THE EET 83309 POLYMICT UREILITE: ITS RELATIONSHIP TO OTHER UREILITES ON THE BASIS OF STABLE ISOTOPE MEASUREMENTS M. M. Grady and C. T. Pillinger, Department of Earth Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA, U. K.

A preliminary examination of the EET 83309 meteorite by Mason [1] identified the sample as an achondrite with some resemblance to ureilites. Further work by Prinz (pers. commun. and this volume) has allowed a more definite classification: EET 83309 is now recognized as a polymict ureilite, along with North Haig and Nilpena. Characteristics of this trio of unusual unequilibrated ureilites are a range in core composition of both olivine (Fo_{60-95}) and pigeonite, plus 2–3wt% plagioclase. As with all other ureilites, the silicates are accompanied by carbon-rich material, occurring both as matrix for the minerals and as cross-cutting veins. The part which carbon plays during differentiation of the ureilite parent body has been shown to be an important one: it influences the extent to which silicates are reduced, and, in monomict ureilites, isotopic composition of carbon is apparently related to olivine composition [2].

Carbon analysis of 3.018mg of the EET 83309 ureilite was carried out by stepped combustion from room temperature to 1200°C; isotopic data were acquired using a VG SIRA 24 dynamic mass spectrometer. Resolution of the stepped extraction technique was higher than employed previously [2], being mainly 50°C temperature steps. The amount (—; in ppm) and isotopic composition (—•—; $\delta^{13}C$ in parts per thousand, ‰) of carbon combusting across each temperature interval is shown in Fig. 1. Essentially, there is one major release between 500°C and 850°C (2.14 wt%; $\delta^{13}C$ *ca* −5.5‰). Since preliminary x-ray diffraction measurements have given no indication of the presence of diamonds, this release can be attributed to the oxidation of graphite. Other lesser components are also observed: carbon combusting below 500°C (0.20 wt%; $\delta^{13}C$ *ca* −14.2‰) is probably organic matter plus loosely-bound Antarctic weathering products such as bicarbonate. Above 900°C, 0.03wt% carbon combusts with $\delta^{13}C$ *ca* −23.4‰, presumably from either carbides/carbon dissolved in metal. All three groups of material are commonly found in ureilites; the $\delta^{13}C$ values for both low and high temperature components follow previously established patterns. The amount of graphite is within the range observed for other ureilites, and its relatively sharp combustion temperature places it in a group with Dyalpur, Goalpara, Haverö, Kenna, Nilpena, Novo Urei and RKPA 80239 [2]. The sharpness of the release is not understood, but it may be related to accessibility, grain size or crystallinity of the graphite. The high resolution extraction technique demonstrates that the isotopic composition of graphite is variable: from 600–700°C, $\delta^{13}C$ is *ca* −4.7‰ but from 700–850°C, $\delta^{13}C$ changes to *ca* −7.0‰. Such a change in isotopic composition has not been seen before in whole-rock samples, in fact the constancy of $\delta^{13}C$ values has been used to argue that diamond in ureilites has been produced from graphite by shock without any carbon loss or isotopic fractionation [2,3]. It is possible that the change in $\delta^{13}C$ value represents two types of graphite with slightly differing degree of crystallinity and $\delta^{13}C$ which derive from two different sources. It may be noteworthy that high resolution combustion has also recognized two major carbon components in acid residues from Kenna.

The $\delta^{13}C$ measurements for graphite in EET 83309 are helpful in understanding the previously reported relationship with olivine composition [2]. Data comparing $\delta^{13}C$ with Fo abundance noted two discrete groups of ureilites (see Fig. 2). The North Haig polymict breccia was the only sample to occupy the middle region, having a $\delta^{13}C$ value intermediate between the two groups and a range in olivine composition. EET 83309 ureilite (also a polymict breccia) is found to possess graphite with an overall $\delta^{13}C$ value (−5.5‰) close to that of North Haig. It seems that these two highly brecciated ureilites might contain carbon which is a mixture of graphite from both main groups, which may argue for a heterogeneous single parent body. To rationalize the carbon isotope data from Nilpena, the third polymict ureilite, which plots in the larger of the two clusters, one would postulate either graphite from a single source, or both sources, one of which is present in dominant quantities over the second, possibly as a result of poor sampling. This model requires that at some time in the ureilites' history the two sources (either different parent bodies or distinct regions within one parent body) have physically been brought together by impact or mechanical mixing.

A second fragment (0.918mg) from EET 83309 was taken for nitrogen isotope analysis by stepped combustion. The database for nitrogen abundance and isotopic composition is much smaller than in the case of carbon, but some comparisons are possible. Nitrogen was liberated in decreasing quantities with temperature, to give a total of 77 ppm. This is high compared to the majority of ureilites, excepting North Haig, believed to be contaminated by extensive weathering. The maximum nitrogen release occurred in the first temperature increment, between room temperature and 200°C, 43 ppm with $\delta^{15}N$ *ca* +29‰, a value which is difficult to equate with any process involving atmospheric nitrogen. At higher temperatures, $\delta^{15}N$ rises, reaching +200‰ at 400°C (14 ppm), before falling to values around +30‰ between 600°C and 1200°C. No nitrogen of such ^{15}N-enrichment has previously been seen in ureilites. North Haig is the only other ureilite with ^{15}N-enriched nitrogen—$\delta^{15}N$ reaches +45‰ at 600°C. Given the high nitrogen abundance in North Haig (152 ppm), a +200‰ component could be masked by weathering products. High $\delta^{15}N$ values have also been encountered in other meteorites—the occurrence of most relevance to ureilites is that in the Abee enstatite chondrite [4], since E-chondrite clasts have been recognized in the Nilpena polymict ureilite [5].

References: [1] Mason, B. (1986) *Ant. Met. Newsletter*, **9**, 15; [2] Grady, M. M. *et al.*(1985) *G. C. A.*, **49**, 903–915; [3] Vdovykin, G. P. (1970) *Sp. Sci. Rev.*, **10**, 483–510; [4] Grady, M. M. *et al.*(1986) it G. C. A., **50**, 2799–2813; [5] Jaques, A. L. and Fitzgerald, M. J. (1982) *G. C. A.*, **46**, 893–900. Mr S. R. Boyd is thanked for technical assistance; financial support was provided by the SERC.

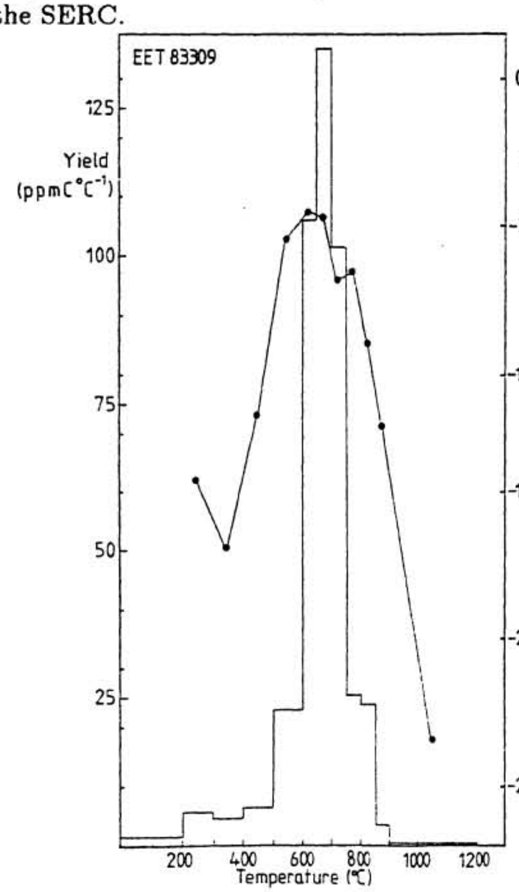

Figure 1

Figure 2