MACRO- AND MICRODIAMONDS FROM ARKANSAS LAMPROITES: MORPHOLOGY, INCLUSIONS AND ISOTOPE GEOCHEMISTRY.

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The lamproites of Arkansas were the first reported occurrences of diamond in igneous rocks in the United States. Diamonds were found at Prairie Creek in 1906, and mining operations commencing shortly thereafter represent the only commercial diamond mine ever operated in the United States (Waldman et al, 1987). In spite of their geological significance, detailed research on diamonds from these localities is lacking. This preliminary study characterizes the morphology, inclusions, and isotope geochemistry of diamonds from these lamproites. Macrodiamonds (>1 mm) for morphology, inclusion and isotopic analysis were obtained from placer operations located on the tailings of the Prairie Creek lamproite. Microdiamonds (<1 mm) were obtained through bulk fusion of ~25 kg samples from the Prairie Creek, Twin Knobs #2, Black Lick, and American lamproites. In total, 63 macrodiamonds and 282 microdiamonds have been examined. Additional color and size information for Prairie Creek diamonds has been tabulated from the Crater of Diamonds State Park records and early mining and historical records covering over 15,000 stones.

For Prairie Creek macrodiamonds, white is the most common colour (62% of total) followed by brown (20%) and yellow (16%; Fig 1). This is in contrast to Australian lamproite diamonds where brown and yellow are predominant (Hall and Smith, 1984). Lamination lines present on both white and coloured stones indicate ductile deformation at mantle conditions (Robinson et al, 1986). The Prairie Creek macrodiamonds are very resorbed- none are octahedra. In the population of 63 stones, 86% are equiform or distorted tetrahexahedroida with irregulars (8%) and fragments (6%) exhibiting only broken or resorbed surfaces. Fine hillocks and low relief sufaces indicate conditions of prolonged and/or intense resorption, similar to diamonds from Ellendale 4 and 9 lamproites in Western Australia (Hall and Smith, 1984). Microdiamond morphology differs dramatically from macrodiamonds. Octahedral twins, aggregates, and fragments are common and tetrahexahedroida are absent. Some tetragonal pitting and crescentric steps occur on otherwise unresorbed crystals. Two microdiamonds exhibit uneven resorption, indicative of a xenocryst origin (Robinson et al, 1989).

Previous studies of inclusions in Arkansas diamonds report inclusions of peridotitic and eclogitic paragenesis, periclase, magnetite, diamond, and sulfides, which were usually retrieved by burning the diamond (Pantaleo et al, 1979). For this study, inclusions were visually located and extracted by cracking the diamond. The translucent surfaces created by resorption made locating and identifying inclusions extremely difficult. Twenty-three inclusions from 10 diamonds were extracted; most are graphite along planes or in masses as described by Pantaleo and others (1979). Two opaque inclusions which exhibited crystal faces prior to breaking were identified as magnetite and pseudobrookite(?). One olivine inclusion of peridotitic paragenesis was partially liberated from a gem quality white stone.

Twenty-one macrodiamonds from Prairie Creek were analyzed for $\delta^{13}C_{PDB}$. Eight stones had internal and external portions analyzed. Within-diamond variations are from 0.07-0.54 ‰, with six diamonds slightly lighter inside. Two peaks occur at -3.00 to -6.17 ‰ (ave. -4.67 ‰; 19 stones) and -10.26 to -10.60 ‰ (ave. - 10.50 ‰; 2 stones; Fig. 2). There is no correlation between isotopic character and colour or morphology. The diamonds containing the magnetite, pseudobrookite, and olivine inclusions have $\delta^{13}C_{PDB}$= -5.13, -4.69, and -3.90 ‰, respectively.

Ten microdiamonds were analyzed, five from Prairie Creek, one each from Twin Knobs #2 and American, and three from Black Lick. Four Prairie Creek microdiamonds are similar to the heavy Prairie Creek macrodiamonds (-0.46, -4.22, -4.45, -6.19 ‰) implying a similar paragenesis (Fig. 2). The American and Twin Knobs #2 microdiamonds are also similar to Prairie Creek (-3.18, -2.20 ‰), as are two of the Black Lick microdiamonds (-3.95,-7.81 ‰). This suggests that the microdiamonds and macrodiamonds share a common carbon reservoir. Light values for one Prairie Creek (-26.06 ‰) and Black Lick (-25.19‰) microdiamond preclude a phenocryst origin from a magma with primitive mantle carbon ($\delta^{13}C \sim -5.0$ ‰).

In summary, these features indicate that macrodiamonds from the Prairie Creek lamproite experienced intense and/or prolonged resorption similar to macrodiamonds from the Ellendale lamproites of Australia. Lamproite may therefore be a more corrosive agent than kimberlite with respect to diamond. Microdiamonds from the lamproites consist of unresorbed forms which may have been shielded from resorption in small xenolith fragments (McCandless, 1989). Microdiamonds which share common $\delta^{13}C$ ratios with macrodiamonds may also be xenocrysts, or could have formed from the same carbon reservoir at the time of pipe emplacement. Two microdiamonds have much lighter $\delta^{13}C$ ratios than would be expected for carbon derived from primitive mantle (-5‰). Carbon isotopes for both macro- and microdiamonds suggest derivation from peridotitic and/or eclogitic regions in the mantle, which is similar to diamonds from lamproites and kimberlites worldwide.

References

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Figure 1

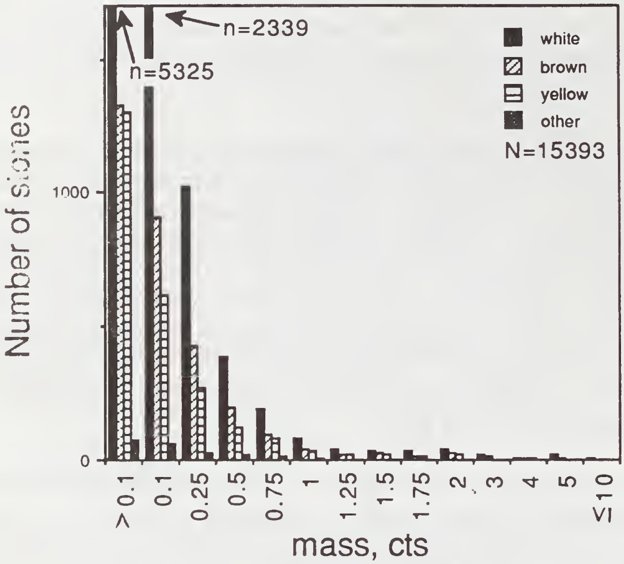

Figure 2