

MINOR HIGH TEMPERATURE CARBON COMPONENTS CONFIRMED IN CARBONACEOUS CHONDRITES BY STEPPED COMBUSTION USING A NEW SENSITIVE STATIC MASS SPECTROMETER. R.D. Ash, S.S. Russell, I.P. Wright and C.T. Pillinger, Planetary Sciences Unit, Department of Earth Sciences, Open University, Milton Keynes MK7 6AA. J.W. Arden, Department of Earth Sciences, University of Oxford OX1 3PR.

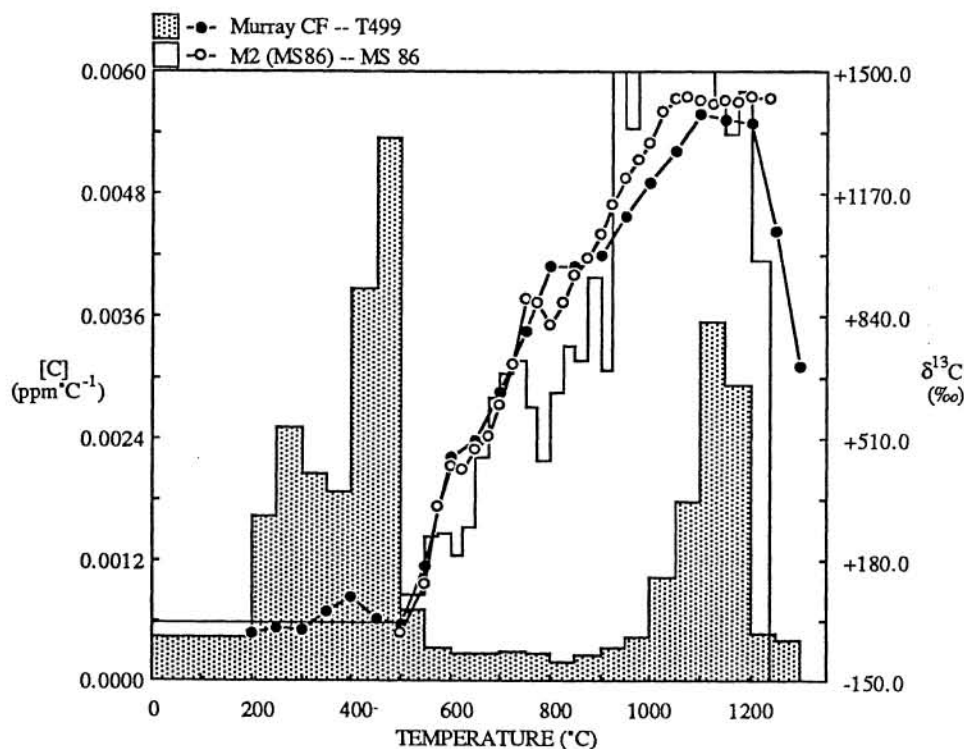
A stepped combustion study of a chemical/physical separate prepared from the Murray meteorite (Murray CF) suggested (1) that this sample contained several minor carbonaceous components in addition to two major ones, diamond and SiC, discerned from ion probe studies (2). Two of the accessory species were postulated because isotopic analysis of the gases released showed a marked deviation from a linear trend in $\delta^{13}\text{C}$ between 500° and 1100°C with additional isotopically heavy excursions recognised at 600° - 650° and 800° - 900°C. A linear trend would have to result from mixing of silicon carbide carbide in the size range 0.01 to 0.2 μm with an isotopically light component of lower stability, irrespective of the nature of the second entity whether it be indigenous to the sample, contamination, or a blank contribution from the analytical system. Whilst the variations from this mixing line could be recognising real minor components they also could be due to experimental error, or slight inconsistencies in a blank/contaminant contribution.

An opportunity to establish the authenticity of the interpretation by Wright *et al.* (1) has now arisen because of the availability of a new higher sensitivity stable carbon isotope mass spectrometer (3) and improved procedures for sample loading and blank reduction (4). The new instrument is capable of measuring samples of 10 picomoles of carbon as carbon dioxide to a precision of better than 1‰; blanks over the entire temperature regime 600° - 1300°C are typically less than 0.5 nanograms/step with steps in excess of 100°C.

In the figure we reproduce the data obtained for Murray CF (1) together with a new analysis of a Murchison residue M2. The latter is from a diamond/spinel/SiC concentrate produced by HF/HCl treatment followed by $(\text{Cr}_2\text{O}_7^{2-}/\text{HClO}_4)$. No attempt was made to remove the diamond by colloidal processing but instead the 184 μg sample was step combusted up to 550°C in a preliminary fashion in a separate analytical system and data pertaining to the diamond abundance and isotopic composition gathered (5). The precombusted M2 sample was stored for several days in a sealed ampoule before transferring to the new line in the shortest possible time. A second combustion experiment recommenced at 500°C and the first step of 23.8 ng at $\delta^{13}\text{C} -24.5\text{‰}$ shows the contaminating effect of the transfer. Thereafter, successive steps in the combustion release gas of increasing $\delta^{13}\text{C}$ up to a seven step plateau value of $1419 \pm 7\text{‰}$ (no allowance for yield variations) from 1050 to 1240°C. What is most remarkable is the degree to which the isotopic profile of Murchison M2 matches to the equivalent data for Murray CF obtained two years earlier with an entirely separate instrument and line, from a completely different meteorite and using a residue made by another group. The same digressions from linearity exist and moreover in M2 they correspond to peaks in the carbon release pattern. Thus we must now accept that two minor components, one burning at 600° - 650°C and the other around 750° - 800°C, exist in the residue. The identity of these species is restricted since they must be stable in the most oxidising acids unless they were protected by other resilient phases. The most interesting inference which can be made from the data is that the mixing trend between 500° and 1000°C must be the result of species indigenous to the sample. It would be entirely too fortuitous for a contaminant/blank contribution to be in exactly the correct proportions with the sample in

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two so unconnected specimens. There appears to be little alternative to accepting that the high temperature heavy component is SiC. If this is so then its size distribution may extend down to almost the equivalent of the nanometer sized diamond C δ or the mineral has to be severely radiation damaged. The isotopically light low temperature component is more difficult to identify given that the only forms of carbon other than SiC known to be stable to Cr₂O₇²⁻/HClO₄ are diamond and possibly C₆₀ (6). In our experience, diamond samples isolated from chondritic meteorites have a very sharp upper temperature limit for burning, *i.e.* the population does not extend to higher grain sizes; C₆₀ has a more pronounced combustion tail. An alternative worth considering is that the mixing line between 500° and 1000°C represents mixing of SiC from two (or more) sources with different isotopic compositions and size distributions. Given that from ion probe data for CF(2) we know that the $\delta^{13}\text{C}$ plateau at 1000 - 1200° is the average for a complicated mix of SiC grains of different isotopic compositions, then it is not inconceivable that the lower temperature isotopic compositions represent variations in the blend, with a greater proportion of the isotopically normal SiC in the finer size fractions. The deviations from linearity in the isotope trace at fixed temperatures might indicate preferential sizes in the populations involved.



References

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