STUDY OF PLATO CRATER WITH THE MINI-RF

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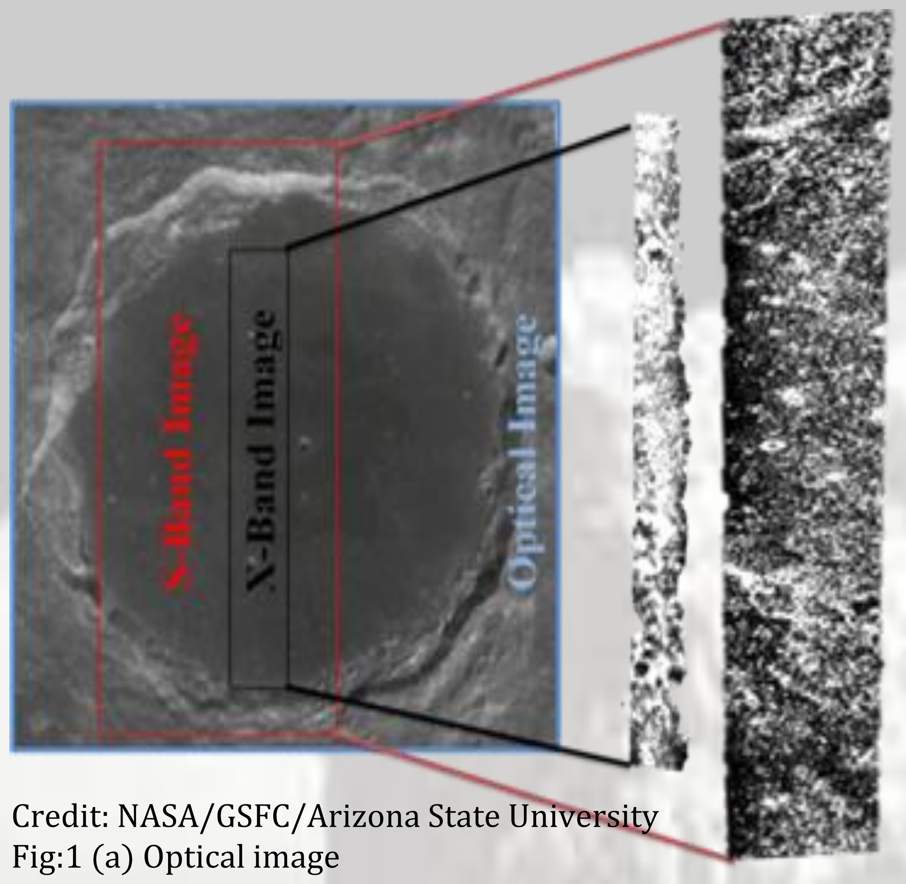
A Brief Overview...

Mini-RF combines SAR at two wavelengths (S-band and X-band) and two resolutions (150 m and 30 m) with interferometric and communications functionality.

Study Area - Plato Crater (51.6°N 9.3°W)



Credit: NASA/GSFC/Arizona State University
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

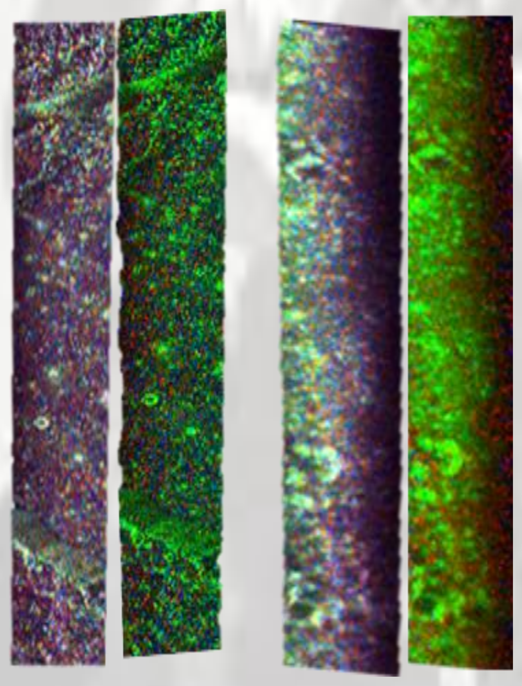
Plato is the lava-filled remains of a lunar impact crater on the Moon. In Figure 1 the optical image of the Plato crater is overlaid with the S and X band images [1,2] having the common area. There are some places on the lunar surface where the data of both S and X band. Such type of study with both frequencies is very useful for analyzing the surface properties in more enhanced manner.

Dielectric Constant

Campbell's model[5] is used for estimating dielectric constant of rock-poor mantling dust based on the normalized ratios between the horizontal and vertical backscattering coefficient. Dielectric constant is calculated over the Plato crater using equation given below

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

Decomposition Techniques



(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

m-χ

$$f_{surface} = \sqrt{S_1 \times m \times \frac{1-\sin 2\chi}{2}} \quad \text{(B)}$$

$$f_{double-bounce} = \sqrt{S_1 \times m \times \frac{1+\sin 2\chi}{2}} \quad \text{(R)}$$

m-δ

$$f_{surface} = \sqrt{S_1 \times m \times \frac{1-\sin\delta}{2}}$$

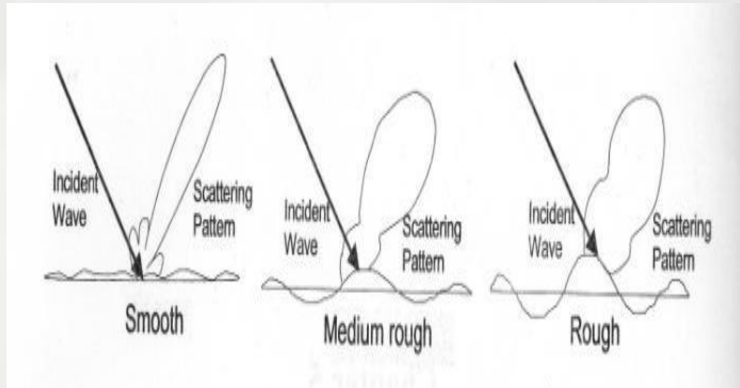
$$f_{double-bounce} = \sqrt{S1 \times m \times \frac{1+\sin\delta}{2}}$$

$$f_{volume} = \sqrt{S_1 \times (1-m)} \quad \text{(G)}$$

m- degree of polarization
δ - relative phase
χ – Poincare ellipticity parameter
S_1- total received backscatter

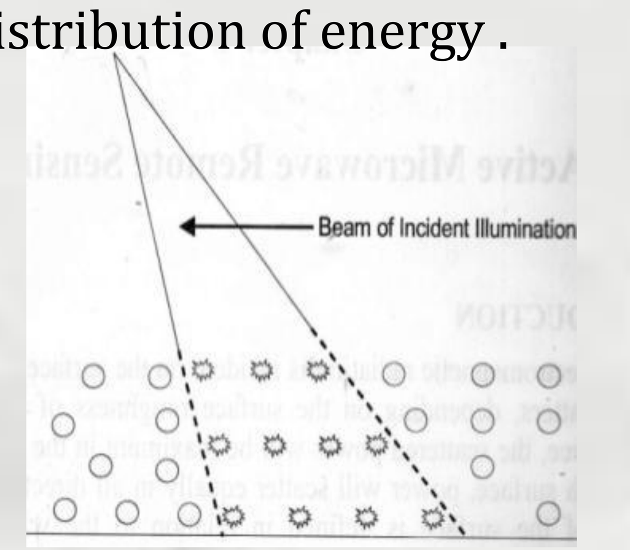
Scattering Behavior

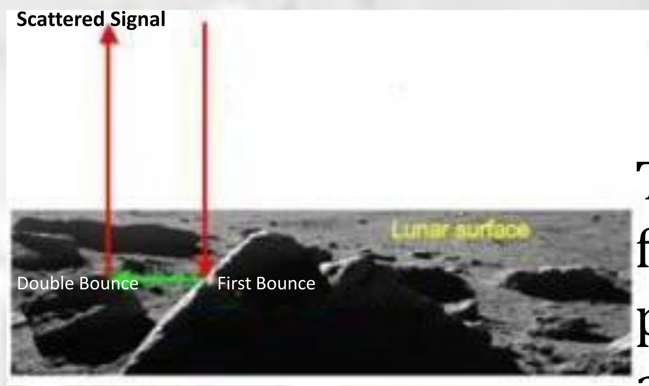
Scattering parameters[3] of a target are influenced by the illuminating frequency, polarization, illumination angle, dielectric and conductive properties of the target. When EM wave impinge from above a boundary surface between two semi-infinite media, a portion of the incident energy is scattered back and the rest is transmitted into the lower medium.



If the lower medium is homogenous, the scattering takes place at the surface boundary, and is referred to as **surface scattering**

If the lower medium is inhomogeneous then the scattering takes place within the volume of the medium. **Volume Scattering** causes the redistribution of energy .





The **double-bounce** scattering is from two surfaces. The reflected pulse hits both surfaces one after the other.

The Scattering behavior of Plato crater has been observed using different decomposition techniques like m-delta and m-chi[4]decomposition which represent the combination of surface, double bounce and volume scattering in RGB format.

Conclusion

This decomposition 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. The decomposition image over S-band data shows less roughness when it is compared with the decomposition image of X-band. 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.

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.

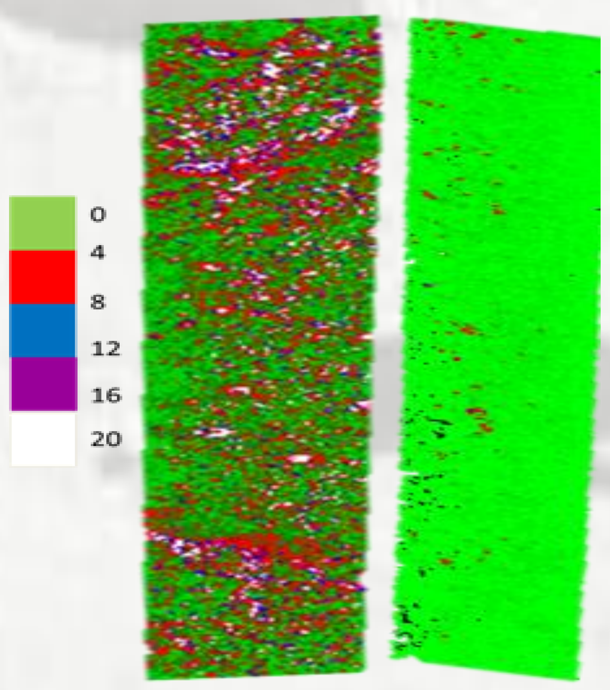


Fig.3 Illustrate the Dielectric constant over S-band and X- band

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[6] data.

References

[1]http://ode.rsl.wustl.edu/moon/productPageAtlas.aspx?product_id=LSZ_05243_2CD_EKU_59N349_V1&prouct_idGeo=12806242

[2]http://ode.rsl.wustl.edu/moon/productPageAtlas.aspx?product_id=LXB_01412_2CD_EIU_50N350_V1&product_idGeo=11903208

[3] OPN Calla "Microwave Remote Sensing" Defence Research & Development Organisation, Ministry of Defence, India.

[4] Raney, R. K., J. T. S. Cahill, G. W. Patterson, and D. B. J. Bussey (2012) "The m-chi decomposition of hybrid dual-polarimetric radar data with application to lunar craters", J. Geophys. Res., 117, E00H21, doi:10.1029/2011JE003986.

[5] B.A. Campbell, J.A. Grant, and T. Maxwell "Radar Penetration In Mars Analog Environments" Center for Earth and Planetary Studies, Smithsonian Institution, Washington, DC 20560.

[6] Yong-Chun Zheng, Y. L. Zou , K. L. Chan , K. T. Tsang, B. Kong , and Z. Y. Ouyang "Global brightness temperature of the Moon: result fromChang'E-1 microwave radiometer"

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