COMPOSITIONAL HETEROGENEITY OF CRATER ARISTOTELES AS REVEALED BY CHANDRAYAAN-1 MOON MINERALOGY MAPPER (M^3) DATA. Satadru Bhattacharya, Mamta Chauhan and Prakash Chauhan, Space Applications Centre (ISRO), Ahmedabad – 380 015, India (satadru78@yahoo.co.in).

Introduction: Complex impact craters often act as windows into the lunar interior as they expose materials from different depths in their walls, central peaks and continuous ejecta deposits and crater floors, which in turn help in understanding the compositional variations with depth and therefore, the lithologic make up of the crust. Aristoteles is a complex impact crater of Eratosthenian age [1, 2] situated near the southern edge of Mare Frigoris along the projection of Montes Caucasus. Previous work on Aristoteles crater using NIR data from the Chandrayaan-1 SIR-2 instrument [3] has revealed the presence of heterogeneous lithology. The present study involves a detailed mineralogical appraisal of the crater Aristoteles based on Chandrayaan-I Moon Mineralogy Mapper (M^3) observations.

Data Used and Methodology: M^3 is an imaging spectrometer onboard Chandrayaan-I, having 85 spectral channels operating in the wavelength range of ~500–3000 nm and having a spatial resolution of ~140m/pixel from 100km orbit and 280m/pixel when the orbit is raised to 200 km [4]. The Level 2 (L2) products have been used in this study, which are photometrically and thermally corrected. A False Color Composite (FCC) mosaic of the study area has been generated using M^3 scenes.

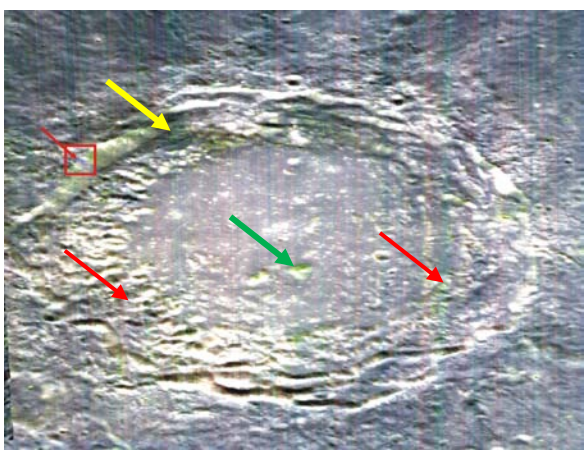

Figure 1. FCC mosaic of crater Aristoteles generated by assigning red channel to M^3 930-nm band, green to 1249-nm band and blue to 2018-nm band. Red box and the arrows in FCC mosaic indicate locations of olivine-rich exposures, low-Ca pyroxene and high-Ca pyroxene-rich exposures are demarcated by green and yellow arrow respectively.

Results: The FCC of crater Aristioteles reflects the complex lithological heterogeneity as manifested in the form of colour variations from blue to purple to green to yellow. The colors indicate mixing of mafic silicates and plagioclase in different proportions. Olivine-rich areas are represented by blue to purple color and are of dunitic affinity. The band depth of 1000-nm composite band of olivine varies from approximately 10-30%. Spinels are also associated with olivine-rich exposures in minor quantities. The average 2000-nm band centre of spinel is found to be ~2137 nm. Olivine-rich exposures are distributed mostly along the terraced walls and crater floors in the western and eastern sides of the crater. However, the domination of olivine is mostly is towards the western and northwestern edges of the crater. The spectra generated for these regions show olivine with spinel as shown in Figure 2. Continous ejecta deposits and the terraced walls of Aristoteles show a complex co-existence of both low- and high-Ca pyroxenes (HCP). The representative spectra of LCP- and HCP-bearing lithologies are presented in Figure 3. However, the central peak of Aristoteles comprises primarily of LCP-rich noritic lithology. The representative spectra of LCP-rich exposures from the central peak are shown in Figure 4. The floor of the crater is mostly occupied by impact melt sheet. We do not find olivine in the geometric centre of this crater as reported by the previous researcher [3]. On the contrary, it probably comprises of impact melt sheet.

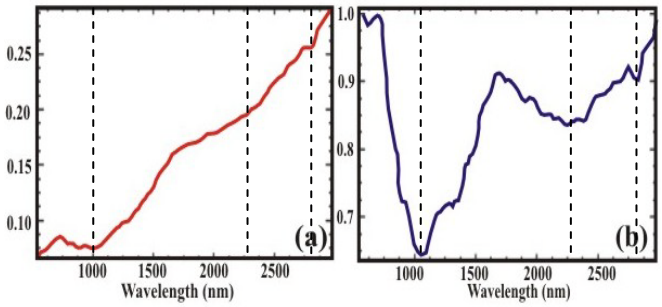

Figure 2. a. Normal and b. continuum-removed reflectance spectra from the steep northwestern terraced walls of the crater rim (indicated by red-box and arrowin figure 1) showing the presence of Olivine ± Spinel with OH-band (~2-3%).

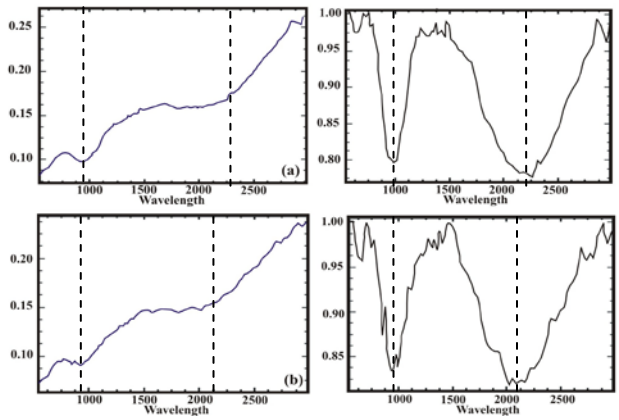

Figure 3. Reflectance spectra extracted from ejecta and terraced wall of the crater showing the presence of a. HCP with its continuum removed spectra and b. LCP and its continuum removed spectra.

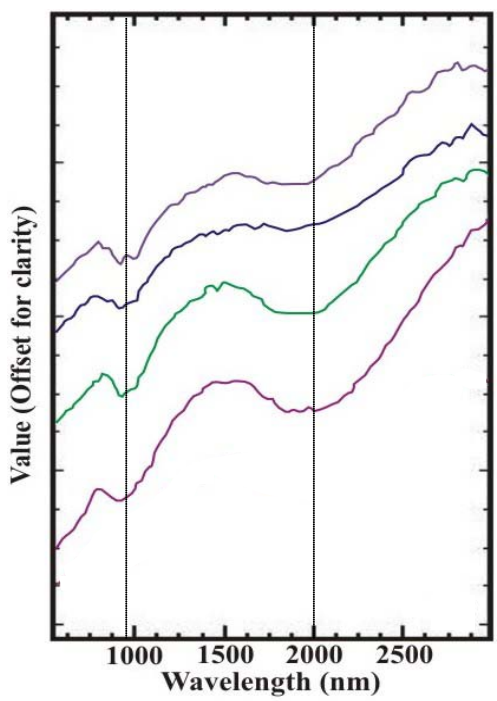

Figure 4. Reflectance spectra extracted from the a. central peak portion showing the presence of (LCP+ Plagioclase) showing noritic affinity. All spectra have been vertically offset for clarity.

Discussions and Conclusions: The geological setting of the Aristoteles crater is unique lying along the massif line and trough line of Mare Frigoris. Considering its complex lithological heterogeneity, it is likely to have excavated the materials from different depths corresponding to the canonical stratigraphic units of lunar crust. Further, based on GRAIL gravity field model [5, 6], the estimated thickness of the crust in this area is about 25 km. Pristine nature of the olivine-rich exposure indicates that it probably would have been derived from deep-seated Mg-rich pluton that intruded into the crust. We have also observed hydration feature near 2800-nm having band strength of ~2-3% (Figure 2) which could be attributed to the hydroxyl bound to olivine and therefore could be of endogenic origin. As such the compositional heterogeneity at Aristoteles is a result of underlying heterogeneity and regional geological events.

References: [1] Wilhelms and McCauley (1971) *U.S. Geol. Survey Misc. Geol. Inv. Map*, I-703. [2] Baldwin R. B. (1984) *Icarus, 61*, 62-91. [3] Bugiolacchi R. et al. (2011) *LPS XXXXII*, Abstract #1067. [4] Boardman J. et al. (2011) *JGR, 116*, E00G14. [5] Zuber M. T. et al. (2013) *LPS XXXXIV*, Abstract # 2037. [6] Zuber M. T. et al. (2013) *Science* doi: 10.1126/science. 1231507.