

A significant proportion of the C in nearly all samples is removed by acid-washing. The soluble fraction must reside on grain boundaries and is presumed to be carbonate. In samples collected from environments in which caliche is present, carbonate contamination from meteoric sources is suspected. In others, carbonate probably also originated by post-eruptive redistribution of C from host lavas.

Most acid-washed Cr-diopside spinel lherzolites contain 10-40 ppm (by wt.) total C. These concentrations are considerably lower than those determined from previous analyses. The range in C contents of four Al-augite pyroxenites is 40-80 ppm, and one of the amphibole-phlogopite-apatite-spinel lherzolites from Nunivak Is., Alaska contains 85 ppm C.

The average C:CO₂ ratio for all samples is 0.06. Assuming that elemental C results from the reaction $2CO \rightarrow C + CO_2$, then the vapor from which C precipitated consisted of ~30 mole % CO.

A4

DIAMOND CHARACTERISTICS OF THE DE BEERS POOL MINES, KIMBERLEY, SOUTH AFRICA

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Diamonds from the four operating mines at Kimberley (Bultfontein, De Beers, Dutoitspan, Wesselton), have been examined using a classification scheme which quantifies, as a function of specific diamond size classes, such physical characteristics as crystal form, colour, ultra-violet fluorescence, and plastic deformation. In addition, from a single size class, the relative abundances of syngenetic silicate, oxide and sulphide minerals in the diamonds have been determined.

The results from the classification indicates that, in general, there is usually <10% variation in the proportion of primary crystal forms between the four mines, although secondary crystal forms show more pronounced variations. Diamond colour is broadly similar for the four mines but the proportions of the principal colours (colourless, yellow, brown) are distinctive at each mine. The numbers of fluorescent diamonds are typically low, levels varying between 5-10% in the small sizes to 20-40% among the larger stones. The principal fluorescent colour is weak blue, other minor colours being strong blue, green, orange and yellow. Blue and strong blue fluorescence are distinctive for diamonds from De Beers and Wesselton, respectively. Plastic deformation levels for the four mines are also distinctive but levels are independent of diamond size. Inclusion studies indicate that the diamonds from all four mines have a dominant (90% plus) 'peridotitic' paragenesis, with a particularly high chromite inclusion content.

Differences in characteristics can separate diamonds from the four Kimberley mines, but those characteristics which can reasonably be associated with diamonds' formation are closely similar, which is compatible with the Kimberley diamonds being derived from a single diamond population.

A5

A TRANSMISSION ELECTRON MICROSCOPY STUDY OF OLIVINE INCLUSIONS IN DIAMOND

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Olivine inclusions in elasticity isotropic diamond (cubic anisotropy factor $A = 2C_{44}/C_{11} - C_{12} = 1.54$) have been studied with a view to obtaining information about olivine dislocation substructure under mantle conditions. Olivine inclusions 0.05- 0.3 mm in diameter have been extracted by combustion from a diamond from the UDACHNAYA pipe, Yakatia, USSR. Individual inclusions have been mounted on cooper grids and ion thinned at 5 KV for T.E.M. examination in a JEOL microscope at 120 KV.

A low dislocation density of less than 10^4 cm^{-2} is observed. To obtain the maximum information from the few dislocations observed, the dislocation images have been recorded under diffracting conditions of $g \cdot b = 0, 1, 2$ where g is the diffracting vector and b is the Burgers vector. Straight mixed free dislocations are present with both $\{001\}$ and $[100]$ Burgers vectors. Heated fractures on the (010) plane are observed with $[100]$ loops and $\{001\}$ straight dislocations.

The above observations are consistent with the low stress and high temperatures thought to prevail in the mantle. No evidence of a subsequent high stress crustal deformation is observed.

A6

THE ABUNDANCE AND CHEMISTRY OF MINERALS ASSOCIATED WITH DIAMONDS AT ROBERTS VICTOR MINE

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A study of minerals in diamonds has shown that their abundance and chemistry are at gross variance with the xenolith mineralogy at the Roberts Victor Mine. The latter is >95% eclogitic.

Olivine and associated minerals predominate (~85%) in diamond. The most abundant paragenesis is harzburgitic (ol, opx, ±chr, ±gar). There is a small garnet lherzolite field (+cpx). The above minerals are similar to peridotitic inclusions world wide; (high Mg/Fe, Cr₂O₃, low CaO). An exception is that opx usually has a higher Al₂O₃ (>1wt%) and Cr₂O₃ (>0.5wt.%). Two gar/ol pairs give high equilibration temperatures >1300°C, but a cpx (Ca/(Ca+Mg)=0.45) probably equilibrated at ~1100°C.

Eclogitic gar and cpx are subordinate (~15%) to peridotitic inclusions. Sulphide occurs in both associations and a single feldspar of presumed eclogitic affinity is the only other mineral found in 166 diamonds.

There is a large compositional gap between the peridotitic and eclogitic inclusion minerals. The latter are characterised by high Fe/Mg, TiO₂, Al₂O₃, CaO, Na₂O and K₂O and by lower Cr₂O₃. The garnets are ~65% almandine, and fall outside the compositional field for Rovic eclogite (Hatton 1978). The cpx show a positive MgO/Cr₂O₃ correlation; negative for MgO/Al₂O₃, MgO/Na₂O and MgO/K₂O.

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 disaggregated eclogite. Some could be related to rare garnet peridotite and chromite peridotite also described by Hatton (1978).

A7

INCLUSIONS IN DIAMONDS FROM EASTERN KASAÏ, 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 biminerale 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", "grosopydite" 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 (0.02-0.06 at.%), (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 (Fog₂₋₉₄), 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.