EPSC Abstracts
Vol. 6, EPSC-DPS2011-441, 2011
EPSC-DPS Joint Meeting 2011

Iron mapping method based on 2μm absorption parameters using SIR-2 data on-board Chandrayaan-1

M. Bhatt, U. Mall and R. Bugiolacchi
Max Planck institute for Solar System Research, Max-Planck-St. 2, 37191 Katlenburg-Lindau, Germany(bhatt@mps.mpg.de)

Introduction

The quantified analysis of iron on the surface provides constrains on initial temp and pressure conditions under which the planetary body formed as well as on the crystallization process which led to the present chemical composition of the crust. The iron content of lunar minerals can be measured by laboratory analysis of lunar meteorites and returned samples from Apollo and Luna missions or by remote sensing using gamma, neutron and x-ray methods. Among the remote sensing techniques, infra-red reflectance spectroscopy allows high spatial resolution (up to few tens of meters) measurements with high signal to noise ratio.

The absorption bands and slope of the infra-red reflectance spectra gives the information about the mineralogical composition of a surface. However space weathering weakens the absorption band depth and reddens the continuum slope which makes the detection of minerals and therefore indirect measurement of FeO wt% challenging [2].

Various attempts have been made to separate maturity or space weathering effects from its mineral composition using 1μm absorption band for Clementine or telescopic data sets. Lucey [3] developed a method considering reflectance ratio of 950 and 750 nm bands, Shkuratov [6] presented a 3D correlation method for simultaneous measurements of Fe, Ti and maturity. Le Mouélic [5] used a correlation of the 1μm band depth with the continuum slope. The main limitation so far was a limited number of spectral channels available for comparison with laboratory measured high resolution lunar sample's spectra.

We correlate iron abundance to 2μm absorption band parameters to generate iron abundance map using a high resolution near-infrared spectrometer, SIR-2 data set on board Chandrayaan-1. The SIR-2 wavelength range is 0.94 to 2.41μm with spectral resolution of 0.06μm and spatial resolution of 200 m from 100 km altitude. The data-set is measured at a constant detector temperature which provided us a uniform and consistent lunar surface measurements [4]. This attempt will provide a tool for comparative study of differences in FeO wt% mapping using 1 and 2μm absorption band parameters.

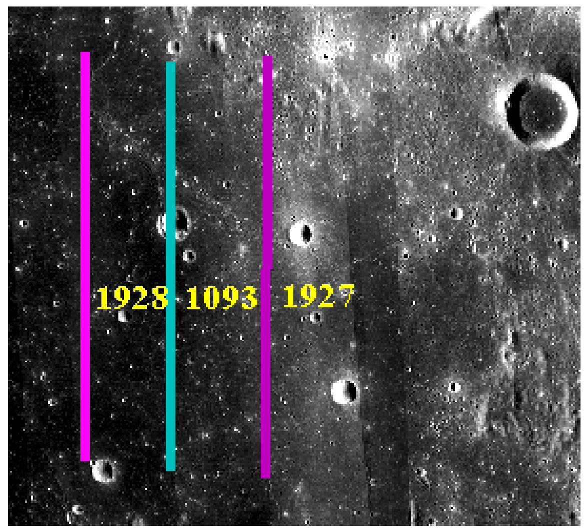

Figure 1: SIR-2 orbits plotted on LROC image (http://wms.lroc.asu.edu/lroc), SIR-2 data selected for 9^0S to 11^0S and 17^0W to 20^0W

1. Data set and Method

In this study we took 50 RELAB lunar spectra from sample return sites summarized by [5] and SIR-2 orbit No. 1093, 1927 and 1928 (Figure 1). The orbit 1093 is crossing a fresh crater in Mare Congnitum region. The SIR-2 and laboratory reflectance spectra are normalized to unity at 1.5μm. We used a continuum removal algorithm based on convex hull method [1] for automatic detection of absorption bands. The band depth is given by 1-(Rb/Rc) Where Rb and Rc are the reflectance values of normalized SIR-2 spectrum and reflectance of continuum line at band center respectively.

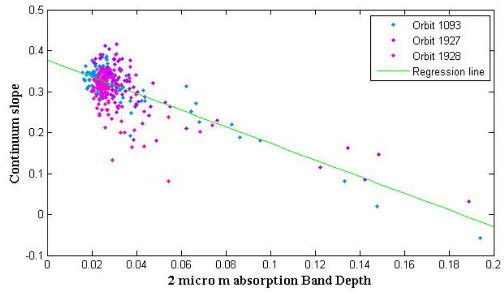

Figure 2: Continuum slope versus absorption band depth for 2μm region.

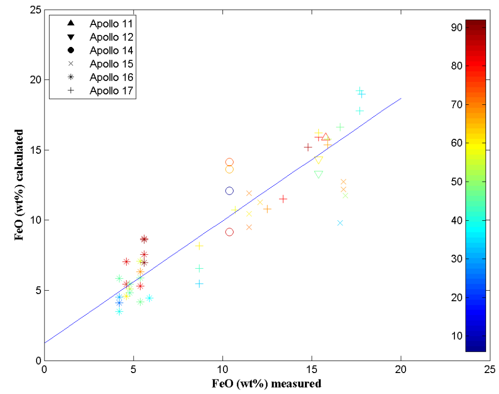

Figure 3: FeO measured versus FeO calculated, the color bar is the range of maturity index of laboratory measured reflectance spectra.

2. Initial Results

A calibration of our method requires reflectance spectra from a fresh crater to make the maturity effect visible in addition we look for small crater size to be sure about the mineralogical composition does not change. We found a linear relationship between continuum slope and band depth for the area shown in Figure 1. We applied this algorithm to 3 fresh craters in mare regions (2 from near side and 1 from far side) and found the same relationship. Based on these initial results, we propose to use the continuum slope and the band depth parameters as a tool for decoupling maturity and mineralogical composition information for 2μm absorption band. The robust regression line fit to the figure 2 gives a coefficient which goes-in the FeO wt% equation based on laboratory measurements. The difference between the relationship derived by band depth and continuum slope is correlated with TiO_2 wt% and the final equation for FeO wt% is given by equation 1,

$$FeO(wt) = 63.94 \times (B + 0.518 \times S) - 5.24 + 0.92 TiO_2 \quad (1)$$

where B denotes the absorption band depth and S the continuum slope.

This equation is plotted versus the measured FeO wt% in figure 3 for the 50 lunar samples considered for this analysis. The correlation factor is 0.90 for 2μm absorption band and 0.96 for 1μm absorption band.

3. Future study

In order to prepare a global FeO wt% map using the SIR-2 data, we will first consider few selective mare and highland regions from near and far side of the Moon to compare our results with other published results. Our method includes contribution of TiO_2 wt% in order to calculate FeO wt%, We will need to define a way for TiO_2 wt% calculation. We will apply our method to 1 and 2μm absorption bands respectively to do a comparative study and find out the deviation in calculation if exists.

References

[1] Clark R. et al. :Automatic continuum analysis of reflectance spectra, Third AIS workshop, JPL Publication 8730, pp. 138-142, 1987.

[2] Fischer E. M. and Pieters C. M. :Remote Determination of Exposure Degree and Iron Concentration of Lunar Soils Using VIS-NIR Spectroscopic Methods, Icarus Vol.111, pp. 475-488, 1994.

[3] Lucey P. et al. :Lunar iron and titanium abundance algorithms based on final processing of Clementine ultraviolet-visible images, JGR, Vol.105, pp.20297-20305, 2000.

[4] Mall, U. et al. :Near Infrared Spectrometer SIR-2 on Chandrayaan-1, Current Science, Vol.96, pp. 506–511, 2009.

[5] Le Mouélic S.et al. :Discrimination between maturity and composition of lunar soils from integrated Clementine UV-visible/near-infrared data: Application to the Aristarchus Plateau, JGR, Vol.105, pp. 9445-9456, 2000.

[6] Shkuratov Y. et al. :Iron and Titanium Abundance and Maturity Degree Distribution on the Lunar Nearside, Icarus Vol.137, Issue 2, pp. 222-234, 1999.