PURE AND MIXED SPECTRA OF ANORTHOSITE, GABBRO AND DUNITE OF SALEM AND NAMAKKAL DISTRICTS OF SOUTHERN INDIA.

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Introduction: There has been extensive study on Sittampundi anorthosite complex since Count de Bornon (1817) named the rock as Indianite [3]. Studies on anorthosites in different parts of the globe have shown that they constitute marker horizons in the Precambrian terrain and define ancient tectonic zones. The discovery of anorthosite in the moon gave an impetus to the study of anorthosites which are rich in calcic plagioclase feldspar [1].

This paper deals with the spectral study of anorthosite, gabbro and dunite rocks of Namakkal and Salem districts of Tamil Nadu, Southern India. These rocks have been studied because such rocks are also believed to exist on the lunar surface also. Spectral studies of rocks that are common to both earth and moon would aid in better understanding of the lunar surface lithology. In addition, this study would help in analysing the images to be acquired by Chandrayaan-1, India's lunar moon.

Study area: The study area forms a part of the dunite (Salem district), anorthosite and gabbro (Sittampundi, Namakkal districts) out crop in Tamil Nadu.

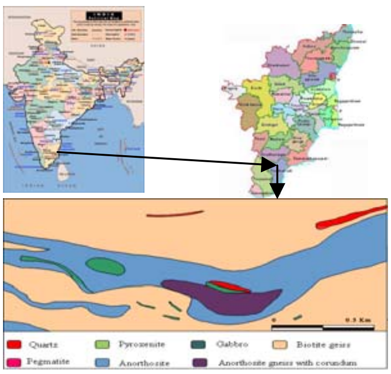

Figure 1: Geological map of Sittampudi anorthosite and gabbro complex, Sittampundi.

Sittampundi complex: The Sittampundi anorthosite complex is mainly composed of dunite, pyroxenite, garnetiferous granulite (eclogite), gabbro, anorthosite (±chromite) and clinozoisite – bearing anorhosite [1]. [2] reinvestigated the complex and discovered that the primary igneous stratigraphy passes upwards from pyroxenite, through gabbros to anorthosite overlain by clinozoisite-anorthosite.

Chalk hills: Olivine-rocks with magnesite has exists in Salem known as the 'Chalk hills'. It lies between the foot of the Shevaroyans hills and Salem town [3]. The name Chalk hills is because of the ramifying veins of white magnesite. The ultramafic body spreads into two types. The northern one is dunite, preidodite, sperpenitine, pyroxenite, hornblendite and magnesite. The southern type consists of predidotite, serpentinite, hornblendite and magnesite [1].

Spectroradiometry: Spectroradiometry is the technique of measuring the spectrum of radiation emitted/reflected by a feature which is illuminated by a source. Spectroradiometer has many uses in geological, agricultural, environmental studies, in industry and in the medical world. The spectroradiometer used for this study has a wavelength range between 375 and 1075nm, with 25 deg FOV and 1.5nm band width.

The samples of rocks (anorthosite, gabbro and dunite) brought from Salem and Namakkal districts were subjected to three types of spectral reflectance studies by using the spectroradiometer: (i) whole-rock spectroradiometry, (ii) Effect of grain sizes on the spectra and (iii) spectra of rock mixtures.

Whole-rock spectroradiometry: Anorthosites, gabbros and dunites with sizes not less than 5"x5" were subjected to spectroradiometric studies.

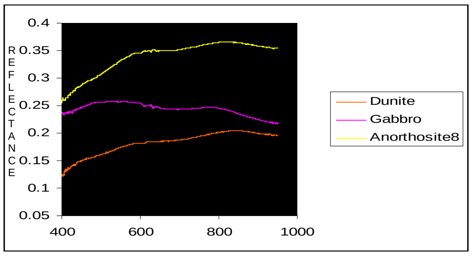

Figure 2: Spectral reflectance of Anorthosite, Gabbro and Dunite whole rocks: wavelength range 400nm- 950nm

Anorthosite (mostly plagioclase feldspar) shows the highest reflection as in fig 2, because of the low mafic content. Gabbro is made up of plagioclase feldspar and pyoxenes. Dunite is almost entirely composed of olivine with little mafic minerals has the lowest reflectance compared to that of anorthosite and gabbro.

Effects of Grain Size: The amount of light scattered and absorbed by a grain is dependent on the grain size [4]. A larger grain has a greater internal path where photons may be absorbed according to Beers Law. It is the reflection from the surfaces and internal imperfections that control scattering. In a smaller grain, there are proportionally more surface reflections compared to the internal photon path lengths. In other words, the surface-to-volume ratio is a function of grain size. This study illustrates the effect of particle size on the rock spectra. Rocks are presented at four different

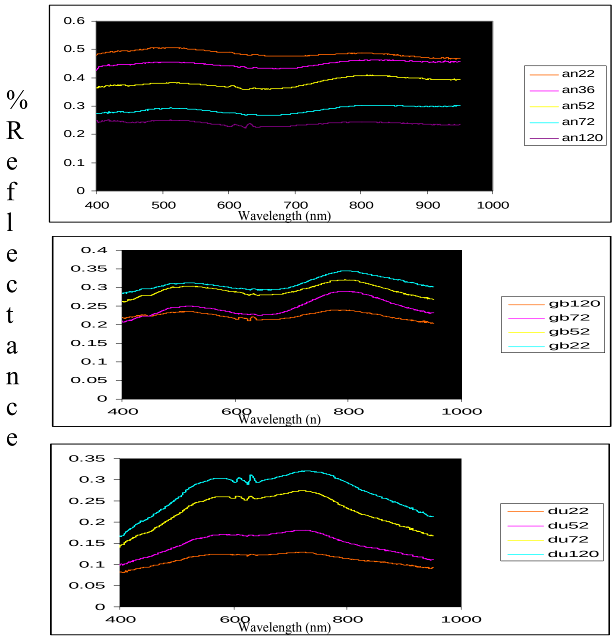

Figure 3: a, b c Effect of grain size (22 µm , 52 µm, 72 µm and 120 µm) on reflectance of anorthosite (an), gabbro (gb) and dunite (du).

grain sizes for this study: 22 µm, 52 µm, 72 µm and 120 µm. From fig.3 it is inferred that for anorthostite and gabbro, the reflectance decreases as the grain size increases, but for dunite the reflectance increases as the grain size decreases.

(a) (b) (c)

Figure 4: (a) Anorthosite (an)100- Gabbro (gb) 0- Dunite (du) 0 (b) Anorthosite (an)100- Gabbro (gb) 50, (c) Anorthosite (an)100- Dunite (du) 50

Rock Mixtures: The real world (and also the moon) is a complex mixture of materials, at just about any scale we view it. For this study, the intimate mixture model has been used (Fig 4) where rocks mixtures were prepared by combinations of two rocks. The first combination is anorthosite and gabbro: second combination is anorthosite and dunite. The rocks were made to 22 µm size. The area for target was determined using the formula: Tan θ = r/h : where, θ = is the FOV of the spectroradiometer (ie 25º)), r= radius of the circle corresponding to the FOV, h= viewing height.

The proportions of the sample for the rock mixture1 is An_{100}-Gb_{0}, An_{90}-Gb_{10}, An_{80}-Gb_{20}…..An_{0}-Gb_{100} Fig.4b For the second rock mixtures anorthosite and dunite An_{100}-Du_{0}, An_{90}-Du_{10}, An_{80}-Du_{20}…..An_{0}-Du_{100} (fig.4c).

Spectral measurements for the rocks mixtures were made (Fig 5.a,b) for both the combinations. Anorthosite (100) has the mazimum reflectance as it has the lowest mafic content compared to gabbro and dunite.

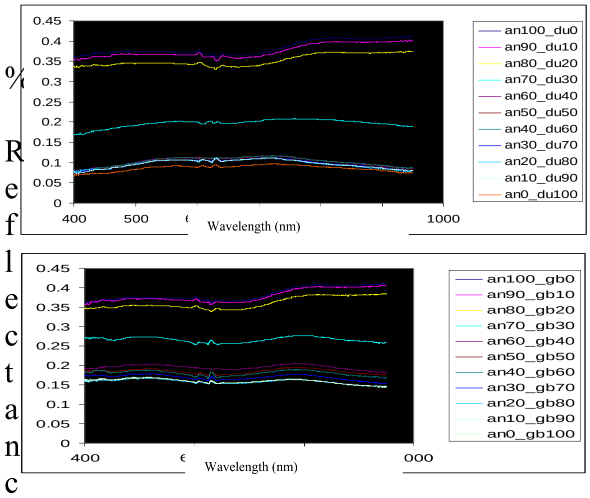

Figure 5: Spectral reflectance of rock mixtures of (a) anorthosite and dunite (b) anorthosite and gabbro

Discusion: This study provides the difference in the absorption and reflection characters of rocks in different grain size as the lunar surface may not have uniform grain size this will help in understanding the regolith and soil spectra on lunar surface.

Conclusion: Spectral studies of rocks that are common to both Earth and the moon would aid in better understanding of the lunar surface lithology. This study has helped in understanding the spectral characteristics of individual rocks and the rock mixtures of different size fractions. The composition of pixels of the proposed HySI images of Chandrayaan-1 can be better resolved by studies such as the one presented in this paper.

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