COMPOSITIONAL DIVERSITY AT TYCHO CRATER : Mg-SPINEL EXPOSURES DETECTED FROM MOON MINERALOGICAL MAPPER (M^3) DATA. P. Kaur , P. Chauhan, S. Bhattacharya, Ajai & A.S. Kiran Kumar, Space Applications Centre, (ISRO), Ahmedabad-380015, India (prakash@sac.isro.gov.in).

Introduction: Tycho (43^0S, 349^0E) is a Copernicus age complex crater (diameter ~85 km) with a prominent central peak located on the lunar near side. Tycho being one of the youngest crater, is of great interest to lunar science for varied reasons like presence of gabbroic bodies, possible link of Tycho's ejecta to Apollo return samples etc. Tycho is one of the prime science target and now can be studied in details using newly available high spatial and spectral hyperspectral datasets.

Compositional studies provide insight into the thermal and evolutionary history of lunar crust and central peaks are ideal locations to study exposed buried crustal material. Tycho crater have been studied earlier using telescopic and Clementine data for composition and morphology of various lithologies present [1,2,3,4]. Spectral studies done by earlier workers suggests presence of gabbro on Tycho's central peak [1]. In this study we have used Chandrayaan-1 M^3 datasets for extracting mineralogical information using high spectral and spatial capabilities of M^3 sensor [5].

Recent observations on the crater Theophillus, Copernicus and Mare Moscoviense by M^3 has revealed the presence of unusal Mg-Spinel bearing lithologies [6,7,8,9]. Lunar meteorite ALHA 81005 which is believed to be a part of far side highlands have also been reported to be rich in ~30% (Mg,Fe)Al spinel with ~20% olivine + pyroxene, supports M^3 observations [10]. Here we report for the first time detection of Mg-spinel along with crystalline plagioclase, olivine and high-Ca pyroxene from the Tycho crater using M^3 data onboard Chandrayaan-1.

Data and Methods: M^3 is an imaging spectrometer covering the spectral range from 0.45-3.00 μm with 85 spectral bands and ~140 m per pixel (in Global mode) spatial resolution [5]. M^3 reflectance data (level-2), corrected for thermal and photometric effects and now accessible from public domain have been used [11]. In this study, we have used images of different illumination conditions, acquired on different dates, so that the areas under shadow in one acquisition can be studied under different illumination conditions. Figure 1 shows albedo image (1508 nm) of Tycho crater acquired by M^3 for different illumination conditions. As evident from figure 1a, the western flank of Tycho crater is under shadow, wheras the same flank is visible in figure 1b.

Mg-Spinel and Olivine exposures at Tycho crater: The present study is aimed at deriving mineralogical information and understanding the association of various

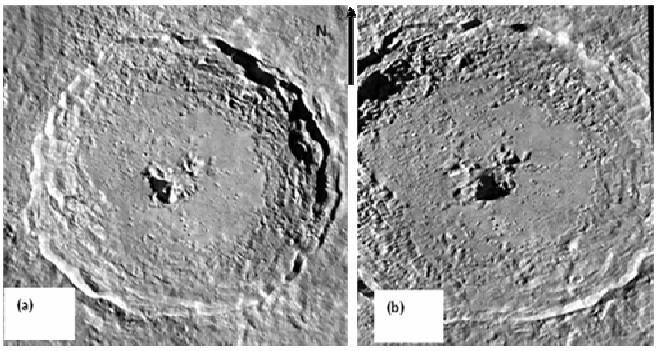

Figure1 (a) & (b). Albedo images of Tycho crater acquired by M^3 in different illumination conditions with phase angle between 55^0 and 68^0, respectively .

lithologies and their geological setting in and around Tycho. The compositional variation can be best displayed using color composite ratio images generated on the basis of wavelengths sensitive to mineral absorptions [6]. Ratios used for generating color composite suggested in [6], are slightly modified in this study. We have used spectral ratio of 1000/1300 nm (Red), 1209/1818 nm (Green) and 750/950 nm (Blue), resulting in less noisy colour composite (Figure 2). In the colour composite image, spinel dominated exposures are in green, olivine dominated regions are in magenta or purple, pyroxenes are seen in cyan and plagioclase exposure are shown in orange shade. Tycho crater displays highly diverse mineralogy exposed at central peak, wall and floor of the crater. Some of the exposures for different mineralogical entities are shown as zoomed portions in figure 2a and the corresponding spectra are shown in figure 2b and 2c. It was found that several small exposures of Mg-spinel has been detected at various locations on the wall, floor and central peak of the crater, depicted by green colour in figure 2, and these pixels are characterized by presence of strong 2 μm absorption but absence of 1 μm absorption feature (figure 2c). Mg-Spinel exposures mostly occurs as discrete patches of around 500-700m in size. Other lithologies detected in this study includes, crystalline plagioclase, olivine and high-Ca pyroxene are also shown in figure 2a and the corresponding spectra are shown in fig 2b.

The central peak of Tycho crater exhibits highly mixed composition with all possible lithologies present, however, the dominated phase present is high-Ca pyroxene (Figure 3).

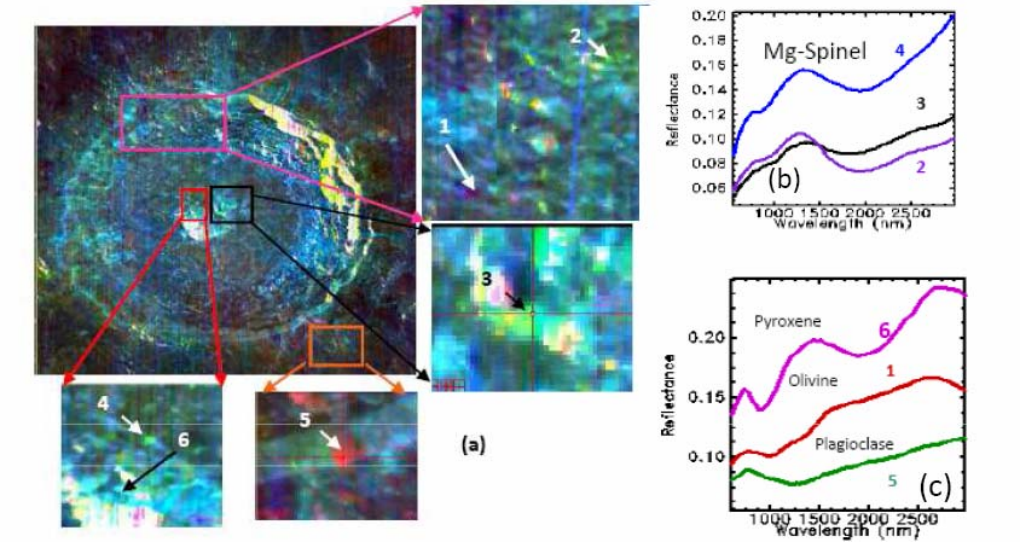

Figure 2 : (a) Color composite ratio image generated using R=1000/1300, G=1208/18181 and B=750/950nm shows mineral diversity of the Tycho crater with zoomed portions of exposures of different mineralogical suites, (b) spectra collected from the marked locations in green colour showing Mg-Spinel occurances, c) spectra for High-Ca pyroxene, Olivine and crystalline plagioclase.

The southern flank of the central peak which was reported earlier to be of crystalline plagioclase by [12], shows mixed signature of pyroxene or spinel with plagioclase (figure 3b).

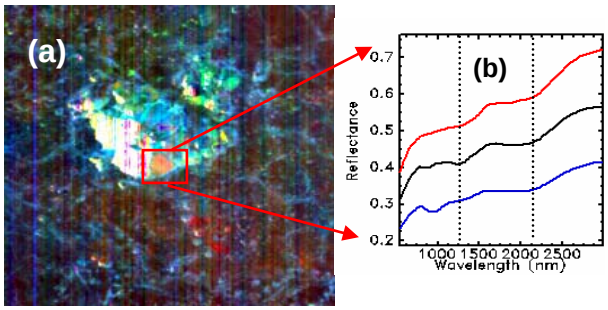

Figure 3(a). Close view of the central peak in ratio image displaying highly mixed nature of the region, (b) Spectra collected from the flank displaying mixed signature of plagioclase with spinel and pyroxene.

Summary: Our analysis of M^3 data clearly brings out new information on the presence of Mg-spinel on crater walls, floor and on the central peak of Tycho crater. The presence of diverse mineralogical suites on crater Tycho, provide clues towards its complex formation. The olivine bearing lithologies along with spinel suggests excavation of the deep seated crustal material, however the formation of spinels on lunar surface is yet to be understood. The presence of Mg-Spinel lithologies on Tycho crater offeres a new opportunity to search for more potential spinel bearing areas on Moon and their geological settings. The detection of Mg- Spinel rich lithologies in Tycho region of Moon will add to existing knowledge on the presence of these litho-units on the lunar surface.

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