Ofioliti, 1999, 24 (1a), 111-112

DIAMOND FORMATION IN THE UPPER MANTLE: MICROCRYSTALLINE DIAMOND AGGREGATES (FRAMESITE) FROM THE VENETIA MINE, SOUTH AFRICA

Dorrit Jacob*, Emil Jagoutz** and **Fanus Viljoen*****

** Mineralogisch-Petrologisches Institut der Universität Göttingen, Goldschmidtstr.1, D-37077 Göttingen, F.R.G.*
*** Max-Planck Institut für Chemie, Abt. Kosmochemie, Saarstr. 23, D-55122 Mainz, F.R.G.*
**** DeBeers Geoscience Center, PO Box 82232, Southdale 2135, South Africa.*

ABSTRACT

Framesite as well as polycrystalline diamond (Gurney and Boyd, 1982) are recovered from kimberlites together with monocrystalline diamond. The diamond crystallites in these aggregates are typically in the micro- to millimeter range and can host interstitial inclusions of silicates and/or sulphides. The silicate inclusions compositionally cover the same range of harzburgite, lherzolite and wehrlite as do inclusions in monocrystalline diamonds, although harzburgitic compositions seem to be underrepresented (Smelova, 1995; Kirkley et al., 1995). $\delta^{13}C$ values are mostly very negative, which has led some authors to propose an origin from subduction of carbon-bearing sediments for these rocks (Kirkley et al., 1995).

We are currently studying a suite of Framesites from the Venetia kimberlite, situated within the Limpopo Belt off the northern edge of the Kaapvaal craton. The four specimens presented here bear eclogitic garnet ± sulphide inclusions with Mg-numbers between 57 and 70. Measured $\delta^{13}C$ values are between -15.6 and -22.9‰ which is within, but at the lower end of the variation found in Framesites from Orapa and Jwaneng (McCandless et al., 1989; Kirkley et al., 1995) and overlaps with the distribution found in eclogitic monocrystalline diamonds.

In a Sr-Nd isotopic plot (Fig.1) all four garnets plot close together with negative initial ε_{Nd} values between -15.86 and -21.67 and low $^{87}Sr/^{86}Sr$ ratios. This is widely separated from the fields for Group I and Group II kimberlites, but within the large variation observed for diamond-bearing eclogites and eclogitic diamond inclusions. In a plot of $^{143}Nd/^{144}Nd$ vs. $^{147}Sm/^{144}Nd$ the samples form a straight line yielding an apparent age of 124 Ma and an initial ε_{Nd} of +1.2. This "age", however, is younger than the age of the Venetia kimberlite (530 Ma) and therefore represents mixing relationships of components with different Sm/Nd- and $^{143}Nd/^{144}Nd$-ratios. The garnet with the most enriched isotopic signature (i.e. with the most negative initial ε_{Nd} value) has the highest Sm/Nd ratios and the highest Mg-number, whereas the most radiogenic garnet has the lowest Sm/Nd ratios and the lowest Mg-number.

Sm and Nd concentrations measured both by isotope dilution and Laser Ablation ICP-MS are identical within error for all but one sample, which was found to be inhomogeneous. This sample contains parts enriched in LILE, but most prominently in Sr which is up to 20 times higher than in the homogeneous main part of the same grain. The Sr-enrichment coincides with an enrichment in Nb, but not Ta, and a depletion in Zr, but not Hf, compared to the homogeneous parts. REE patterns are typical for garnet with depleted LREE and enriched HREE to about 50 times chondrite. No significant Eu-anomaly was detected. Spidergrams normalised to primitive mantle show a prominent negative Sr anomaly, Sr contents in these garnets (between 0.332 and 0.427 ppm) are at the lower end of Sr concentrations from eclogitic garnets from kimberlite worldwide.

Calculated equilibrium melts, using the partition coefficients of Zack et al. (1997) give very similar melt compositions for all four garnets which display positive anomalies for Nb, Ta, Zr, Hf and Ti compared to primitive mantle. The melt calculated from the enriched part in the fourth sample mimicks this pattern at higher LILE and LREE concentrations but has a much stronger positive Sr anomaly.

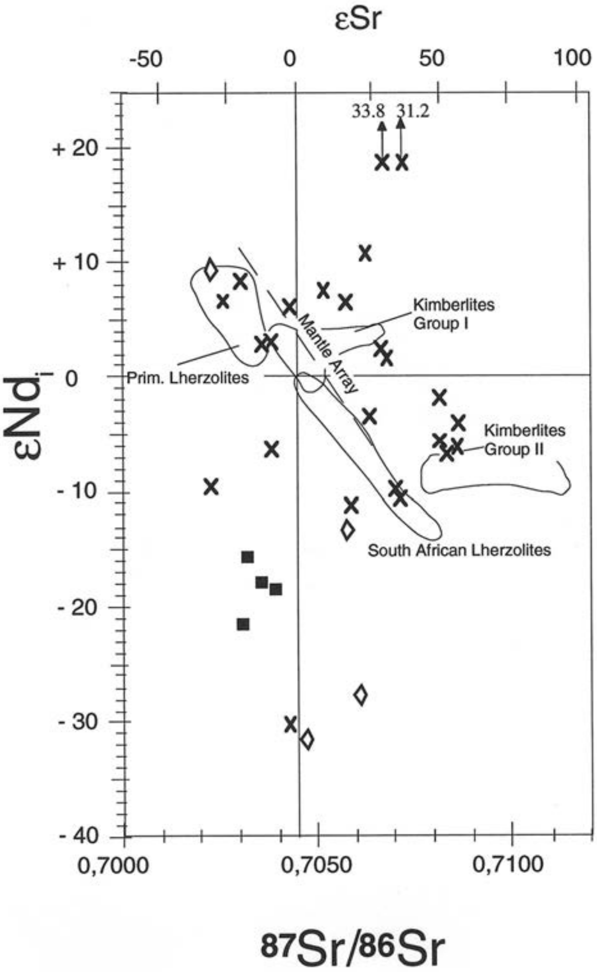

Fig. 1 - Combined Sr-, Nd- isotopic data for eclogitic garnets from Framesites (Black squares) compared to eclogitic cpx from diamond inclusions (diamonds) and diamond-bearing eclogitic xenoliths (crosses) worldwide. All data corrected for the time of emplacement of the respective kimberlite. The Venetia kimberlite is classified as a Group I kimberlite.

REFERENCES

Gurney J.J. and Boyd F.R., 1982. Mineral intergrowths with polycristalline diamonds from the Orapa Mine, Botswana. Carnegie Inst. Y. Book, p. 262-273.

Kirkley M., Gurney J.J. and Rickard R.S., 1995. Jwaneng Framesites: Carbon isotopes and intergrowth compositions. In: H. O. A. Meyer and O. H. Leonardos (Eds.), Diamonds: Characterization, genesis and exploration. CPRM Spec. Publ. 1/95: 127-135.

McCandless T.E., Kirkley M.B., Robinson D.N., Gurney J.J., Griffin W.L., Cousens D.R. and Boyd F.R., 1989. Some initial observations on polycristalline diamonds mainly from Orapa: Abstract. Ext. Abstr. 28th Intern. Geological Congress, p. 47-51.

Smelova G.B., 1995. The sequence of crystallization of different types of bort from Yakutian kimberlites and the conditions of their formation. Ext. Abstr. 6th Intern. Kimberlite Conf., p. 538-540.

Zack T., Foley S. and Jenner G. 1997. A consistent partition coefficient set for clinopyroxene, amphibole and garnet pyroxenites from Kakanui, New Zealand. N. Jb. Miner. Abh., 172: 23-41.