MAPPING OF MOON – A PRELIMINARY STUDY

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Abstract
The main aim of this work is to mapping of moon with standard reference points similar to the Earth as geo-referencing points. The primary objectives of the Chandrayaan-1 mission are simultaneous chemical, mineralogical and topographic mapping of the lunar surface at high spatial resolution. These data should enable us to understand compositional variation of major elements, which in turn, should lead to a better understanding of the stratigraphic relationships between various litho units occurring on the lunar surface. The mineral composition will be determined by a hyper-spectral imaging spectrometer (HySI) sensitive in the 400–920 nm range. The wavelength range is further extended to 2600 nm where some spectral features of the abundant lunar minerals and water occur, by using a near infrared spectrometer (SIR-2), similar to that used on the Smart-1 mission, in collaboration with ESA. A terrain mapping camera (TMC) in the panchromatic band will provide a three-dimensional map of the lunar surface with a spatial resolution of about 5 m. Aided by a laser altimeter (LLRI) to determine the altitude of the lunar craft, to correct for spatial coverage by various instruments, TMC enable us to prepare an elevation map with an accuracy of about 10 m.

Keywords: *Moon, mapping, Chandrayaan, TMC*

Introduction

The Earth and Moon is intimately linked ever since their formation 4.543 billion years ago. The scientific advancements from the Apollo era included recognition of major planetary processes such as formation of a magma ocean and pervasive differentiation. These early events of planetary evolution were dated with returned Apollo and Luna samples. Many processes active on the early Moon are also common to most terrestrial planets. Since most major geologic activity ceased on the Moon since last 3 billion years, the Moon's surface provides a nearly unaltered record of the earliest era of terrestrial planet evolution. The type and composition of minerals that comprise a planetary surface are a direct result of the planetary body's initial composition and its subsequent thermal and physical processing. Lunar mineralogy seen today is thus a direct record of the early evolution of the lunar crust and the subsequent geologic processes acting upon it. In particular, the distribution and concentration of specific minerals is closely tied to magma ocean products and any process such as cratering that might redistribute or transform primary and secondary lunar crustal materials.

The current decade has seen a revival in the field of planetary exploration and in particular in lunar exploration, with several new initiatives by various national space agencies including the Indian Space Research Organization (ISRO). Even though the need for further exploration of the moon has been discussed in the late nineties, a renewed effort in this direction has formally begun in 2003 with the Smart-1 mission of ESA that was followed by the Change-1 mission of China, the Japanese mission Kaguya (SELENE), both in late 2007, the Indian Chandrayaan-1 mission in late 2008 and the US mission LRO (Lunar Reconnaissance Orbiter) in 2009. The possibility of an Indian mission to the moon was mooted in the late nineties and was discussed extensively in different academic forums during 1999 and 2000. This paper describes the mapping of moon surface in terms of geographical and geological features and some preliminary results obtained on the data of Chandrayaan-1 mission.

Methodology and Data used

Used the standard methodology of accessing and analysing the datasets mentioned for Planetary Data System (PDS). The data used is from Chandrayaan-1 mission of TMC that is processed as per the processing level definitions and provided with Planetary Data System (PDS) standards of the international archival. The TMC and Digital Elevation Model (DEM) were used on the basis of date of pass, orbit number and latitude and/or longitude.

Results and Discussion

A large amount of data on the Moon covering chemical, geophysical and geochronological aspects are now available as a result of the pioneering observations made by Apollo, Luna, Clementine and Lunar Prospector missions and the laboratory analysis of lunar samples. These data, relevant to the origin of the Moon, have been discussed in Hartmann et al. (1986) and Canup and Righter (2000). Some of the crucial data and the need for further lunar exploration have been summarized by Bhandari (2004). The observations made by Apollo missions, although limited to the equatorial regions of the near side of the Moon, and the documented rock and dust samples from nine locations, available for laboratory studies, have given important clues to the origin of the Moon and its early evolutionary stages. However, they are inadequate for accurate modeling of the chemical and physical evolution of the Moon. The details of these processes, their time scales and the extent to which the Moon was subjected to them have not been fully understood. It is therefore desirable to undertake further studies and carry out a sustained exploration of the Moon using orbiter, landers and sample return missions. The launch, imaging strategies and detailed description of some payloads can be found in Kiran Kumar and Roy Chowdhury (2005).

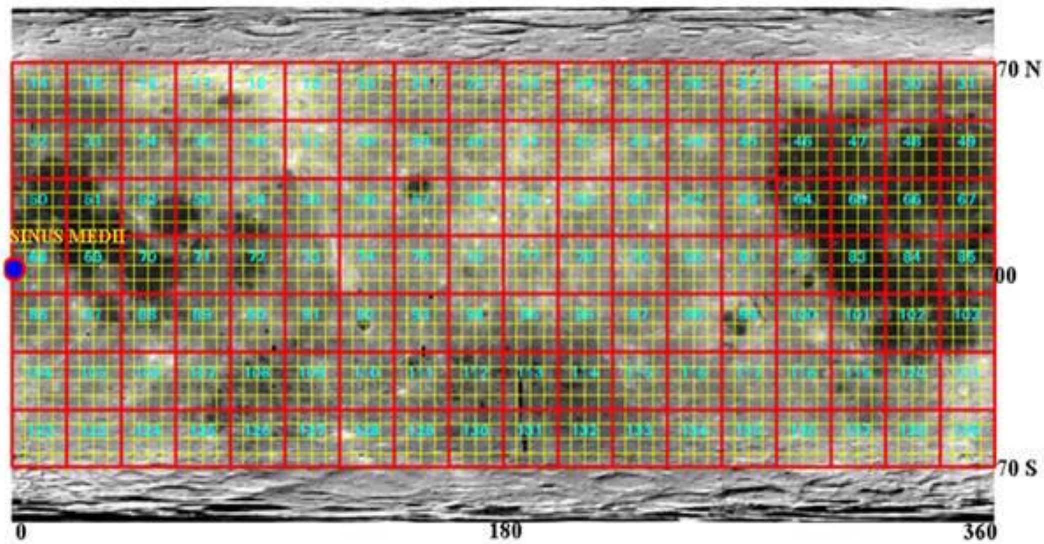

Figure 1. Map Index of the Chandrayaan-1 mapping

Lunar Atlas generated from Chandrayaan-1 of TMC data is shown in Figure-1. Lunar Atlas comprises of lunar topographical maps which is a collection of ortho-image, contours, annotation, grids and other mapping features. Lunar Topographical map is generated at 1:50,000 mapping scale with a contour interval of 100 m. The contours overlaid on the map are extracted from the Digital Elevation Model (DEM) generated by Photogrammetric restitution of Chandrayaan-1 TMC triplet. The map show the names of prominent features, mostly craters present on the moon surface taken from IAU list. These maps followed the mapping scheme and standards prepared by ISRO to prepare global topographical maps of the moon at 1:50,000.

Selenographic projection for equatorial region (70 N to 70 S) and Polar stereographic projection for North and South Pole regions (60N-90N and 60S-90S). The Center latitude for Polar stereographic projections is 90 N and 90 S for north and south poles respectively. Moon mean radius datum has been used for the mapping. Wherever, the Digital Elevation Model (DEM) is having undefined height value of -20000, orthoimage will have zero pixel value. A few sample gray scale images developed from PDS for DEM are shown in Figure-2.

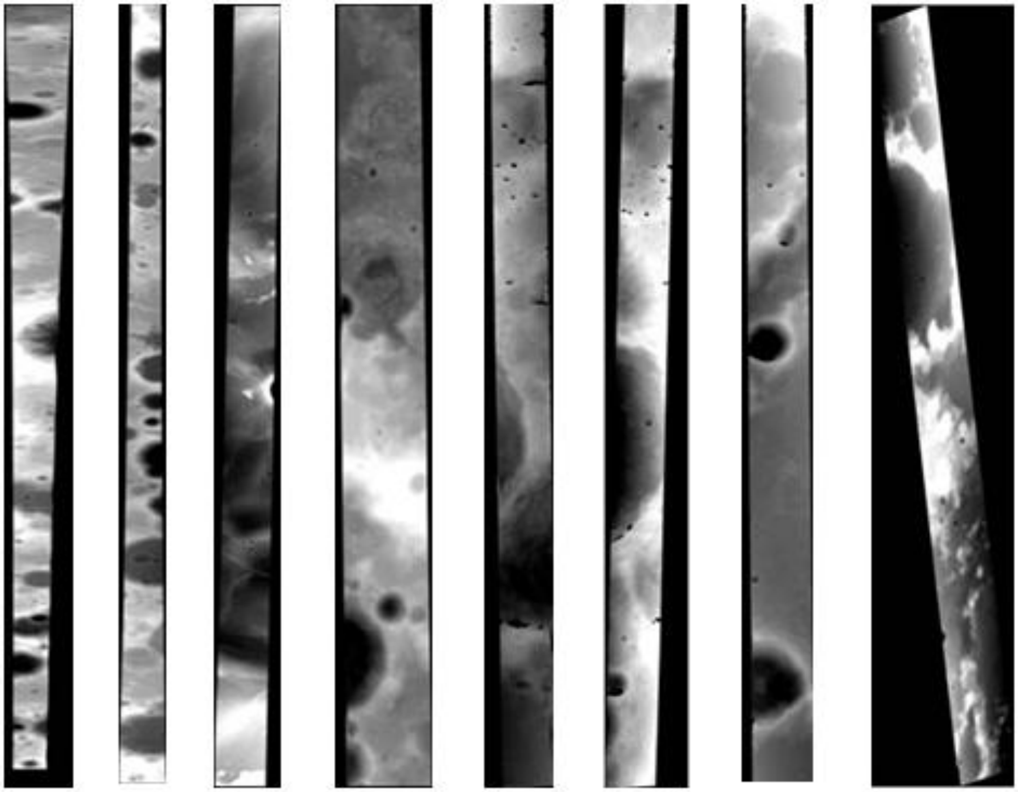

Figure 2. Sample Digital Elevation Model of a TMC Image (dark to bright gray tone represent the minimum to maximum height value of the respective DEM)

It is also possible to visualize the mosaics of the TMC, DEM and HySI North Pole and South Pole datasets as shown in the Figure-3 and also for the equatorial plane as in Figure-4.

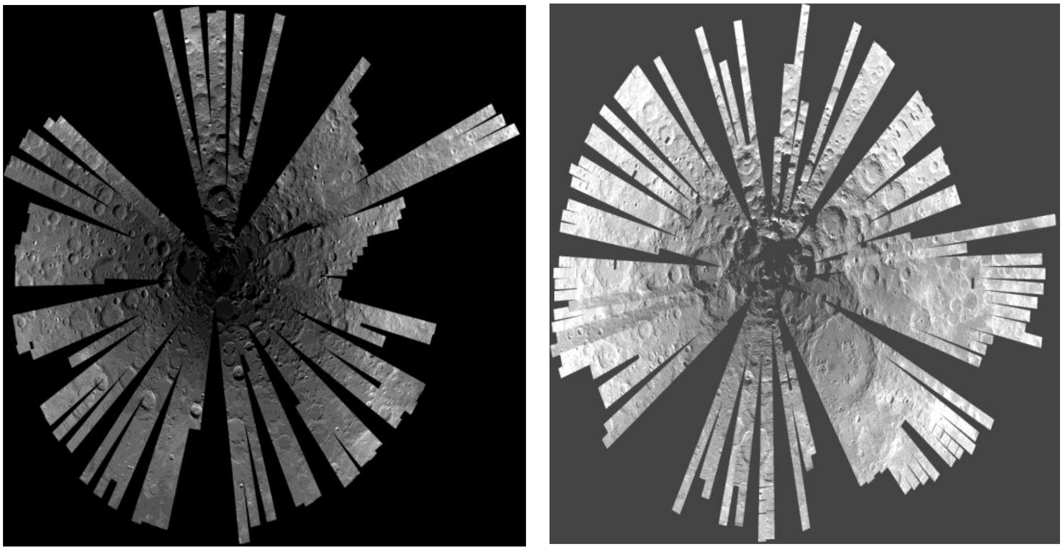

Figure 3. Visualization of North and South Pole of moon

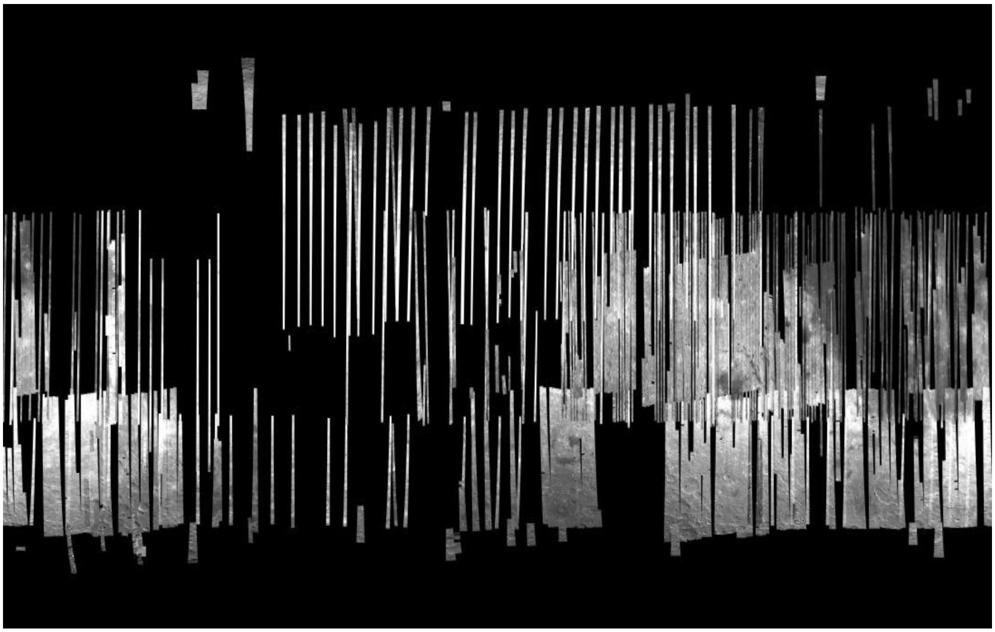

Figure 4. Visualization of Equatorial mosaic without poles

Using this data an effort is made to identify the craters, its dimension, depth and other dimensional parameters as surface features. One can estimate the physical parameters by making use of well known tools such as QGIS, Web GIS and Google Earth packages. Some of the interesting moon features are shown in Figure 5.

Figure 5. TMC - Interesting Moon Feature

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