EPSC Abstracts
Vol. 6, EPSC-DPS2011-1842, 2011
EPSC-DPS Joint Meeting 2011

Combined analysis of Chandrayaan-1 HySI and SMART-1 SIR data over central peak of Tycho

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Abstract

We have combined Hyperspectral Imager (HySI) data from Chandrayaan-1 mission with SMART-1 Infrared Spectrometer (SIR) data to study the composition of the central peak of the Tycho crater at high spatial and spectral resolution. Combining the spectral responses of HySI and SIR, it is possible to completely characterize the 1-µm and 2-µm absorption features of major lunar minerals. Here we present the HySI-SIR combined spectra from the central peak of Tycho. Pyroxene-bearing lithologies have been identified from the crater central peak. From the present study, it can be concluded that the central peak of Tycho is predominantly basaltic in composition.

1. Introduction

Tycho is a Copernican age (~110 Ma) bright ray crater with a prominent central peak and is located in the southern highlands on the near side of the Moon. It is having a diameter of ~85 km. The central peak of Tycho exhibits an unique compositional assemblage, comprising of a high-Ca pyroxene bearing lithology of plausibly gabbroic nature and pure crystalline plagioclase bearing anorthosites [1,2,3,4,5]. In the present study, the main objective was to combine for the first time the spectral responses of HySI and SIR and study the composition of Tycho's central peak. Very high resolution images from Chandrayaan-1 TMC and LROC-NAC images from LRO mission reveal presence of impact melt ponds and/or lava pond within the central peak as well as on the terraced crater walls [6,7]. The composition of these melt and/or lava ponds are important in deciphering about the depth and nature of the source region from which the melts have been originated.

2. Data Used

HySI data from the Chandrayaan-1 mission has been used in combination with SMART-1 SIR data for the presented purpose. HySI is an imaging spectrometer with 64 contiguous bands in the spectral range of 420-964 nm. It is having a spatial resolution of 80 m [8]. SIR, on the other hand, is a spectral profiler (point-spectrometer) with high spectral resolution of 6 nm measuring the reflected solar light in the spectral range between 940-2400 nm. The footprint size varies from 330 m to 2.5 km owing to the elliptical nature of the orbit [9].

3. Methods

Radiometrically calibrated, dark corrected and band-to-band registered Level 1b HySI data products have been used for the present study. Radiance data was then converted to reflectance using Relative Spectral Response (RSR) data of 64 HySI filters and convolving the Exo-atmospheric Solar Irradiance values to HySI RSR within the spectral range of 421-964 nm. Out of band response for all the 64 HySI channels have also been computed and subtracted from the data during radiance to reflectance conversion. Improved dark and bias corrected SIR data has been used for the present purpose. SIR reflectance spectra has been cross-calibrated with Clementine NIR data and finally converted into standard geometry using Shkuratov's photometric function [10,11,12]. The optimization of SIR coordinates is done by minimizing the differences between SIR and Clementine intensity profiles. Finally, reflectance values have been extracted from HySI image corresponding to the corrected coordinates of the SIR track.

4. Figures

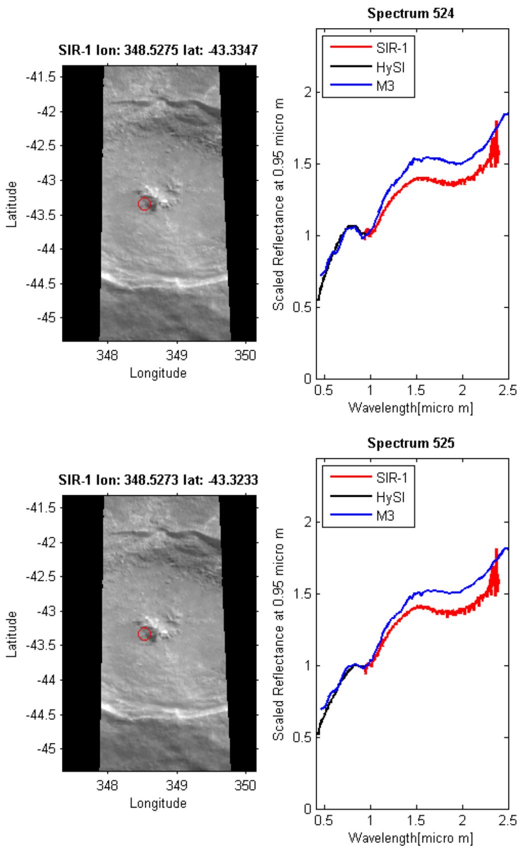

Figure 1A-B: HySI-SIR combined reflectance spectra of Tycho's central peak. The red circle in the left-hand image indicates the location of SIR footprint on the HySI image. HySI, SIR and M3 spectra are shown in black, red and blue solid line respectively.

5. Summary and Conclusions

For the first time an attempt has been made to combine spectral data from Chandrayaan-1 HySI and SMART-1 SIR spectrometers to cover a larger spectral range of 420-2400 nm which is required for complete characterization of major lunar minerals. Prominent band absorptions could be seen in spectra#524 and #525 (Fig. 1A-B). Combined reflectance data from HySI and SIR have been compared with M^3 spectra. The reflectance values from all the three instruments have been scaled to unity at 0.95 µm. It is evident from Figure 1 that the combined spectral responses from HySI and SIR matches well with that of M^3 spectra. Prominent absorption features around 1 and 2 µm indicates presence of pyroxenes which in turn confirms the gabbroic nature of the central peak.

Acknowledgements

We express our thanks to the HySI Chandrayaan-1 team at SAC and the SIR SMART-1 team at MPS for developing the sensors. We also thank Dr. R. R. Navalgund, Director, SAC for his enduring support and encouragement in this study. We are also thankful to Shri A. S. Kiran Kumar, Associate Director, SAC and Dr. J. S. Parihar, DD, EPSA for their valuable guidance and support.

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