Since the predominant diamond inclusion is peridotitic and the rarer eclogitic inclusions are chemically discrete from the xenoliths this study suggests that most of the diamonds at Roberts Victor are not derived from disaagregated eclogite. Some could be related to rare garnet peridotite and chromite peridotite also described by Hatton (1978).

A7

INCLUSIONS IN DIAMONDS FROM EASTERN KASAI, ZAIRE.

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Zaïre is probably the major diamond producer outside the USSR and Australia yet little is available in the scientific literature concerning the mineralogy and geochemistry of kimberlites, diamonds and associated xenoliths Probably this lack of information is due to the fact that the major portion of the diamond output of Zaïre is industrial grade material. Nevertheless,the geographic position of Zaïre in the central part of southern Kapvaal craton,which has received much attention, makes it an important locality for mantle and related studies. Accordingly, a preliminary investigation of diamond inclusions, megacrysts and xenoliths has been undertaken from Mbuji Mayi and Tshibua in Eastern Kasaï, Zaïre.

About 200 diamonds from Eastern Kasaï were examined for mineral inclusions. Olivine, garnet, cpx,kyanite, rutile, zircon, chromite, ilmenite, pyrrhotite, diamond and bimineralic assemblages garnet+cpx are recorded as primary inclusions. Goethite, graphite and hematite are probably epigenetic while quartz is of uncertain origin.

In contrast to many localities, olivine is not an abundant mineral in the diamonds selected. No enstatite is recorded.
Instead garnet and cpx are the most abundant silicates in these samples. Both these latter belong to either lherzolitic or eclogitic suites. The first occurrence in the world of jadeitic cpx as inclusion in diamond is recorded. Jadeitic cpx, kyanite and diamond outline a new paragenetic suite for inclusion called "kyanite eclogite", "grospydite" or "diamond eclogite". Pyrrhotite with fine intergrowths of pentlandite(?) forms the most abundant inclusion in the examined diamonds.

A8

THE ABUNDANCE, MINERALOGY AND CHEMISTRY OF SULPHIDE INCLUSIONS IN DIAMONDS

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A study of the abundances of sulphide inclusions in diamond has enabled a detailed electron microprobe examination of these minerals to be completed as part of a general evaluation of this impurity in natural diamonds from worldwide occurrences. The work has concentrated on sulphides in diamonds from specific southern African kimberlites (e.g. Premier, Finsch, Jagersfontein, Orapa, Roberts Victor), but sulphide inclusions in diamonds from kimberlites in Sierra Leone and in East Africa are also reported.

Inclusion abundance tables show that sulphides are often the commonest mineral type (over 40%). The iron-nickel sulphide minerals identified are monosulphide solid solution, pyrrhotite, pentlandite, pyrite and heazlewoodite, and copper sulphides, chalcopyrite, cubanite and probably cubanite solid solution. A wide variety of mineral assemblages have been found within the polished mounts of single inclusions of sulphide, several being specific to diamonds from specific kimberlites (e.g. the m_{ss} assemblages from the Koffiefontein mine.) Some chemical features of these minerals are:- (i)m_{ss}:- variable Fe/Ni+Co ratio (15.0-1.3) with majority of data clustering about 6.6, (ii)po:- typically contains 0.2-0.5 at.% Ni+Co with 0.1 at.% Cu, (iii)pn:- invariably nickeliferous (26.5-30.0 at.% Ni+Co)with 0.1-0.2 at.% Cu, (iv)cp:- close to stoichiometry approx. 0.1 at.% Co, variable Ni (0.02-0.06at.%), (v)py:- few good analyses but seems to be Cu-enriched (0.2-0.3 at.%) with 1.2-1.5 at.% Co and 0.02-0.06 at.% Ni, (vi)cb:- analyses cluster around cb with >1.0 at.% Ni+Co.

The sulphide mineralogy is linked to both the 'peridotitic' and 'eclogitic' growth environments of diamond and these results provide information about sulphide geochemistry in the Earth's upper mantle and is the case of Koffiefontein data on the emplacement history of this kimberlite.

A9

SILICATE AND OXIDE INCLUSIONS IN DIAMONDS FROM ORAPA MINE, BOTSWANA.

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In approximate order of decreasing abundance sulphides, garnet, clinopyroxene, chromite orthopyroxene and olivine occur as inclusions in Orapa diamonds. One coesite has been identified. Except for the olivines (Fo_{92-94}), the common minerals show a wide range in chemistry; from a low calcium, high Mg, harzburgitic assemblage (ol,opx$\pm$gar$\pm$chr); an inferred small lherzolite field; a websterite field (opx,cpx,gar$\pm$chr.); an eclogite field (cpx,gar)terminating with high calcium garnets and jadeitic clinopyroxenes typical of kyanite eclogite. Chromium shows a positive, and sodium a negative correlation with MgO. Potassium in clinopyroxene ranges unsystematically up to 1.2 Wt.% Orthopyroxene and clinopyroxene buffer the calcium content of garnet. Calcium enrichment of garnet only occurs in the absence of opx, and calcium depletion only in the absence of cpx. Mineral compositions in single diamonds and tie lines for co-existing phases indicate that inclusions approximate equilibrium assemblages. Geothermometry tentatively suggests T of formation within an interval of 150°C and close to 1150°C. The inclusions are restricted to an iron rich sector of the overall eclogite xenolith field although xenoliths outside the inclusion field can contain diamonds. The websterite field is expanded in the diamonds relative to the xenoliths.

The inclusion suite is unusual for southern Africa because (i) Eclogitic and websteritic mineral compositions predominate over peridotitic by more than 10:1 (ii) There is no readily apparent compositional gap between the peridotitic and non-peridotitic associations (iii) The orthopyroxenes have a wide range in Mg/Fe ratio and (iv) Chromites are relatively common.

A10

THE RELATIONSHIP BETWEN INCLUSION COMPOSITION AND CARBON ISOTOPIC COMPOSITION OF HOST DIAMOND

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The ^{13}C content of the diamonds from the Premier and Fisch kimberlite is not related to diamond shape, color, state of deformation, type of mineral or the type of mineral paragenesis included. For the Premier mine it could be demonstrated that inclusion containing and inclusion free diamonds have the same mean $\delta^{13}C$ value. However, an isotopic composition difference between diamonds from Premier and Finsch kimberlites is observed, and in both occurrences there is a distinct association of diamonds of higher ^{13}C contents with inclusions low in SiO_2 (olivine, eclogite suite garnets and clinopyroxenes), Al_2O_3 (orthopyroxenes, peridotite suite garnets, eclogite suite garnets and clinopyroxenes), Cr_2O_3 (olivine, orthopyroxene, peridotite suite garnets, eclogite suite clinopyroxenes), MgO and Mg/(Mg+Fe), (clivines, orthopyroxenes, peridotite suite garnets, eclogite suite garnets), Na_2O, K_2O, TiO_2 (eclogite suite clinopyroxenes) and high in FeO (olivines, orthopyroxenes, and peridotite suite garnets), CaO (peridotite suite garnets, eclogite suite garnets and clinopyroxenes) and Ca/(Ca+Mg) (eclogite suite garnets and clinopyroxenes). Mg-Fe partitioning between ultramafic suite minerals occluded by the same diamond indicates higher pressure and temperature conditions of equilibration for diamonds with $\delta^{13}C$ larger than -4 o/oo and essentially peridotite subsolidus conditions for those with lower $\delta^{13}C$ values. For eclogite type inclusions, equilibration conditions in excess of 1100°C and 140 km depth are deduced and no further separation of carbon isotopic composition according to equilibration conditions was observed. The data are interpreted to indicate that in the mantle zones exist in which the average $\delta^{13}C$ value of carbon is above -4 o/oo and that these zones lie below about 140 km depth

A11

DIAMOND AND GRAPHITE ECLOGITE FROM ORAPA

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Orapa eclogite xenoliths are unique for the relative abundance of diamond eclogite (~0.7%) and graphite eclogite (~4.6%). The diamonds closely resemble mine production in colour, the common presence of interpenetrant twins and of aggregates. They differ in that octahedral growth forms are well preserved. The graphite is euhedral and tabular.

Mineral analyses confirm previous studies that diamond eclogites have a wide range of compositions. They tend to be calcium rich compared to inclusions in Orapa diamonds. There is only minor overlap of the two fields. The large garnet websterite field in the diamonds is rare in the diamondiferous rocks. Framesite minerals are contrastingly common in this region of the incl usion field. Minerals intergrown with coarser grained polycrystalline aggregates of diamond are more frequently similar to diamond eclogite minerals. This suggests slower growth is associated with calcium rich eclogite minerals.

Clinopyroxene in diamond from an eclogite is markedly less jadeitic than clinopyroxene in the host rock. This and other observations in mineral inclusions suggests the formation of the magnesian eclogites before the high iron and calcium types.

Graphite eclogites form two chemical groups, one with garnets of high Mg/Fe similar to garnet websterite xenoliths; the seond larger group form a narrow compositional band across the diamond eclogite field chiefly the result of a wide variation in Ca/Fe ratio.

Attempted application of the Ellis and Green (1979) geothermometer fails to account for the observed distribution of carbon phases as a temperature effect.

Ref : Ellis, D.J. and Green D.H. (1979) Contrib. Mineral Petrol. 71, 13-22.