NOT ALL DIAMOND FROM CHONDRITIC METEORITES IS IDENTICAL!

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In a recent communication, Huss (1) has argued strongly that fine grained diamond isolated from different classes of chondritic meteorites has a remarkably uniform Xe(HL) content with ^{132}Xe estimated at $25 \pm 3 \times 10^{-8}$cm^3 g^{-1} and 124/132 Xe and 136/132 Xe ratios of 0.774 ± 0.008 and 64.2 ± 0.7 respectively. Because of the consistency of the values he has obtained, Huss proposes to use the ^{132} Xe yield and the 136/132Xe ratios for minimally processed acid residues to calculate diamond abundance in the parent meteorites. In several previous publications (2-5) we have argued that the same chondritic diamonds have nitrogen abundances which are far from fixed. This clearly paradoxical situation needs to be resolved since the parasitic elements N and Xe are crucial for arguments that diamond is an interstellar grain. Our data can also be used to show a variation in C/N ratio within the diamond isolated from individual samples on top of the already identified differences between samples. Moreover a much more precise investigation of carbon isotopes during stepped combustion of diamond samples reveals that there are real differences in δ^{13}C between CM2/CI carbonaceous chondrites and type 3 carbonaceous and ordinary chondrites.

All the diamond samples studied here have been isolated and analysed by identical methods. δ^{13}C measurements have been made over the temperature regime 300° - 525°C during stepped combustion of samples of Cδ + spinel + SiC isolated from seven meteorites using HF/HCl treatment followed by $Cr_2O_7^{2-}$/HClO$_4$; in most cases no effort was made to separate the diamond from higher stability components by colloidal suspension. Between 450° and 500° the isotopic composition for Cold Bokkeveld falls to a nadir of -37.8‰; samples of Murchison, ALH 83100,78 and Orgueil show virtually identical profiles with the δ^{13}C minima measured at -38.2‰ -38.8‰ and -38.5‰ respectively. In contrast, replicate runs of Allende and Inman and a single analysis of Tieschitz failed to reach δ^{13}C lower than -35.5‰. The largest sample of Allende (264 µg), a diamond specimen isolated from spinel by ammonia treatment, gave a plateau value of 35.0 ± 0.2‰, superceding the value of 32.3 ± 1.6‰ measured by Arden et al (6) on a much smaller specimen of the same material. It could be argued that the diamond δ^{13}C is being affected by heavier carbon burning at higher temperatures. However, if this were the case, it should be the CM2/CI which gave the higher δ^{13}C values since these classes of meteorites contain substantially more heavy carbon when compared to CV3 and ordinary chondrites. The data from a Murchison residue stepped combusted to higher temperatures by Ash et al (7) shows the difficulties which might be encountered with CM2's in this respect.

In previous publications, (2-5), we have estimated the nitrogen content of different samples of meteorite diamond by interpreting the release of nitrogen during simultaneous C and N stepped combustion as a mixture of two components: one atmospheric contamination and the other indigenous to the specimen. Complimentary information can be acquired from a plot of variations in C/N ratio vs. the cumulative yield of nitrogen which demonstrates that all the samples studied follow a consistent pattern but provide distinctive values for N in diamond concentration. After an initial rise to a peak from very low values, C/N falls to an approximately level plateau. For the CI and CM chondrites the C/N plateau is relatively constant for about 50 - 70% of the nitrogen release, the duration of the plateau for Allende is

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substantially less.   The C/N ratios can be calculated by averaging the individual measurements across the plateau and used to provide nitrogen in carbon abundances ranging from 3773ppm for Allende to 12345 ppm for Cold Bokkeveld. Whilst the trend in N concentration established this way follows the same sequence as arrived at by previous methods, the absolute values are higher because the peak C/N ratios in low temperature fractions are ignored.

Both the carbon isotopic systematics of the various diamonds and the high C/N ratios in low temperature steps could be used to argue for some kind of metamorphic alteration of the diamond although it is not clear whether the finest grains or grain surfaces are being affected. On the other hand, the nitrogen isotopic composition of the diamonds is entirely inconsistent with such an idea; all the samples studied here show a minimum $\delta^{15}N$ of 343 $\pm$ 16 (n = 20) in or close to the maximum nitrogen release step. Moreover, in a comparison of the isotopic composition of nitrogen released from Allende with that liberated from Cold Bokkeveld it can be seen that whilst the first 50% evolved is isotopically heavier in the former case, the final 50% for both meteorites is isotopically identical but with C/N ratios which are different by a factor of four. Thus, whilst some degassing may have occurred the diamonds from different meteorites must have had inherently different nitrogen concentrations of the same isotopic composition to begin with. It is hard to envisage a mechanism whereby nitrogen could be degassed by a factor of at least four without some effect being registered on the noble gas, particularly Xe(HL), content. If chondritic diamonds are distinguishable according to carbon isotope and nitrogen abundance characteristics but not Xe(HL) content and isotopic composition, then these properties must have been established before the noble gas was implanted in the mineral. It follows that nitrogen rather than xenon is the better indicator of diamond provenance.

References
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