THE MILDLY-HEATED C2 WIS91600 EVALUATED THROUGH COMPLEMENTALY ANALYSES OF THE INSOLUBLE ORGANIC MATTER. H. Yabuta[1], C. M. O'D. Alexander[2], M. L. Fogel[1], A. L. David Kilcoyne[3] and G. D. Cody[1], [1]Geophysical Laboratory and [2]Department of Terrestrial Magnetism, Carnegie Institution of Washington. [3]Advanced Light Source, Lawrence Berkeley National Labotatory. E-mail: hyabuta@ciw.edu

Introduction: The meteorite WIS91600 has been identified as an ungrouped C2 with a reflectance spectrum consistent with a D- or T-type asteroidal parent body [1]. The mineralogy of this chondrite differs from CMs [2], but is reported to be similar to Tagish Lake and have some similarlities with Orgueil in regards to the types of hydrated matrix phases present [1]. On the other hand, other mineralogical [3] and trace element [4] features show that WIS91600 is thermally metamorphosed. Thus, the origin and history of this meteorite is still unresolved.

Given these physical and inorganic characteristics, it is worth comparing the chemical features of the insoluble organic matter (IOM) in WIS91600 with those of other carbonaceous chondrites to aid further interpretation of the chemistry of this intriguing meteorite. Here we report the elemental, isotopic, and structural characteristics of the IOM from WIS91600.

Experimental: IOM separates from WIS91600 and the other carbonaceous chondrites were prepared using a CsF-HF technique [5] followed by desulfidization in air, rinsing (with HCl, Milli-Q water, and dioxane), and drying. The elemental and isotopic compositions of the IOM were measured by elemental analyzer (C and N) or thermal conversion elemental analyzer (H and O) coupled with isotope mass spectrometry. The chemical structures of the IOM were analyzed by solid-state ^{13}C NMR, pyrolysis-GC-MS, and Carbon-X-ray Absorption Near Edge Spectroscopy (XANES), respectively.

Results and discussion: *Elemental and isotopic analyses* [6]: The H/C ratio of WIS91600 IOM (0.41) is similar to those of the mildly-heated CMs, Yamato (Y-) 793321 (0.42) and PCA91008 (0.35), and to Tagish Lake (0.33), but is distinct from those of the unheated CMs (0.6 – 0.7). Figure 1 shows a plot of δ^{13}C and δD for IOM from each meteorite. The C (-11.19‰) and H (349‰)) isotopic compositions of WIS91600 IOM are different from those of unheated CMs, CI, Tagish Lake, but similar to those (δ^{13}C = -11.38‰, δD = 243‰) of the heated CM, PCA 91008. Such isotopic similarlities indicate that WIS91600 and PCA91008 probably experienced the same sort of parent body process.

^{13}C NMR: The NMR spectrum of WIS91600 IOM is dominated by aromatic carbon, similar to that of the heated CMs, Y-793321 [7] and PCA91008, laboratory-heated Murray [8], and Tagish Lake [9]. To be

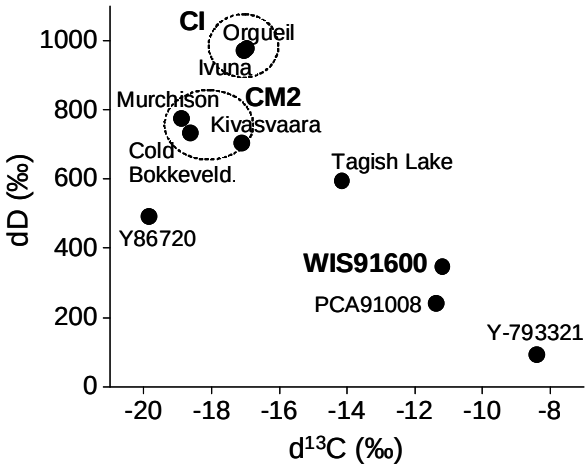

Fig. 1. A distribution plot of δ^{13}C and δD of IOM from WIS91600, CM2, CI, Tagish Lake, and heated CMs.

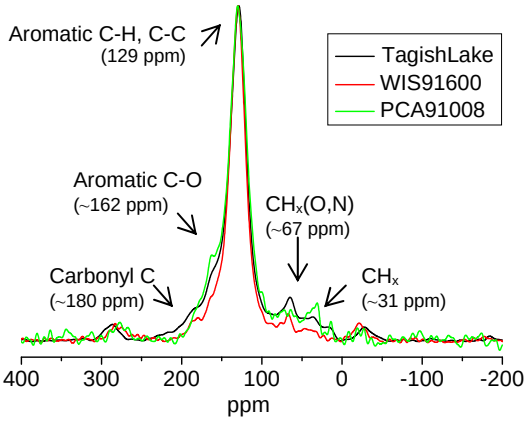

Fig. 2. Solid state ^{13}C NMR of WIS91600 (Red), PCA91008 (Light green), and Tagish Lake (Black) IOM.

exact, the distribution patterns of carbon functional groups with minor compositions, such as CHx(O, N), CHx, and carbonyl carbons, are quite similar between WIS91600 and Tagish Lake, compared to those of PCA91008 (Fig. 2). The variable contact time behavior of WIS91600 differed significantly from that of Tagish Lake and CI-CM-CR type chondrites [5]. Its magnetization grew as quickly as Tagish Lake and CI-CM-CR, however, the magnetization and the relaxation were much slower than these meteorites but rather similar to that of PCA91008 (Fig. 3). For comparison, Vigarano CV IOM followed much slower magnetization than that of WIS91600. These results indicate that the distances between C and H atoms within the IOM

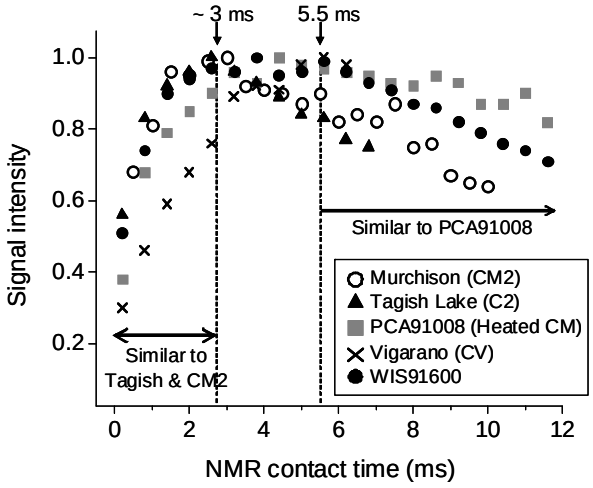

Fig. 3. Change in signal intensity of aromatic carbon of IOM with contact time with VACP MAS.

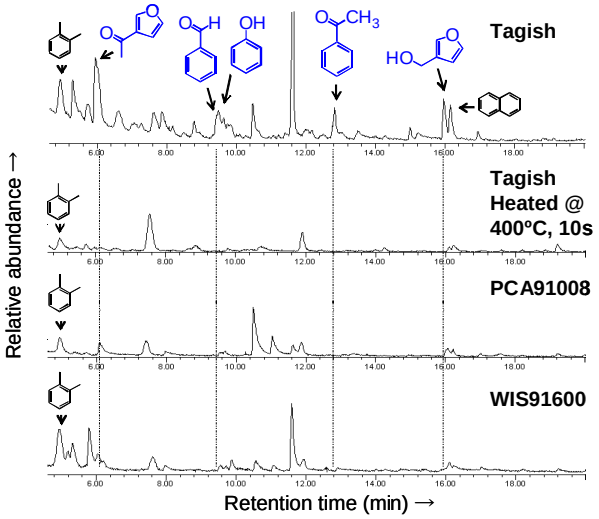

Fig. 4. A part of the total ion chromatograms of pyrolytically generated compounds from IOM of Tagish Lake, experimentally heated Tagish Lake, PCA91008, and WIS91600.

structure appeared to increased in the order: CI-CM-CR ~ Tagish Lake ≤ WIS91600 ≤ PCA91008 < Vigarano, probably reflecting the degrees of thermal metamorphism on the parent bodies.

Pyrolysis-GC-MS: The pyrolysis yield from WIS91600 IOM was low and the molecular distribution of the pyrolysates was very simple, which was quite distinct from the pyrolytic behavior of most of CI-CM-CR type chondrites [10]. The same was true for the IOMs from PCA91008 and Tagish Lake. However, unlike WIS91600 and PCA91008, Tagish Lake IOM also had a variety of O-containing pyrolysates that could be indicators of aqueous alteration [10]. However, after heating of Tagish Lake IOM at 400°C for 10s, most of the peaks, including the O-containing compounds, were absent from the pyrolysate (Fig. 4). Thus, if once absent, the organic trace of Tagish Lake-type aqueous alteration in WIS91600 might have been erased by moderate, shock heating around at ~ 400°C.

C-XANES: Generally, the presence of planar or linear domains of highly conjugated sp^2 carbon can be manifested in C-XANES spectra as a Frenkel-type 1s - σ *exciton at 291.1eV. A recent study revealed that the exciton can be used as a novel thermometer of chondritic IOM [11]. However, C-XANES spectra of WIS91600, PCA91008, Y-793321, and Y-86720 IOM exhibit a weak exciton intensity. According to the mineralogical studies, Y-793321 appears to have been heated at 300 - 500°C [12] or 400 - 470°C [13]. Y-86720 appears to have been heated above 500°C [14]. The poorly resolved exciton intensity for these samples contrasts with the sharply developed exciton intensity exhibited by the type 3 chondrites heated to similar temperatures, e.g., Allende CV3.2. This may suggest that these altered CM were altered through shock heating that occurred over a much shorter duration than the type 3 metamorphosed chondrites that were long-term heated for ~ 10^7 years.

Conclusion: Integrating these results, we conclude that WIS91600 IOM reveals a history that includes mild-heating. The clear signature for Tagish Lake-like aqueous alteration was not detected in WIS91600 IOM, but despite some mineralogical evidence for alteration [1, 2]. The organic signature for aqueous alteration might have been erased by the heating that followed aqueous alteration. The molecular and isotopic features of IOM from WIS91600 and Tagish Lake have shown that the histories of the two chondrites are distinguishable.

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