DISCOVERY OF LUNAR OLIVINE WITH OH/H$_2$O BAND AT MOSCOVIENSE BASIN USING HYPERSPECTRAL IMAGING SPECTROMETER DATA (M$^3$)

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ABSTRACT

Hyper spectral imaging spectrometer data (M$^3$) has allowed identifying olivine mineral with OH/H$_2$O band in Moscoviense basin on the Moon surface. Moon Mineralogy Mapper (M$^3$) sensor records the reflected radiance between 0.46 and 2.97 μm in 85 contiguous spectral bands, between 20 – 40 nm spectral sampling with 140 m/pixel spatial resolution from the Moon’s surface in push broom mode. A spectral reflectance profile was collected (average of 3 pixels) and modeled and continuum was removed. Automatic straight-line approximations continuum-removal method was used for removing background continuum. A strong absorption band near 1000 nm and moderate absorption band near 2800 nm wavelength regions have been observed due to presence of olivine mineral with OH/H$_2$O band. The olivine sample with OH/H$_2$O band indicates that magmatic water could be present in the lunar olivine. Presence of olivine along with OH/H$_2$O band could be of endogenic origin. One paragraph only (Maximum 200 words).

Keywords: Hyperspectral, Olivine, OH/H$_2$O Band, Moon, Moscoviense Basin, Moon Mineralogy Mapper

INTRODUCTION

Identifying mineral distributions on the lunar surface provides clue to know the origin, crustal evolution, geological history and stratigraphy of the Moon. Olivine is a useful mineral to evaluate the geologic evolution of igneous planetary bodies such as the Moon (Isaacson et al., 2011). Olivine represents the exposure of the lunar mantle, but could also represent differentiated plutons resulting from secondary magmatic intrusions into the lunar crust (Yamamoto et al., 2010). At the present time, imaging spectroscopy provides finest information about the planetary surface to discriminate various minerals across the spectrum. The M$^3$ onboard Chandryaan-1 provides hyperspectral data of lunar surface to study about the Moon. In this paper, olivine with OH/H$_2$O band mineral is investigated using M$^3$ data in the part of Moscoviense basin. Visible to near-infrared reflectance imaging spectroscopic data is helpful for identifying minerals on the Moon surface due to analytical absorption bands as a result of transitions of electrons in a crystal field (Burns, 1993). The spectral (spectra) characteristics such as shape and absorption centers are useful for identifying various minerals. Many literatures are provides insight into detection of minerals on the lunar surface based on minerals absorption characteristics (Anbazhagan and Arivazhagan, 2010; Sivakumar and Neelakantan, 2014; Anbazhagan and Arivazhagan, 2010; Klima et al., 2011; Adams, 1974). The olivine and OH/H$_2$O minerals can be identified based on absorption characteristic near 1000 nm and 2800 nm wavelength regions (Isaacson et al., 2011; Bhattacharya et al., 2014; Clark, 2009; Pieters et al., 2009; Saal et al., 2008).

Regional Setting

Moscoviense basin is a multiringed impact basin located in the far side of the Moon at 27°N, 148°E (Figure 1). A recent study suggested that the Moscoviense Basin is actually the thinnest on the entire Moon (Ishihara et al., 2009) using data from the Japanese Mission, Kaguya. The basin was first identified as a large region of dark mare in Luna 3 spacecraft images, launched in 1959 by the USSR. Moscoviense basin has been filled by mare basalts of varying compositions (Craddock et al., 1997; Kramer et al.,

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MATERIALS AND METHODS

Data Used

M^3 data was used for identifying olivine with OH/H\textsubscript{2}O band in the Mare Muscovine basin of the Moon. M^3 sensor was a guest instrument from NASA, which was on the Chandrayaan-1, the Indian Space Research Organization’s (ISRO) first mission to the Moon (Goswami and Annadurai, 2009). M^3 sensor records the reflected radiance from the Moon’s surface in pushbroom mode between 0.46 and 2.97 μm in 85 contiguous spectral bands, between 20 – 40 nm spectral sampling with 140 m/pixel spatial resolution (Pieters et al., 2009). Photometrically calibrated and pixel-located reflectance image (Level-2) was downloaded from http://ode.rsl.wustl.edu/moon/. Optical period-2 coverage was used for identifying mineral.

Methodology

ENVI image processing software was used for collecting, modeling and analyzing mineral spectra. M^3 data was clipped for analyzing mineral in the basin region. Spectral reflectance profile was collected (average of 3 pixels) and modeled and continuum was removed for the reflectance spectra for better understanding of absorption parameters. Automatic straight-line approximations continuum-removal method was used for removing background continuum (Clark et al., 1987).

RESULTS AND DISCUSSION

Results

Figure 2 and Figure 3 shows the reflectance and continuum removed spectra of olivine with OH/H\textsubscript{2}O band, respectively. A location of the sample spectra is shown in the Figure 1. Olivine rich area located in the southern edge of the inner ring of the basin. Olivine rich spectra shows strong absorption band near
1000 nm (Isaacson et al., 2011). The spectra shows typical absorption bands near 2800 nm wavelength regions due to OH/H$_2$O content in the sample (Bhattacharya et al., 2014; Clark, 2009; Pieters et al., 2009). Theses specific absorption indicates the presences of olivine mineral with OH/H$_2$O band.

**Figure 2:** Reflectance spectra of olivine with OH/H$_2$O band. Sample location is shown on the Figure 1. Absorption near 1000 nm shows presence of olivine and near 2800 absorption indicates OH/H$_2$O band. Doted circle shows absorption region of the sample spectra.

**Figure 3:** Continuum removed reflectance spectra olivine with OH/H$_2$O band. Sample location is on the Figure 1. Absorption near 1000 nm shows presence of olivine and near 2800 absorption indicates OH/H$_2$O band. Doted circle shows absorption region of the sample spectra.

**Conclusions**

Hyperspectral imaging spectrometer data has allowed identifying lunar olivine with OH/H$_2$O band. Olivine rich spectra shows strong absorption band near 1000 nm and also near 2800 nm wavelength region due to presence of OH/H$_2$O band in the sample. The sample contains OH/H$_2$O band, it indicates that magmatic water could be present in the lunar olivine. Presence of olivine along with OH/H$_2$O band could be of endogenic origin. This study put forward that hyperspectral imaging spectrometer data is extremely suitable for mapping and identifying the minerals on the Moon surface. Further scope of the
study would be identifying similar spectra at different locations with thermal corrected different optical period data.

ACKNOWLEDGMENT

Authors wish to acknowledge M³ team for supplying the data. Currently first author is working with C-DAC, Pune, India and thankfully acknowledges C-DAC for providing resources and support to carry out the study.

REFERENCES


