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Effects of Visible Albedo on Mid-Infrared Spectra under Simulated Lunar Environment as Compared to Diviner Lunar Radiometer

Katherine Shirley and Timothy Glotch
Stony Brook University, New York, USA, (katherine.shirley@stonybrook.edu)

Abstract

Effects of space weathering on the mid-infrared have been shown to be present in the Diviner Lunar Radiometer Experiment dataset, and the decrease in visible albedo as a result of space weathering correlates well with the variations observed in the lunar mid-infrared data. In this study, we examine several locations on the Moon with variable degrees of space weathering to further examine this effect and compare the remote sensing data to laboratory spectra measured under simulated lunar environment conditions. We show that both laboratory and remote sensing spectra show similar trends of decreasing visible albedo with Christiansen feature values moving to longer wavelengths, and that the lunar locations examined show similar variation in Christiansen feature shifts corresponding to the type of feature, i.e. young craters versus swirls.

1. Introduction

Reduced visible albedo an optical effect of exposure to space weathering. While space weathering produces a number of physical changes to regolith on the Moon (vitrification, formation of nanophase iron rims, formation of agglutinates, and physical breakdown of regolith), the overall darkening of the regolith appears to be a driving factor in variation of mid-infrared spectral features [1].

Work by [2] noted that space weathering is apparent in the Diviner dataset, which targets the mid-infrared, and, specifically, the Christiansen Feature (CF). The CF is an emissivity maximum the corresponds to silicate polymerization and is used by Diviner to determine bulk silicate composition across the lunar surface. [3] developed an empirical correction to the Diviner CF dataset to account for variation due to space weathering by using an optical maturity parameter [4], and noted the anticorrelation between CF position and albedo. From laboratory work using a simulated lunar environment, we see similar shifts in the CF position in Apollo samples [5] and experimentally space weathered samples [1] to longer wavelengths with higher degrees of optical maturity or reduced visible albedo. Here we examine the utility of laboratory data from [1] to inform interpretation of Diviner data, and look at young lunar craters and swirls to understand differences in the albedo-CF correlation due to the mode of space weathering at these different types of features.

2. Study Sites

We expect to see the most variation in space weathering or optical maturity on the lunar surface at young craters that excavate fresh un-weathered material, and at swirls which are thought to dampen the solar and cosmic irradiation aspect of space weathering. From the optical maturity map [4], we chose Giordano Bruno Crater (36° N, 103° E), Kepler Crater (8° N, 38° W), Reiner Gamma Swirl (7.5° N, 59° W), and Airy Swirl (18° N, 5° E). These are all within relatively consistent surrounding terrain, and show the two types in a highlands (Giordano Bruno and Airy) setting, and in mare (Kepler and Reiner Gamma). Data from Kaguya Multiband Imager, Clementine and Diviner were used to measure albedo at 750 nm, optical maturity index, and CF value, respectively, at all of these locations.

3. Results

At all locations we observed the anticorrelation between visible albedo at 750 nm and CF value where decreasing albedo (increasing optical maturity) corresponds to CF values moving to longer wavelengths. Fig.1a shows Diviner and Kaguya maps of Kepler Crater and Fig.1b the data for a profile taken from the crater to the surrounding material.

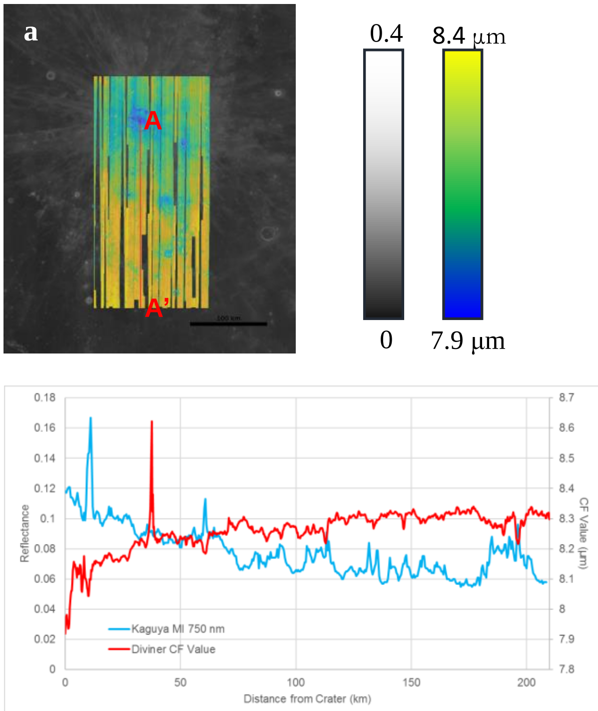

Figure 1: (a) Kepler Crater with Diviner CF value map (color) overlain on the Kaguya 750 nm reflectance (greyscale). (b) Data from A to A' for the Diviner CF value (red) and Kaguya 750 nm reflectance (blue) along the profile shown in (a).

4. Discussion and Conclusions

When directly comparing changes in albedo to those in CF value, we see linear trends in both the laboratory spectra and in the remote sensing data. When comparing the two (Fig.2) we see a much steeper trend in the laboratory data likely because we used anorthite which is brighter and purer than what we would find on the Moon and could therefore represent an endmember case. We see this further in the change in slope between the highlands and mare craters. The swirls show similar overall trends, but the linear trend is much weaker, which makes sense as the space weathering is different at the swirls than the craters. Overall we have shown similar trends in laboratory and remote sensing data and will include more sites and larger laboratory sets to better constrain the trends, and create a laboratory based calibration.

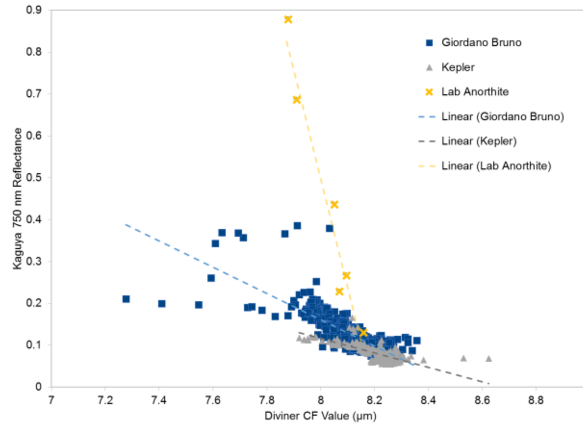

Figure 2: 750 nm albedo compared to CF values for Giordano Bruno Crater (blue squares), Kepler Crater (grey triangles), and laboratory measured anorthite (yellow Xs). All show linear trends of CF values moving to longer wavelengths with decreasing albedo, though with varying slope of those trends.

References

[1] Shirley, K. A., Glotch, T. D., Yang, Y., Jiang, T., & Zhang, H.: Synthetic Space Weathering Effects in the Near-and Mid-Infrared. In Lunar and Planetary Science Conference (Vol. 48). March 2017.

[2] Lucey, P. G., Paige, D. A., Greenhagen, B. T., Bandfield, J. L., & Glotch, T. D.: Comparison of Diviner Christiansen Feature position and visible albedo: Composition and space weathering implications. In Lunar and Planetary Science Conference (Vol. 41, p. 1600), March 2010.

[3] Lucey, P. G., Greenhagen, B. T., Song, E., Arnold, J. A., Lemelin, M., Hanna, K. D., ... & Paige, D. A.: Space weathering effects in Diviner Lunar Radiometer multispectral infrared measurements of the lunar Christiansen Feature: Characteristics and mitigation. Icarus, 283, 343-351, 2017.

[4] Lucey, P. G., Blewett, D. T., Taylor, G. J., & Hawke, B. R.: Imaging of lunar surface maturity. Journal of Geophysical Research: Planets, 105(E8), 20377-20386, 2010

[5] Hanna, K. D., Greenhagen, B. T., Patterson III, W. R., Pieters, C. M., Mustard, J. F., Bowles, N. E., ... & Thompson, C.: Effects of varying environmental conditions on emissivity spectra of bulk lunar soils: Application to Diviner thermal infrared observations of the Moon. Icarus, 283, 326-342, 2017.