Spectral Studies of Anorthosite and Meteorite. Aarthy. R. S[1] .,Sanjeevi. S[1.], Vijayan. S[1] and Krishnamurthy. J[2]., [1]Deparment of Geology, Anna University, Chennai 25. India : ssanjeevi@annauniv.edu [2] Director NNRMS, Antariksh Bhavan, Bangalore 94, India.

Introduction: The lunar surface has lighter (terrae / highland) and darker (mare / low lands) regions. The terrae of the moon are made up of anorthositic suite of rocks and are densely impacted by meteorites.

Anrothsoties is also present on the terrestrial surface. The Archean anorthosites (> 2.6 Ga) are primarily of interest because their closer chemical similarity to highland anorthosites on the moon **[1]**. The Sm-Nd isotopic studies on the Sittampundi anorthosites of southern India shows an age of 2935±60 Ma, indicating the Archean age **[2]**.

There are many craters formed due to meteoritic impaction on the moon. Meteorite studies in general provide clues to understand the evolution of their parent bodies **[3]**.The common types of solar system meteorites are the ordinary chondrites. Thus the lunar surface also may also be impacted by many ordinary chondrites. Since there is minimum space weathering, there may be chances of the meteoritic fragment present on the lunar surface along with the common rock types (eg. Anorthosite).

The surface of the moon is covered by a layer of unconsolidated debris called the lunar regolith. Glass and lithic fragments in the lunar soil are of great interest, because they provide clues of the nature rocks derived from well beyond the sampling site. For this reason, lunar scientists have shown great interest in the coarse - fine fraction of the lunar soil **[4]**.

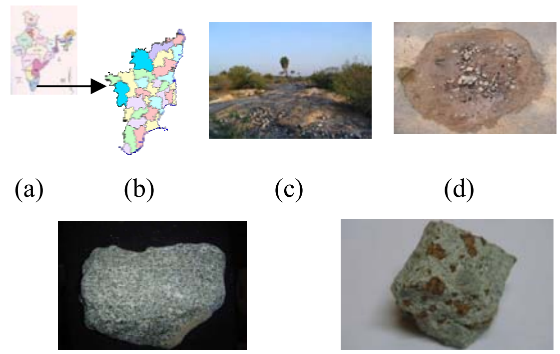
Methodology: Using a handheld spectroradiometer operates in VNIR (325nm-1075 nm) in 751 bands, four types of samples studies were carried out (i) massive rock (ii) pulverized (iii) chondorite meteorite and (iv) anorthosite- meteorite combined,

The reason to study anorthosite and meteorite is that, to study the lunar surface, Chandrayaan-1 mission has been sent by India. It has eleven sensors including the Hyperspectral imager (HySI). The aim of the HySI is to perform mineralogical mapping of the lunar surface. HySI operates in the wavelength region between 421nm-953nm in 64 bands.

The spectra were convolved to 64 bands similar to that of the HySI sensor. The convolved spectra may aid to identify the anorthosite rock, different grain sizes and (if any) meteoritic association.

Study sites: Site 1: The rock types in the anorthosite complex near Sittampundi are mainly anorthosite (± chromite), clinozoisite- bearing anorthosite, dunite, pyroxeinite, gabbro **[2]**.

Site 2: Meteorites fell into the roads and agricultural fields in two villages (Addakurki and Kammandody) near Hosur, Krishangiri district of Tamil Nadu on September 12th 2008 around 08:30 hrs. The meteorite fall was witnessed by villagers and the meteorites were retrieved.



(a) (b) (c) (d) (e) (f)

Fig 1 (a) India map (b) Tamil nadu map (c)Sittampundi (d)Addakurki (e) Anorthosite sample (f) Meteorite sample

The anorthosite samples were collected from Sittampundi anorthosite complex and the meteorite samples were collected from Addankurki village near Hosur of Figure 1(c) and (d) shows the sample sites.

Petrography: The Sittampundi anorthosite rock sample (fig 1e) composed of mostly plagioclase feldspar (85%) and remaining is hornblende. The meteorite sample (fig 1f) is composed of olivine, pyroxene as major minerals with few types of feldspar (clouded) and minor amount of pyrite, chlocopyrites (compostion of ordinary chondrite).

Results and discussions

(i) Whole rock spectra: The anorthosite rock sample (25 cm x 18 cm) was used to obtain the whole/bulk rock spectra in the VNIR region From the spectra it is observed that reflection occurs in the wavelength range between 400nm-500nm, while absorption is occurs in the wavelength range between 800-950nm. The absorption may be due to the presence of hornblende.

(ii) Meteorite spectral studies: The surface of the moon is covered with a layer of fragmental debris referred to as regolith consisting of range of particle sizes from micron to few meters with superposed impact craters **[5]**. From the spectra of the meteorite sample it is observed that there is absorption in the wavelength range between 800nm-950nm due to the presence of iron content in the meteorite sample composition.

(iii)Anorthosite and meteorite combined spectra: The spectra was obtained as the meteorite sample was kept on the anorthosite sample. This was done to know and to identify if any anorthosite and meteorite are present contemporarily on the lunar surface. Figure 2 (a) shows the spectral curve of the massive anorthosite, pulverized and meteorite-anorthosite combined respectively.

(ii) Effect on grain size: The anorthosite bulk sample was pulverized to various grain sizes (1/16mm,1/36 mm, 1/52 mm, and 1/72 mm). Figure 3 (a1) shows the spectra of different grain sizes of anorthosite rock. The largest grain size of 1/16 mm has the highest reflection and the smallest grain size 72µm has the lowest reflection. It has been observed that as the reflection decreases as grain size decreases in the anorthosite rock sample.

Hyperspectral imager (HySI): The sensor onboard Chandrayaan 1 mission consists of hyperspectral imager sensor in order to map the lunar surface. The sensor operates in the VNIR region (421nm-953nm: Source: Kiran Kumar **[6]**) with 64 bands.

For this study the wavelength range between 421nm-953nm wavelength ranges of the spectra from spectroradiometer were convolved to the 64 bands similar to that of the HySI bands. Figure 2 b shows the spectral curve of the massive anorthosite, pulversized and meteorite-anorthosite combined respectively.

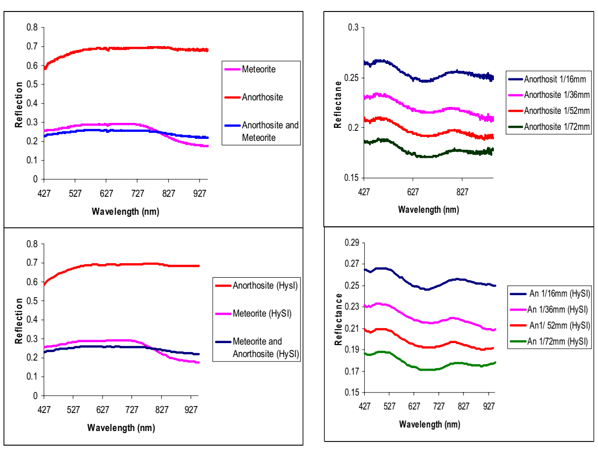


Fig. 2 a Anorthosite massive, meteorite, and meteorite-anorthosite combined spectra. B Anorthosite massive, meteorite, and meteorite-anorthosite combined spectra convolved to 64 bands

Fig 3 a . Anorthosite pulverized spectra b. Anorthosite pulverized spectra convolved to 64 bands

Conclusion: This study is an attempt to understand the lunar highland surface. The massive anorthosite sample spectra have the highest spectral reflectance due to less iron content in the composition. This would aid in the identification of the anorthosite outcrop and massive anorthosite on the lunar surface. If there are meteorites fragments present may also be detected in the 850-900nm wavelength range. When the anorthosite and meteorite occurs together the anorthosite reflectance tends to reduce as the meteorite is composed of ultramafic minerals. In the wavelength range between 802nm-820nm (bands 46-48) there is a overlap of the spectra between anorthosite and meteorite. Thus in this wavelength both the rocks cannot be used to differentiate. This study may be useful to differentiate the lunar surface rocks.

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References: **[1]**. Petrology igneous sedimentary and metamorphic second edition Harvey Blatt and Robert J. Tracy, W. H. Freeman and company New York.
[2]. Selvan. And Subramaian (2001). Geology of Tamil Nadu and Pondicherry. GSI publication.**[3]**. Chattopadhyay1. B. K., Goswami. J. N., Murty S. V. S., Thapliyal1. A. P., Ghosh. J. B., Shukla. P. N., Shukla. A. D., Mondal1. P. K., Pant1. N. C. and Sinha.(2005) N.Meteorite falls over India during 2003:Petrographic and chemical characterization and cosmogenic records. current science, vol. 88, no. 5, 10.
[4] Meyer. C., 2008, Lunar sample compendium.
[5] Korotev Randy L., compositional trends in Apollo 16 soils. Lunar and planetary institute. Provided by the NASA astrophysics Data system.
[6] Kiran Kumar 2008: SAC Meeting.