**LUNAR ORIENTALE BASIN: TOPOLOGY AND MORPHOLOGY OF IMPACT MELT REGION FROM CHANDRAYAAN-1-TMC AND HYSI .** A. Senthil Kumar[1], A.S. Kiran Kumar[2], J.N. Goswami[3], C. M. Pieters[4], B.G. Krishna[2] and P. Chauhan[2] [1]National Remote Sensing Centre, ISRO, Hyderabad (senthilkumar_a@nrsa.gov.in) , [2]Space Applications Centre, ISRO, Ahmedabad, India (kiran@sac.isro.gov.in), [3]Physical Research Laboratory, ISRO, Ahmedabad (goswami@prl.res.in), [4]Dept. Geological Sciences, Brown University, Providence, RI 02912, USA (Carle_Pieters@brown.edu).

**Introduction:** Chandrayaan-1, India's first planetary mission was launched successfully on October 22, 2008 and reached its final lunar orbit of 100 km altitude on November 14, 2008 [1]. All eleven instruments have been operated as a part of early phase of mission operations. Two optical payloads from ISRO are 1)Terrain Mapping Camera (TMC) with a triplet panchromatic sensor and 2) Hyperspectral Imager (HYSI) meant for topographic and mineralogical mapping in the visible and near infrared spectral range with 64 contiguous bands of 15 nm bandwidth [2]. Initial findings of these camera images over the Orientale basin in the south west of lunar surface are reported here. Situated on the extreme western edge of the nearside view, the Orientale basin assumes importance by virtue of observational difficulties from Earthbound instruments and also was not part of the areas investigated by the Apollo program. A detailed discussion of the Basin including its possible age is given by Head[3].

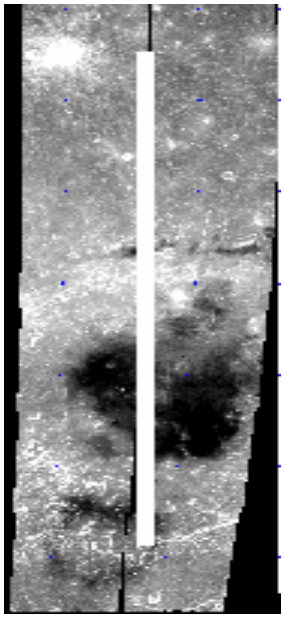

**Fig 1**. Extent of the TMC / HYSI data coverage across the Orientale Basin. The base image is the Clementine 750 nm data.

Data for the Orientale Basin were acquired by TMC and HySi at 5 m/pixel and 80 m/pixel respectively, both with the field of view of 20 km. The location of the TMC/HYSI coverage over the Clementine mosaicked tiles is shown in Figure 1. M3 has covered the data with its global mode at 140 m /pixel and a field of view of 40 km. The details and analysis of M3 on this area can be found in companian abstract [4].

**Description and Interpretation of area of study**: The area of joint analysis between TMC/HYSI and M3 payload data is a subset of the long pass data that covers north-south across the center of the basin. Figure 2 shows the selected portion of the subset image covering island and the Mounder Formation of Northern Unit (MF-NU).

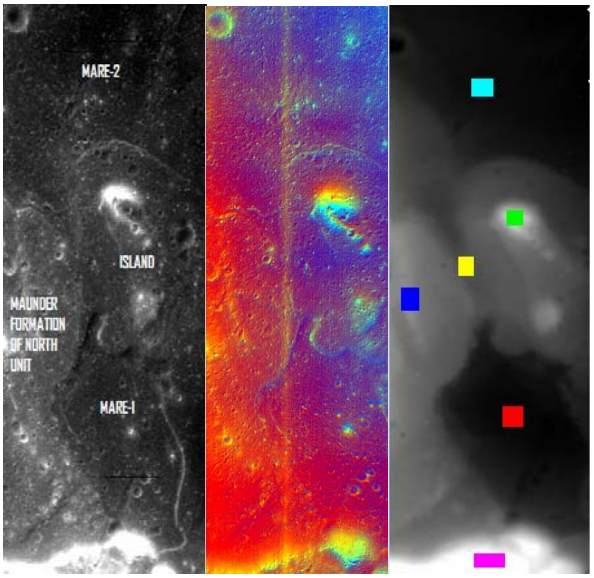


**Fig. 2. A)** TMC subscene showing some regions of interest taken for present study. **B)** color composite of band ratioed three images from the HYSI and **C)** The DEM gray map image with color codes (*red*: mare-1, *cyan*: mare-2; *green*: island mountain; *blue*: MF-NU; *yellow*: VR and *magenta*: MF-South Unit (MF-SU)).

Stereo pair analysis was carried out to generate the digital elevation model (DEM) of the region. The details of the procedure followed to derive the DEM is given in a separate abstract [5].

For quick interpretation of the HYSI image, band ratio (BR) product was made with near similar spectral bands of the Clementine UV/VIS image. The prime base bands for this product was obtained by spectral binning of three bands each: B(463, 471 and 479 nm), G(767, 775 and 783 nm) and R(872, 880, 888 nm). The final band ratios (B/G), (G/R) and (G/B) were

computed to obtain false color composite (fcc) image. Figure 2 shows the BR image of the selected region. Different spectral featues present at the island and the MF and the valley region (VR) in between them can be visually observed.

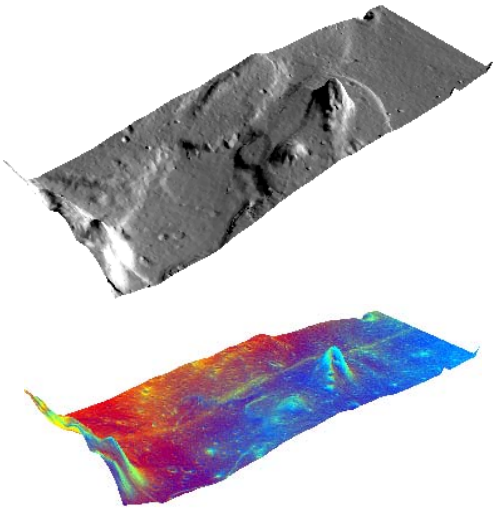

**Fig. 3**. Three dimensional views of the surface relief (top) and HYSI BR image(bottom). The topological variations can be observed (vertical exaggeration: 15).

**Topological analysis**: The 3-D surface views of the relief and HYSI BR image using the DEM are shown in Figure 3. Of the many interesting features, six distant regions describing the topology of this area can be clearly seen. A sample window of each region was selected and its height information was analyzed. The six selected windows of these regions are shown in Fig 2. Topological variation at five different locations with respect to mean height value of the Mare-1 was computed. Table 1 gives the relative height differences for the locations shown in Figure 1.

| Feature | Color | Min. (m) | Max. (m) | Mean (m) |
|---|---|---|---|---|
| **Mare-2** | cyan | 17 | 45 | 32 |
| **Island** | green | 951 | 1367 | 1242 |
| **MF-NU** | blue | 712 | 910 | 814 |
| **MF-SU** | magenta | 1558 | 1867 | 1715 |
| **VR** | yellow | 442 | 439 | 481 |

**Table 1**. Five different features shown in Fig. 2c selected for estimating *relative* height differences (the mean height of the Mare-1 is taken as reference).

**Morphological analysis:** The presence of numerous fine structures has been brought out by TMC by virtue of its 5 m/pixel and 10 bit radiometry. New structural patterns were observed which were not noticeable with HYSI and M3 acquired simultaneously. Figure 4 illustrates this with fine structures present around the crater and a large number of microcraters, as evident from its edge map shown in the extreme right. The spatial content from the TMC and the spectral information about the region from HYSI and M3 would likely provide new information on lunar morphology. Attempts are being made to further explore the data from these sensors data and will be reported at the conference.

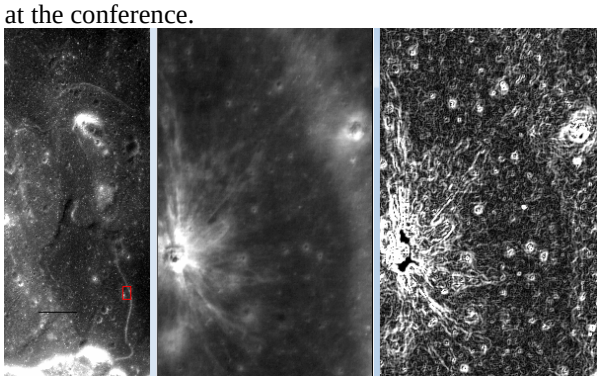

Fig. 4. A small portion highlighted in the left TMC image is shown at full resolution in the middle and corresponding edge feature map in the extreme right.

**Conclusions:** The preliminary topological studies carried out have shown that Mare-1 is the lowest feature in this region, and the edge of the MFSU is the highest region with the difference of about 0.5 km to the nearest highest 'island mountain' peak. The Mare-2 in the north of the island is at an elevated height of about 0.3 km from Mare-1. The valley region between the MFNU and the island is also at an elevated place at about 0.8 km. Similarly, surface morphology has shown many new features by virtue of 5m pixel resolution combined with 10 bits/pixel of the TMC. Many medium and micro-sized craters can be easily identifiable when compared to companion HYSI or M3 images.

The initial results of the TMC and HYSI on the Orientale basin as a sample data demonstrate the capabilities of the Chandrayaan-1 TMC and HYSI for detailed investigation of the lunar morphological and topological characteristics. Efforts are underway to combine and relate the spectral and spatial contents of these sensors along with M3 to provide further understanding of specific lunar regions of scientific interest.

**References:**[1] ISRO page: http://www.isro.gov.in [2] K. Kumar et al, Current Science in press [3] J.W. Head (1974) The Moon 11, 327-356. [4] C. Pieters et al (This volume). [5] B.G. Krishna et al. (This volume).