A STUDY OF PHYLLOSILICATES AS POSSIBLE COMPONENTS OF THE SURFACES OF C ASTEROIDS.

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Introduction: The detailed mineralogy of the C and C-like asteroids, which constitute ~50% of MBAs, is poorly known. A 3 µm feature suggests hydrated silicates [1], while 0.7 µm feature has been attributed to Fe bearing phyllosilicates [2,3,4]. The meteorites most closely resembling the C asteroids in their reflectivity spectra are the CI and CM chondrites. The 0.7 and 3 µm spectral features have been used to link the meteorites to the asteroids [4]. The spectra are otherwise usually considered featureless [5], although recent efforts suggest otherwise [6]. C chondrites consist essentially of phyllosilicates, but there is considerable uncertainty as to their exact nature; chlorite, serpentine, mica, montmorrillonite, and many others are possible [7]. In order to explore the mineralogical nature of the surface of C asteroids we obtained new spectra for 11 C asteroids and we have looked at the spectra of 22 terrestrial phyllosilicates. We have also performed heating experiments on the phyllosilicates to simulate impact heating.

Experimental: Between 2004 and 2006 we made seven runs on the NASA IRTF telescope and obtained 11 spectra for C and C-like asteroids in the range 0.8 to 2.5 µm. Data in the range 0.4-0.9 µm were taken from the SMASS database [8-15]. Data for two CI and five CM chondrites and for terrestrial phyllosilicates came from the PDS [16] and the USGS [17], respectively.

Since the spectra are essentially featureless, we focus on continuum slope, plotting the slope between 1.8 and 2.5 µm against that at 1.0 and 1.75 µm.

Results: Fig. 1 shows the data. The upper gray ellipse shows the field occupied by our 11 asteroids, while the lower ellipse shows the field of data for phyllosilicates. Actual data are given in ref. [18]. Superimposed on these are our data for heated terrestrial phyllosilicates, montmorillonite and notronite, and the Hiroi et al data for Murchison [19].

Discussion: Although not presented in the manner of Fig. 1, it has been known for some time that the spectra of C asteroids do not precisely match the spectra of C chondrites, and we now extend that conclusion to terrestrial phyllosilicates. What is significant is that although the terrestrial phyllosilicates spread fairly uniformly along the ellipse in Fig. 1, when heated in the laboratory to ~500°C they migrate to the asteroid ellipse and then after heating at 900°C they converge to a region in the middle of the ellipse. Temperatures in excess of 800°C can reduce or remove the near infrared hydroxide features which we presume is associated with a collapse of the phyllosilicate structure and the formation of other phases. Similar heating experiments have been performed on Murchison [19,20], which show very similar trend. Heating to 500°C moves the data to the tip of the asteroid ellipse, and subsequent heating moves it down to the central region.

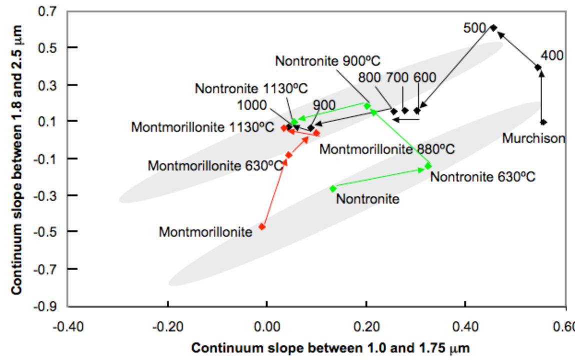

***Fig. 1**: Continuum slope comparison between asteroids (upper ellipse), terrestrial phyllosilicates (lower ellipse), heated phyllosilicates and Murchison.*

Conclusion: The present data suggest that the surfaces of asteroids consist of a variety of primary phyllosilicates heated to ~500°C by repeated impact heating. The range of primary compositions includes Murchson-like mineralogies. Changes in the spectra by impact heating in the range of 500-1300°C are also a possibility for explaining the range of C asteroid spectra.

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