ANOMALOUS HOSTS, UNUSUAL CHARACTERS AND THE ROLE OF HOT AND COOL GEOTHERMS FOR EAST AUSTRALIAN DIAMOND SOURCES.

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Eastern Australia is an enigmatic diamondiferous region. Unlike the southern and western Australian cratonic provinces. it lacks obvious kimberlitic or lamproitic sources. Mining has largely recovered diamonds from alluvial deposits, usually from leads under basalts. There are separate diamond provinces in which stones show different morphological, inclusion, carbon isotope and nitrogen aggregation characteristics. Some alluvial diamonds show so little abrasion that nearby sources are indicated. Known volcanic hosts are basaltic rocks not normally associated with diamonds. The abundant diamond type (Copeton, NSW) is distinct from most other diamond suites.

The concentration in northern NSW (Copeton, Bingara. Walcha) mostly shows rounded, resorbed multiply twinned crystals. Inclusions are notably coesite and an unusual calc-silicate suite. The $\delta^{13}C$ values are dominantly heavy (-3.3 to +2.4°/oo) and N contents (up to 1200ppm) commonly aggregate to show relatively high % of A defects. The data points to a parent of sedimentary or sea water modified character, which entered diamond facies conditions in the lithosphere probably before the early Palaeozoic. Six diamonds came from tholeiitic dolerite forming dykes in late Carboniferous granite and are probably a contaminant, being accompanied by accessories typical of granite contact suites. They could come from older deep leads or late Carboniferous basal beds below the granite contact. Late Cretaceous (c.70Ma) tholeiites and laterites occur in New England and diamonds under lateritised basalt (Inverell) suggest pre-Cainozoic sources. Diamonds related to a 36Ma alkaline dyke in Silurian (?) metamorphics at Walcha suggest underlying sources within the fold belt.

Diamonds in Airly Mt. deep leads (pre-41Ma) are octahedra and rounded forms. They contain coesite and have $\delta^{13}C$ values (-3.8 to -9.8°/oo; N.V. Sobolev, comm.) typical of the range for both peridotitic and eclogitic paragenesis. Diamonds from Rocky River, between Walcha and Copeton, are octahedra.

Pale zircons found with diamonds at Airly Mt., Bingara and nearby breccia pipes range in uranium contents (50-600 ppm U) and yield Jurassic to Triassic ages (130-240Ma). Elsewhere (Tolmie, Gundagai, New England, Brigooda, central Queensland gemfields, Cooktown) large zircons with low U contents typical of kimberlitic zircons (<30ppm) are found with breccia pipes or in gem alluvial deposits (some diamondiferous). These zircons range from late Tertiary to Cretaceous ages (3-107Ma).

Studies of mantle xenoliths from Mesozoic-Tertiary volcanics using new thermobarometry (Brey & Kohler) show 'hot' geotherms, some as hot as any recorded, existed in eastern Australia at various times. However variations in the thermal gradients suggest that lower gradients were linked to limited deep melts in the Mesozoic. The high Cainozoic gradients may represent restricted perturbations caused by magma ponding and need not affect the diamond graphite transition at depth.

Analysis of the Mesozoic-Cainozoic intraplate volcanism suggests episodic surges related to rifting and subsequent hot spot activity. A new concept of 'boomerang' volcanism proposes migratory flare ups from incipient deep undersaturated melting develops into major silicic crustal magmatism then dwindles back to minor amounts of deep melting. The 'boomerang' tips and beyond have potential for leucititic and nephelinitic melts, approaching lamproitic and kimberlitic activity, to tap any existing diamond zone. Even during thermal rifting, flood basalt or hot spot activity (Tasman Cretaceous margin, Tasmanian Jurassic dolerites, Cainozoic central volcano migration) the thermal effects were probably laterally localised or intermittent so that cooler geotherms could co-exist elsewhere. An example from southern Australia is Jurassic tholeiite on Kangaroo Island contemporaneous with diamond-bearing kimberlites 350km away at Terowie.

Cooler geotherms were probably most widespread in interior east Australia in the Cretaceous interval between the major hot spot episodes, linking into ages of some low-U zircons and apparent initial exposures of sources of alluvial diamonds. Diamonds appearing at basaltic centres which only carry mantle xenoliths from PT regions lying well above the normal diamond stability zone can be explained by:

(1) blasts of degassing from the diamond zone; or
(2) intersection of diamond sources already emplaced at higher levels (older kimberlites or peridotite bodies).

Diamonds can survive greenschist metamorphism and the unusual Copeton diamonds are located in a tectonically complex fold belt, which includes ophiolitic bodies. An older lithospheric source for these diamonds may be related to widespread subduction events of Cambrian or earlier age suggested by various lines of isotopic evidence on Tasmanian, Victorian and New South Wales igneous and xenolith suites.

The east Australian diamond province is unusual and its detailed study provides scope for some interesting solutions for locating its diamond sources. The mantle isotopic characteristics, and high geotherms recorded from Tasmania suggests that this area is the least prospective for diamonds within eastern Australia in post Triassic igneous provinces.

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FIGURE CAPTIONS: (a) Distribution of reported alluvial diamonds and diamond-bearing pipes and dykes, eastern Australia, shown in relation to the main topographic divide. The distribution of the unusual Copeton diamond type (Sobolev, 1984) is shown in relation to the more usual Airly Mt. diamonds. Low U zircon finds are also indicated.

(b) Pressure-temperature section, east Australia-Antarctica showing PT fields derived from lower crust-upper mantle xenolith suites in Mesozoic-Cainozoic basaltic rocks, based on Brey & Kohler (1990) geothermometer barometer estimates on garnet - 2 pyroxene analyses in the literature and authors unpublished data. The position of the spinel/garnet lherzolite transition (Spl/Gnt) is shown. The Southeast Australian (SEA) and Eastern Margin Australian Craton (EMAC) geotherm curves (after O'Reilly & Griffin 1990) are steepened downwards to give minimum depths of intersection of the graphite/diamond transition (G/D).