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EUROMET UREILITE CONSORTIUM: A PRELIMINARY REPORT ON CARBON AND NITROGEN GEOCHEMISTRY; Monica M. Grady, Department of Mineralogy, The Natural History Museum, Cromwell Rd. London SW7 5BD, U. K. and C. T. Pillinger, Planetary Sciences Unit, Department of Earth Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA, U. K.

The first Euromet expedition to the Frontier Mountain in Antarctica in December 1990 recovered two ureilites, FRO 90036 (34.6g) and FRO 90054 (17.5g). Preliminary classification [1-2] indicated that the specimens had very different textures and mineral chemistries, and hence were not paired. A third ureilite, Acfer 277 (41.0g; ref. 3) has also recently been returned from the Sahara. Due to the small sample sizes of the meteorites, and the unusual mineralogy of FRO 90054, a consortium was established to ensure the most effective study of these samples; this abstract reports on the carbon and nitrogen stable isotope geochemistry of two of the three ureilites issued to the consortium.

Acfer 277. An outline of the mineralogy of Acfer 277 was presented by [3]: the meteorite is a typical ureilite, with a mean olivine core composition ca $Fa_{20.7}$. The olivine exhibits undulose extinction, implying shock facies 2 - 3, *i.e.* a moderate shock level of 5 - 10 GPa [4]. The carbon results for Acfer 277 bear out its classification as a ureilite: a carbon content of 2.4 wt. % and $\delta^{13}C$ *ca.* -2.8‰, placing the sample firmly within the field of main group ureilites defined by [5]. Interestingly, this ureilite is apparently not depleted in carbon by weathering processes, as has been found for other carbon-containing meteorites recovered from the Sahara [6], presumably a reflection of the more fixed nature of ureilite carbon. Approximately 86% of the carbon combusts between 650°C and 900°C (Fig. 1), the temperature range across which crystalline graphite generally burns, and has $\delta^{13}C$ *ca.* +0.6‰; the remainder of the carbon is released above 900°C, has a $\delta^{13}C$ *ca.* -23.5‰, and is presumably from combustion of carbides. Slightly ^{13}C-enriched carbon as graphite co-existing with ^{13}C-depleted carbides is a commonly observed assemblage in ureilites [5]. Nitrogen systematics are also typical of ureilites: a yield of 20.9 ppm nitrogen with $\delta^{15}N$ *ca.* -22.1‰. The coupled variation of carbon and nitrogen isotopic compositions is also within the spread of values shown by other ureilites (Fig. 2).

FRO 90054. Initial petrographic study of this meteorite described it as one of the few augite-bearing ureilites [2], although the modal content of 60% augite is high, even in comparison with other high Ca-pyroxene ureilites [7]. The mineral assemblage of FRO 90054 is therefore atypical, although the olivine composition of $Fa_{13.1}$ [2] falls within the range of measured values for main group ureilites. FRO 90054 is only lightly-shocked, with similar textural features to Acfer 277 in terms of olivine deformation. Carbon and nitrogen data for FRO 90054 serve to reinforce the belief that this meteorite, if it is a ureilite, is most unusual. The bulk carbon content of 0.24 wt. % is the lowest ever measured for a ureilite, with only a silicate-rich portion from Goalpara giving a similar result. Dissolution of an aliquot in HF and HCl resulted in a total weight loss of almost 100%, also implying a very low indigenous carbon content. The summed $\delta^{13}C$ of *ca.* -24.3‰ would be unique for a ureilite; all other samples analysed have $\delta^{13}C$ values between -11‰ and 0‰ [5]. Closer scrutiny of the carbon data (Fig. 1) show that 85% of the total carbon combusts below

500°C, implying that the bulk of the carbon is present as either poorly-ordered carbon or organic material. In view of its apparent solubility, the latter seems more probable. The isotopic composition of -24.4‰ implies a terrestrial, contaminant origin for this component, although such a contamination level is high for an Antarctic meteorite. A small amount of carbon combusts between 600°C and 1200°C, showing a maximum in the yield histogram at 600 - 700°C, consistent with identification of a very minor amount of poorly-crystalline graphite. However, the isotopic composition of this component is ca. -23.4‰, a value again outside the range shown by most ureilites. Nitrogen data are also unusual: the yield of 7.9 ppm is low for ureilites (range is 20 - 100 ppm), and isotopic composition is high, $\delta^{15}N$ *ca.* +64‰. Positive $\delta^{15}N$ values have been noted before, but only in brecciated ureilites [8], which generally have much higher nitrogen contents, and exhibit greater shock effects. Fig. 2 shows that FRO 90054 plots well outside the field of $\delta^{13}C/\delta^{15}N$ values exhibited by other ureilites.

Conclusions: In terms of C and N stable isotope geochemistry, Acfer 277 is a typical ureilite, containing ^{13}C-enriched and ^{15}N-depleted graphite, and ^{13}C-depleted carbides. In contrast, FRO 90054 is almost totally non-ureilitic in character, containing minimal carbon and nitrogen. Given the lightly-shocked nature of the specimen, it is unlikely that large amounts of carbon have been lost during shock-processes: FRO 90054 has the same shock classification as Acfer 277, which demonstrably has not lost its quota of volatiles. FRO 90054 is a very small specimen, only 17 g in total. It might be that the meteorite is simply a silicate-rich portion from the inhomogeneous ureilite parent, but the $\delta^{13}C$ value of the "graphite" which is present is entirely unlike that of all other ureilites. Either FRO 90054 extends the known stable isotope compositional range of ureilites, or it is not a ureilite at all. Further investigations are in progress, to include the other consortium sample, FRO 90036.

Figure 1

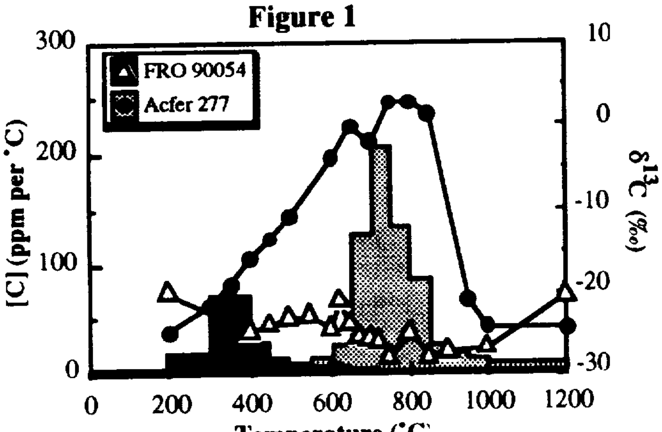
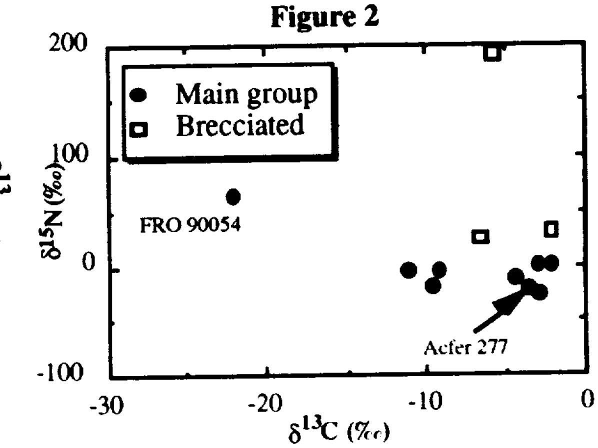


Figure 2



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