LITHOLOGICAL AND CHRONOLOGICAL DISCRIMINATION OF LUNAR MARE MOSCOVIENSE BY USING LUNAR ORBITAL DATA. [1]A.Karthi, and [2]S.Arivazhagan, Centre for Applied Geology, The Gandhigram Rural Institute – Deemed to be University, Gandhigram, Dindigul, Tamilnadu, India – 624302 ([1]karthiatkj@gmail.com, [2]arivusv@gmail.com).

Introduction: Mineralogical and chronological studies could provide an important clues like compositional variations and chronological information of the geological units which reveal the origin and evolution of specific lunar regions. Nearside and farside of the moon are very different in their topography and geologic point of view. Thus resulting as low reflectance of nearside of the moon is dominated by basaltic mare deposits whereas farside high albedo deposits of anorthosite is remnants of the Moon's original crust. However, the farside regionally have some mare regions such as Moscoviense, Orientale, Ingenii and some craters with SPA. The Moscoviense is dominantly filled by mare surface as well as contains the feldspathic assemblages over the ring (located at the rim of the basin) [1,2]. Hence, the mare Moscoviense would be a proper location from farside to investigate the mare deposits which is considered as a mantle catcher in the surface of the moon [3,4,5]. The Moscoviense provides a hint to the lunar mare terrain and an opportunity to explore the geologic context of initial lunar crustal development and modification. In the present study, we have done extensive analysis such as compositional and chronological characteristics of the Moscoviense basin.

Study area: The multi-ring impact basin of mare moscoviense is situated on the lunar farside of the moon within the highland topography and it is covering about 445km in diameter. The Moscoviense is one of the prominent mare-filled basins on the lunar surface which is holding key insights about volcanism of farside [4, 6]. The study aims to map the compositional variability and chronological understanding of the Moscoviense basin.

Data: The Chandrayaan-1 hyperspectral data of Moon Mineralogical Mapper (M^3) has global mode in 85 bands with a spectral interval of 20-40nm and spectral range of 400-2500nm with spatial resolution of 140m/pixel [7] have been utilized for mineral mapping and compositional discrimination in the Moscoviense. Lunar Reconnaissance Orbiter (LRO) - Lunar Reconnaissance Orbiter Camera - Wide Angle Camera (LROC - WAC) is a 7-color push-frame camera to map the Moon at a uniform resolution of 100m/pixel [8] is used in the present study for chronological mapping.

Methodology: The Standard Band Ratio (SBR) technique is used to outline the various lithological features of the moscoviense [11,18]. The integrated 1µm and 2µm band depth methods are used as primary resources for evaluate mineralogy of surface of moscoviense, in particularly, mafic minerals like olivine and pyroxenes [9, 10, 11]. The crater size frequency distribution (CSFD) method is used to map the ages of the mare Moscoviense units.

Results and discussion: The Standard band ratio map (Fig.1) shows the yellow and orange colors which represent the mature mare units. The dark blue color is indicating the highland areas with mare implications around the basin whereas the cyan color shows the high mafic index. The Red color is exposing the highland materials. The spectral characterization of the SBR mature mare units show the strong asymmetrical absorption at 1030nm along with broad absorption observed at 2137nm due to CPx absorption, moderate plagioclase absorption at 1250nm, and weak Ti-ilmenite absorption noticed at 1458nm which indicates the basaltic composition [11,12,13, 14, 15]. The mafic units show the weak Fe^{2+} absorption at 810nm, the strong asymmetrical absorption at 1010nm along with broad asymmetrical absorption observed at 2058nm due to CPx and the moderate Ti-Ilmenite absorption at 1490nm which represent the basaltic composition. The highland lithology is showing the Fe^{2+} absorption near 800nm, moderate plagioclase absorption near 1200nm and the moderate ilmenite absorption observed at 1548nm, which represent the anorthositic composition with ilmenitite contamination [19].

The 1µm integrated band depth (IBD) shows olivine and pyroxene presence at central, southern and western portions (Fig.2.i). The 2µm integrated band depth (IBD) is showing the strong pyroxene absorptions at central and southern portions of the basin (Fig.2.ii). Based on the 1µm IBD results, M^3 spectral profiles were taken for the Olivine and Pyroxene exposures (Fig.2.iii.a,b). The broad and deep Olivine absorption observed at 1050nm [16]. The Olivine – Pyroxene Mixtures (OPM) spectra is showing strong narrow asymmetrical absorption at 1050 nm and moderate broad absorption at 2000nm [17,18]. Based on the 2µm IBD results, the spectral profiles were taken for characterizing the high calcic pyroxene (HCP) and Low calcic pyroxene (LCP) (Fig.2.iii.c). The HCP shows the strong narrow symmetrical absorption at 1000nm and moderate absorption at 2100nm. LCP shows the strong asymmetrical absorption at 900nm and broad absorption at 1850nm.

The mare Moscoviense basin has been divided into four units based on geology (unit1-4). Unit -1 shows the Imbrian age (3.65Ga). Unit-2 gives the age about 3.57Ga which displays the middle Imbrian and may indicates the younger and intermediate mare deposits. Unit-3 is showing age about 3.8Ga which indicates end

of the Nectarian as well as beginning of Imbrian age. Unit-4 shows the age about 3.92Ga, which notifies nectarian age. The CSFD Absolute Model Ages image is shown in the Fig.3.

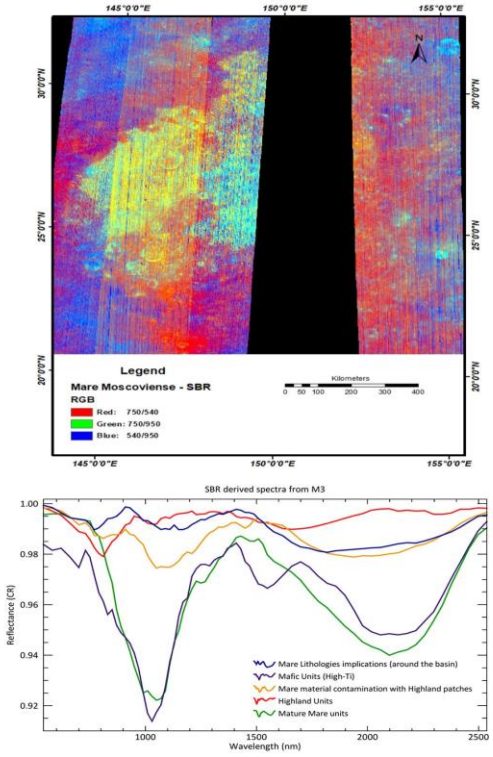

Figure 1. SBR map and their respective lithological spectra

Conclusion: In the present study, compositional and chronological discrimination have been done with the assist of SBR, IBD and CSFD method. The M^3 SBR technique reveals the various lithological characters and their boundaries such as of mature mare units, mafic units, mare material contamination with highland units and highland lithology and validated by characterizing of different basaltic and anorthositic spectral features. The 1 µm & 2 µm IBD show the mineral compositions of Ortho and Clino pyroxenes, Olivine and Olivine-pyroxene mixtures. According to this, the presence of Olivine and Olivine-Pyroxene mixtures (OPM) which could indicate the possibility of relatively thin crust on the Moscoviense [11]. The CSFD chronological studies reveal that, the major activity (impact cratering along with robust mare emplacement) of the basin were occurred during 3.4Ga-3.9Ga age.

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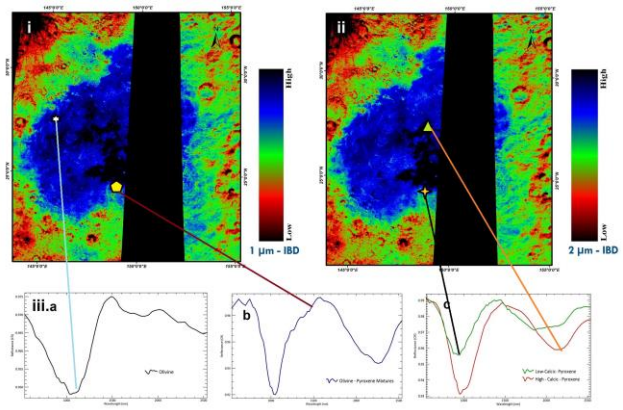

Figure.2. i. 1µm IBD map, ii. 2µm IBD map, iii.a. Olivine spectra, b. Olivine – Pyroxene spectra, c. pyroxene spectra

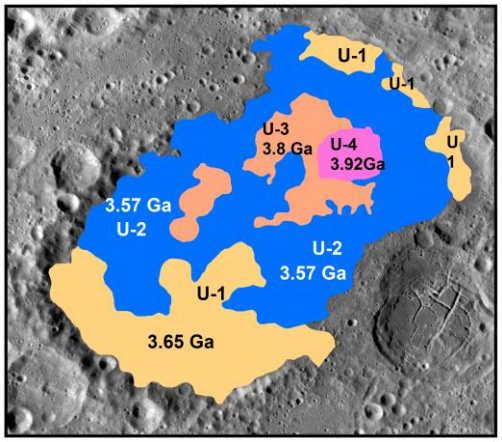

Figure.3. CSFD AMA image of Moscoviense

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