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Diamonds

A1 SOME OBSERVATIONS RELEVANT TO THE FORMATION OF NATURAL DIAMONDS

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Apparent old ages for some diamonds in cretaceous kimberlite support a non-cognate diamond paragenesis. Calculated equilibrium conditions for peridotitic inclusions in diamonds closely match those for coarse peridotite xenoliths in Kimberlite, though the latter rarely contain diamonds. The P/T estimates lie close to calculated shield geotherms and the peridotite solidus. The lowest temperatures for inclusion pairs imply sub-solidus crystallisation. In contrast observations of growth spirals on octahedral diamonds and of poly crystalline nuclei inside diamonds favours metamorphic or igneous growth. He isotopic ratios favour a mantle origin and argue against subduction models.

The release of diamond into kimberlite by disaggregation of xenoliths may sometimes be important but in general neither the relative abundance nor the chemistry of diamond inclusions correlates well with mantle xenoliths found at a specific locality. Most inclusions in diamonds have a harzburgitic paragenesis with distinctive mineral chemistry compared to peridotite xenoliths. Macrocryst minerals in diamondiferous kimberlite fill the compositional gap between the inclusions and coarse grained xenoliths. This does not fit a simple disaggregation model.

Whilst the peridotitic and eclogitic inclusion parageneses have often been regarded as discrete processes their ubiquitous association and their compositional continuity at some localities suggests a related origin.

Some of these observations are irreconcilable so that neither primordial mantle, nor mantle melting nor crustal subduction models are entirely convincing, leaving the relationship of diamond to kimberlite unresolved.

A2 THE GENESIS OF DIAMOND

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During the last decade or so a large amount of information pertaining directly or indirectly

to the formation of diamond in nature has become available. The numerous studies of the mineral chemistry of xenoliths in kimberlite, as well as the studies of kimberlite and of inclusions in diamond provide the bulk of the information.

Early chemical analyses of inclusions in diamonds indicated the overall similarity of mineral types from worldwide localities and differing geological ages. However, the most important aspect of the early studies was the recognition that diamonds form in two geochemically distinct environments - one ultramafic and one eclogitic. This simple division although still valid in a general way, needs modification in the light of recent observations of inclusion chemistry and diamond occurrence. It appears most likely that within the upper mantle carbon is in the form of diamond and that this latter mineral can exist in several rock types within the broad subdivision of eclogite and ultramafic types.

The occurrence of diamond in kimberlite or other rock types is due to the speed and mode of transportation of the diamond to the earth's surface and thus it is highly unlikely that diamond is a phenocryst in kimberlite.

A3 ABUNDANCES OF CARBON IN MANTLE XENOLITHS FROM ALKALIC BASALTS

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In mantle xenoliths from volcanic rocks, C exists as CO₂ in fluid inclusions and as an elemental form in microcracks and on inclusion walls. Carbonate is usually present as well and is generally believed to have been introduced after eruption. Both absolute amounts of C and relative abundances of its various forms were determined in a suite of representative xenoliths. Interior portions of samples were crushed to coarse (<1.4 mm) fragments, washed in cold 1N HCl, and fused with a flux. Fusion in an oxidizing atmosphere liberated all elemental C and vapor as CO₂, which was then determined by titration. In contrast, only vapor was liberated from samples fused in a reducing atmosphere. A similar procedure was followed for unwashed samples.