A Comparative Study of Charnockite Rocks Based on Spectroscopic and Mineralogical Analysis.

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Introduction: Charnockite, Ortho-pyroxene bearing granitic rocks are the primary component of Anorthosite–Mangerite–Charnockite-Granite (AMCG) suite associated with rift-related magmatism and hence, plays a vital role in the formation and evolution of Proterozoic crust [1]. It constitutes only a small portion of the world-wide granitic rocks and occurs in the high temperature and pressure region [2]. These rocks provide the possibility to know about the processes and formation that happens in the deep crust or deep within the granitic plutons [2]. The planetary bodies surface like Lunar highlands mainly composed of anorthosite [3]. Hence, the association of charnockite with the anorthosite rocks also gives rise to the possibility of a similar association on the planetary bodies. Thus, charnockite gains significant interest in planetary exploration in terms of analogue studies.

In this study, the spectroscopic and mineralogical study of the charnockite rocks has been employed. Spectroscopy of rocks can provide useful diagnostic information of their elemental and mineralogical composition based on diagnostic absorption feature [4, 5]. The objective of the study is to compare charnockite rocks of the different location based on spectroscopic study in VNIR/SWIR and TIR region and mineralogical (from XRD) analysis. It can be used as an analogue for planetary exploration.

Study Area: The Southern Granulite Terrain (SGT) is well known for its vast areal extent (~ 2,00,000 km^2), which occupies the southernmost part of peninsular India. It is considered to be one of the largest exposed deep continental crustal section of Pre-Cambrian age all over the world. It consists of two blocks (Northern and Southern) [6], separated by the Palghat-Cauvery Shear Zone (PCSZ) [7]. The charnockite rocks were collected from the marked location as shown in figure 1. The massif charnockite rocks named as KK1A and OD1E were collected from Kodaikanal (10.37°N, 77.54°E) and Oddanchatram (10.47°N, 77.68°E) near Palani hills, Tamil Nadu, India respectively. The sample OD1BA charnockite with banded gneiss was collected from the Oddanchataram (10.51°N, 77.82°E), Tamil Nadu, India.

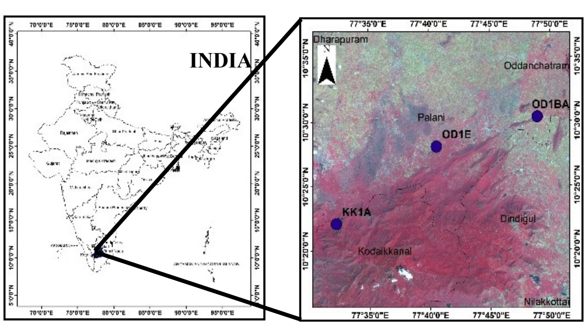

Figure1: Study Area (Standard FCC of Aster Image) with marked sample locations.

Materials and Methodology: The field spectroradiometer (SVC-HR 768i) having the spectral range of 350-2500 nm and FTIR with Diffuse Reflectance Accessory (DRA) having the spectral range of 2.5-15.3 µm were used to obtain data in the VNIR/SWIR and TIR region respectively. In this study, 400 nm- 2400nm and 8 µm to 14 µm spectral range were used to observe the spectral behavior as these regions of EMR are generally used for the study of lithology and mineralogy of the planetary bodies through remote sensing [8, 9].

The rocks sample were prepared accordingly, for measuring the spectra in the VNIR/SWIR region, the bulk sample has been used. The spectra have been acquired in the controlled field condition, i.e. instrument has been kept stable and has the same illumination condition. The total of 6 spectra of each sample of rock was measured in the bright sunlight with no shadow on the sample. Averaging of those spectra were done to get the final spectra of the rock sample.

The chips of the rock samples have been used to measure the spectra in the TIR region. FTIR with DRA acquired the spectra in the reflectance mode. Consequently, reflectance data were converted into emissivity, using the Kirchhoff's Law, E= 1-R; (where, E= emissivity, R = reflectance) a well-established method used by several researchers [10,11]. The diagnostic absorption features of the spectra obtained in the VNIR/SWIR and TIR region were analyzed and mineralogical analysis was also performed using the powder XRD method.

Results and Discussion: The spectra of KK1A, OD1E and OD1BA charnockite rocks show the absorption around 600-700 nm 900-1000 nm, and 2200-2300 nm in the VNIR/SWIR region as shown in figure 2(a). The pyroxene are responsible for the diagnostic absorption feature around 1000 nm and 2000 nm as shown in the spectra of all charnockite rocks sample. Among the three samples of charnockite, OD1E is showing clear

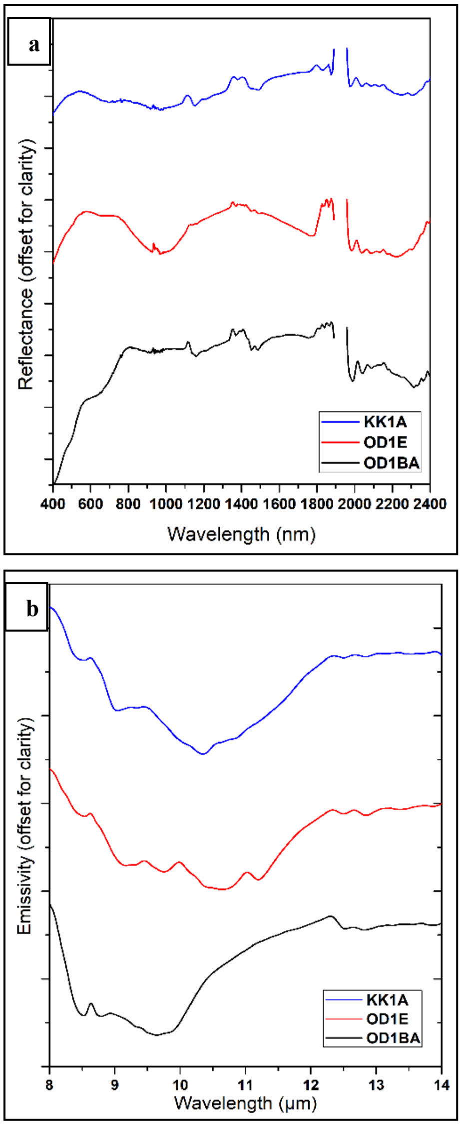

Figure 2 (a) Reflectance spectra (350-2400 nm) **(b)** Emittance spectra (8-14 μm) of charnockite rocks of different location.

absorption feature near 900-1000nm. This could be due to the higher percentage of pyroxene minerals in the sample. OD1BA shows absorption feature around 700 nm which could be due to the charge transfer of Fe2+ to Fe3+. The spectra of in the TIR region. The results from the FTIR analysis of the charnockite rocks (KK1A, OD1E and OD1BA) as shown in figure 2(b) represent the spectral characteristics in the TIR region. All the sample shows the reststrahlen band at around 8.6 μm and 9.2 μm is due to asymmetric stretches between O-Si-O, suggesting the presence of quartz. The weak absorption obtained at 13-14 μm due to symmetric stretches within (Si, Al)-O- (Si, Al) groups. The diagnostic absorption feature of the charnockite rocks were matched with diopside, augite, pigeonite, microcline

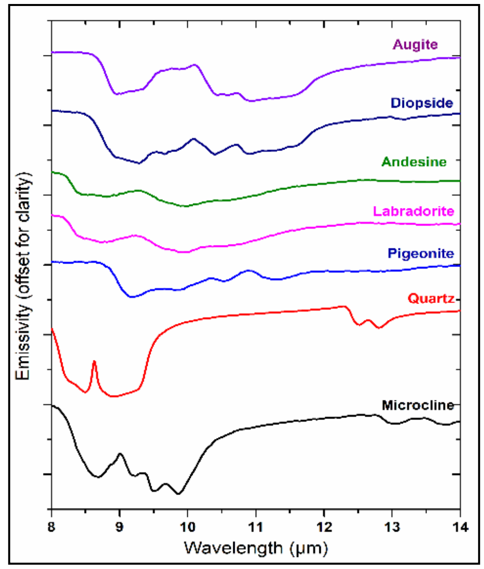

Figure 3 Well Characterized minerals spectra from ASU spectral Library [12].

and andesine minerals spectra from the ASU spectral library (figure 3) [12]. The presence of all these minerals were identified and verified through XRD analysis. However, the presence of quartz was identified in the OD1BA sample through XRD analysis while spectral analysis picked up the presence of quartz in the other two sample also.

Conclusions: The study of spectral characteristics of charnockite rocks of different location shows similarity to the spectral feature of the mafic and granitic rocks in both VNIR/SWIR as well as TIR region. This could be due to the fact that charnockite rocks have quartz, feldspar and pyroxene as major minerals. The presence and abundance of these minerals were verified using powder XRD method. Considering it as an additional analogue rock type for planetary exploration demands further analysis on its spectral behavior.

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