Investigation for water-ice within lunar polar PSR using Chandrayaan-2 DFSAR data

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Multi-frequency polarimetric observations from dual frequency synthetic aperture radar (DFSAR) and miniaturised synthetic aperture radar (Mini-SAR) were used to investigate four craters named as *C*1–*C*4 within the permanently shadowed Faustini crater floor, near the lunar south pole. Amongst these four craters, *C*1 exhibits plausibility of shallow subsurface water ice with enhanced circular polarisation ratio (CPR) at S-band and low mean cross-polarised backscattering coefficient. CPR greater than unity at L-band has been detected in an unnamed sub-km-scale crater (*C*2). Further, the CPR signature characterising the interior and exterior of the crater at L-band is observed to be unambiguously distinct, non-overlapping, and separated by a margin of 0.63. This distinct CPR signature is not observed at S-band, emphasising the plausibility of water ice in deeper layers. The crater *C*3 indicates erosion associated with subdued backscatter returns. The penetration ability of the L-band signal reveals buried rocks inside crater *C*4 associated with depolarised cross-polarisation (VH) returns, enhanced CPR, and high co-polarised backscattering coefficient. Polarimetric decomposition methods were used to emphasise the dominance of volume scattering in the deeper layer.

Keywords: Chandrayaan-1, Chandrayaan-2, DFSAR, lunar water ice, Mini-SAR.

preserving ice deposit at greater depth[7] could be ejecta blanketing of cold traps from neighbouring craters, which preserved and protected it from surface loss[6].

Radar is an optimal instrument for the detection of water ice in PSR as it has its own illumination source[8] and has the ability to probe subsurface material[9]. Radar measured circular polarisation ratio (CPR) is a descriptor of planetary ice deposits and fresh ejecta[10,11]. CPR depends on a wide range of parameters, including system parameters such as radar frequency, incidence angle, and geophysical parameters of the lunar surface such as surface slope, surface roughness, size and shape of surface and subsurface rocks, dielectric constant, regolith thickness, and orientation of the buried rocks[12,13].

Typically, regolith observes low CPR[14] (< 1.0) whereas cold trapped ice deposits[11] exhibit elevated CPR (> 1.0) due to its high sensitivity to the presence of volumetric scattering[15]. However, CPR is not a unique representative of ice deposits, as wavelength-scale surface roughness also shows high CPR caused by multiple double bounce reflections[16].

Morphologically young, fresh craters display high CPR both inside and outside of the crater due to roughly textured impact melts in the floor, presence of rock debris, boulders on the rim and crater walls, and blocky proximal ejecta[15]. In general, CPR increases with greater roughness[17], decreasing wavelength[17] or increasing incidence angle[15]. Hence, L-band radar echoes with longer wavelength exhibit lower CPR than S-band[15]. Moreover, some craters exhibit anomalously high CPR only in the interiors of the rim while