# Cohenite (iron carbide) and native iron formation within garnet included in polycrystalline diamonds by redox freezing in the cratonic lithosphere

A. KRONZ[1], D.E. JACOB[2], P. CARTIGNY[3] AND K.S. VILJOEN[4]

[1] Geowissenschaftliches Zentrum der Universität Göttingen, Goldschmidt-Str. 1, D-37077 Göttingen, Germany (akronz@gwdg.de)

[2] Institut f. Geologie, F.L. Jahnstr. 17a, D-17487 Greifswald, Germany (djacob@uni-greifswald.de)

[3] Laboratoire de Géochimie des Isotopes Stables, I.P.G.P., Université Paris 7, 4, place Jussieu, 75252 Paris Cedex 05, France (cartigny@ipgp.jussieu.fr)

[4] DeBeers Geoscience Center, PO Box 82232, Southdale 2135, South Africa (fanus.viljoen@mhs7.tns.co.za)

Syngenetic garnet of eclogitic/pyroxenitic composition included in a polycrystalline diamond aggregate from the Venetia kimberlite, Limpopo Belt, South Africa shows multiple inclusions of spherules up to ca. 50 µm, consisting of 61±5 vol% $Fe_3C$ (cohenite), 30±2 vol% Fe-Ni and 9±3 vol% FeS (troilite). Troilite forms shells around the native iron-cohenite assemblage, implying that both compositions were immiscible melts and were trapped rapidly by the silicate. The oxygen fugacity of the metal-silicate system can be calculated using the mole fractions of Fe in metal and FeO in silicate and is 2.1 orders of magnitude below the iron-wustite oxygen buffer (IW) and is, thus, more reduced than the majority of samples from the subcratonic lithosphere. It is proposed that this polycrystalline diamond-silicate-metallic spherule assemblage formed by redox-freezing in the subcratonic lithosphere from a C-H-O fluid that reacted with surrounding silicate at about 1300°C. In a mantle fluid consisting of $CH_4>H_2O>H_2$ from a starting point near $fO_2$ =IW, $aH_2$ increases rapidly when carbon from the fluid is consumed by diamond precipitation, driving the oxygen fugacity of the system to lower values along the diamond saturation curve, reaching the stability field of cohenite. Water from the fluid induces melting of surrounding silicate material, and hydrogen reduces metals in the silicate melt, reflected by an unusually low Ni content of the garnet. $\delta^{13}C$ = -13.69 ‰ (PDB) and the lack of nitrogen as an impurity is consistent with formation of the diamond from abiogenic methane, whereas $\delta^{18}O$ = 7.4 ‰ (SMOW) of the garnet implies derivation of the silicate from subduction-related material. Hence, highly reducing conditions within the subcratonic lithosphere can be created locally by this process and do not necessarily call for involvement of fluids derived from subducted material of biogenic origin.

# Isotopic constraints on the origin of the Bushveld Complex magmas in a back-arc environment

F. JOHAN KRUGER

Hugh Allsopp Laboratory, Bernard Price Building, University of the Witwatersrand, WITS 2050, South Africa. Email: 106fjk@cosmos.wits.ac.za

Sr, O, Nd, Pb, Os, and Cl isotopic and concentration data indicate that the magmas of the Bushveld Complex contained variable proportions of crustal material *prior* to intrusion into the magma chamber. These magmas can be divided into three fundamentally different lineage's, a harzburgitic-noritic Lower and Critical Zone (L&CZ) lineage, a gabbronoritic Main Zone (MZ) lineage and a ferro-gabbronoritic Upper Zone (UZ) lineage. Petrological modelling using the available isotopic data indicates that these represent mixtures of different mantle and crustal provenance's.

Magmas with both high and low ***Sr concentrations and Sr isotopic ratios*** were injected into the magma chamber. $^{87}Sr/^{86}Sr$ ratios suggests that the first magma was less radiogenic (*c.* 0.7044) and that subsequent additions were more radiogenic (0.7085-0.7090).

The ***$^{18}O$*** characteristics of rocks from the whole stratigraphic extent of the Bushveld Complex indicates that there was a significant crustal content in the magmas higher in the succession and especially in the magma injected into the MZ. A strong positive correlation of very radiogenic $^{87}Sr/^{86}Sr$ initial ratios with the $^{18}O$ values also supports this model.

***Nd isotopic data*** indicate an upper mantle and old crustal sources, and the Sr/Nd relationship indicates an Archaean upper crustal source as the "contaminant" as Sr is highly radiogenic. The ***LREE enriched profiles*** can also be reconciled with this model.

***Pb isotopic data*** indicates that the L&CZ magmas have a lower to middle crustal imprint on a "CHUR" type source, whereas the imprint on the MZ is upper crustal which is also consistent with the other isotopic data.

***Os isotopic data*** on the chromitite layers and the Merensky reef indicate a substantial crustal signature in the upper CZ and lower MZ.

***Heavy $^{37}Cl$ and very high Cl/F*** *ratios* indicate a subducted altered ocean floor component.

Geochronological data on the Bushveld Complex and other cratonic rocks indicate that the c. 2.0 Ga Kheis-Magondi convergent tectonism and the Bushveld Complex are coeval. The combined isotope and chronological data outlined above indicate that the Bushveld Complex is a back-arc phenomenon related to that convergent tectonism, which subducted a significant proportion of Archaean upper crustal material into the source region of the Bushveld Complex magmas.