Mineralogical Mapping Using Chandrayaan-1 Hyperspectral (HySI) data From The South Pole Region Mohammed Zeeshan R[1] and S. B. Sayyad[2] ([1,2]Department of computer science, Milliya Arts, Science and Management Science College Beed Maharashtra India). zeeeshan.shaikh@gmail.com syedsb@rediffmail.com,

Introduction: The moon minerals can be well distinguished in the visible and near infrared part of the spectrum by its characteristic absorption features [1].the chemical structure of the mineral causes change in shape, position and strength of the absorption band across the spectrum [2-4]. The spectral profile analysis helps to study and identify different mineral from the lunar surface. The hyperspectral remotely sensed data provides a great opportunity to assess the mineralogy but the derived spectral signatures has great influence of an active mechanism that is consistently effects the lunar surface is termed as space weathering process. Space weathering involves two mechanisms firstly solar wind ion implantation and micro meteoritic bombardment [5-6]. These two processes create a thin layer of submicroscopic iron (SMFe) which alters the spectral properties of soil and reflects strong influence on the spectra [7]. Reduction in the overall reflectance, shallow absorption bands and red sloped continuum are the effects of space weathering on the spectra The space weathering effect acts as barrier for accurately assessing the surface mineralogy and compositional analysis. These effects can be address by means of a model based on theory of radiative transfer that best explains the space weathering effect on remotely sensed spectra.

The Methodology: Modeled spectra is created for modeling the Chandrayaan-1 hyperspectral (HySI) data, The Bi-directional reflectance function [8] is used. The five pure end member spectra of common lunar minerals are selected from RELAB database. considering the spectral coverage of HySI from 0.43 µm to 0.96 µm the five end member is sufficient because within this spectral range most of the lunar mineral does not exhibit the absorptions and if we have data at longer wavelengths can only sense to take more end members for modeling process. The artificial modeled spectra tested against the three components standard lunar mixtures by setting other parameters like grain size, phase function as average at 30 degree phase angle, 65 per- cent porosity and zero iron content means no space weathering effect for lab samples. initially all mineral mass fractions and other parameters are set to lab specified values and it is found that the resultant modeled spectra is having close resemblance with the laboratory mixtures For finding out the difference between measured and modeled spectra the mineral mass fractions is adjusted and it is observed that there is about 10 percent difference between measured lab spectra and modeled spectra.

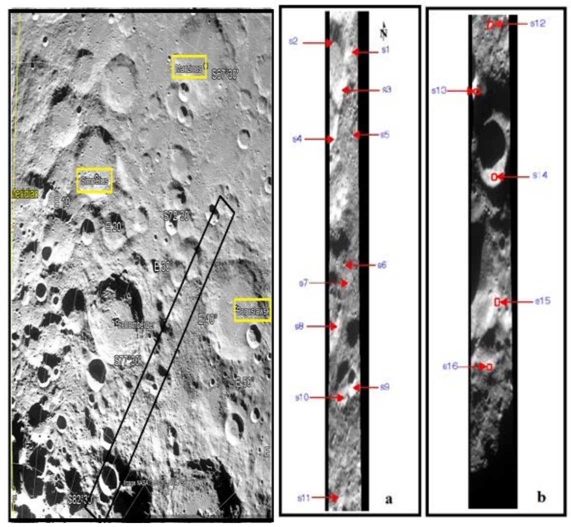

Fig. 1. South Pole map on google moon tool and extent of study area

Results and Discussions: The Chandrayaan-1 HySI dataset is used for the study. the image cube is downloaded from ISRO-issdc.gov.in website with product Id HYS_NREF_20090605T225556626. The image covering the area from south pole region close to Boguslawsky crater. Figure (1) shows the extent of the study area and the actual HySi dataset which is divided into two parts The Figure (1) also shows the subset of the study area with sampling site locations. the image is corrected and cross calibrated using 10084 Apollo bulk soil sample. further the geometrical correction is performed using the geometry information provided with the data set. the region seems to be rugged and heavily cratered. for spectral profile analysis around 40 spectra from varying locations were selected. most of the spectra has no significant absorption and having red sloped continuum which indicates the high maturity of the area. however some 16 spectra selected from area appearing bright show adequate absorptions that can be suitable for modelling. these spectra are selected from the small young craters and from the crater walls of the large craters. the spectra from crater wall showing good reflectance with suitable band strength may be because of the gravitational slumping the material underneath getting exposed and these spectra are used for modeling. the spectral resolution of modeled spectra is 5 nm whereas the HySI spectral resolution is 15 nm so before modeling each HySI spectra is interpolated to 5 nm and imported to the model routine. The Figure (2) shows the reflectance spectra from the highlighted areas. The spectra with no significant absorption and having very low reflectance is discarded from further modelling process. each spectra is modeled individually and the mineral mass fraction for each spectra and the parameter like grain size, porosity, iron fraction is is recorded as model results. The spectra s7 shows the maximum reflectance around 21% with good absorption strength similarly spectra s4 and s13 is also showing good reflectance as they are extracted from the crater walls. The model results obtained for these spectra showing low iron mass fractions around 0.00015 with smaller grain size and showing 35 to 45 % of Clinopyroxene with low percent of agglutinates with around 40 % of plagioclase. The spectra s1 derived from northern part of the upper part from Figure (1) with low reflectance around 10% with complete absorption at 900 nm with 48% of orthopyroxene. About 11% low reflectance for spectra s16 shows mature soil with 0.00032 iron fraction with 30% plagioclase and 37% Clinopyroxene and extracted from the crater wall. from modeling results no spectra shows olivine mineralogy may be it is lower mantle material so no impact would have penetrated through the crust to the lower mantle but here all representative spectra shows high values of Clinopyroxene may be the cratering event have penetrated to the upper mantle or the huge south pole Aitken event causes the material to spread around the south pole region. There are prominent rays scattered around the South Pole region form south pole Aitken.

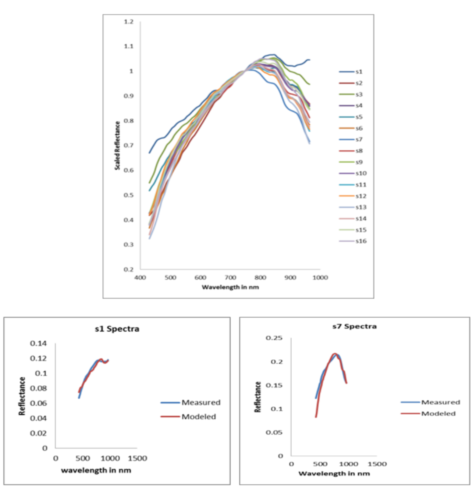

Fig.2. Normalized spectra at 748.3 nm of the study area and the sample measured and modeled spectra.

Conclusion: The Chandrayaan-1 Hyperspectral data from south pole region near Chandrayaan-2 landing site is used for mineral analysis . For quantifying the mineralogy the radiative transfer model has been implemented for better prediction of mineralogical variation on the lunar surface. moreover the space weathering process on an airless body like moon complicates and impedes the ability to get meaningful information hence the model also helps to determine the degree of space weathering in terms of iron fraction content. The results obtained from modeling process shows the high mass fraction of clinopyroxne and low Orthopyroxene content for small fresh craters spread across the study area . The highland spectra shows high mass fraction for plagioclase. the mature spectra shows overall low reflectance and model return high iron content for such spectra with high agglutinates. the selected spectra shows around 40 percent of Clinopyroxene as spectra is selected from small young craters or either from crater wall having steep slopes. spectra derived except the selected spectra showing very low reflectance with almost no absorption indicates very mature entire area hence difficult to model . at south pole region there is a strong chance of getting hydroxyl absorptions but the limited coverage of HySI dataset is constraint however data sets from other sensor with larger spectral coverage will gives an opportunity to model the spectra more accurately.

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References:[1]Burns, R. G., (1970), Cambridge University Press, New York.[2]Anbazhagan, S. and Arivazhagan, S. (2009). Planet. [3]Anbazhagan, S. and Arivazhagan, S. (2010) Planet. Space Sci., v.58, no.5, pp.752-760. [4]Hapke, B., 1965. DOI: 10.1111/j.1749- 6632.1965.tb20395.x.[5]Hapke, B., 1970. Radio Sci. 5,293-299, DOI: 10.1029/RS005i002p00293. [6]Hapke, B., 1973. The moon 7,342-355, DOI: 10.1007/BF00564639.[7]Hapke, B., Cassidy, W., Well, E., 1975. The moon 13,339-353, DOI: 10.1007/BF00567525. [8]Hapke, B., 1981, J. Geophys.Res., 86,3039–3054.