Evidence for UV/blue space weathering of S, Q, and O asteroids from the Sloan Digital Sky Survey?

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The space weathering of S-complex asteroid surfaces is manifested in grain coatings caused by a combination of vapor deposition of submicroscopic iron, solar-wind irradiation, and micrometeorite or heavy-ion bombardment of the bodies' surfaces [e.g., 1]. The onset and length of time for space-weathering effects to alter the reflectance spectrum of an object can lead to information about the object's age and processing history. In previous work, we show that the spectral effect of space weathering in the ultraviolet (UV)/blue spectral region for S-complex asteroids is consistent with the addition of iron or iron-bearing minerals [2]. Further, we expect to see the onset and effects of space weathering on these surfaces more rapidly in the UV/blue than in the VNIR wavelengths, as short wavelengths are more sensitive to the thin coatings on grains that could be the result of weathering processes. We found evidence to support this effect in UV/blue photometry acquired by spacecraft data, most strongly evident across a spectral range of 300 to 400 nm [2], and confirmed that we can relax the spectral interval to the Johnson U (360 nm) and B (440 nm) filter wavelengths (see Figure), opening this area of study to ground-based photometry [3]. The separation of space-weathered asteroid photometry vs. laboratory spectra of fresher ordinary chondrite samples occurs roughly at U – B slope < or = 0.002. We now want to sample a large number of smaller, fainter S-, Q-, O-class asteroids for evidence of space weathering in the UV/blue spectral region. The largest sample of existing small-body photometry is the Sloan Digital Sky Survey (SDSS) Moving Object Catalog. The SDSS has two filters with short wavelengths, u' (354 nm) and g' (477 nm). Extensive work has been done to class asteroids using SDSS photometry, relating these classifications to VNIR spectral range taxonomic systems [4,5]. We have culled subsets of 3648 S- and 786 Q-class asteroids from this tabulation; these subsets have UV/blue slopes that could indicate less weathering ("fresher") surfaces. The figure shows that the distributions of these asteroids with semimajor axis (au) echo the general S-asteroid distribution. We use these distributions to direct our search for specific objects that are minimally space weathered.

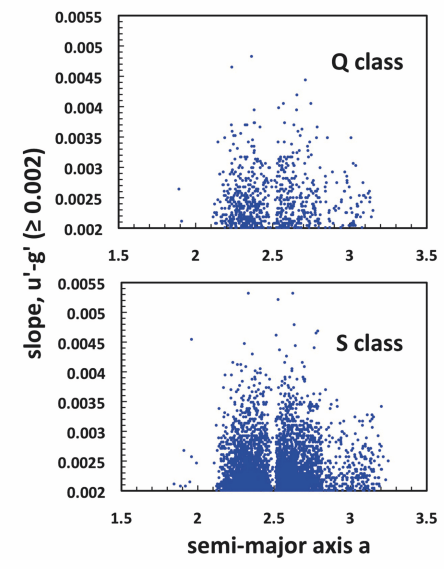

Figure: SDSS u'-g' slopes for Q-asteroid observations (upper right frame) and S-asteroid observations (lower) against osculating semimajor axis a (au): the greater the slope, the higher chance that the observation sampled a fresher asteroid surface.

References: [1] Nogushi T. et al. (2011) Science, 333, 1121–1125. [2] Hendrix A. R. and Vilas F. (2006) AJ, 132, 1396–1404. [3] Vilas F. and Hendrix A. R. (2013) 2013 DPS abstract no. 101.07. [4] Carvano J. M. et al. (2010) A&A, 510, DOI:0.1051/0004-6361/200913322. [5] Hasselmann P. H. (2012) EAR-A-I0035-5-SDSSTAX-V1.1. NASA PDS.