LUNAR SWIRLS IN THE MARIA AND HIGHLANDS: NEAR-ULTRAVIOLET AND NEAR-INFRARED SPACE-WEATHERING TRENDS.

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Introduction: Solar-wind ion bombardment is one of the agents responsible for altering the optical properties of materials that are exposed on the surfaces of airless bodies. Micrometeoroid impacts are also thought to play an important role in such optical alteration, which is termed "space weathering" [e.g., 1, 2], although the relative contribution to space weathering by the solar wind and micrometeoroids is not fully understood and can vary from place to place on the Moon [3, 4] and throughout the Solar System [e.g., 5]. Typical lunar space weathering involves introduction of a strong positive ("red") spectral slope from the visible to near-infrared (NIR), an overall decrease in reflectance, and weakening of Fe^{2+} absorption bands near 1000 and 2000 nm. The effects of lunar-style space weathering in the ultraviolet (UV) were described by Hendrix and Vilas [6]. The near-UV (NUV) slope at wavelengths shortward of 415 nm is steep in fresh material and shallows (becomes "bluer") in more mature material [6, 7]. The optical alteration is caused by the accumulation of submicroscopic blebs and coatings of iron (SMFe) on and within regolith particles [1, 8]. Soils have steep (red) NIR continua and shallow (blue) NUV ratios. The reverse is true of powdered rocks, which have shallow NIR continua but steep NUV slopes.

Lunar Swirls and Anomalous Weathering: Areas of magnetized crustal rocks (magnetic anomalies) have been mapped globally by *Lunar Prospector* [e.g., 9, 10], and magnetic anomalies are known to decrease the flux of solar-wind ions reaching the lunar surface [e.g., 11–13]. Hence, it might be expected that a magnetically shielded area could experience atypical space weathering [14]. Indeed, the unusual high-albedo markings called lunar swirls [e.g., 15–19] are all collocated with magnetic anomalies. We have undertaken an analysis of spectral trends in order to gain further insight into the nature and origin of swirls and the causes of lunar space weathering.

Spacecraft Observations: Prior studies have examined lunar swirls with data from the *Clementine* UVVis camera [e.g., 3, 17, 18, 20–22], the *Clementine* NIR camera [18], M^3 [23–25], *Kaguya* Multiband Imager (MI) [23], and in the far-UV using LAMP [26, 27]. LROC NUV images have proven to be especially useful for mapping swirls [7, 19].

We perform an analysis similar to that of Hemingway et al. [3], who defined regions of interest (ROIs) on and around the high-reflectance portions of mare swirls in *Clementine* images. We use the NIR continuum ratio (1550-nm/700-nm, from topographically corrected *Kaguya* MI [28]) to focus on the effects of SMFe on continuum slope. This ratio is favored over the 950-nm/750-nm ratio, which is a function of both the continuum slope and the strength of the 1000-nm band. We simultaneously examine swirls in the NUV using LROC WAC [29].

Results: We have performed analyses for both mare and highland swirls. Observations include the following. The bright portions of mare swirls have NIR ratios that are lower than the mature background (lower NIR continuum), and NUV ratios that are lower than the mature background (steeper NUV slopes). The bright portions of highland swirls have NIR ratios that are lower than the mature background (lower NIR continuum), and NUV ratios that are similar to or slightly lower than that of the mature background. We are interpreting these spectral characteristics in terms of the size distribution of SMFe [30, 31].

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