dependent on frequency. Conversely, imaginary permittivity inversely proportional to frequency (constant conductivity for pure ohmic loss) yields frequency-independent attenuation. The weak frequency dependence of investigation depth and attenuation coefficients here and elsewhere confirm that constant loss tangent is a poor approximation to GPR loss. Ground conductivity in the depth interval of the GPR investigation was determined by DC resistivity to contribute 0.7 dB/m, leaving 0.3-1.2 dB/m. This residual attenuation is attributed to scattering and is well fit by a Born model using an exponential correlation function (0.85-m correlation length, 33% velocity contrast). The frequency dependence is still much weaker than would be expected for constant effective loss tangent. Nearly frequency-independent dB/m loss implies that SHARAD will penetrate to depths not much less than MARSIS, but with greatly improved resolution.

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