Antarctic Diamonds in South-eastern Australia? Hints from $^{40}Ar/^{39}Ar$ Laser Probe Dating of Clinopyroxene Inclusions from Copeton Diamonds.

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There are numerous detrital diamond deposits worldwide whose primary volcanic sources are unknown. The Copeton diamond population in New South Wales, Australia represents one such deposit (see review by Griffin et al., 1997). These diamonds are mostly derived from streams draining Tertiary 'deep lead' gravels that are capped by Tertiary basalt. The deposit is located within the Phanerozoic Tasman Fold Belt, which is composed of a complex succession of accreted subduction complexes, exotic ocean floor fragments, ocean island remnants and associated volcanic complexes. The diamonds exhibit minor signs of abrasion, mostly in the form of occasional large percussion scars. They contain an unusual suite of calc-silicate eclogitic inclusions, including clinopyroxene, coesite and grossular-rich garnet (Meyer et al., 1997; Sobolev, 1984). Also present are olivine inclusions with 'normal' peridotitic compositions. No kimberlitic indicator minerals have been found in association with the deposit.

Some authors have postulated that the south-east Australian diamonds derive ultimately from magmatic intrusives located beneath the Tertiary basalts in the area (e.g. MacNevin, 1977; McLachlan, 1989). The unusual inclusion chemistry, the lack of kimberlitic indicators and the paucity of abrasion features, has also led to suggestions of more 'exotic' origins for the diamonds, such as derivation from leucitites and tholeites (e.g. Taylor, 1991; Sutherland et al., 1994; Barron et al., 1994, 1996). Evidence for a subduction-related origin for the diamonds is reviewed by Griffin et al. (1997).

In the current study, $^{40}Ar/^{39}Ar$ laser probe analyses of Copeton diamond inclusions (diamonds provided by P. Kennewell, Cluff Resources, Sydney) were undertaken in an effort to provide additional insight into the possible source of these diamonds Burgess et al. (1992, 1997) have suggested that $^{40}Ar/^{39}Ar$ analyses of clinopyroxene inclusions can provide information on both host eruption and diamond genesis ages. During mantle residence, temperatures will be sufficiently high to allow diffusion of pre-eruption argon to the diamond/inclusion interface. On kimberlite emplacement, temperatures will decrease to below the closure temperature for argon migration in clinopyroxene, leading to accumulation of post-eruption argon in the clinopyroxene. If the rationale of Burgess et al. (1992, 1997) is correct, then total extraction of clinopyroxene inclusions from their host diamonds should result in loss of all pre-eruption argon and analyses of these inclusions should yield the age of kimberlite intrusion.

On the basis of the above premise, five clinopyroxene-bearing Copeton diamonds were selected for laser probe analysis. Only three inclusions from two diamonds yielded sufficient argon for accurate age determination. Two inclusions from one stone gave ages of 355 ± 14Ma(2σ) and 327 ± 34Ma(2σ), while a third inclusion yielded an age of 293 ± 52Ma(2σ). These results are within error of one another, with a weighted mean age of 340 ± 28Ma.

In the absence of a high temperature (>~450°C) crustal heating event, this result could be interpreted as representing the eruption age for the source kimberlite/lamproite of the Copeton diamonds. However, recent results obtained by Phillips et al. (1998) suggest that extracted inclusions may still give apparent ages significantly older than the time of source intrusion. Therefore, the above ages must strictly be considered as maximum estimates for the time of source eruption. Nonetheless, the similarity in apparent ages from the three Copeton inclusions is evidence to indicate proximity to the true intrusion event. In the latter instance, it is interesting to note that the age of ca. 340Ma predates the Permian glaciation event that affected much of southern Australia (e.g. Herbert, 1980). Therefore, it is possible that the Copeton diamonds were transported from kimberlite-bearing cratonic areas in Antarctica northwards, where they were deposited during glacial retreat and reworked by later alluvial systems. This explanation can account for the off-craton tectonic setting and the lack of obvious proximal kimberlitic sources.

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Figure 1. Locality map showing the position of the Copeton alluvial diamond deposit, in relation to other detrital diamond deposits in New South Wales, Australia.