RECREATING INTERCALATED CLAYS OF CHONDRITIC METEORITES. K. E. Winchell[1], D. M. Applin[2], and E. A. Cloutis[2] [1]Western Washington University, Department of Geology, Building: ES 240, 516 High Street – MS-9080 Bellingham, WA 98225-9160 winchek@wwu.edu, [2]Department of Geography, University of Winnipeg, 515 Portage Ave., Winnipeg, MB, Canada R3B 2E9

Introduction: A suite of six combinations of nontronite plus fine-grained metal, organics, or sulfur ± water were heated at a temperature of 200°C in sealed Parr bomb containers for a period of three months to examine the reactions between these materials and how these reactions may apply to the formation of intercalated clays in carbonaceous chondritic meteorites, as well as whether better spectral analogues of carbonaceous chondrites could be produced.

Methods: Nontronite collected from Eastern Washington in the summer of 2016 was used as the base of each mixture. The nontronite samples were powdered, and ~0.8 grams (range of 0.8000 to 0.8045 grams) was included in each mixture. Sulphur, magnetite, or lampblack (carbon black) were also powdered, and ~0.2 grams (range of 0.1998 to 0.2004 grams) were mixed with each portion of nontronite at an 80/20 ratio of nontronite to the other material.

Two of each nontronite+other material combinations were made, one of which included ~1 gram of deionized water added to it once in the Parr bomb. The Parr bombs were sealed, and placed in an oven at 200°C for three months. After this, the samples were removed from the oven and remeasured with the ASD spectrometer using the same method described below.

Once thoroughly mixed, each of the six powder combinations was analyzed with an ASD spectrometer before being placed into a Parr bomb. A LabSpec 4 Hi Res ASD was used to take measurements over the 0.350 to 2.500 µm range of these powdered samples. The ASD was allowed to run for over an hour before data collection began to allow the detectors and light sources to stabilize. Before data collection began, a Spectralon 99% diffuse reflectance standard was measured to optimize instrument performance. The ASD spectrometer has a spectral resolution between 3 and 6 nm. For each sample, 200 spectra of the dark current, standard, and sample were acquired and averaged, in order to provide a high signal to noise.

Results and discussion: After heating, all the dry-heated samples appear to be very fine grained. The wet-heated sampled appear to have formed larger aggregates of smaller particles.

The pre-heated magnetite+nontronite mixtures (Fig. 1) exhibit the strong NIR blue slope of magnetite, peaking near 750 nm. After both dry- and wet-heating, the magnetite appears to have formed hematite, with no spectrally significant differences between the two post-heating spectra.

The sulphur+nontronite mixtures (Fig. 2) have formed at least some Fe-sulphate phases, as evidenced by the characteristic absorption band near 430 nm that now appears. Both of these heated samples are blue-sloped in the visible spectral region, perhaps due to formation of Fe sulfides. XRD analysis will give more insight into the mineralogical makeup of these samples.

The post-heating lampblack+nontronite spectra (Fig. 3) appear very different. The dry-heated mixture became very brown, indicative of the formation of brown carbon. This is consistent with the results of Parr bomb dry-heating of siderite and humboltine, which were found to form a wide variety of intermediate and reduced organic compounds [1]. The wet-heated sample spectrum appears much like a lampblack spectrum, with an additional peak in reflectance near 610 nm. The darkening of this sample is likely due to the nanophase lampblack particles fully enveloping the nontronite grains, inhibiting any penetration of light, and therefore the reflectance properties of those grains.

Conclusions: Various differences between wet- and dry-heated mineral mixtures has been observed. In general, it appears that magnetite formed hematite, sulphur formed at least some Fe-sulphates, and the carbon mixtures formed both brown carbon and reduced spectral contributions from the nontronite.

One of the interesting preliminary results from this study is that it appears that dry heating of magnetite-bearing mixtures that include phyllosilicates can result in the production of hematite-like phases. This is at odds with the observation of magnetite in carbonaceous chondrites, such as CI1 that have been pervasively aqueously altered.

These results suggest that the presence of water during heating of carbonaceous chondrite precursors can have a strong influence on the spectral properties of the resulting products and that evidence of dry or wet heating may be derivable from such spectra. Ongoing detailed analysis of the samples will provide further insights into the mechanisms that accompany wet and dry heating. Further experiments are also planned to more thoroughly investigate the effects of the atmosphere in contact with the samples in the Parr bombs.

References: [1] McCollom T. M. and Simoneit B.R. (1999) *ISSOL 29(2)*, 167-186.

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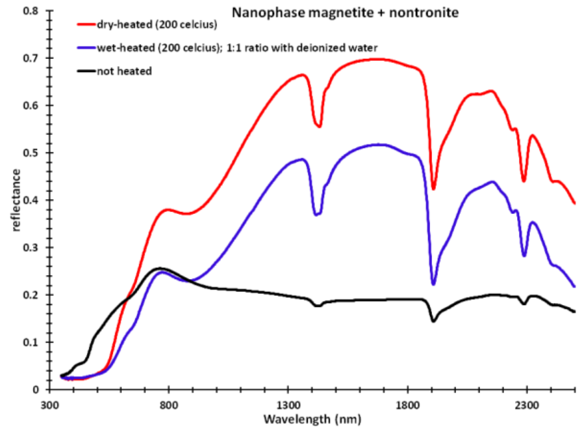

Fig. 1. Reflectance spectra of magnetite-nontronite mixtures.

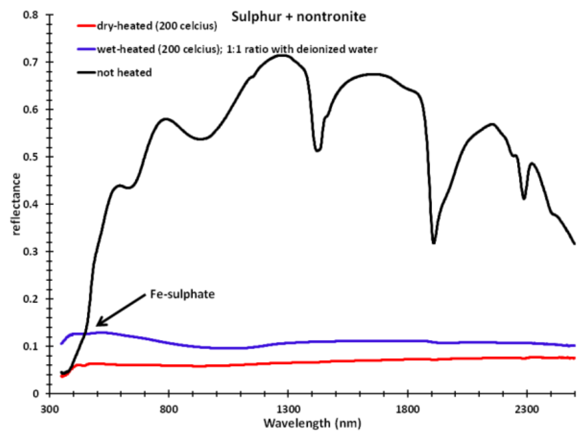

Fig. 2. Reflectance spectra of sulphur-nontronite mixtures.

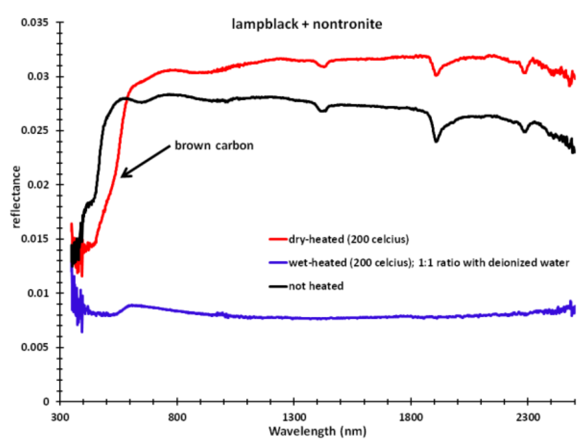

Fig. 3. Reflectance spectra of lampblack-nontronite mixtures.