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Understanding the source: The nitrogen isotope composition of Type II mantle diamonds

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Diamonds can be broadly subdivided into 2 groups based on their nitrogen content; type I with > 10ppm nitrogen and type II with < 10ppm (1). Roughly 98 % of upper mantle diamonds are classified as type I, interestingly nearly all lower mantle diamonds are of type II (2). This study aims to identify the processes involved or source of type II diamonds from several localities by measuring their carbon and nitrogen stable isotope compositions simultaneously for the first time. Samples have been categorised as type II using Fourier transform infra-red (FTIR) analysis. The carbon and nitrogen isotopes as well as additional nitrogen content data have been acquired using a custom made a hi-sensitivity gas sourced mass spectrometer built and housed at the Open University, UK.

There are two ways in which we can model the petrogenesis of type II diamonds. 1- During diamond growth nitrogen can be incorporated into diamond as a compatible element in a closed system and therefore the N/C ratio in the source can be depleted by Rayleigh fractionation as the first diamonds to crystallise will partition nitrogen atoms into their lattice as a 1:1 substitution for carbon atoms (type I diamonds). However nitrogen may behave as an incompatible element in diamond (and be a compatible element in the metasomatic fluid), this coupled with an open system would lead to the removal of nitrogen by the metasomatic fluids, thus causing the source to progressively become depleted in nitrogen. Continued diamond crystallization in either system will produce diamonds with ever decreasing nitrogen concentrations with time, possibly to the point of them being almost nitrogen free. 2- It is conceivable that type I & II diamonds found in the same deposit and sharing a common paragenesis (eclogitic or peridotitic) may have formed from different metasomatic fluids in separate diamond forming events. The latter has been proposed for samples from the Cullinan mine (South Africa) based on their carbon isotope compositions (3). Both models can be tested using the stable isotope compositions of carbon and nitrogen with the N/C ratio of the diamonds in a given population with varying nitrogen content (from type I to type II).

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