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Carbon isotope compositions in sublithospheric diamonds
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Harte Ben[1]*
HARTE, Ben[1]*

[1]CSEC, Earth Sciences, School of Geosciences, University of Edinburgh, Scotland, UK.
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Studies of silicate and oxide mineral inclusions in diamonds have provided evidence of a small number of diamonds formed at depths of approximately 250 to 800 kms in the Earth's mantle. The major source of these diamonds is kimberlites of Cretaceous age from Juina province, Brazil; but small numbers of similar diamonds have been found on most of the world's continents. On the basis of their inclusions, the diamonds have been divided into three major groups (ref 1) as follows: *(a) majoritic garnet suite* (basic bulk compositions and relatively Ca-poor); *(b) perovskite and periclase suite* (dominantly ultrabasic Mg-rich bulk compositions); *(c) Ca-rich suite* (with Ca-Si-Ti minerals, carbonates and some aluminous silicates). The estimated principal depths of formation these groups are respectively in the ranges of: (a) 250-500 km; (b) 650- 750km: (c) 300-550 km.

The Carbon isotope compositions of the diamonds hosting the above suites of inclusions show some marked differences. Majoritic suite inclusions of group (a) have δ^{13}C in the range of -5 to -24 ‰. The ultrabasic inclusions of group (b) have δ^{13}C compositions in the range -3 to -7 ‰. However, some rare inclusions of basic composition from the same depth range as the ultrabasic inclusions have δ^{13}C extending to -24 ‰ (ref 2), as with the majoritic suite. In group (c) the diamonds largely range in δ^{13}C from -3 to -25 ‰. The highly negative δ^{13}C values have been considered to indicate carbon of organic origin and therefore suggest derivation from subducted ocean floor protoliths (refs 3, 4, 5, 6). Other evidence of initial ocean floor protoliths is shown by Eu anomalies in some majoritic inclusions, and the occurrence of some highly aluminous phases in group (c). A very small number of diamonds with δ^{13}C close to 0 (zero), may indicate a marine carbonate source.

The nature of the ultrabasic protoliths yielding diamonds with δ^{13}C values of -3 to -7 is particularly interesting. These carbon isotope values are regarded as typical of the mantle. But what is the petrological history of this mantle? Given the evidence of an ocean floor origin for the protoliths of the other inclusion suites, it is suggested that the mantle protolith for the ultrabasic inclusions also formed part of the oceanic lithosphere before being subducted. Unlike basic rock compositions forming the ocean crust, the ultrabasic rocks of the oceanic mantle lithosphere were probably too far below the ocean floor to acquire organic carbon - thus they retained their primitive mantle carbon signatures, although they may have undergone hydration.

With subduction, the oceanic lithosphere may give rise to a stagnant slab lying close to the upper/lower mantle boundary (refs 1 and 7). During descent of the slab, dehydration reactions may give rise to fluids/melts from which the diamonds of groups (a) and (b) crystallised (ref 4). In the accompanying image for the Juina diamonds at 101 Ma, the formation of diamonds of groups (a) and (b) is indicated by the red and green diamond shapes respectively. Once formed these are represented by the solid circular shapes and transported with the stagnant slab. Diamonds with Ca-rich inclusions (group c) are suggested to form in association with carbonatitic melts (ref 5), which also transport all diamonds towards the continental lithosphere of the Amazonion craton.