

Multiple Origins of Alluvial Diamonds from New South Wales, Australia

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Abstract

In eastern Australia, diamonds occur in alluvial deposits overlying Phanerozoic basement. The origin of the diamonds is not known. No feeder pipes of kimberlite or lamproite are known, and none of the usual diamond indicator minerals occurs in association with the diamonds.

Alluvial diamonds from Wellington, Bingara, Copeton, and Airly Mountain in New South Wales form two distinct groups, here termed A and B. Group A diamonds are similar to those found in kimberlites and lamproites globally and are thought to have formed in Precambrian lithospheric mantle. Group B diamonds have unusual characteristics that indicate they formed in a subduction environment. Surface features of diamonds of both groups indicate that all were brought to the surface by magmas.

Group A diamonds are similar in primary crystal form, internal structure, mineral inclusion composition (mainly peridotitic), and carbon isotopes to diamonds found in kimberlitic and lamproitic hosts in Archean and Proterozoic cratons worldwide. Re/Os ages (3.4 and 2.1 Ga; Pearson et al., 1998) of sulfide inclusions in two Group A diamonds constrain the origin of these diamonds to ancient mantle sources. This, along with the nature of the surface abrasion structures and radiation damage, suggests that the Group A diamonds represent an older group of diamonds that have been in secondary collectors for a significant time. If this is so, it is feasible that the Group A diamonds may have been derived from a number of primary sources, including possible sources in Antarctica.

Group B diamonds are unlike any other diamond suites worldwide in their combination of shape, surface features, strained and irregular internal structures, ¹³C-enrichment, and Ca-rich eclogitic mineral inclusions. The features are best explained as a product of diamond growth under varying P-T conditions in a high P/T dynamic environment such as a subducting slab. The diamonds may well have formed during arc-continent collision at the time of the development of the New England fold belt. This would explain why the major known concentration of Group B diamonds is within the New England fold belt at Copeton and Bingara, and is consistent with the Phanerozoic ages for diamond emplacement determined from mineral inclusions.