Carbon is isotopes in Kerguelen plume-derived carbonatites: evidence for recycled inorganic carbon

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Abstract
Carbonatites form from deep mantle melts that are believed to incorporate recycled crustal carbon. Most of the evidence in favour of this hypothesis is, however, circumstantial and comes from the study of radiogenic (Nd–Sr–Pb) isotopes that show HIMU and EM-I mantle signatures. In this work, we present direct evidence for the incorporation of recycled crustal carbon in carbonatites of Eastern India through a study of their stable isotope systematics. The 40Ar/39Ar age of one of these coeval complexes is 107.2 ± 0.8 Ma, which suggests that these carbonatites represent late magmatic pulses of the Rajmahal–Bengal–Sylhet flood basin province. Their age, spatial proximity to the Sylhet traps, HIMU-EM I isotopic signatures, and Sr-isotopic similarity to the 115–105 Ma old Kerguelen Plateau basalts are consistent with the hypothesis of their Kerguelen plume origin. The carbon and oxygen isotope compositions of three of these carbonatite complexes are homogeneous, unlike most of the carbonatites world-wide, and is suggestive of batch crystallization of these rocks under plutonic conditions. The δ18O values of all the complexes are consistent with their derivation in equilibrium with mantle silicates, whereas δ13C shows higher values than a ‘normal’ mantle (δ13C = −5.0 to −8.0‰). The homogeneity of isotope compositions, absence of 18O enrichments, co-precipitation of calcite and dolomite in isotopic equilibrium and absence of any crustal contamination effects, preclude the possibility of any change in δ13C of the parent magma (average for all the complexes = −3.2‰) than that of a ‘normal’ mantle is clear evidence for incorporation of recycled inorganic carbon. We suggest that this incorporation is a result of entrainment of a subcontinental lithospheric mantle, which was already enriched in 13C derived from subducted ancient oceanic crusts through mantle metasomatism.

Keywords: carbonatites; stable isotopes; mantle plumes; recycling; Kerguelen

1. Introduction
The carbon budget of the mantle has been affected by degassing of CO2 through volcanic activity and subduction of large volumes of volatile-bearing rocks over geologic time. As the subducting crust contains both inorganic (carbonate) and organic (biogenic organic material) carbon with distinct δ13C signatures [1–3], one would expect their signatures in the carbon isotopic compositions of various mantle-derived materials. However, most