STUDY OF CENTRAL PART OF MARE MOSCOVIENSE USING CHANDRAYAAN-1 HYPERSPECTRAL IMAGER (HySI) DATA. Satadru Bhattacharya, P. Chauhan, A. S. Rajawat, Ajai and A. S. Kiran Kumar, Space Applications Centre (ISRO), Satellite Road, Ahmedabad – 380 015 (satadru@sac.isro.gov.in).

Introduction: Spectral study of central part of Mare Moscoviense (Fig.1) has been carried out using Chandrayaan-1 Hyperspectral Imager (HySI) data. Mare Moscoviense (27ºN, 148ºE) is a well studied region in the far side of the moon and is located within ~100 km thick anorthositic crust [1]. Previous workers [2, 3] classified Mare Moscoviense into four basaltic units mainly based on TiO_2 and FeO content by analysing Clementine UVVIS data. Recent studies [4, 5] using high resolution data from Kaguya Terrain Camera established and modified the earlier suggested ages of these mare units. Study of compositional variations amongst different mare units present within large impact basins such as the Moscoviense helps in understanding the compositional heterogeneity of the basaltic source regions. In the present study, mare units have been classified mainly from the perspective of relative dominance of low and high-Ca pyroxene and/or olivine. The name of the mare units are kept unchanged and the nomenclature used by [2] has been followed, except for the youngest unit that was mapped as Ihtm by [2] but has been changed to Ehtm [4] as this unit no longer falls in Imbrian system but in Eratosthenian system.

Data: HySI data from Chandrayaan-1 mission has been used for the present study. HySI collected data in 64 contiguous bands spanning over the spectral range of 421-964 nm at 80 m spatial resolution. Radiance calibrated level 1b data has been used for the present purpose. Radiance data was then converted to reflectance using Relative Spectral Response (RSR) data of 64 HySI filters and convolving the Exo-atmospheric Solar Irradiance values to HySI RSR within the spectral range of 421-964 nm. Finally the reflectance spectra from HySI have been cross-calibrated with RELAB spectra of Apollo-11 bulk soil (Sample No. 10084) using average reflectance spectra from a dark mare region belonging to the high-Ti-rich youngest Ehtm unit in order to correct for the anomalous nature of few HySI channels at the beginning and the end of the spectral range.

Methods: Three band parameters, namely, band curvature, band tilt and band strength [6-8] have been used for lithological discrimination depending upon the nature of the spectral profile. RGB false color composite image has been generated assigning red channel to band curvature, green to band tilt and blue to band strength. These band parameters essentially measure the shape, position and strength of the absorption feature near 1000 nm arising due to electronic transition of Fe^{2+} in crystallographic sites of major rock forming silicates. In the rock type composite image, the low-Ca pyroxene (LCP) rich rocks appear in the shades of red, pink and orange, high-Ca pyroxene (HCP) and/or olivine rich rocks appear green to yellow and anorthositic and/or optically matured surfaces appear in the shades of blue.

Observations: From the analysis of individual spectra and spectral band parameters, four compositionally different units have been identified (Figs. 2 and 3), namely, highland pyroclastic deposits, high-Ca pyroxene rich ancient mare unit (Im), low-Ca pyroxene rich intermediate unit (Iltm) and abundant low-Ca pyroxene rich youngest mare unit (Ehtm). The highland pyroclastic unit appears blue to purple in the rock type color composite image (Fig. 3) indicating anorthositic to noritic anorthositic composition. However, there are few small fresh craters found in this unit that appear yellow to green in the color composite indicating gabbroic composition and therefore hinting towards a mixed nature of the highland crust (Fig. 3). Ancient mare unit (Im) appears green indicating basaltic composition (Fig. 3). Fresh crater within this unit appears bright yellow in the color composite due to the presence of strong 950-nm absorption feature (Fig. 3). The intermediate mare unit (Iltm) appears blue to purple indicating relatively noritic nature of the crust. This unit is optically highly matured and contaminated with highland material, leading to its blue to purple appearence in the rock type composite (Fig. 3). Within this unit, a few small fresh craters rich in low-Ca pyroxene, as evident from strong 900-nm absorption feature (Fig. 2) and red to pink appearance in the color composite, have been found. CSFD deflection of craters of ~1.4 km diameter within this intermediate unit indicates a buried older unit [5] that is younger than the ancient mare unit and more noritic in composition. The youngest mare unit (Ehtm) appears pink in rock type composite indicating highly noritic nature of the crust. This unit is characterised by very low albedo and very high-Ti content as mapped by earlier workers [2, 3]. Therefore, very low albedo of this youngest mare unit may be attributed to the high Ti content in the form of ilmenite.

Conclusions: From the present study, it can be concluded that the early stages of basin formation event might have produced the pyroclastic deposits as observed within the southern part of the basin followed by atleast four phases of basaltic lava flows at different times. CSFD analysis [5] shows that the ancient mare unit (Im, age ~3.9 Ga), buried mare unit (age ~3.7 Ga) and highland contaminated intermediate mare unit (Iltm, age ~3.5 Ga) are temporally separated from each other by ~0.2 Ga. Also compositionally these units show a progressive differentiation trend of the magma source region starting from gabbroic oldest unit to more noritic buried unit followed by comparatively less noritic highland contaminated intermediate unit. Relatively less mafic nature of the intermediate mare unit could also be due to mixing of anorthositic crust with the basaltic melt as this unit is in close proximity to the highland. The youngest mare unit (Ehtm) appears pink in color composite and much more noritic in comparison to that of highland contaminated intermediate unit (Iltm) and therefore, could not be generated by further fractionation of the basaltic source that has produced relatively less noritic Iltm unit. Also CSFD analyses [4, 5] show that these two units are separated from each other by ~0.9 Ga. Thus, it can well be concluded that the basaltic source region for the youngest mare unit is chemically different from that of the source of other older mare units in the basin. This hints towards multiple basaltic source regions and a probable record of mantle heterogeneity within the basin.

References:

[1] Zuber M. T. et al. (1994) *Science*, *266*, 1839-1843. [2] Gillis-Davis J. J. et al. (2006) *LPS XXXVII*, Abstract #2454. [3] Kramer G. Y. et al. (2008) *JGR*, *113*, E01002. [4] Haruyama J. et al. (2009) *Science*, *323*, 905-908. [5] Morota T. et al. (2009) *GRL*, *36*, L21202. [6] Isaacson P. J. and Pieters C. M. (2009) *JGR*, *114*, E09007. [7] Dhingra D. (2008) *Adv. Space Res.*, *42*, 275-280. [8] Tompkins S. and Pieters C. M. (1999) *Meteoritics & Planet. Sci.*, *34*,25-41.

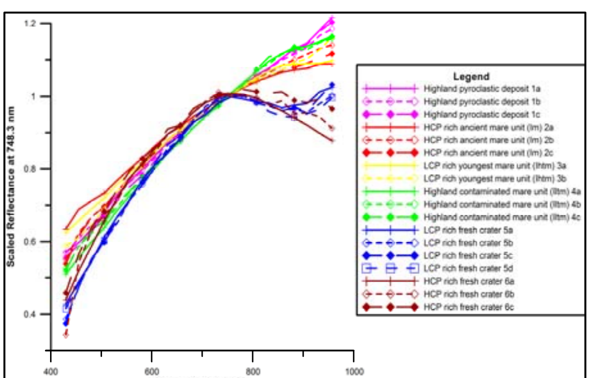

Fig 2. Reflectance spectra of different highland and mare units in the study area scaled at 748.8 nm

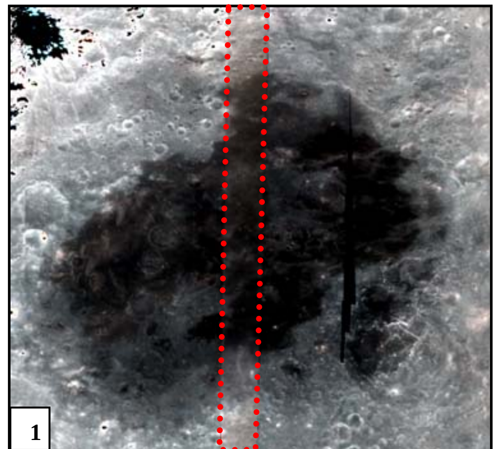

Fig. 1. HySI coverage of Mare Moscoviense shown by red dotted box.

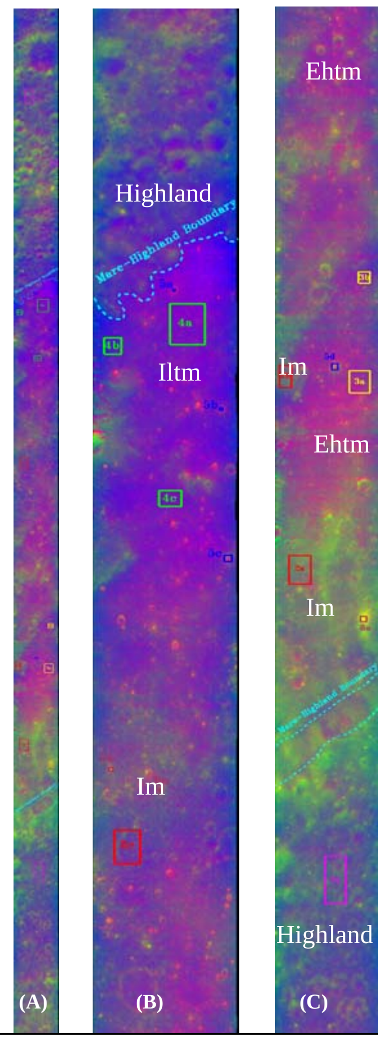

Fig 3. Rock type color composite image of central part of Mare Moscoviense. (A) Full HySI scene. (B) Northern or upper half of the HySI image. (C) Southern or lower half of the image.