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"Hot zircons" from the Merlin kimberlite field, Northern Territory, Australia

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Current diamond exploration strategy includes the search for kimberlite indicator minerals (KIMS) such as chromite, garnet and Cr-diopside in stream sediments and soil samples. KIMS are, however, prone to chemical dissolution in tropical weathering conditions, and therefore alternative approaches involving the geochemical analysis of resistant minerals such as zircon would enhance exploration success in tropical regions such as Australia, India and Brazil.

Helium thermochronology is a technique that can be utilized to differentiate between "cool" and "hot" zircon originating from shallow and deep crustal regions, respectively. Helium retention in zircon is temperature-dependent and controlled primarily by the Earth's geothermal gradient. With a nominal helium closure temperature of $\sim$200˚C, zircon xenocrysts from the lower- to mid-crustal regions ($>$6 km) entrained within a kimberlite eruption will have (U-Th)/He ages equivalent to the eruption age of the kimberlite, whereas upper crustal zircons will have older (U-Th)/He ages approaching that of the surrounding craton.

We have investigated U-Th-Pb-He isotope systematics of a zircon mineral separate obtained from a bulk sample from the Sacramore pipe located in the Merlin kimberlite field in the Northern Territory of Australia. SHRIMP U-Pb ages of the zircons have an average age of 1688 $\pm$ 165 Ma (n=14, 1ó, range 1515-2080 Ma), consistent with the Mesoproterozoic formation of the North Australian Craton. This indicates that the zircons in the mineral separate obtained from the kimberlite are clearly of xenocrystic

origin. (U-Th)/He ages of zircon from the same mineral separate produce a normal age distribution of 395 $\pm$ 60 Ma (n=33, 1ó, range 330 - 660 Ma). The (U-Th)/He results indicate that over 95% of the zircon grains from the Merlin kimberlite have helium ages equivalent to that of the age of emplacement of the diamondiferous kimberlites ($\sim$370 Ma: Lee et al., 1998), indicating that the zircon xenocrysts could only have originated from depths greater than 6 km where temperatures during the eruption exceeded the helium closure temperature for zircon ($\sim$200°C).

Because the majority of zircon grains from the bulk sample of the Merlin diamond pipe are "hot zircons" with (U-Th)/He ages indicative of a deep crustal origin ($>$6 km), there is scope for application of helium thermochronology in diamond exploration.

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