SPECTRAL REFLECTANCE STUDIES FOR MATURATION TRENDS IN A MARE AND HIGHLAND SWIRL N. Srivastava, Planetary Sciences and Exploration Program, Physical Research Laboratory, Ahmedabad, India, email: sneeraj@prl.res.in

Introduction: Space weathering on airless planetary bodies such as moon, mercury and asteroids is primarily caused by interaction of their surface with solar wind ions and micrometeorites [1]. Laboratory studies have revealed the presence of nano phase Fe and glassy agglutinates in lunar soil, formed due to a combined effect of both these agents. Space weathering ultimately modify the optical properties of the regolith components, thereby, distorting their inherent composition dependent spectral signature [2,3]. Such effects are also dependent upon the composition of the target surface [4] and size of the planetary body. The flux and intensity of solar wind particles also vary from one planetary body to other depending upon their distance from the Sun. Therefore, a proper understanding of their individual contributions towards space weathering and the dependence on the target lithology is of paramount interest.

The anomalously bright regions on moon, the so-called "swirls", possess unusually high magnetic field. It is expected that, the local magnetic field completely or partially shields such area from solar wind ions, thereby, locally altering the space environment. These areas therefore provide a natural laboratory to study space weathering dominantly due to micrometeoritic bombardment.

Background: Several attempts have been made previously to understand the maturation process using both laboratory experiments [2,5,6] and optical images [7,8]. Under normal conditions, it is observed that lunar soil darkens and redden with increase in maturity and that, in a time span of about ~ 1 b.y., it completely matures. Further, low iron lithologies are characterized by high reflectance and high R950/R750 values, whereas high iron rock types are characterized by low reflectance and low R950/R750 values [2]. The spectral characteristics of swirls, especially Reiner Gamma has been studied in detail by several groups [9,10,11], to understand the causes leading to its high albedo.

In this study Clementine UVVIS data are used to infer spectral characteristics of soils within swirl and compared them with the spectral behavior of the nearby soils undergoing normal maturation process. The proto-type swirl, Reiner gamma (centred at 7.9^0N, 301^0) and recently reported swirl near Airy crater (18^0S, 5.7^0) [12], that are located in different geological settings, have been chosen in this study (figure 1). Reiner gamma formation lies in basaltic terrane of Oceanus Procellarum, whereas, swirl near Airy crater is located in the highlands. Both the regions have comparable magnetic field (a maximum of 7 nT from an altitude of 35.5 km) as measured by Lunar Prospector.

Methodology: Reflectance at 750nm (R750) and NIR ratio (R950/R750) for young craters (~1-4 km diameter) and their ejecta respectively, lying within and outside the swirl regions have been derived from Clementine UVVIS images of spatial resolution ~ 200m. For the data points within the swirls, care has been taken to ensure that they were selected from the portions shielded by maximum magnetic field intensity (figure 2). Special care was taken to select areas in the proximity of the crater boundaries for analysis and avoid areas prone to mixing of soils of diverse ages. Measurements from crater walls/ rims were also avoided to minimize slope related affects. The maximum value of R950/R750 and corresponding value of R750 have also been extracted from both the regions of interest.

Observations and Inferences: A plot of R750 Vs R950/R750 (figure 2) for the spectral values derived as above, clearly shows that the soils within and outside the swirls show different trends in both the cases. In case of basaltic Reiner Gamma, the data points within the swirl fall above the normal trend defined by data points from nearby areas, not shielded by magnetic field. In contrast, most of the values for highland swirl near Airy crater lie below the normal trend, consistent with the telescopic observations [12]. In case of Reiner Gamma, the value of the color ratio (R950/R750) for most immature soils within the swirl is considerably higher than the corresponding ones in the viscinity, whereas, the value is lower for the swirl near Airy crater

At higher NIR ratio and low reflectance values the trends tend to merge with the usual trend in both the cases. This may be due to sampling of soils that have experienced different environmental conditions during their long-term maturation process within the area defined by the present day swirl. Recent inception of magnetic field in these areas, either due to meteoroid swarms [11] or cometary impact [10] may be responsible for such changes.

Eventhough, the results obtained in this study may be attributed to maturation under magnetically shielded conditions, either completely or partially, other possibilities such as compositional mixing [13] and/or alterations in physical properties of the soils also need to be investigated. Hyperspectral and topographic data at high spatial resolution is required for this purpose. Analysis of hyperspectral (HySI and M-3) and topographic (TMC) datasets from Chandrayaan – 1 will significantly enhance our understanding in this regard.

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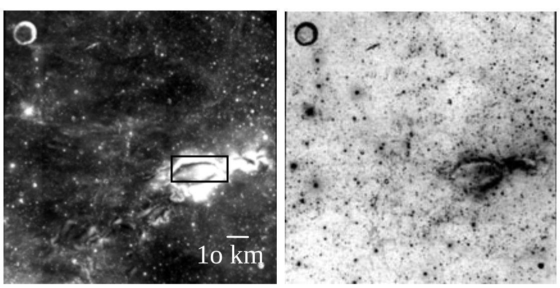
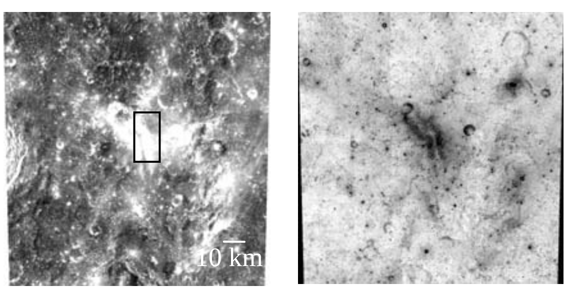


(a)



(b)

Figure 1: Clementine 750 nm (left) and NIR ratio (R950/R750) images (right) of Reiner Gamma Formation [RGF] (a) and Swirl near Airy crater (b). Region of interest within the swirl area have been marked.

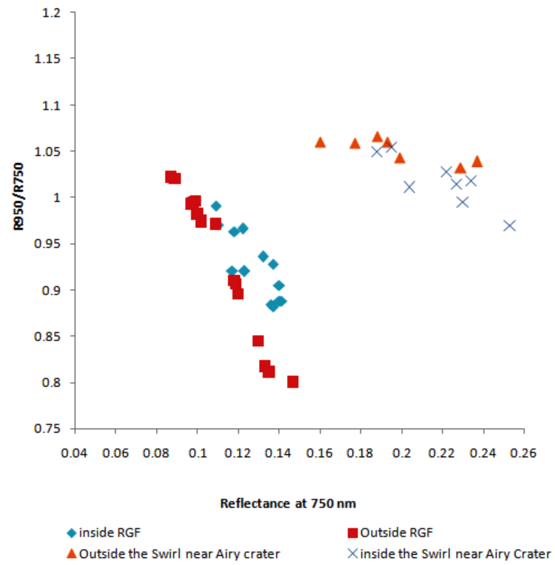


Figure 2: Scatter plot of NIR ratio (R950/R750) Vs R750 for soils of RGF, swirl near Airy crater, and their nearby regions devoid of appreciable magnetic field.
* Uncertainity in data points does not affect the trend.