Mineralogical Mapping of Dionysius Crater using Moon Mineralogy Mapper data.

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Abstract: This investigation infers mineralogical study of the Dionysius crater of Moon using hyperspectral data of Moon Mineralogy Mapper (M^3) from Chandrayaan-1 mission. Band ratio technique has been used to generate mineralogical map of the crater. The crater is located at Mare-Highland boundary and exposes material from Mare and highland area. Central and western part of the crater shows presence of Fe-spinel bearing mineralogy which belongs to Mg-suit of highland rock material and western rim exposes high calcium pyroxene bearing material which represents basalt at the rim of Mare Tranquillitatis.

Index term: Crater; Mineralogy; Hyperspectral remote sensing; Moon.

I. Introduction:

Dionysius Crater is centered at (2.8°N, 17.3°E), on the south-western limb of Mare Tranquillitatis, on the eastern near side of the Moon. Its diameter is 18.4 km [1]. It is a Copernican aged crater with the brightest crater albedo and the characteristic long-darker ray system. Dionysius is situated on mare-highland boundary, its dark ray system spreads over highland and mare region. A feasible dark ray system of the Copernican-aged crater Dionysius (Fig. 1) implies impact melt deposits and dark primary ejecta [2], [3]. Later, it was concluded that dark rays of Dionysius are dominated by mare basalts, not glassy impact melts [4]. For the first time, this crater has been studied using hyperspectral data in this work.

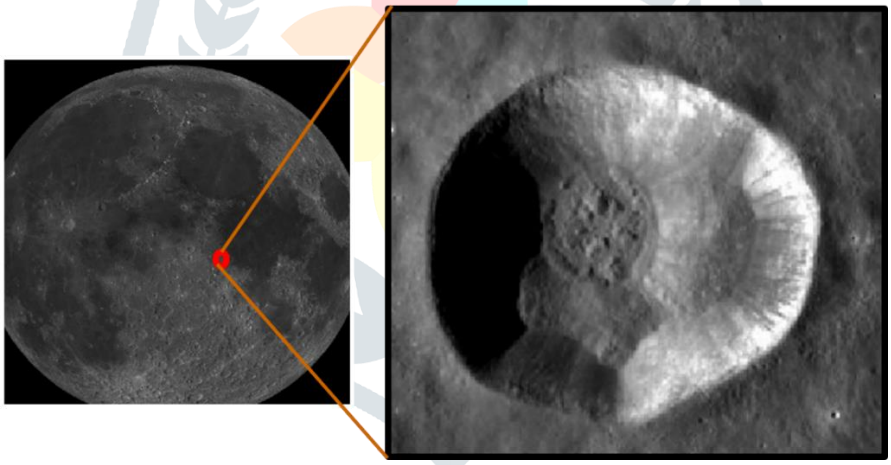

Figure 1: LROC WAC image shows location map of the Dionysius crater.

II. Data set and Calibration:

Hyperspectral data from Moon Mineralogy Mapper (M^3) [5] instrument onboard India's first Lunar mission-Chandrayaan-1 is used for the compositional analysis. M^3 operate in VNIR spectral region, ranging from 540 nm to 3000 nm with 85 contiguous bands and has 140 m/pix spatial resolution at 100 km orbital altitude [6]. M^3 level-2 data which is pixel located, thermally corrected, photometrically corrected [7], reflectance data with optical period-OP1A and OP1B from the 100 km orbital altitude is acquired from PDS Geoscience node (https://ode.rsl.wustl.edu/moon/indexProductSearch.aspx). The mosaic generated using M^3 data for Dionysius crater is shown in Fig.2.

III. Methodology:

To study the compositional variation of the crater, band ratio technique has been used. Band ratio technique for primary identification of pyroxene, spinel and plagioclase mineral, was applied from Pieters [8]. Red channel was assigned to pyroxene ratio image, Green colour was assigned to spinel ratio image and blue was assigned to plagioclase ratio image to generate False Colour Composite (FCC) image (Fig. 3). Spectral reflectance profile was calculated to identify mineral and mineral mixture from the locations given in Fig. 3.

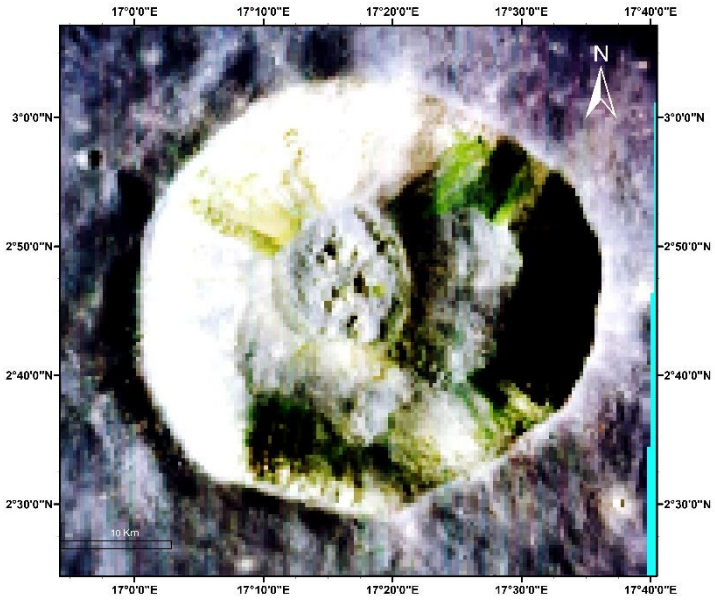

Fig. 2: M^3 mosaic of Dionysius crater. Red channel is assigned 930 nm band, Green channel is assigned 1250 nm band and blue channel is assigned 2000 nm band.

IV. Results and Discussions:

Green colour in the FCC image shows presence of Fe-spinel bearing material. Blue colour shows plagioclase anorthosite bearing highland material. Yellow colour shows presence of high calcium pyroxene bearing material. This Copernican aged crater is situated on Mare-Highland boundary of Mare Tranquillitatis. It exposes material from mare and highland both the area. Western part is exposing mostly the highland material such as spinel and anorthosite. While eastern half part of the crater exposes HCP rich mare material.

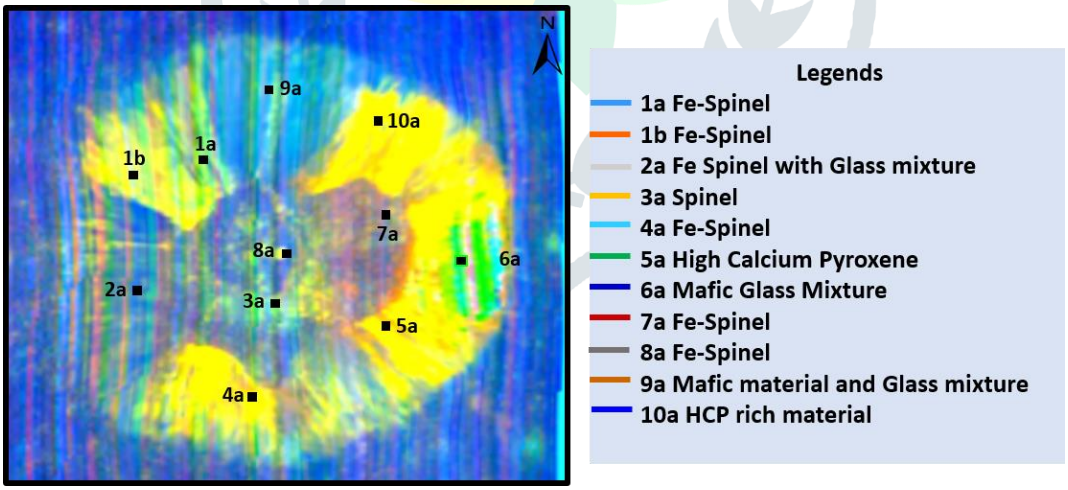

Figure 3: M^3 False colour composite image generated using band ratio technique. Marked boxes in the image shows location of the reflectance spectra collected and presented in the graph of Fig. 4. Legends are colour coded according to the representative graph.

North east part, marked with 1a, 1b, 4a and 7a shows presence of Fe spinel bearing material. Western part with blue colour in FCC image shows presence of Fe spinel with glass mixture that is marked with 2a. Floor region marked with 8a and 3a also shows presence of spinel bearing material which gives green colour in FCC image. Spectra 6a and 9a is showing presence of mafic glass mixture at northern wall and eastern wall of crater. North-East and south-east wall show presence of HCP rich material presented with the reflectance spectra (Fig. 4A, 4D) which have been collected from location 10a and 5a. Normal and Continuum removed reflectance spectra for all the marked location shown in Fig. 3 is presented in graph 4A-F.

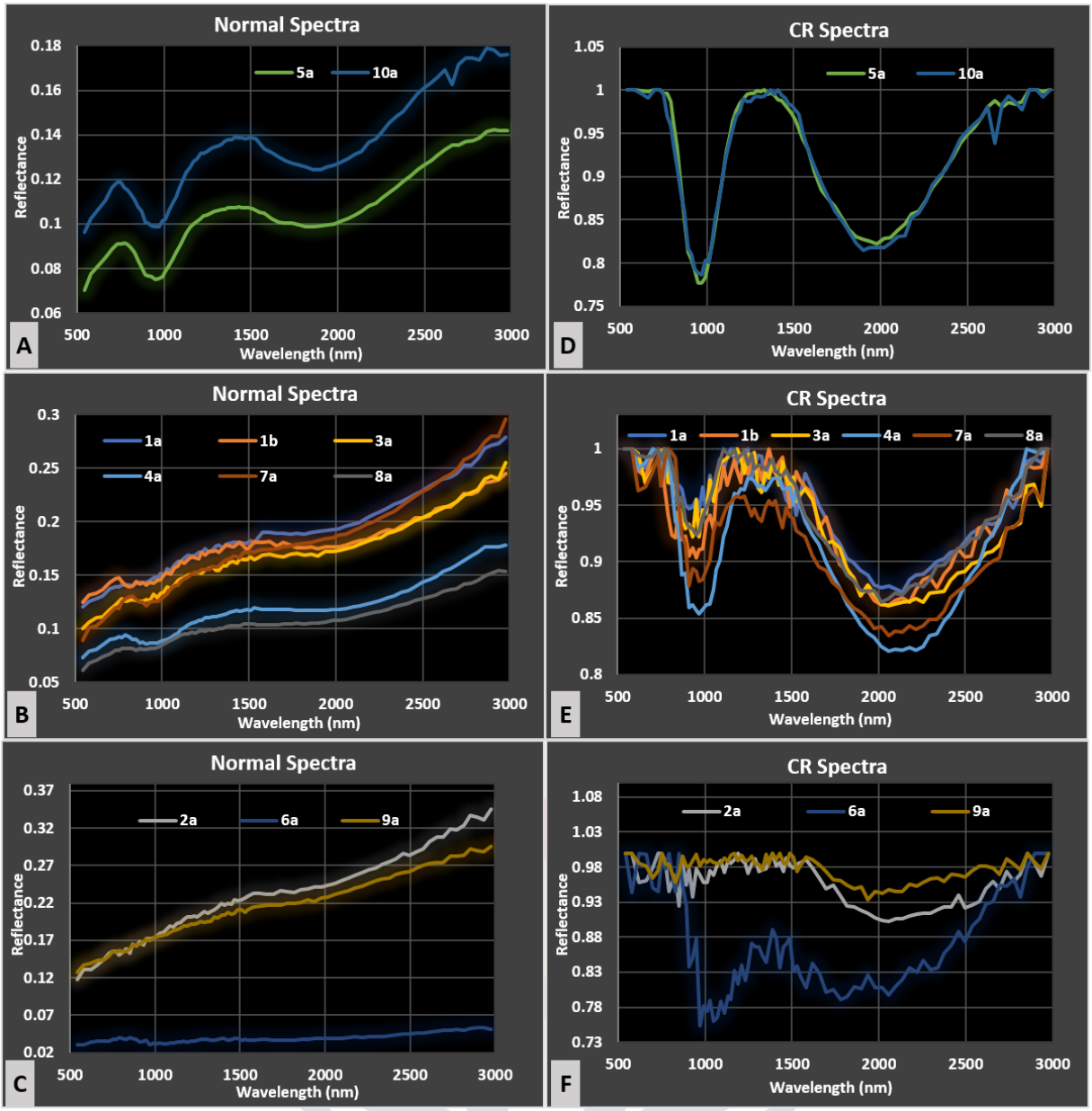

Figure 4. A; B; and C shows average normal reflectance spectra for corresponding HCP; Fe-Spinel and Glass-mixtures and D; E; F shows continuum removed average reflectance spectra for corresponding HCP; Fe-Spinel and Glass-mixtures. Legends for the graphs is given in Fig. 3.

V. Conclusion:

Dionysius crater exposes highland material in the western part, which shows presence of Fe-spinel bearing material that exposes highland Mg-suit of rock type. Eastern part shows presence of high calcium pyroxene bearing material which exposes basalt material from the Mare Tranquillitatis. Central part of the crater floor shows presence of Fe-spinel bearing material. Northern most, eastern most and western most wall-rim part shows presence of mafic glass mixture, which may have produced due to shock induced processes by impactor on the pristine mafic material present in the area.

VI. References:

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