Growth condition of super-deep diamonds inferred from carbon isotopic compositions and chemical composition of nano-inclusions

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Superdeep diamonds originating from the mantle transition zone and the lower mantle were found from alluvial deposits of Sao-Luis river (Juina, Brazil). We investigated carbon isotopic variations and chemical compositions of nano-inclusions in the superdeep diamonds which can give a clue for the growth condition.

We found syngenetic inclusions of superdeep paragenesis from 59 diamond samples from Sao-Luis. Our SIMS analysis showed the wide variations of carbon isotopic compositions ranging from 2.7 to -25.3 ‰ in $\delta^{13}C$. The diamonds with inclusions of ferropericlase have a very narrow $\delta^{13}C$ values in the range from -2.1 to -7.7 ‰ which is close to the "normal" mantle values. From this observation, it may be suggested that their formation may proceed from isotopically homogeneous mantle reservoir. $\delta^{13}C$ values of diamonds with inclusions of majoritic garnet, CaSi-perovskite and CaSiTi-perovskite show marked differences from the expected "normal" mantle values. Low $\delta^{13}C$ values from -10 to 25 ‰ have been observed exclusively in a series of superdeep diamonds containing calcic-majorite garnets, Ca-silicates, aluminous silicates and SiO_2 inclusions. The carbon isotope measurements in core–rim traverses within some individual crystals varied substantially, indicating the multi-stage growth histories. It therefore appears that the cores and rims of the Sao-Luis diamonds precipitated from different fluids/melts under different growth conditions.

Nanometer-sized inclusions were found in sevearal samples. TEM observation revealed that the nano-inclusions have a negative cystal shape suggesting the syngenetic origin directly related to the diamond growth. Chemical composition obtained from synchrotron X-ray fluoresncence analysis clarified that the nano-inclusions contain S, Cr, Mn, Fe, Co, Ni, Cu Zn, and so on. The present study suggests that the growth media of the superdeep diamonds are composed of sufilde melt.