Compositional variations of Mare Humorum Basin: Insights into basaltic pyroxene chemistry.

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Introduction: Mare Humorum, centered at 39ºW 23ºS, is located in the lunar nearside. It is bounded by prominent craters with Gassendi in the north, Hippalus in the east, Doppelmayer and Vitello in the south [1]. Mare Humorum is characterized by concentric mare ridges, concentric rilles [2]. It comprises geological units ranging in age from 2.79 to 3.51 Ga [3]. Nature of Pyroxene chemistry for Humorum basin is reported [4] but a detailed mapping on the spatial variation of pyroxene composition in the Humorum basin is lacking. Therefore, this work is aimed to bring insights into the compositional units of the mare Humorum and their remote geochemistry based on pyroxene chemistry and pyroxene thermometry.

Datasets and Methodology: Moon Mineralogical Mapper (M3) spectrometer on-board Chandrayaan-I datasets (Level 2, Optical Period OP1B, Global mode) are used for this study. For mapping pyroxene composition, the following spectral parameters are used: band center I (BC1) at ~1000 nm; band center II (BC2) at ~2000 nm; integrated band depth I (IBD1); integrated band depth II (IBD2) and band area ratio (BAR). The wavelength of the data is kept up to 2500 nm for this work. Continuum Removal of the M3 reflectance spectra is obtained by fixing the shoulders at 750nm, 1548nm and 2497nm, followed by fitting a polynomial of third degree at 830nm to 1189nm for BC1 and at 1778nm to 2337nm for BC2. Minimum of the polynomial is assigned as BC1 and BC2 respectively. Then, IBD is estimated for spectral subset of 750.4nm to 1548.9nm at band I and 1548.9nm to 2497.1nm at band II. Lastly, BAR is calculated as ratio of area under curve of BC2 to area under curve BC1.Spectral maps for each of the parameters are derived namely BC1, BC2, IBD1, IBD2, BAR. Also, several RGBs are prepared to investigate and understand the spectral behavior.

Results: The RGB (BC1 as red, BC2 as green, and BAR as blue) is found reliably useful in bringing out the spectral characteristics and differentiating the mare units (Figure 1). Accordingly, five mare units are recognized. Figure 1(b) shows the interpreted spectral units (Unit A to Unit E) in Mare Humorum and similar spectral units and filled with same color. The representative spectra and their corresponding continuum-removed spectra of the spectral units are shown in Figure 2. Figure 3 shows the scatterplots of BC2 versus BC1 for the different spectral units A to E.

Discussion: Unit A shows a prominent greenish-blue to magenta tones, indicating larger values of BC1, BC2 mixed with high BAR. Unit B shows very bright yellow-greenish tones, implying higher values of both BC1, BC2. Unit C which are bright ejecta ray craters show reddish - blue tone indicating high BC1 accompanied by high BAR in crater surroundings (Figure 1). Unit D shows very bright red tone indicating very high BC1 and almost absence of BC2 and BAR (Figure 1(a)). This is more evident from Figure 2. Unit E shows green-bluish tone indicating larger values of BC2 mixed with high BAR.

Summary and Future work: The preliminary analysis of the spectral parameters derived indicates that in the central part of the Humorum basin area (Unit B) there is likely dominance of Fe^{2+} bearing pyroxene as both BC1 and BC2 shifts towards longer wavelength (Figure 3). And as we move towards the rim (Unit A and E) there is a trend of increasing Ca^{2+} bearing pyroxene as BAR values increases significantly. Detailed work is in progress investigating the spectral parameters with pyroxene composition and thermometry to understand the formation and the geologic processes of the mare basaltic units in Humorum basin.

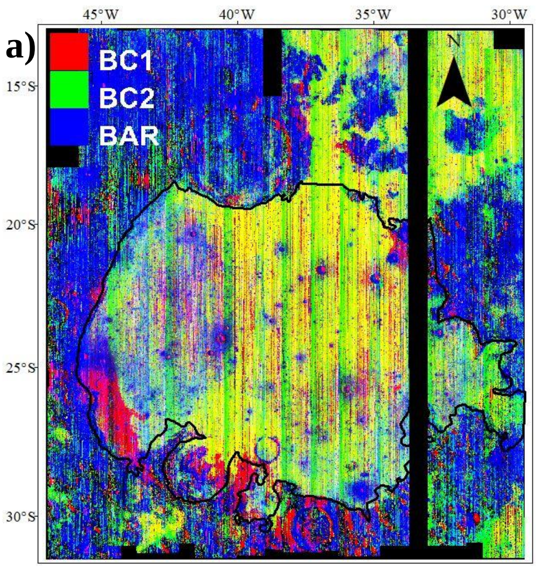

Figure 1(a): RGB composite of Humorum region.

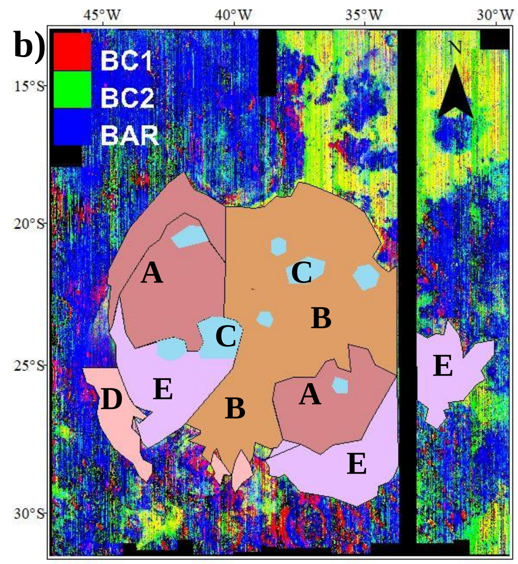

Figure 1(b): RGB composite with similar spectral units filled with same color.

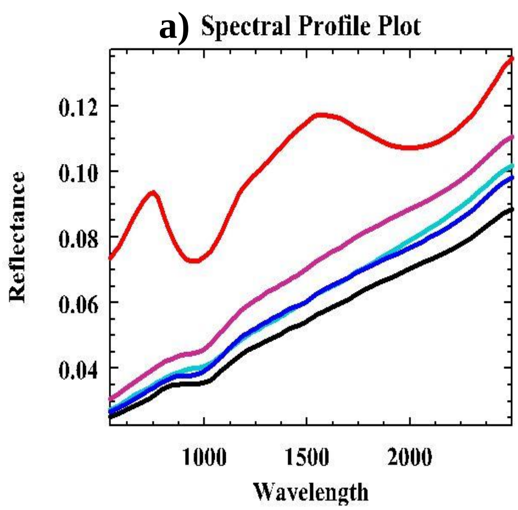

Figure 2(a): Reflectance profile of the units A to E.

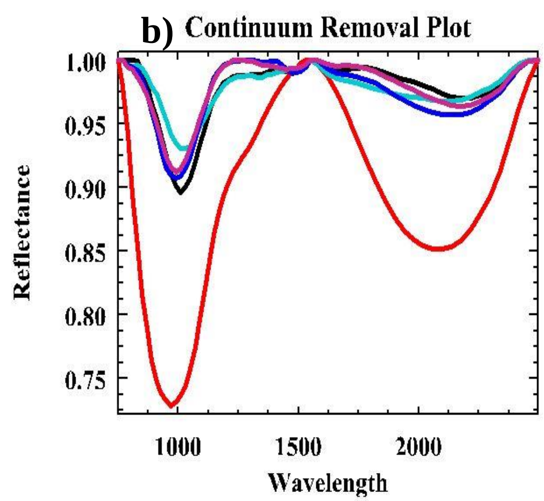

Figure 2(b): Continuum removal spectra of units A to E.

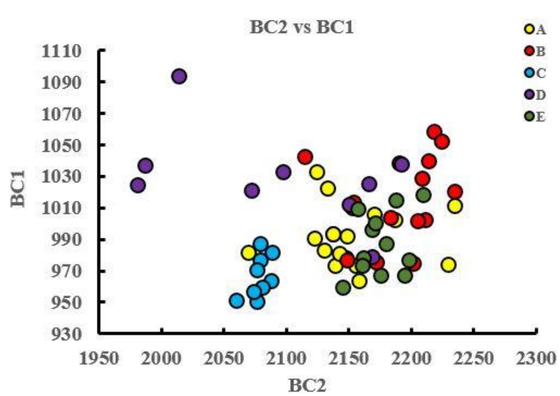

Figure 3: BC2 vs BC1 of the units A to E.

References: [1] Tjia, H. D. (1976) Physics of the Earth and Planetary Interiors, 11.3:207-215. [2] Hiesinger, Harald,et.al (2000) JGR Planets, 105.E12:29239-29275. [3] Hackwill, Terence, John Guest, and Paul Spudis (2006) Meteoritics & Planetary Science, 41.3: 479-488. [4] Thesniya, P. M., and V. J. Rajesh (2020) Planetary and Space Science, 193: 105093.