CARBONACEOUS CHONDRITES: THERMAL ANALYSIS BY DIFFERENTIAL SCANNING CALORIMETRY (DSC).

J. L. Gooding, SN2/Planetary Materials Branch, NASA/Johnson Space Center, Houston, TX 77058 USA.

Introduction. DSC, a method for measuring thermodynamic and phase-compositional properties of small amounts of materials, has been overlooked by most meteorite scientists. Low-temperature DSC can provide information about aqueous diagenetic processes on meteorite parent bodies [1] whereas high-temperature DSC can be used to evaluate bulk mineralogical properties of various types of meteorites (cf., DTA data in [2-4]).

Samples. Allende, Murchison, and ALHA77003 samples each were the < 100-mesh portion of an homogenized bulk sample that was prepared by E. Jarosewich whereas the Karoonda sample consisted of similar material that was prepared by H. B. Wiik (provided by E. K. Gibson, Jr.). A representative whole-rock chip (0.3 g) was pulverized to obtain the PCA82500 sample.

DSC. Each sample was held in a graphite container and heated or cooled at 5 K/min, under constant purge of dry nitrogen gas, in a full-range, Perkin-Elmer Model DSC2C. Initial experiments involved heating each sample, as received, from 300 K to 1000 K to observe heat-capacity changes and phase transitions at high temperatures. In other experiments, a new aliquot was mixed with a precisely measured quantity of water and then thermally cycled at 200-300 K.

Murchison (C2) (Figs. 1-2). Heating to 1000K produced a weight loss of 9.7% and endoenthalpic peaks F, G, and H are attributed to decomposition of hydrous phases. Peak F is assigned to loss of loosely bound water (as in phyllosilicate interlayer sites) whereas H is attributed to loss of strongly bound water (as in phyllosilicate octahedral layers). The small, integrated F/H peak-area ratio suggests that non-expandable phyllosilicates (e.g., chlorite- or serpentine-type) predominate. Peaks at G are attributed to decomposition of hydrous oxides, salts, carbonates, and/or organic compounds. Negative slope of the heat-flow curve above 710 K indicates reduction of iron by graphite.

Upon cooling, wet Murchison (water/meteorite mass ratio = 0.57) crystallized water ice near 260 K (peak A), followed by solidification of a more freeze-resistant water complex (B), and decrease in heat capacity (C). Upon heating, frozen Murchison produced liquid water (D), followed by thermal decomposition of a water complex (E). Heat capacity of the unfrozen mixture was substantially higher than that of the frozen precursor. Both the cooling- and heating-curve transitions were reproducible through several temperature cycles. Persistence of "unfrozen" water at temperatures far below 273 K supports the proposition that aqueous alteration on the Murchison parent body might have occurred at very low temperatures [6].

Allende and ALHA77003 (C3) (Fig. 3). The two chondrites displayed similar heat-flow curves at high temperatures except that ALHA77003 exhibited apparent decomposition peaks (A, B) that did not occur in Allende. Furthermore, Allende showed a sharp exoenthalpic peak (D) that did not occur in ALHA77003. Weight losses for Allende and ALHA77003 were 0.2% and 3.1%, respectively. It is likely that most of the differences between results for Allende and ALHA77003 are attributable to Antarctic weathering effects in the latter.

Karoonda and PCA82500 (C4) (Fig. 4). Weight losses for Karoonda and PCA82500 were 0.4% and 5.7%, respectively and it seems clear that PCA82500 was strongly affected by Antarctic weathering. Although PCA82500 is a Karoonda-type chondrite [5], its heat-flow curve was significantly different from that of Karoonda. A strong endoenthalpic peak occurred in PCA82500 (A) but not in Karoonda and the onset of graphite-induced reduction occurred at a lower temperature (B) in PCA82500. Peak A is attributable to decomposition of hydrous Mg-sulfate that was independently documented by electron probe microanalysis. This also suggests that C2-like aqueous alteration products can form from anhydrous precursors under very cold conditions [1].

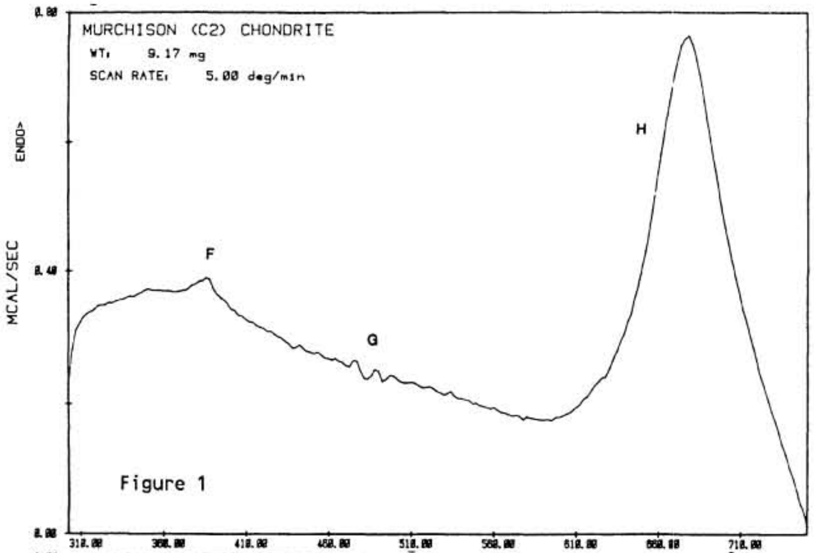

Figure 1

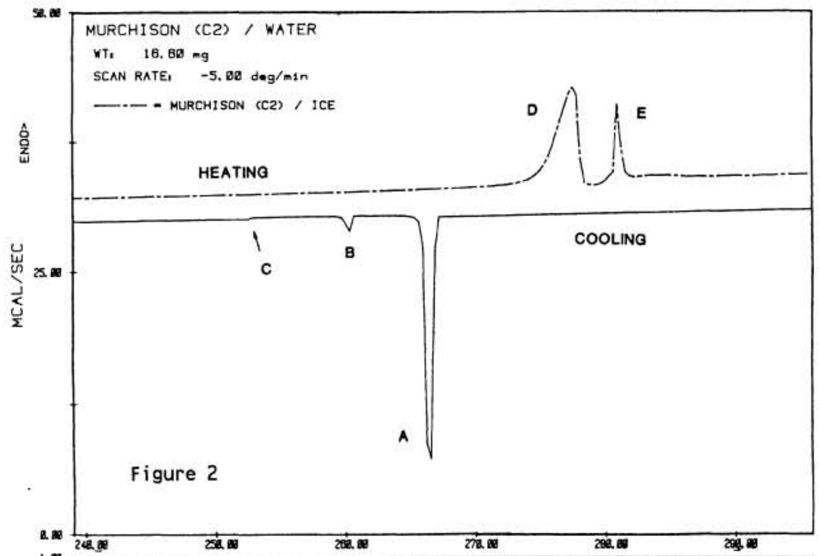

Figure 2

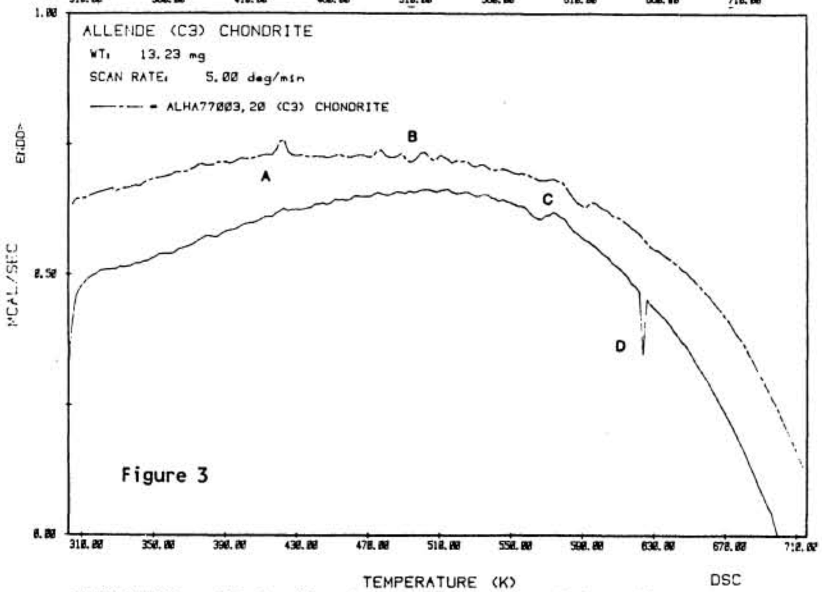

Figure 3

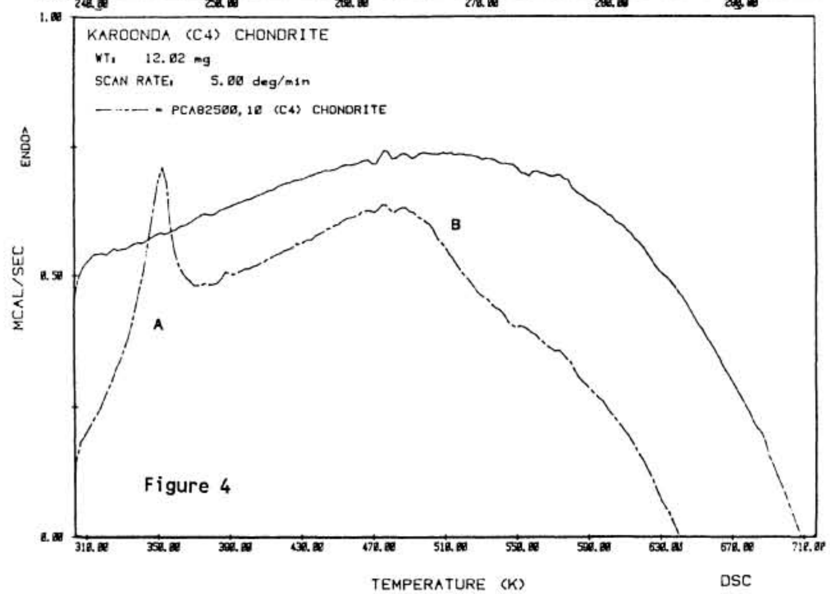

Figure 4

REFERENCES: [1] Gooding J. L. (1984) Meteoritics, 19, 228. [2] Gooding J. L. (1981) Proc. Lunar Planet. Sci. 12B, 1105. [3] Lang B., et al. (1981), Meteoritics, 16, 345. [4] Lang B., et al. (1983) In T. Nagata (ed.), Proc. Eighth Symp. Antarctic Meteorites, Mem. NIPR Spec. Issue No. 30, Tokyo, 378. [5] Scott E. R. D. and Taylor G. J. (1985) Proc. Fifteenth Lunar Planet. Sci. Conf., 2, J. Geophys. Res., 90, Suppl., C699. [6] Clayton R. N. and Mayeda T. K. (1984) Earth Planet. S Lett., 67, 151.