TESTING THE EFFECTS OF SPACE WEATHERING ON S-CLASS ASTEROIDS WITH NEW MMT UV/BLUE REFLECTANCE SPECTRA

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Introduction: We report the results of ground-based moderate-resolution spectroscopic observations of 6 S-class asteroids covering the ~330 – 600 nm wavelength range which we have previously analyzed using IUE spectra and ground-based photometry (1). Our previous studies indicate that for both lunar sampled and S-class asteroids, a strong trend in spectral slope (change in reflectance with wavelength) is seen between 300 – 400 nm. The slope in this range is significantly bluer (increase in reflectance with decreasing wavelength) for telescopic reflectance spectra of S-class asteroids than for laboratory reflectance spectra of ordinary chondrite meteorites, and stronger for laboratory spectra of lunar soils than for lunar rocks. One explanation for this bluing is that the Fe^{3+} UV/blue intervalence charge-transfer transition band seen in almost all iron silicate-bearing surfaces is degraded due to the weathering of the surface. This is similar to the spectral effects seen in weathered surfaces at near-infrared wavelengths.

Manifestations of Space Weathering in UV/Blue: Space weathering in the inner Solar System is largely attributed to the bombardment of airless bodies by micrometeoroids and irradiation by solar wind particles, which create vapor deposition of submicroscopic iron (SMFe) resulting in degraded absorption features in reflectance spectra and changes in spectral slope (2). The effects at UV wavelengths were first demonstrated in measurements made by the Apollo 17 UVS of lunar surface features: visibly-dark lunar maria are 5-10% brighter than the visibly-bright lunar highlands at far-UV wavelengths (147 nm) (3). EUVE images confirmed this phenomenon (4). This lunar spectral reversal was linked to space weathering when it was found that lunar soils that had undergone more space weathering exhibit this spectra reversal, while powdered lunar rocks do not (5). Extending these studies to the asteroids, we have found that rotational UV spectral coverage of asteroid 4 Vesta shows evidence of lunar-like space weathering compared to spectra of Howardite-Eucrite-Diogenite meteorites (meteorite potentially derived from Vesta) (6). In addition, UV spectra combined with largely blue /UV broadband photometry of S-class asteroids suggests that a bluing has occurred from 300 – 400 nm (1).

The effect in the UV/blue spectral region for weathered bodies is consistent with the addition of iron or iron-bearing minerals. Opaque minerals (such as iron) are dominated by surface scattering, controlled by Fresnel reflection (5), and are therefore spectrally flat over a wide range of wavelengths. In contrast, at VNIR wavelengths, non-opaque materials are dominated by volume scattering, where the intensity of reflected light is inversely proportional to wavelength. In non-opaques, the transition to surface scattering occurs in the 150-450 nm range (5), and is marked by a minimum in reflectance. Thus, compared to materials such as pyroxenes and feldspars, iron-bearing minerals can be relatively bright at FUV-NUV wavelengths. In the 150-450 nm range, iron-bearing minerals also vary from non-opaques in spectral shape, where the non-opaques experience a decrease in brightness as they transition from reflectance dominated by volume scattering to reflectance dominated by surface scattering and opaques tend to be spectrally flat. Therefore, in the 150-450 nm range, we expect surface consisting of iron-bearing minerals to be less spectrally red and potentially brighter than surfaces with lower amounts of iron-bearing minerals.

New Observations: Our results in the spectra region of 300 – 400 nm are based primarily on broadband photometry. Data have been acquired largely using Johnson U or B filters, or ECAS u, b filters all having broad spectral passbands; some data were acquired using medium-band(~30-nm) filters. A slight error in one filter will affect our result for a given object.

We have acquired spectra of 6 S-class asteroids that we reported as having UV/blue evidence of space weathering (1) on the nights of UT Dec 11 and 12, 2006, using the 6.5-m telescope at the MMT Observatory, in order to test our earlier results with higher spectral resolution data. The MMT facility Blue Channel spectrograph was used with a $CuSO_4$ blocking filter to avoid effects of higher orders on the UV/blue spectra. Reflectance spectra were obtained for S-class asteroids 7, 18, 20, 23, 42, 471 on 11 Dec; 7, 18, 20, 42, 471 on 12 Dec. Additional asteroids were also observed, including Karin family asteroid 10783 on 12 Dec. Observing conditions were problematic on 11 Dec, but clear and photometric with sub-arcsec seeing on 12 Dec. All observations were made at low airmass. Results of these observations with a comparison to the results of our earlier S-class asteroid paper (1) will be presented.

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