STUDIES OF LUNAR DARK HALO CRATERS IN NORTHWESTERN MARE NECTARIS USING HIGH RESOLUTION CHANDRAYAAN-1 DATA. P. Chauhan[1], P. Kaur [1], N. Srivastava[2], S. Bhattacharya[1], D. Lal[3], Ajai[1] and A.S. Kiran Kumar[1], [1]Space Applications Centre, (ISRO), Ahemdeabad, India(prakash@sac.isro.gov.in), [2] Physical Research Laboratory, Ahmedabad, India, [3]M.G.Science Institute, Gujarat University,Ahmedabad, India.

Introduction: An essential parameter to investigate the magmatic history of Moon is accurate assessment of extent of mare basalt in space and time. Though surface of most of the mare basalts are exposed, a certain fraction of them are obscured from the view since they are covered by ejecta materials derived from later impacts in adjacent and / or distant regions, or covered with later volcanic eruptions. Of these hidden mafic secondary crustal units, the ones exhibiting basaltic signatures are popularly known as "cryptomare", and are mainly identified by the occurrence of Dark Halo Craters (DHC) in the different regions of the Moon [1, 2]. The term DHC refers to circular - semicircular craters or depressions surrounded by an aura of low albedo deposits compared to the surroundings. The origin of these craters have been debated and early workers generally interpreted dark haloed craters as volcanic vents associated with explosive volcanism resulting in deposition of dark pyroclastics around the vent [3,4]. However, the impact origin of these craters was not ruled out [2].

In this study, we present the results from remote sensing data of very high resolution (both spatial & spectral) for a localized dark mantle deposits (LDMD) around crater Beaumont-L in the northwestern part of Mare Nectaris from Chandrayaan-1. Crater Beaumont-L is a young, small crater (~ 5 km) on southeast to large impact crater, Theophilus. High spatial resolution photogeological data from TerrainMapping Camera (TMC) and hypespectral reflectance data from Hyperspectral Imager (HySI) and Moon Mineralogy Mapper (M^3) confirms that Beaumont-L crater excavated mare basalt from beneath lighter deposits emplaced by the larger impact craters e.g. Theophilus and Maddler, which produced an ejecta blanket around the region.

Data Analyses: Beaumont - L (14.4^0 S, 30^0 E) is a ~5 km diameter dark haloed crater on the western edge of Nectaris basin, a major multi-ring impact basin located on the eastern side of lunar nearside have been investigated for its plausible origin. Imaging datasets from three payloads onboard Chandrayaan – 1 mission namely, Terrain Mapping Camera (TMC), Hyper Spectral Imager (HySI) and Moon Mineral Mapper (M^3) have been used in this study. A high resolution digital elevation model have been derived for the study area using fore, aft and nadir images from TMC. The hyperspectral datasets from HySI and M^3 have a spatial resolution of 80 and 160 m, respectively.

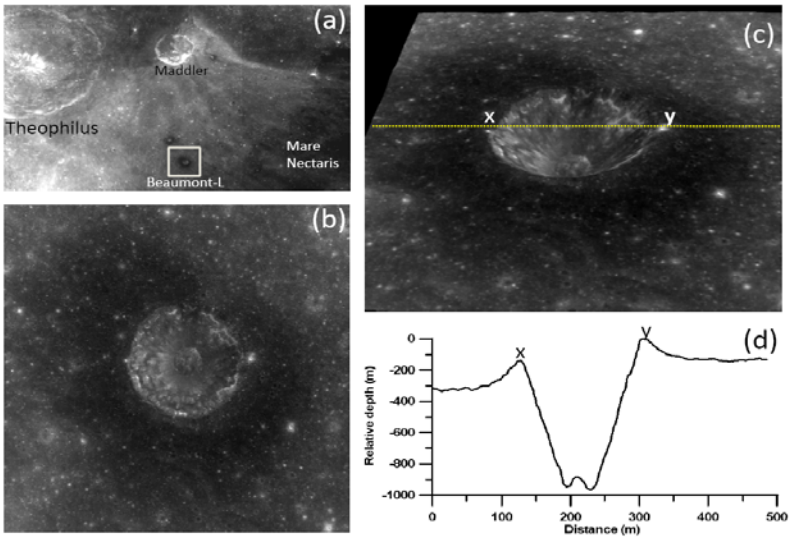

Figure 1: (a) Clementine basemap showing geological settings around Beaumont-L dark halo crater, (b) Chandrayaan-1 TMC image of crater Beaumont-L showing dark halo and its detailed morphology, (c) 3D view of the crater using TMC stereoscopic data and (d) relative depth profile along the yellow line depicting a depth to diameter ratio of 1:5 for the crater Beaumont-L.

The spectral coverage is 0.4 – 0.96 microns for HySI and 0.50 – 3.0 microns for M^3 [5, 6]. Here, we have used M^3 data only upto 2.5 microns to avoid thermal contributions. Figure 1 shows the geological settings of the study area along with high resolution images of crater Beaumont-L from Chandryaan-1 TMC data. As seen in figure, the basin exhibit diverse geologic units, including mare basalts, dark mantle deposits, ejecta cover of large craters such as Theophilus (diameter ~ 100 km), Maddler (diameter ~ 28 km) etc. and also many dark halo craters [7].

Results and Discussions: High spatial resolution photogeological data from Terrain Mapping Camera (TMC) sensor and hypespectral reflectance data from Hyperspectral Imager (HySI) and Moon Mineralogy Mapper (M^3) confirms that Beaumont-L crater excavated mare basalt from beneath lighter deposits emplaced by the larger impact craters e.g. Theophilus and Maddler, which produced an ejecta blanket around the region. TMC analysis have indicated an impact origin for Beaumont–L as revealed by its circular appearance, raised rims, terraced walls, systematic distribution of ejecta material, dendritic ejecta pattern and anomalous colour relative to the surrounding. The interior of the crater showed a distinct colour anomaly showing rusty-coloured bands and a hue of brown colour on a true colour composite made by HySI data (Fig 2(a)). The reflectance data in 0.4 to 2.5 µm range from M^3 sensor shows presence of Olivine rich lithologies within and just outside the crater (Fig 2(b & d). The presence of olivine rich litholohies the ejecta, indicating a plausible exposure of Mg-Suite pluton from beneath a thin veneer of basalt and overlying anorthositic material. The morphological details captured by TMC data provides direct evidence that Beaumont-L and other surrounding small dark halo craters in the northwestern Mare Nectaris are of impact origin and do not show evidence of volcanic origin.

References: [1] Schultz, P.H. and Spudis, P.D., 10th LPSC, 2899-2918, 1979. [2] Hawke B.R. and Bell, 12th LPSC, p. 665 – 678, 1981. [3]Hackman, R. J., (1962), *Generalized Photogeologic map of Moon: Military geology branch,* U.S., Geological Survey, Washington, D.C. [4] Head J.W. and Wilson L. 10th LPSC, 2861-2897, 1979. [5] Kiran Kumar A.S. et.al. (2009), *Current Science, 96,* 492-499. [6] Pieters C. M. et. al. (2009), *Current Science,* 96, 500-505. [7] Coombs et al. (1990) Proc. LPSC, 20th, 161-174.

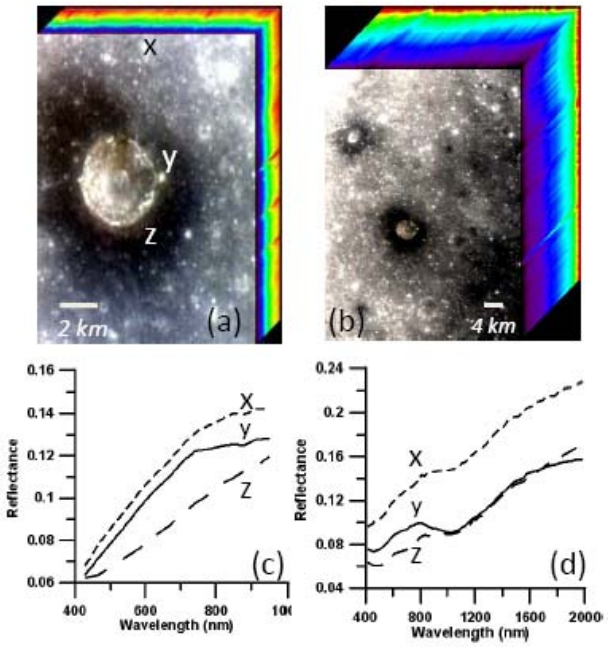

Figure 2 (a). True color composite HySI image of Beaumont-L crater. (b). M^3 image of the same crater. (c) & (d). Reflectance spectra collected using HySI and M^3 image respectively. At location 'y' HySI & M^3 spectra shows presence of olivine rich rocks.