COMPOSITIONAL DIVERSITY MAPPING OF RIMA HYGINUS AND HYGINUS CRATER REGION.

P. R. Kumaresan[1], J. Saravanavel[2], K. Palanivel[3], [1]Research Scholar, [2]Assistant Professor, [3]Associate Professor, Centre for Remote Sensing, Bharathidasan University-Khajamalai Campus, Tiruchirappalli - 620023 Tamil Nadu, India, email: prkumaresan@bdu.ac.in.

Introduction: Hyginus Crater and Rima Hyginus are significant features of Moon with volcanic origin. Volcanism is not only restricted to Earth, but it is also found in other planetary bodies. The Earth closest neighbor Moon has major and minor features related to volcanic origin such as mare region filled with lava flows, volcanic domes, rilles, pyroclastic deposits, and etc. However, presently no active volcanism in the lunar surface [1]. Hyginus Crater and Rima Hyginus region located south to the Mare Vaporum on near side of the moon (Fig.1). The Moon Mineralogy Mapper (M^3), scientific payload of Chandrayaan-1, which is extensively used to bring out the detailed lithological discrimination and mineral identification in lunar surface [2]. The M^3 imaging spectrometer providing data in the visible to the near-infrared spectrum of 500 to 3000 nm [3]. Major lunar minerals like olivine, pyroxenes and plagioclase are having significant absorption features in this spectral domain. In the present study, the hyperspectral analysis of M^3 data revealed the mineralogical and lithological diversity of Hyginus Crater and Rima Hyginus region.

Morphology: Crater Hyginus and Rima Hyginus forms a unique volcanic feature in the lunar surface. The topographical profiles drawn using the Lunar Reconnaissance Orbiter - Lunar Orbiter Laser Altimeter Elevation Model 118m (LDEM GDR) data revealed the various significant morphology of this region. Rima Hyginus is a collapsed lava tube and channel like structure which run for a length of 220 km and its width vary from 2 – 3.5 km [4][5]. The depth of the rille varies from 65 – 315 m and depth increases towards from east to west (b-b', Fig.1). Along this rille, 25 number of non-impact volcanic origin craters with diameters vary from 0.9 to 10.6 km were identified [6]. Amongst these, a largest rim less one is Hyginus crater which is a caldera of volcanic eruption and surrounded by thin pyroclastic deposits to a radius of 15-20 km (a-a', Fig.1). A small volcanic dome / cone like feature also noticed within the study area (c-c1, Fig.1)

Compositional Diversity Mapping: Lithological and mineralogical variation of the study area were brought out by generating The RGB color composite using modified band shape algorithms with different band combination is shown in figure 2. The bs, bc, bt and br at critical wavelengths are calculated, with ratios between ((R750.44+ 1149.68) /930.10) nm, (R930.10 / R1149.68) nm, (R1149.68 /750.44) nm respectively. The band shape algorithms such as band curvature (bc), band tilt (bt) band strength (bs) are analyzed to understand the Compositional diversity of this region.This technique successfully used for Clementine data [7]. This has been modified according to the spectral character of M^3 data and the same used to discriminate the compositional diversity of the study area. This modified band shape algorithm is distinctly separates the various lithological units of the study area.

The higher values of band curvature (bc) indicates presence of pyroxene mostly pigeonite and the same appears as red to dark rose color in the RGB color composite image generated using bc, bt and bs. The most of the walls of rilles exhibits pigeonite in composition (1). Higher band tilt value in composite image generally appearing as bright yellowish green color indicates the pyroclastic deposits and Mare basalts. The pyroclastic material spread around the crater Hyginus is distinctly visible in the RGB composite (2). Bright yellow color indicates presence of Augite (3) in the study area. The bluish to purple color in composite image indicates the higher band strength which probably indicates the low mafic and weathered Anorthosites and soils derived from the high land region (4, Fig.2).

Further, the spectra collected from the M3 data along the above various lithological units is shown in figure 3. Generally, pyroxene group of minerals has unique absorption features along 1000 nm and 2000 nm and depend upon the position and peak of absorption it has been categorized into norite, Augite and Pigeonite [8]. Pigeonite is a type of clinopyroxene is concentrated all along the walls of Rima Hyginus and crater Hyginus which has strong absorption at 900 nm and 2000-2100 nm (1, Fig.3). The most of the small craters found in this region are also concentrated with Pigeonite and also exhibit red color in RGB color composite image (1, Fig.2). Whereas for Augite, yellow in color composite image shows strong absorption at 1000 nm and 2300 – 2400 nm [9] (3, Fig.3). The Augite disseminated in the floor of the crater Hyginus and also as speckles in Mare basalts (3, Fig.2). Further, a small volcanic dome like structure found within the mare land (c-c', Fig.1, 3, Fig.2) also made up of augite. The spectra collected from the lunar soils mostly derived from the high land region of low mafic and weathered Anorthosites are distinctly exhibit no absorption or least absorption along 1000 nm (4, Fig.3). The spectral signature of pyroclastic materials of crater

Hyginus as well as the mare basalts of the study area are almost very similar indicates both came from the same source (3&5, Fig.3). The image analysis carried out using the M^3 data vividly explains the various lithological and mineralogical diversity of the study area.

Conclusion and Summarys: The spectral and spatial resolution of M^3 has opened a new depth of understanding that was not possible in the past. Newly developed modified band shape algorithms gives clear information about the rocks and mineral diversity of Hyginus Crater and Rima Hyginus. The spectra of various lithological and mineralogical units derived from M^3 data perfectly match with the RELAB spectral library. Volcanism in Rima Hyginus and Hyginus crater region is enriched with pyroxene of Pigeonite and surrounded by the pyroclastic deposits on the Hyginus crater. The RGB Color composite generated using the modified band shape algorithms for M^3 data can be used for lithological and mineralogical mapping of other unexplored areas of lunar surface.

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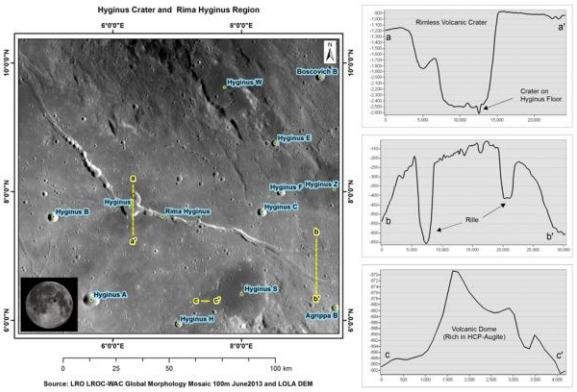

Figure 1: Study area with topographic profiles.

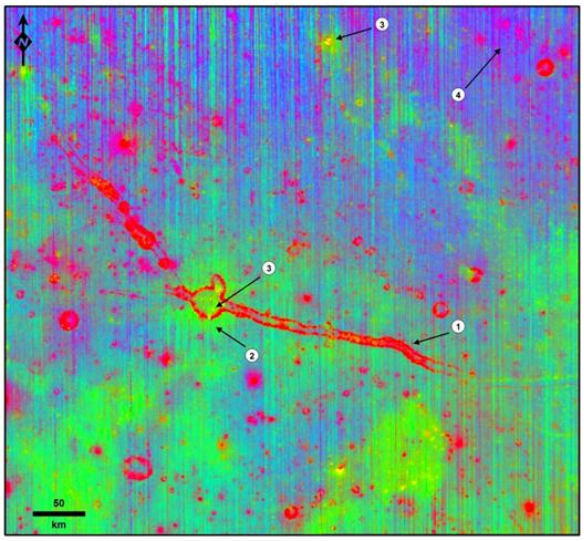

Figure 2: Modified band shape algorithm color composite of Hyginus Crater and Rima Hyginus region.

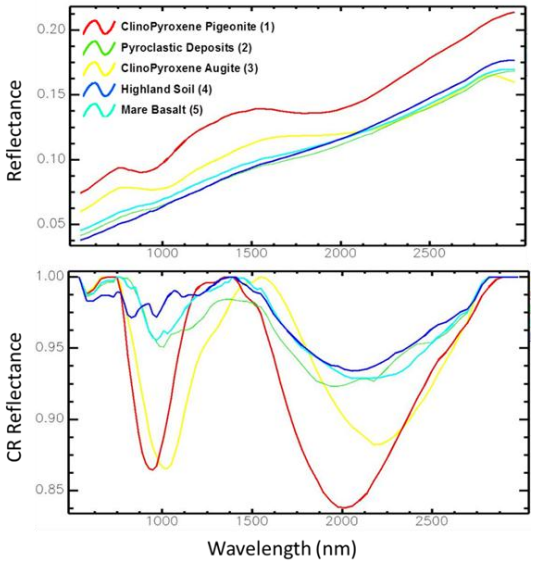

Figure 3: Spectra of various lithological units.