
The meteorites Winona, Mount Morris (Wisconsin), Pontlyfni, ALHA 77081, Acapulco and Tierra Blanca have been classified on the basis of mineral compositions and trace element data as a primitive achondrite group related to the silicate inclusions of IAB irons (1). This classification rejected a previous suggestion that Winona, Mount Morris (Wisconsin) and Pontlyfni were linked with Kakangari and xenoliths from the Cumberland Falls aubrite (2). The Kakangari and Cumberland Falls material is chondritic (1), and hence merits the term "forsterite chondrite" on account of the high proportion of forsteritic olivine present. However, Kakangari has also been tentatively grouped with carbonaceous chondrites on the basis of chondrule mineralogy (3).

Recognition of genetic links between groups of meteorites places constraints on the number and identity of meteorite parent bodies in the early solar system, and is therefore of primary importance. The successful use of oxygen isotopes in this respect is limited by the occurrence of silicate inclusions in iron meteorites (4,5). Since carbon and nitrogen are not so limited, we are endeavouring to evaluate the role which these elements may play in establishing interrelationships. Here we discuss carbon isotope measurements made on Pontlyfni, Kakangari and Cumberland Falls.

Figure 1 shows the carbon release profile obtained on combustion of Pontlyfni in steps from room temperature to 1200°C. The total carbon abundance in this meteorite is high, ca 0.7 wt%, even after allowing that most of the element released below 400°C with a \(^{13}C\) of around -26 ‰ is probably terrestrial contaminant. The major release (0.6 wt%) of carbon occurs over the range 650 – 900°C, a temperature interval appropriate for the combustion of graphite, which has indeed been observed in winonaites (1). The average isotopic composition of this material is -9 ‰, a value just outside the limit measured for nodular graphite in IAB irons (\(^{13}C = -8\) to -4 ‰, ref. 6).

Graphite associated with silicates in IABts shows a slightly wider range (-8.8 to -3.9 ‰), but the database is smaller (6).

The non-magnetic fraction of Kakangari was reported (2) to have a carbon content of 0.98 wt%; replicate stepped combustions give values of 0.76 and 0.81 wt%. In contrast to Pontlyfni, more than 80% of the carbon in Kakangari combusts at temperatures below 400°C. Although the isotopic composition of the carbon rises to a maximum \(^{13}C\) value of -9 ‰ at 700°C, there is no evidence of a peak in the release profile over the temperature range 600 – 900°C, which suggests that graphite, if present, is only a minor constituent. As a high carbon content had been anticipated in Kakangari, the sample taken for the analysis shown in Fig. 2 was very small, ca 100µg, and thus may not have been representative. Hence a much larger specimen (14mg) was investigated: its carbon release pattern and measured isotopic composition were essentially identical. It would appear that there are no grounds, on the basis of carbon data, to suggest that Kakangari is related to Pontlyfni or consequently to the other winonaites or type IAB irons. A consideration of the low temperature carbon may help in establishing a link between Kakangari and carbonaceous chondrites, however the \(^{13}C\) values obtained are lighter than the -17 ‰ normally found for CI and CM macromolecular material. In fact, Kakangari looks most like a terrestrially contaminated unequilibrated ordinary chondrite, although links to CV and CO chondrites cannot be ruled out.
It is possible that nitrogen isotope measurements in progress may be more informative.

The "chondritic inclusion" from the Cumberland Falls aubrite, which was also assigned to the forsterite chondrite group, gave a carbon release profile unlike either Pontlyfi or Kakangari. Its overall carbon abundance of 0.04 wt%, total isotopic composition of -22‰ and carbon release pattern are akin to those obtained from ordinary chondrites of petrologic grade higher than type 3.

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