HYDRATED E-CLASS AND M-CLASS ASTEROIDS;

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For airless bodies like asteroids and meteorites, the 3-μm region of the spectrum is diagnostic for hydrated minerals. Reflectance studies in this region can determine the hydration state of surface minerals, and by inference, thermal histories. We have made spectrophotometric observations of nine E-class and M-class asteroids in August 1993 using the IRTF on Mauna Kea, Hawaii. We confirm the presence of a 3-μm absorption band on 92 Undina (Figure 1) and on 44 Nysa (Figure 2) and have possibly detected this feature on the M-asteroid 201 Penelope. Because the 3-μm band is diagnostic of water of hydration, these discoveries and confirmations demonstrate for the first time that high-albedo objects such as E- and M-asteroids need not be of igneous origin. The discoveries also suggest that current interpretations of asteroid surfaces may not be completely accurate.

Based on their moderately high albedos (0.15–0.25) and red-sloped featureless spectra, M-asteroids have been thought to be composed of metals such as iron and nickel. E-asteroids, with similar spectral features but a higher albedo (0.4–0.5) have been thought to be composed of enstatite [2][3]. M-asteroids were thought to be the cores of disrupted, differentiated asteroids and E-asteroids were thought to have formed and differentiated under more reducing conditions in the solar nebula. However, observations done over the past several years in many different wavelength regions seem to contradict these interpretations [1][4][5][6]. Jones et al. (1990) found evidence of hydrated silicates on two M-class asteroids in the 3-micron region of the spectrum. Unfortunately, the lack of strong absorption features in the near-IR on M-asteroids has hampered our ability to identify any non-metallic contribution to their surface composition. In 1992 Howell and Nolan found evidence of hydrated silicates on the E-asteroid 44 Nysa. This surprising result shows us that the E-asteroids as a class are also not homogeneous in composition.

Because hydrated minerals are not stable at even moderately high temperatures (above 500 K) they are not expected to be present on igneous bodies [1]. These discoveries imply either that some E- and M-asteroids are *not* igneous and have little in common with other members of their current taxonomic classes, or that currently unknown post-igneous aqueous alteration processes have occurred. However, it is worth noting that there *cannot* have been any free metal on the surface on these asteroids, or it would have been oxidized in the alteration episode, giving these asteroids an ultraviolet absorption feature that is not present.

These results open a series of questions: 1) what percentage of high-albedo objects have this hydration feature, 2) what mineral or minerals are creating it, 3) what relationship might these bodies have to hydrated minerals in our meteorite collection, 4) what relationship (if any) is there between these high-albedo hydrated asteroids and heliocentric distance, 5) what do these asteroids imply about the conditions in the early solar system, and 6) what do these asteroids imply about metamorphic processes and mineral evolution in the solar system?

References:

[1] Jones et al. (1990) *Icarus* **88**, 172-192. [2] Gaffey et al. (1989) in *Asteroids II*, U. of Arizona Press, Tucson. [3] Tholen (1984) Ph.D. Thesis, University of Arizona. [4] Lupishko and Belskaya (1989) *Icarus* **78**, 395-401. [5] Ostro et al. (1985) *Science* **229**, 442-446. [6] Lebofsky and Britt (1992), Preprint.

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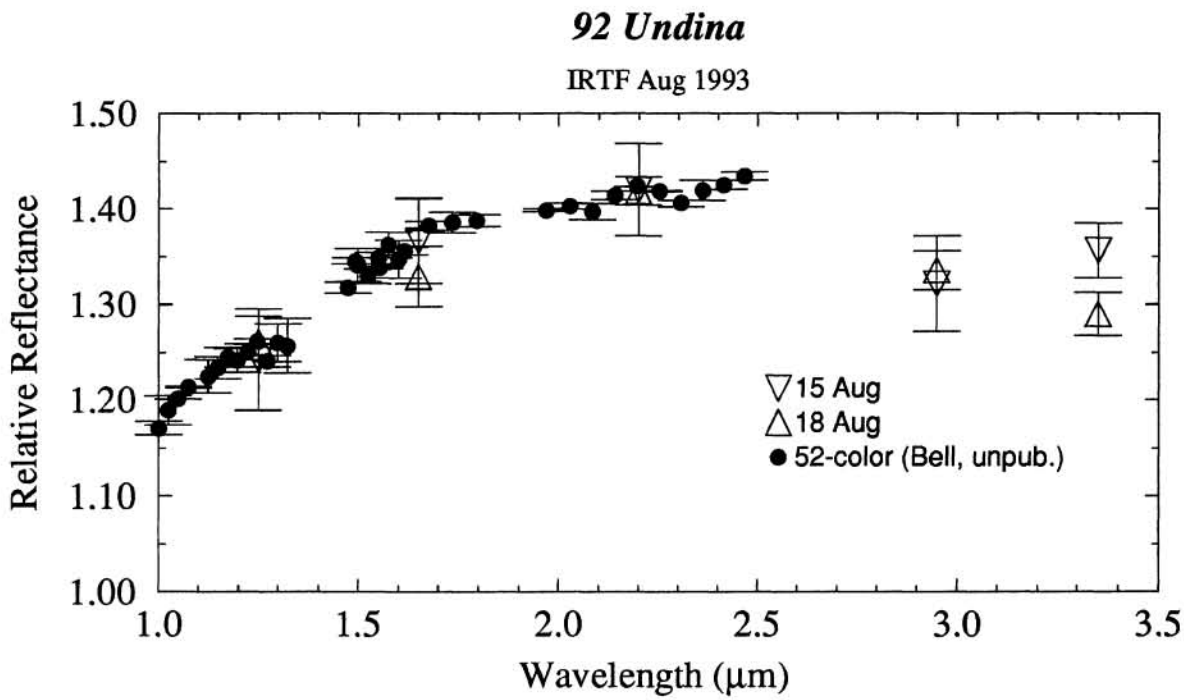

Figure 1: Spectrum of M-class asteroid 92 Undina from IRTF, with spectrum from Bell's 52-color survey. The IRTF data is scaled to be equal to the 52-color data at 2.2 μm.

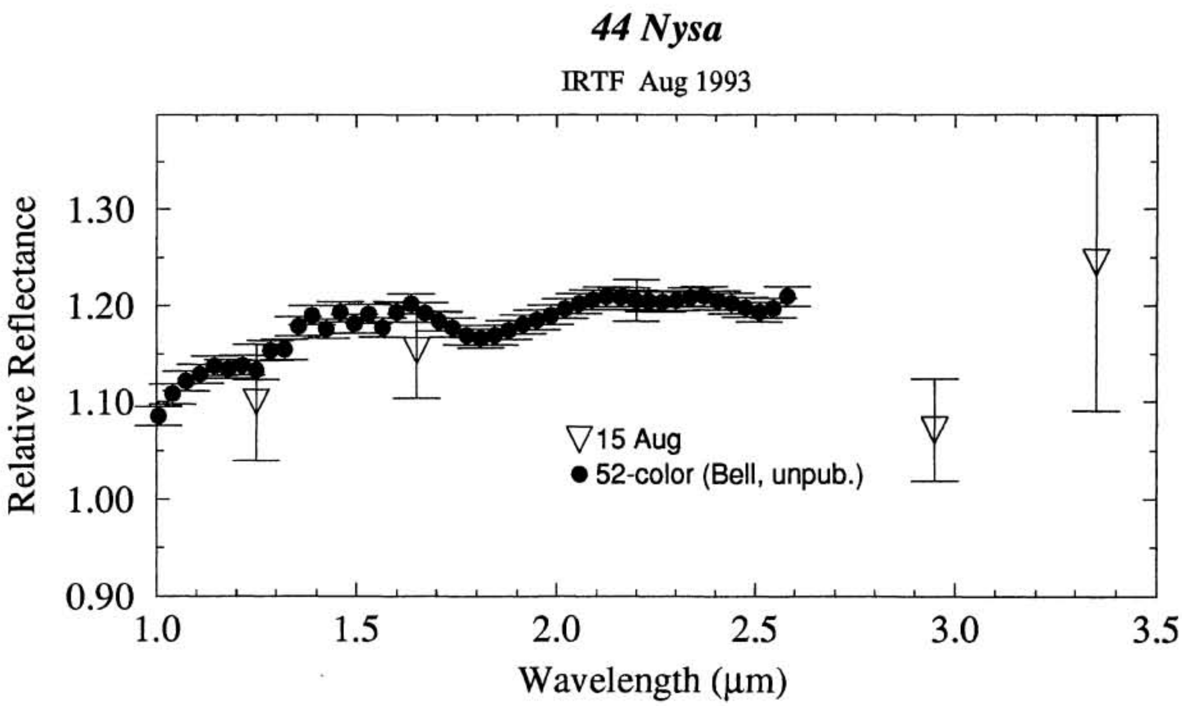

Figure 2: Spectrum of E-class asteroid 44 Nysa, scaled with Bell's data as above.