A DIAMOND-GRAPHITE BEARING ECLOGITIC XENOLITH FROM ROBERTS VICTOR – INDICATION FOR PETROGENESIS FROM Pb, Nd, AND Sr ISOTOPES.

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The 8.6 kg eclogitic xenolith "Rovic 124" is the largest known diamond-bearing xenolith. It consists of three different zones A1, A3 and A6, which are distinguished in colour as well as in mineral composition and which confirm a complex history of this rock.
All zones show subhedral or rounded garnets in an interstitial matrix of cpx and can be classified as Group I according to the classification for Roberts Victor eclogites by Macgregor and Carter (1970) or as Type A according to Jagoutz et al. (1984). Zone A1 and A3 are of normal eclogitic petrography with about equal amounts of cpx and gnt,while zone A3 contains a small amount of graphite. The Graphite is flaky and shows no pseudomorphosis after diamond. Zone A6 consists of more than 90 Vol% garnet and is rich in diamond. Diamond occurs in various shapes and sizes and is only interstitial, sometimes surrounded by phlogopite which occurs along cracks in all three zones (very small amounts in zone A1).

The garnets of Rovic 124 plot in the fields of group B and group A eclogites in the Ca-Mg-Fe plot of Coleman et al. (1965) and show a grospyditic trend; zone A6 having the highest (up to 10.2 % CaO) and zone A1 the lowest (up to 5 % CaO) Calcium-concentrations.Applying the cpx-gnt thermometer by Ellis and Green (1979), zone A1 yields a temperature of 1133°C.

The trace element concentrations in the different sections vary between 1 (A1 gnt) and 5 ppm (A1 cpx) Nd, 0.45 (A6 cpx) and 1.8 ppm (A6 gnt) Sm and 2.5 (A4 gnt) and 137.1 ppm (A1 cpx) Sr. Lead concentrations lie between 49 (A3 cpx) and 523 (A1 cpx) ppb. The partition coefficients for Nd, Sm, Sr and Pb between clinopyroxene and garnet give a systematic trend, where zone A1 shows the highest and zone A6 the lowest D:

Zone	D_{Nd}	D_{Sm}	D_{Sr}	D_{Pb}
A1	5.10	1.45	47.00	2.86
A3/A4	1.06	0.42	43.90	1.10
A6	0.65	0.27	3.34	0.18

The Phlogopite contains 64 ppm Sr, 0.54 ppm Sm, 3.34 ppm Nd and 1076 ppb Pb. It is clearly of metasomatic origin judging by its occurrence along cracks in the nodule.
Fe^{3+}/Σ Fe ratios as obtained from microprobe analyses of garnet in the different zones seem to be variable.

The Sr isotopic composition are different in clinopyroxenes of the different layers which the Rb content can not account for. It is suggested that the variations in Sr isotopes are a remanent of a layered protolith.
The neodymium isotopes yield yong internal mineral ages for the different sections, although the trend of zone A1 being the youngest and zone A6 being the oldest is visible. Zone A1 equilibrated at the time of eruption of the kimberlite (124 Ma, Allsopp and Barret (1975)) and yields an age of 168 Ma ± 52. The small amount of metasomatic phlogopite in this zone in comparison to the much higher amounts in other zones indicates that the phlogopite might have reacted out at the time of the resetting of the minerals in this zone. The Nd internal age is much younger than the one obtained from lead isotopes (363 Ma), but the datapoints lie on or close to the 2.75 Ga isochron which is defined by clean whole rock compositions of diamond-free eclogites from Roberts Victor (Jagoutz et al. (1984)) (Fig.2).

In Lead isotopes (Fig.1), the datapoints of Rovic 124 form a well defined linear array on the left side of the geochron which intersects at $\mu = 8.3$. The range of the ratios observed is large and covers about half of the range observed for several different nodules from Roberts Victor measured by Jagoutz and Zindler (in prep.).The age of the array is 2.98 Ga. Some of the datapoints (A6 gnt, A3 gnt and Phlog.) lie close to or in the field defined for Group II

Kimberlites (Smith et al. (1985)) which is interpreted as influence of the kimberlite on the eclogite during eruption.

There are basically two possible explanations for the observered heterogeneities in Rovic 124:

(i) A likely explanation for the layering is a primary origin:
A layered protolith of basaltic composition and rich in carbon, e.g. oceanic basalt with carbon bearing sediment layer(s), was subducted under the African craton. During subduction all carbon was transformed to diamond. Some part of the diamonds then formed flaky graphite, e.g. due to shearing or uplift along the diamond -graphite stability boundary.
This hypothesis is supported by the Sr isotope compostion which account for primary differences in Rb content of the layers prior to subduction.

(ii) The layering could have been produced by metamorphic reactions, induced by a fluid front. This fluid front penetrated zone A1, reduced its trace element content and equilibrated cpx and gnt in their Nd isotopes; any existing diamond would be reacted out. In zone A3 the reaction with the fluid was not complete.This resulted in a partial equilibration of cpx and gnt, yielding an "age" and an amount of trace elements intermediate between the ones for zone A1 and A6, and reducing the carbon content, leaving some graphite behind. Zone A6 was not reached by the fluid front and retains its original mineralogy and chemistry. Against this theory is the fact that the existing graphite does not show pseudomorphosis after diamond. Also the distribution of phlogopite is inverse to the one expected from an entry of the fluid front at zone A1.

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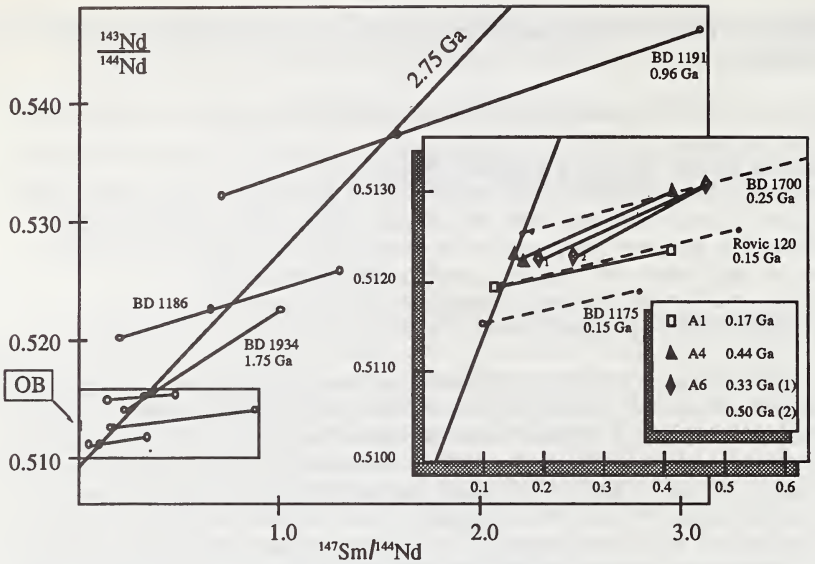

Fig.1: $^{147}Sm/^{144}Nd$ versus $^{143}Nd/^{144}Nd$ plot shows the 2.75 Ga isochron, defined by "clean whole rocks" of non-diamondiferous xenoliths from Roberts Victor. Open circles are cpx and gnt respectively, closed circles are calculated whole rock compositions. Inset shows isochrons and internal ages for Rovic 124. Age (1) for layer A6 is a clean cpx, age (2) is a ultraclean separate from the same cpx split.

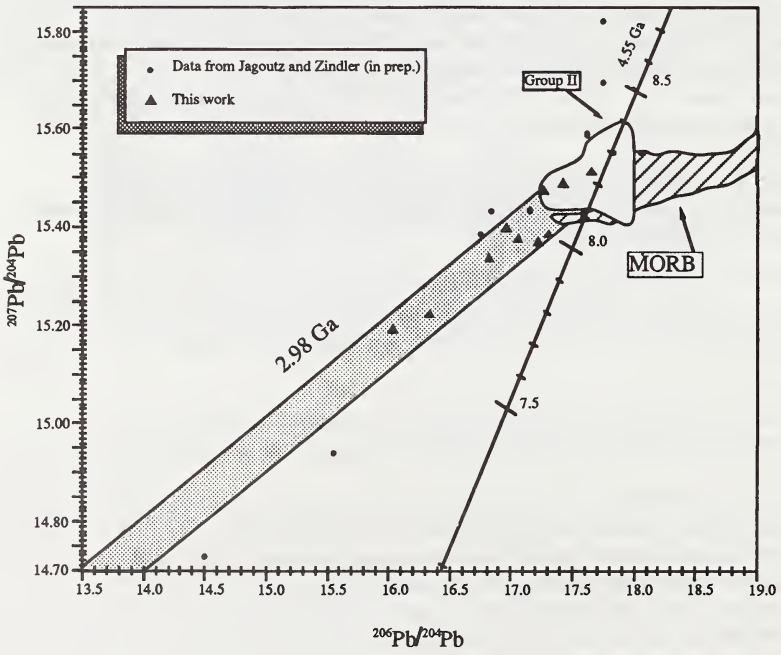

Fig 2: In a $^{207}Pb/^{204}Pb$ versus $^{206}Pb/^{204}Pb$ plot the Rovic 124 data forms a linear array, yielding an age of 2.98 Ga. Geochron and fields for Group II Kimberlites and MORB shown for reference.