Initial results from Imaging Infrared Spectrometer (IIRS) onboard ISRO's Chandrayaan-2 for lunar mineral detection

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***Abstract*—The paper presents some initial results from ISRO's Chandrayaan-2 Imaging Infrared Spectrometer (IIRS) reflectance data analyzed for mineral detection from the lunar surface.**

Keywords*—*Imaging Infrared Spectrometer (IIRS), Reflectance, lunar minerals

I. Introduction

Indian Space Research Organization's (ISRO) had launched its second lunar mission Chandrayaan-2 on 22nd July 2019 from Sriharikota (India) by GSLV MkIII-M1. It was an orbiter, lander and rover intended for compositional, topographical, mineralogical investigation of lunar surface in detail. Alongwith its orbiter payloads (total 07) it carried Imaging Infrared Spectrometer (IIRS) which is a grating-based dispersive instrument designed to measure the reflected solar radiations and thermal emissions from the lunar surface in spectral range of 0.8 to 5μm with spectral sampling of ~16.8 nm in 256 contiguous spectral bands [1, 2]. Imaging with 80 m ground sampling distance and 20 km swath at nadir view from 100 km orbit altitude provides high-resolution spectral information to detect, characterize, and map the lunar surface composition and volatiles. The study presents initial results of common lunar mineral detection using IIRS data strip from ISRO's recent Chandrayaan-2 mission.

II. Datasets and Methodology

The present study have utilized Level 1 radiometrically calibrated IIRS radiance data cubes for mineralogical study. The initial processing involved conversion of radiance to reflectance by normalizing with solar flux followed by spectral smoothening by empirical line correction [2]. Standard band combination were utilized for generating band ratio images and to detect specific mineral from the various lunar mafic components. Reflectance spectra were acquired and analyzed in the wavelength range from 0.8 to 2.5μm part of the spectrum for observing their diagnostic absorption features from the analyzed strip. During spectral analysis the low response bands from the IIRS reflectance spectra at order sorting filter (OSF) joining locations were removed (~1.2 μm and 1.9 μm). Representative spectra for specific minerals were extracted from the various locations and tectonic settings, sampling both highland and mare lithology. The obtained results were initially compared with Chandrayaan-1 Moon Mineralogy Mapper (M^3) reflectance spectra in the same region to evaluate the results [3]. The spectra were showing similarity in their spectral shape despite variation in the observation geometry, spatial resolution, and wavelength resolution.

III. Results and Discussions

The present study reports detection of Mg-Spinel, plagioclase feldspar, orthopyroxene, low and high-Calcium pyroxenes from various locations based on their band center location and characteristic spectral shape in VNIR region.

Mineral analysis from reflectance spectra involves characterization of the spectral features arising from the electronic transitions within their structures [4]. The IIRS spectra analyzed for Mg-Spinel is characterized by a broad absorption near 2μm with negligible 1μm feature due to presence of iron in its structure [5]. Iron presence in plagioclase feldspar imparts a prominent absorptions near 1.3μm [6,7]. For pyroxenes iron presence is reflected by dual absorptions features at ~1 and 2 μm and these band positions shifts as a function of calcium content giving rise to its different varieties (e.g. 8). The compositions sampled from the specific locations and tectonic setting reflects the physical and chemical conditions under which they were formed and are significant in understanding the crustal evolution of the Moon. ISRO's Imaging Infrared Spectrometer (IIRS) is an advanced hyperspectral imaging spectrometer with high spatial and spectral resolution and is likely to provide better result for mineralogy. Further processing for thermal removal, normalizing to the standard geometry, ground-truth corrections are under progress.

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