STUDY OF PLATO CRATER WITH THE MINI-RF. OPN Calla[1],Shubhra Mathur[1,2] and Monika Jangid[1,3] ,[1] International Center for Radio Science, Ranoji Ka Baag, Nayapura, Mandore, Jodhpur Rajasthan India opnc06@gmail.com; [2]shubhra.icrs@gmail.com; [3]monika.jangid.icrs@gmail.com .

Introduction: The Miniature Radio Frequency (Mini-RF)[1] is one of the payload of Lunar Reconnaissance Orbiter (LRO), launched by NASA in 2009. The Mini-RF is the active sensor which works on the dual frequency i.e. S-band & X- band. In this paper the Plato crater[2] which lies in the 51.6°N 9.3°W has been studied. Plato is the lava-filled remains of a lunar impact crater on the Moon [2].

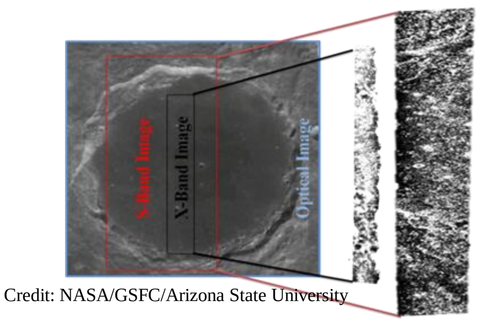


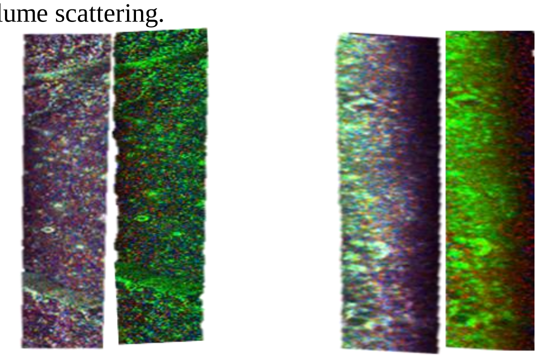
Fig:1 (a) Optical image
(b) lxb_01412_2cd_eiu_56n350_v1.img of Mini-RF
(c) lsz_05243_2cd_eku_59n349_v1.img of Mini-RF

In Figure 1 the optical image of the Plato crater is overlaid with the S and X band images [3,4] having the common area. There are some places on the lunar surface where the data of both S and X band. Such type of study with both frequencies is very useful for analyzing the surface properties in more enhanced manner.

Scattering Behavior: This paper presents the scattering behavior of the Plato crater at S and X band of Microwave frequencies. Scattering parameters[5] of a target are influenced by the illuminating frequency, polarization, illumination angle and dielectric and conductive properties of the target. Since the penetration of incident signal depends on the frequency of the signal, as higher the frequency less will be the penetration depth, thus scattering behavior of surface and subsurface layer using different frequencies will help in determining the topography of the target i.e. its roughness, presence of rocks (above as well as beneath the surface) etc. A given surface may appear very rough to an optical wave, may appear smooth to the microwave. This is because the degree of roughness of a random surface is characterized in terms of statistical parameters like surface correlation length and standard deviation of the height variation which are measured in unit of wavelength [5].

The Scattering behavior of Plato crater has been observed using different decomposition techniques like m-delta[6] and m-chi[7]decomposition which represent the combination of surface, double bounce and volume scattering in RGB format.

In these decomposition techniques [7]blue colour indicates single bounce or surface scattering (If an incident wave, with a particular polarization, has a simple interaction with a target i.e. lunar regolith), red corresponds to double bounce that might occur between two surfaces at an angle to one another (due to presence of bedrocks beneath the surface) and green colour represents the randomly polarized constitutes or volume scattering.



(i)S-Band (ii)X-Band

Fig. 2 (i) Illustrate the m-delta and m-chi decomposition of Plato crater over S-Band & (ii) Illustrate the m-delta and m-chi decomposition of Plato crater over X-Band

In S Band, m-delta analysis shows the maximum volume scattering over rim of the crater while the floor shows combination of surface and double bounce scattering. m-chi shows the maximum points of volume scattering at the rim with the random distribution of surface scattering, double bounce scattering with the maximum points of volume scattering. While in the case of X-band, m-delta analysis of crater shows the partial floor covered with volume scattering and partially with the combination of surface and double bounce scattering. m-chi decomposition shows the maximum floor with the volume scattering with some area showing combination of all three type of scattering behavior.

This decomposition analysis of scattering behavior shows that floor of the crater is slightly rough because of presence of small and secondary craters and the maximum points of volume scattering over rim with some points over crater floor is due the presence of lava deposits. In figure 2, red block shows one of the secondary crater present on the floor of the Plato crater. The decomposition image over S-band data shows less roughness when it is compared with the decomposition image of X-band.

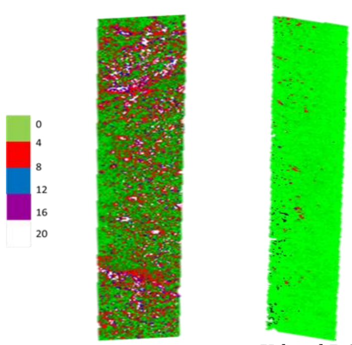
Dielectric Constant: Campbell's model[8] is used for estimating dielectric constant of rock-poor mantling dust based on the normalized ratios between the horizontal and vertical backscattering coefficient [8]. Dielectric constant is calculated over the Plato crater using equation given below

$$\varepsilon_{\min} = \left(\sin\varphi \Big/ \sin\left[\cos^{-1}\left(\frac{\sigma^0_{HH}}{\sigma^0_{VV}}\right)^{0.25} - \varphi \right] \right)^2 \qquad \text{Eq.1}$$

Where, Φ is the angle of incidence
σ∘HH= Horizontal backscattering coefficient
σ∘VV = Vertical backscattering coefficient

Here the PDS (Planetary data system) format of Mini-RF data has been used. The radar transmits RCP and receives linear horizontal and vertical polarization. These scattering values are used for analyzing Dielectric constant over Plato crater.

In case of S-band value of the dielectric constant varies from 0 to 20 with the maximum points observed between 1 to 4 and some anomalous points while in X-band maximum points are observed between 1 to 3 with few points above the given range i.e. 1 to 3 are shown in the figure 3 along with the colour bar indicating the dielectric constant values.



S-band DC X-band DC

Fig.3 Illustrate the Dielectric constant over S-band and X- band

Low values of DC shows the presence of multiple layers below crater floor with the high values showing the increasing surface scattering. In both frequency bands the difference in value of dielectric constant may be due to concentration of the constituent materials forming the crater and temperature of the area. Since the dielectric constant of dry material remains same for large frequency band but has small variation due to its constituents. Thus change in dielectric constant for different frequency bands is due to variation in constituents. The brightness temperature value at this location is also high which is related to dry material. Thus the value of dielectric constant obtained by Mini-RF gets validated by brightness temperature obtained by Chang'E 1[9] data.

References:

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