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Characterizing the Martian subsurface using SHAllow RADar (SHARAD)

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Radar remote sensing typically probes to deeper layers in a medium due to penetration ability of microwave signal. Among various orbital radar, Mars is being probed using deep probing radars named SHARAD (SHAllow RADar) onboard NASA's Mars Reconnaissance Orbiter and MARSIS (Mars advanced Radar for subsurface and ionosphere sounding) onboard ESA's Mars Express. These radars have shown evidence of subsurface ice, water and lava flow. It has improved the maps obtained by MARSIS by providing more details about the layering structures.

The SHARAD radar instrument on board MRO (Mars Reconnaissance Orbiter) uses linear frequency modulation (LFM) in the range of 15MHz to 25MHz. The radar transmits signals at a 700 Hz pulse repetition frequency (PRF) and collects reflections from both the surface and near subsurface of Mars. Vertical and horizontal resolutions are, respectively, 15 m (free-space) and 3–6 km (cross-track) by 0.3–1 km (along-track). Waves those transmitted into the subsurface may reflect from the dielectric interfaces and return to the instrument at greater time delay than the surface echo. The data represents surface reflections and intensity of return signal from off-nadir or subsurface in time domain. One of the major obstacle is in the identification of subsurface echo is due to surface returns which arrive at the sensor at same time. For handling this issue, radar surface returns are simulated and is compared with actual radargram (Ref. Fig.1).

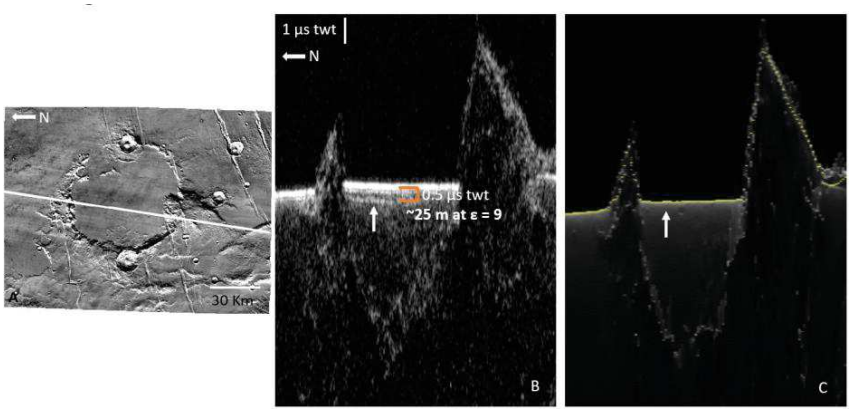

*Fig.*1: (*A*) *SHARAD ground track passing through unnamed Crater (B) SHARAD radargram with time delay and arrow indicate the subsurface reflection (C) Simulated radargram showing the off-nadir topographic clutter echoes*

Analysing SHARAD data of subsurface reflection from an un-named crater (14°35′/152° 36′ and 18°08′/148° 42′), the subsurface material is noticed to exhibit low loss tangent value and dielectric constant, which may correspond to the sedimentary rock layers. For instance, the loss tangent is observed to take values of the order of ~ (10^{-3} - 10^{-2}) while the dielectric constant may vary in the range of ~ (3-15).

References:

1. Carter et al., GRL, 2009, VOL. 36, L23204, doi: 10.1029/2009GL041234
2. Seu,R., et al., J. Geophys. Res., 2007,112,E05S05, doi: 10.1029/ 2006J E002745.