LITHOLOGICAL DISCRIMINATION OF REINER GAMMA USING REMOTE SENSING TECHNIQUES

Adnan Ahmad[1] and Archana M Nair[2], [1]Department of Civil Engineering, Indian Institute of Technology, Guwahati, Assam, India Email: adnan176104005@iitg.ac.in.

Introduction

The Reiner Gamma region on the nearside of moon (7.5 N, 301.4 E) has an uncommon surface feature called "lunar swirl." Lunar swirls regions have a higher albedo than the surrounding region lunar surface with a magnetic field [1]. Reiner Gamma's magnetic field strength measured from the elevation of 28 km is approximately 15 nT. On the lunar surface, it is one of the strongest localized magnetic anomalies [2]. The magnetic strength of this region may be enough to develop a mini-magnetosphere, it could deflect the solar wind. The solar wind can darken the lunar surface, the magnetic field could be the reason of the albedo feature of this region[3]. In the present study, mineralogical mapping of Reiner Gamma region was attempted to know the variation in mineralogy of this unusual feature with respect to its surroundings.

Mineralogical mapping of the surface helps in understanding the evolution and composition of the crust of the moon [4]. Spectroscopy is the analytical technique that can be used to identify minerals especially remotely based on measuring the amount of light absorbed or reflected by a sample at a given wavelength. The different types of absorption processes and wavelength dependence allow us to understand about the minerals chemistry [5]. In this study, we examine the lithology of the Reiner gamma in order to find out the distribution of minerals like olivine and pyroxenes over the region using M3 data of Chadrayaan-1 mission.

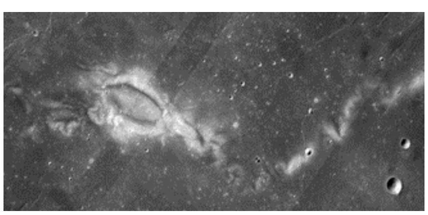


Figure 1: Study Area Reiner Gamma

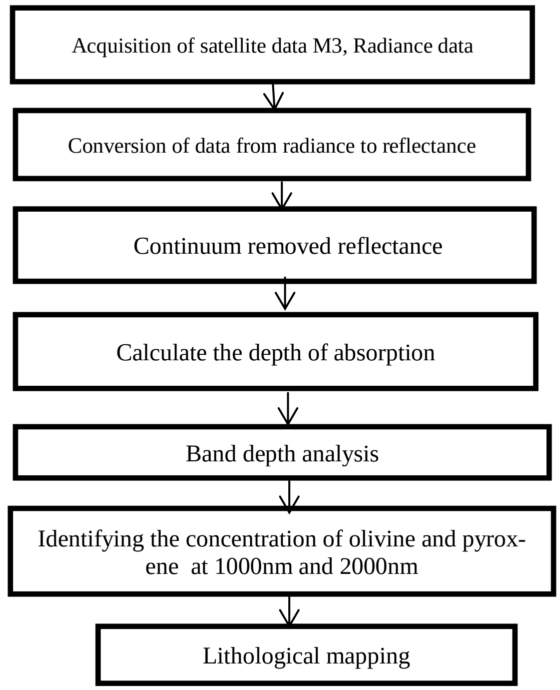
Methodology

The Moon Mineralogy Mapper (M3) Level-1B on board Chandrayaan-1 mission data has been used to study the mineralogy of Reiner gamma region. Olivine has absorption features at 1 µm wavelength and Pyroxene is characterized by two distinct absorption features at 1 µm and 2 µm that vary according to the composition[6]. With the increase in the concentration of Fe and Ca the absorption feature of the spectra shift towards longer wavelength[7]. The band depth (BD) is computed using formula given by [8].

$$\text{Band depth} = 1 - R_b/R_c,$$

Where, R_b is the normalized reflectance spectrum at band center and R_c is the continuum removed reflectance value at same band center.

Flow Chart:



Result and Discussion

The M3 has been processed to obtained the continuum removed reflectance data. The continuum removed spectra of different location has been shown in figure 2. The Band depth analysis has been obtained for Reiner Gamma at two band centers as shown in figure 3 for 1 µm and 2 µm respectively. BD at 1 µm band center represents the presence of both olivine and pyroxene whereas BD at 2 µm band center represents the presence or concentration of only pyroxenes. It has been observed from BD at 1 µm band center as shown in figure 3 (b) that the highest absorption is shown in blue colour towards the central part of swirl. BD at 1 µm band center can be due to olivine or pyroxenes as both shows characteristic 1 µm absorption feature. Therefore, the image is closely analyzed along with BDA at 2 µm band center, which represent only pyroxenes. It was found that both images show different pattern suggesting 1 µm BD to be representative of only olivine and not pyroxenes. Hence, it could be assumed that the concentration of olivine is likely to be more at the central region of

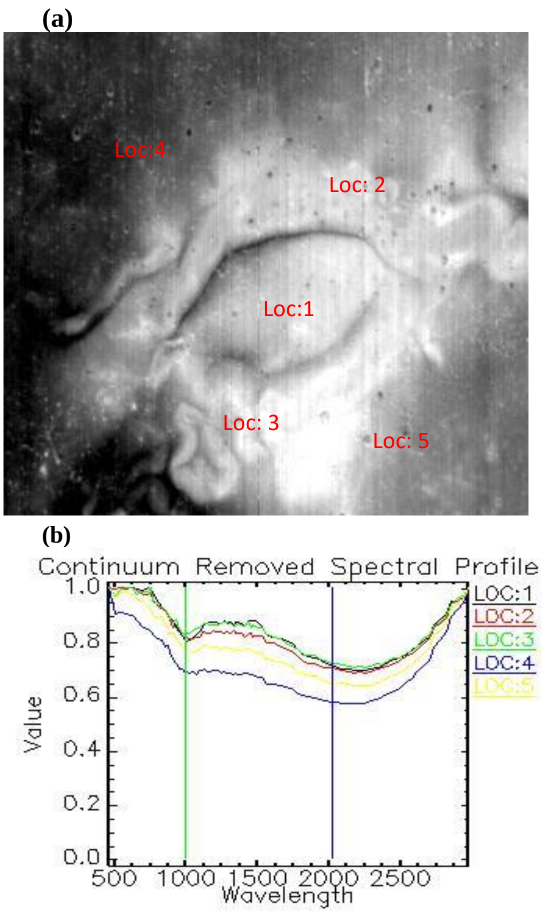


Figure 2: (a) Continuum removed M3 image of Reiner gamma (b) Continuum removed spectra of different location.

swirl as compared to the surrounding region. The variation of pyroxene could be analyzed using BD for 2 µm as shown in figure 3 (c) and (d) with low concentration of pyroxene obtained around the central region of the swirl and high concentration of pyroxene towards the western part surrounding the swirl. The iron and magnesium concentration is more in the regions where pyroxene and olivine has been obtained.

Conclusion

The mineralogical analysis of M3 hyperspectral data of the lunar swirl Reiner Gamma indicates that the brightest areas of the swirls have the stronger mafic absorptions especially due to olivine. The presence of olivines are mainly concentrated over the region where high albedo is obtained whereas pyroxenes are concentrated more towards the surrounding region. Higher concentration of olivine and pyroxenes suggest higher concentration of iron and magnesium. High magnetic field of the central swirl region suggest higher concentration of iron.

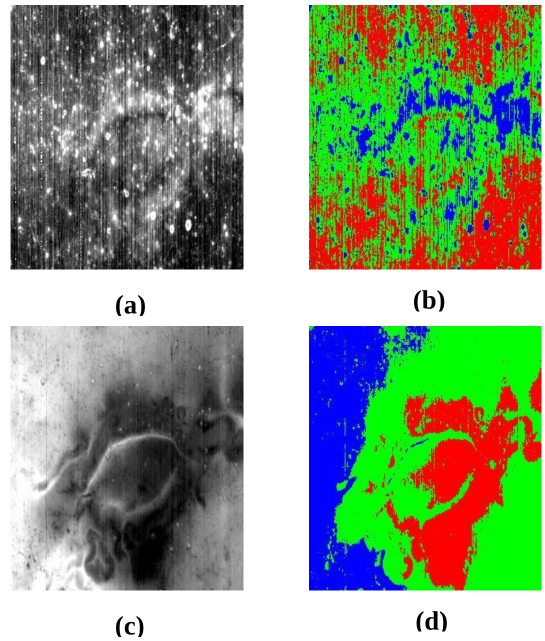


Figure 3: (a) Grey scale image is showing BD for 1µm (b) Density slice image of BD for 1µm(c) Grey scale image is showing BD for 2µm (d) Density slice image of BD for 2µm.

References: [1] Blewett et al., (2011), Lunar swirls: Examining crustal magnetic anomalies and space weathering trends, JGR, 116.[2] Richmond et al. (2003) Correlation of a Strong Lunar Magnetic Anomaly with a High-Albedo Region of the Descartes Mountains. GRL 30 (7): 48.[3] Hood & Williams C. R. (1989) The Lunar Swirls-Distribution and Possible Origins. Proceedings 19th Lunar and Planetary Science Conference,Cambridge University.[4] Sivakumar et al., (2017) Lunar surface mineralogy using hyperspectral data: Implications for primordial crust in the Earth–Moon system, Geoscience Frontier, 8.[5] Clark, R. N., (1999) Spectroscopy of rocks and minerals, and principles of spectroscopy. In Remote Sensing for the Earth Sciences,John Wiley, New York, 3, 3–58 [6] Hunt,and Salisbury, (1970) Visible and near infrared spectra of minerals and rocks. I. Silicate minerals, Mod. Geology 1, 283-300.[7] Nair and Mathew (2012), Lithological discrimination of the Phenaimata felsic–mafic complex, Gujarat, India, using the ASTER,IJRS, 33:1, 198-219.[8] Clark, & Roush (1984). Reflectance Spectroscopy, Quantitative Analysis Techniques for Remote Sensing Applications, J. Geophys. Res., 89, 6329–6340.