NITROGEN AND CARBON COMPONENTS IN C_δ; A POSSIBLE PRESENCE OF NITROGEN-FREE DIAMONDS IN C_δ; A.B. Verchovsky, J. Newton, I.P. Wright, J.W. Arden[1] and C.T. Pillinger, Planetary Sciences Unit, Dept. of Earth Sciences, The Open University, Milton Keynes MK7 6AA. [1]Dept. of Earth Sciences, Parks Road, Oxford.

The use of quasi-three isotope plot ($\delta^{15}N$ vs. C/N) for data acquired by stepped combustion of C_δ fractions from primitive chondrites may be interpreted in terms of several nitrogen containing components. The preferred explanation of the results however requires diamonds or diamond-like material free of nitrogen.

Variations of the abundance of nitrogen and carbon isotopic composition observed during stepped combustion of C_δ are still not well understood. So far we do not know whether metamorphic processing is involved [1] or if different components are present within C_δ; indirect evidence seems to favour the latter interpretation [2-4]. Unfortunately the two isotope systems of C and N cannot allow resolution of more than two component mixtures. Therefore to find out whether C_δ indeed contains greater than two nitrogen and/or carbon components, it is useful to use quasi-three isotope plots including elemental ratios for example $\delta^{15}N$ *vs.* C/N. Analysis of the stepped combustion data on such a plot surprisingly showed that N-C system of C_δ for some meteorites is rather simple: most of the experimental points define two distinct mixing lines which on occasion (*eg*. Krymka, Fig. 1) are practically ideal with deviation of the points from the lines within experimental errors. Thus, intuitively it would seem that isotopic variations of N in C_δ can be explained in terms of a three component mixture: (i) a $\delta^{15}N= 0‰$ component with low (possibly 0) C/N ratio released at low temperature that could be adsorbed atmospheric nitrogen, (ii) an intermediate lighter ($\delta^{15}N \sim -200‰$) component with high C/N ratio that appears to be a carbonaceous phase; and (iii) a component with very light nitrogen ($\delta^{15}N = -350‰$) and low C/N ratio released at high temperature which, presuming the C/N is finite, could in principle be either carbonaceous or a non-carbon nitrogen rich phase. This interpretation would suggest that both components (ii) and (iii) are presolar in that they have anomalous $\delta^{15}N$ values.

A more detailed look at the data suggest that the above interpretation is over-simplified. First of all considering plots from several meteorites the range of $\delta^{15}N$ for the intermediate component (from the mixing line intercepts) is rather high (from –50‰ to –250‰) to believe that it is a single entity. Likewise then intercept C/N ratio varies from 250 to more than 1000 to support this argument. Secondly, whilst the experimental points lie along the mixing lines for the pure components, they do not always lie within the experimental uncertainties; in such examples however the points are not obviously inside the triangle (Fig. 1). For this to be true the carrier of the lightest nitrogen (with $\delta^{15}N = -350\%$) cannot be oxidised at low temperature at all. It seems very odd for a mixture of three combustible phases whose total range for complete combustion is only from 300°C to 500°C to be so apparently completely resolved.

Another, quite different interpretation of the data is that nitrogen in the samples is a mixture of only two nitrogen containing (light $\delta^{15}N$ ~– 350‰ and heav y $\delta^{15}N$~0‰) components, in the presence of a carbonaceous nitrogen-free phase which causes the variability of the C/N ratio. In this case the different intercepts for $\delta^{15}N$ and C/N during stepped combustion can be easily understood as being due to change in the abundance of the nitrogen-free-carbon. In the other words the variations of $\delta^{15}N$ and C/N ratio on the quasi-three isotope plots are mostly independent and controlled by different processes. Analysis of all available data on stepped combustion and pyrolysis of C_δ suggest that the heavy nitrogen itself is complex and probably consists of two components: a relatively small amount of physically adsorbed air nitrogen on grain surfaces and another more abundant component associated with a small amount of carbon (Fig. 2). Thus both components seem to be a laboratory contamination.

The experimental data also allows calculation of the putative nitrogen free component and its release pattern as a function of temperature. For simplicity we use a C/N ratio for the component containing the lightest nitrogen (–350‰) of 100 and C/N = 0 for the heavy nitrogen component. In some samples the nitrogen-free carbon can be as high as 80%; it is isotopically heavier ($\delta^{13}C$ = –32‰) than carbon containing the light nitrogen (–40‰). More complicated models are needed to take into account the carbon which comes from laboratory contamination.

None of the carbon phases discussed here appear to contain the anomalous noble gases. As we have argued in a previous paper [4] the noble gases have significantly higher release temperatures during stepped heating than light nitrogen. Nitrogen-free-carbon unequivocally has a lower combustion temperature than the other carbon *ie.* that associated with –350‰ nitrogen in the carbon colloquially known overall as C_δ. The relationship with P-type noble gases is unknown. If the nitrogen-free-carbon is also diamond or diamond-like we conclude that it may have been created under different conditions from the diamonds which contains the light nitrogen. The carbon isotopic composition –32‰ is entirely compatible with a solar system origin. There is no other diagnostic isotopic anomaly. N.B. however that the $\delta^{13}C$ value for the nitrogen-free-carbon is also entirely different from other diamonds of believed solar origin [5].

References: [1] Russell S.S. *et al.* (1992) *L.P.S.* **XXIII**, 1187. [2] Russell S.S. *et al.* (1991) Science **254**, 1188. [3] Huss G.R. and Lewis R.S. (1993) *G.C.A.* in press. [4] Verchovsky A.B. *et al.* (1993) Meteoritics **28**, 452. [5] Russell S.S. *et al.* (1992) *Science* **256**, 206.