ORIGIN OF DIAMONDS OF PERIDOTITIC AND ECLOGITIC PARAGENESES

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Syngenetic mineral inclusions in diamonds provide the best means for determining their age and origin. Among such inclusions, the peridotitic paragenesis of olivine, orthopyroxene and purple subcalcic chrome-pyrope garnet is on average far more abundant than the eclogitic paragenesis of orange pyrope-almandine garnet and pale green omphacitic clinopyroxene.

Subcalcic garnet inclusion bearing diamonds and related heavy mineral concentrate garnets from the ~100 Ma old Kimberley and Finsch kimberlites in southern Africa were previously shown to have originated in residual yet trace element enriched lithosphere beneath the Kaapvaal craton ~3300 Ma ago (Richardson et al 1984). Comparable Sm-Nd and Rb-Sr isotopic data have been obtained for subcalcic garnets in two diamondiferous megacrystalline harzburgite-dunite xenoliths (Uv402 & Uv727) and a similar albeit modally non-diamondiferous specimen (Uv49/76) in the suite described by Pokhilenko et al (1977) from the ~350 Ma old Udachnaya kimberlite in Yakutia. These data (Fig.1) are consistent with a similar origin and Archaean age for diamonds of peridotitic paragenesis from the Siberian and Kaapvaal cratons. The significant xenolith preservation potential of the Udachnaya specimens relative to their disaggregated southern African counterparts may be attributed to minor physico-chemical differences possibly correlated with the time-integrated Rb/Sr ratio of their enriched lithospheric hosts. Thus, the dominant peridotitic diamonds and their host rocks have been stored in the subcontinental lithosphere at depths of 150-200 km and temperatures of 900-1200°C (Boyd & Finnerty 1980; Boyd et al 1985) for more than 3000 Ma, surviving convective disruption and remaining available for episodic sampling by kimberlite.

At a few localities such as the Premier kimberlite in southern Africa and the Argyle lamproite in northwest Australia diamonds of eclogitic paragenesis predominate, allowing recovery of sufficient material for complementary isotopic analysis. At Argyle and with greater difficulty at Premier, a distinction within the eclogitic garnet inclusion population can be made between deep orange garnet, which may be paired with pale green clinopyroxene, and pale orange garnet which has no obvious clinopyroxene complement. Deep orange garnet and pale green clinopyroxene inclusions in Premier diamonds yield a Sm-Nd isochron age of 1150 ± 60 Ma (Fig. 2). This coincides with the preferred host kimberlite age of 1180 ± 30 Ma (Smith 1983; Jones 1984) as well as a model Pb age of ~1200 Ma for sulphide inclusions in Premier diamonds (Kramers 1979). The corresponding result for the same eclogitic inclusion mineral pair in Argyle diamonds is 1580 ± 60 Ma (Fig. 2). This age is a few hundred Ma greater than the host lamproite emplacement age of ~1130 Ma (Skinner et al 1986) and closer to the ~1800 Ma age of stabilization of the surrounding Halls Creek mobile zone (Atkinson et al 1984). While this indicates that Argyle eclogitic diamonds are xenocrysts in the host lamproite, it does not preclude an original phenocrystal relationship with related small-volume mantle magmatism ~500 Ma earlier and subsequent lithospheric storage. In contrast, there is no resolvable time difference between Premier eclogitic diamond crystallization and host kimberlite emplacement. Eclogitic diamond inclusion chemistry, ages and precursor isotopic signatures indicate a second genetically distinct origin of diamonds apparently related in time and space to mantle magmatism of kimberlitic or lamproitic affinity.

ACKNOWLEDGMENTS

I wish to thank De Beers Consolidated Mines Ltd. and in particular J.B. Hawthorne, J.W. Harris, J. Scott, A. van Niekerk and V. Anderson for diamond specimens and support; N.P. Pokhilenko and A.J. Erlank for xenolith specimens; S.R. Hart for analytical facilities at MIT and C.J. Allegre for support at IPG.

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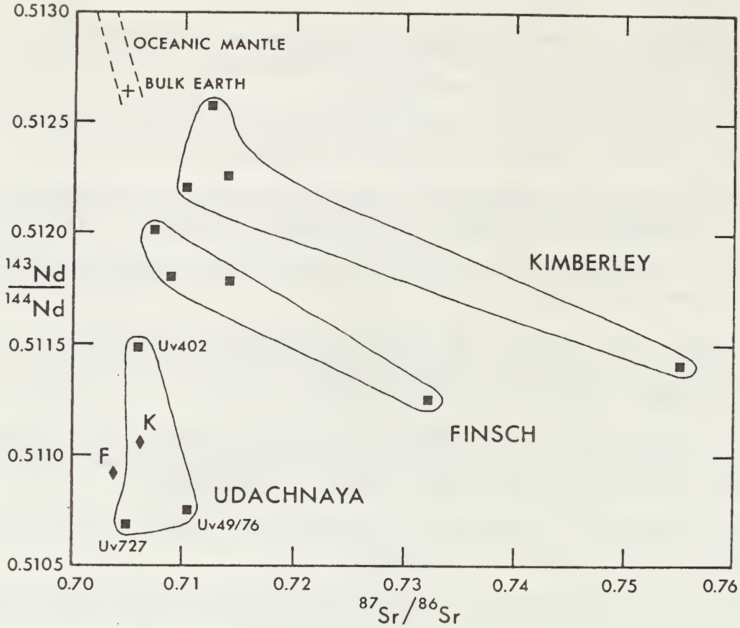

Fig. 1 Nd-Sr isotope correlation diagram for subcalcic garnets in diamondiferous harzburgite-dunite xenoliths from the Udachnaya kimberlite. Data for similar peridotitic garnets in Kimberley (K) and Finsch (F) diamond inclusions (diamond symbols) and heavy mineral concentrates (squares) are from Richardson et al (1984).

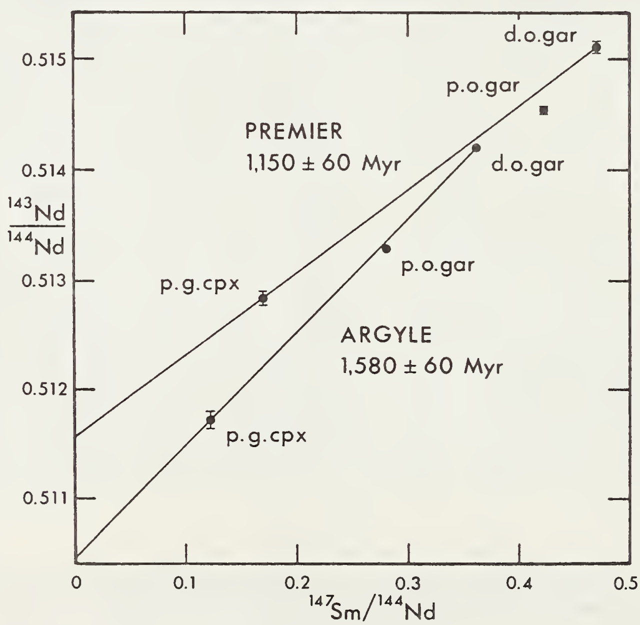

Fig. 2 Sm-Nd isochron diagram for eclogitic garnet and clinopyroxene inclusions in Argyle and Premier diamonds. Ages are for deep orange garnet - pale green clinopyroxene pairs.