Fe AND Mg COMPOSITIONAL VARIATIONS IN CM/CI METEORITES AND DARK ASTEROIDS M. M. McAdam[1], J. M. Sunshine[1], K. T. Howard[2,3], M. S. Kelly[1], T. McCoy[4], [1]Univeristy of Maryland, Astronomy Department College Park, MD 20742, mmcadam@astro.umd.edu. [2]Kingsborough Community College of the City University of New York. [3]American Museum of Natural History. [4]Smithsonian Museum of Natural History.

Introduction: CM and CI meteorites are aqueously altered [1, 2], the state of which has been extensively studied in their visible and near infrared spectra [e.g. 3, 4, 5, 6, and 7] particularly at 3 µm. Comparatively little has been published at longer wavelengths. This study focuses on the spectra of CM2 and CI1 meteorites between 8 and 15 µm, which includes a broad 12 µm spectral feature whose position is correlated with phyllosilicate composition in aqueously altered meteorites and that is now observed in dark asteroids.

Samples, Preparation and Data Collection: To date, seven CM2 meteorites and one CI1 bulk meteorite samples have been examined. These 8 samples were prepared and mineralogically characterized by Howard *et al.* and Bland *et al.* with PSD-XRD data collected from of 200 mg samples ground to less than 30 µm [2, 6, 8]. These powders were used to collect spectra with RELAB's bidirectional and FTIR spectrometers [9]. The bidirectional data was collected at an incidence angle of 30° and emergence angle of 0°. The resolution of the bidirectional and FTIR data is 10 nm and 4 cm^{-1}, respectively. The 8 sample suite consists of the following meteorites: Orgueil (CM1), Essebi (CM 2-ung), ALHA 81002 (CM2), Nogoya (CM2), Cold Bokkeveld (CM2), Mighei (CM2), Murchison (CM2) and Murray (CM2).

Meteorite Spectra: The spectra of these meteorites are remarkably muted at near infrared wavelengths with slight if any metal-OH overtones in the 0.5-2.5 µm region. The most prominent feature is the 3-µm water/OH band that is indicative of aqueous alteration. Additionally, these meteorite spectra include a 6-µm water/OH absorption feature that further confirms the presence of hydrous materials. The most notable features of these meteorite spectra longer than 3-µm are in the 8-15 µm region, which includes a strong phyllosilicates absorption feature that varies in shape and position. The 8-15 µm region is plotted in **Figure 1.**

Compositional Trends: The ~12-µm feature's peak position is plotted against the modal abundance of Mg-rich phyllosilicate. This calculation was performed on data that was normalized to 1.0 at 8 µm. The modal data is taken from Howard *et al.* [2, 7] for the CM meteorites and Bland *et al.* [8] for Orgueil. For meteorite spectra with a doublet at the top of the ~12 µm feature (Nogoya, Mighei and Essebi), the position was determined at the average position of the doublet's peaks.

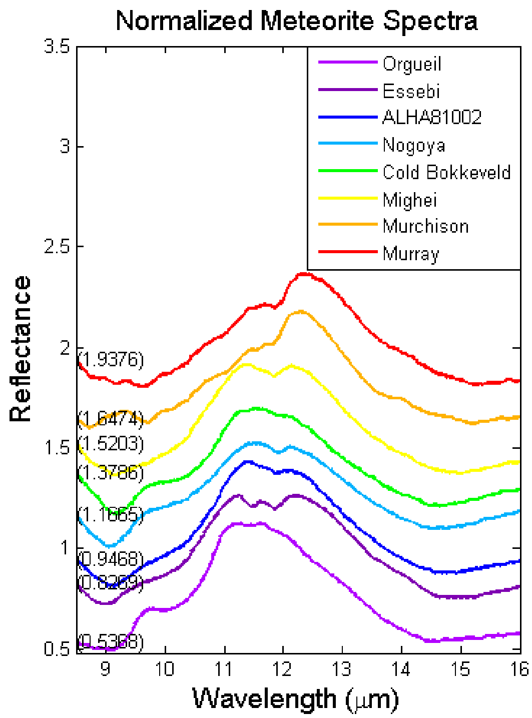

Figure 1 Spectra of the 8 meteorite suite. These data are normalized to 1.0 at 8 µm and offset for clarity. The position of the ~12-µm peak varies systematically.

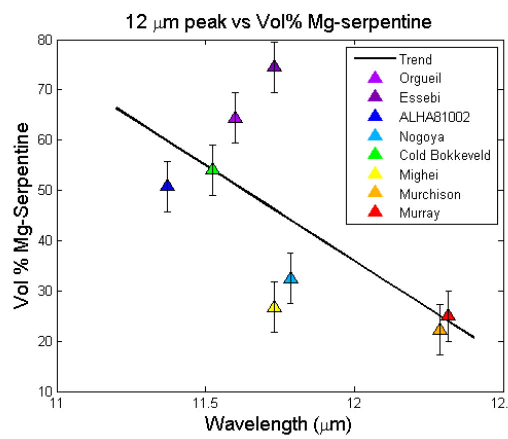

Figure 2: Volume % of modal Mg-rich phyllosilicate plotted against position of meteorite's ~12-µm feature. There is a strong correlation between amount of Mg-rich phyllosilicate and band position.

There is a strong correlation with 12-µm band position and phyllosilicates composition (**Figure 2**). Meteorites with a greater abundance of Mg-rich phyllosilicates tend to have shorter wavelength band peaks compared to meteorites with more Fe-rich phyllosilicates.

Implications: The trend between band position and phyllosilicate composition could either probe the alteration state of a meteorite [10], reflect the initial composition of the anhydrous silicates [2, 6], or represent some combination of these two possibilities. As primitive meteorites alter, the anhydrous silicates are converted into phyllosilicates. The Fe-rich matrix alters first. Then the chondrules, which have more Mg-rich silicates, begin to alter as the process progresses. For this reason, late stage alteration tends to produce predominantly Mg-rich serpentines. Meaning the trend in the 12-µm band should allow us to probe differences in the relative degrees of alteration and perhaps infer initial anhydrous mineralogies on the surfaces of asteroids using remote sensing.

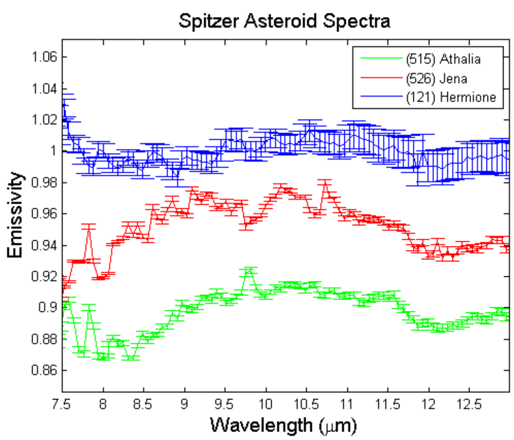

Figure 3: Thermally corrected, emissivity spectra of three C-type asteroids: 515 Athalia, 526 Jena and 121 Hermione. Like the meteorites, these asteroids include an emission feature in 10-13 µm region.

Spectra of Asteroids: Three asteroids have been considered. These data were collected using the *Spitzer Space Telescope*. The asteroids are 515 Athalia [11], 526 Jena [11], both Themis family members and 121 Hermione [12], a Cybele group member. These three asteroids are classified as C-type using the Tholen classification system [11, 12]. These emissivity spectra have been thermally corrected with NEATM as described in [13]. The spectra have been smoothed using a 5 channel moving average filter. They are plotted in **Figure 3** offset by 0.05 for clarity.

To compare these asteroids to the meteorites, their spectra have subsequently been normalized such that their maximum is 1.0 and the minimum is 0.0. Spectra of the two meteoritic compositional end-members (Orgueil: Mg-rich and Murchison: Fe-rich) are converted to emissivity using Kirchoff's law and have been similarly normalized and are plotted with the asteroid spectra in **Figure 4**.

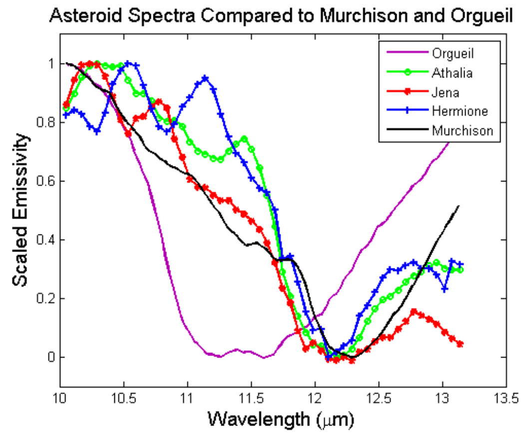

Figure 4: Normalized spectra of asteroids compared to Orgueil and Murchison. The three dark asteroids all have a ~12-µm emission minimum, similar to Murchison.

The asteroid emissivity spectra each include a broad feature in the region of 8-15 µm that is centered at longer wavelengths and most closely match the spectra of Murchison and Murray. Murchison and Murray are the Fe-rich phyllosilicate endmembers of the suite. This suggests that Fe-rich phyllosilicates are globally abundant on surfaces of these dark asteroids. Furthermore, this may indicate that the surfaces of these asteroids have experienced limited aqueous alteration or that the surfaces of these asteroids initially had Fe-rich anhydrous silicates.

Future Work: The current suite of meteorite spectra will be expanded to include CR class meteorites to investigate how oxidation state may affect the 8-15 µm region. In parallel, additional spectra of asteroids will be examined to continue to probe the alteration history of asteroid surfaces.

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