

Heterogeneous carbon reservoir in sublithospheric mantle: variations of carbon isotopic composition in diamonds from Sao-

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The Juina kimberlite field in Brazil is a well-known source of alluvial sublithospheric diamonds as identified by their properties and mineral inclusions. Taking advantage of the rather common occurrence of superdeep mineral inclusion assemblages in diamonds from Sao-Luis river alluvial deposits (Juina, Brazil), we carried out a study of variations of C isotope in diamonds from this locality.

Diamonds from Sao-Luis are characterized by rough morphologies and have complex growth histories. Episodic growth, plastic deformation and breakages are visible in these crystals and most diamonds have experienced a final episode of resorption before exhumation. Total nitrogen content in studied diamonds reach 1200 ppm and more. Only several studied diamonds are nitrogen-free (type IIa). Some diamonds consist of domains that are also nitrogen-free but other parts may contain nitrogen. Many diamonds have very low (>10 ppm) but still detectable nitrogen impurity. Extremely high nitrogen aggregation state and overall platelet degradation detected in the majority diamonds from Sao-Luis are suggested they have stored at considerably higher temperatures that are typical for continental lithosphere.

Syngenetic inclusions in 59 diamonds from Sao-Luis were represented by phases of superdeep paragenesis as it was described previously. The dominated inclusions are majoritic garnets, ferropericlases, CaSi- and CaSiTi-perovskites, MgSi-perovskites, TAPP, SiO₂ phases, kyanites, AlSi-phases, olivines and Fe-sulfides. Rare inclusions of clinopyroxenes, KFsp (K-hollandite?), CF, NAL, grossular, native iron, magnesite, CaCO₃+CaMgSi₂O₆ (composite inclusions) have been found in separate diamonds. All majoritic garnets we found are of metabasic affinity and in some cases associated with omphacitic clinopyroxenes.

The studied diamonds from Sao-Luis display wide variations of carbon isotopic compositions ($\delta^{13}\text{C}$) ranging from 2.7 to -25.3 ‰. The diamonds with inclusions of ferropericlase have very narrow range of $\delta^{13}\text{C}$ values from -2.1 to -7.7 ‰, which are closely similar to the normal mantle values [Cartigny, 2005; Stachel et al., 2009]. From this observation, it may be suggested that their formation may proceed from isotopically homogeneous mantle reservoir that do not support the model of large primordial isotopic variability of carbon isotopes in primitive Earth's mantle with a predicted pyrolite composition. Diamonds with inclusions of majoritic garnet and CaSi- and CaSiTi-perovskites in many cases show marked differences from the expected normal mantle values of $\delta^{13}\text{C}$ values. Low $\delta^{13}\text{C}$ values (-10 to -25 ‰) have been observed exclusively in a series of superdeep diamonds with calcic-majorite garnets, Ca-silicates, aluminous silicates and SiO₂ from Sao-Luis.

The $\delta^{13}\text{C}$ measurements in core to rim traverses within some individual crystals varied substantially, indicating multi-stage growth histories. The variations in $\delta^{13}\text{C}$ within individual diamonds may be attributed to either different source of carbon or fractionation effect during diamond growth. No correlation of carbon isotope composition and nitrogen content has been found in individual diamonds. It therefore appears that the cores and rims of the Sao-Luis diamonds precipitated from different fluids/melts with variable N/C ratios and/or under different growth conditions. The highly negative $\delta^{13}\text{C}$ values in the core (-20 to -25 ‰) potentially represent organic matter in sediments or altered basalts, and the lower $\delta^{13}\text{C}$ values may represent mixing trends towards normal mantle compositions [Schulze et al., 2004; Harte, 2011]. In this study, we have also described a series of diamonds which show opposite trend of change carbon source from primordial mantle to subducted/crustal (either biotic or abiotic carbon).

Keywords: carbon, diamond, sublithospheric mantle, subduction