THE CORRELATION OF KIMBERLITE ACTIVITY WITH MANTLE METASOMATISM

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Metasomatism of the lithospheric mantle by magmas or fluids is well documented in the case of the Kaapvaal Craton using kimberlite-bourne mantle xenoliths (Erlank et al., 1987). The precise timing of such metasomatic events, however, is unknown and therefore it has proven difficult to relate mantle metasomatism in the source to igneous activity at the surface. A suite of mica-amphibole-diopside-ilmenite-rutile bearing xenoliths (MARID) (Dawson & Smith, 1977) represents the product of such metasomatic fluids or melts. Here we report the first precise U-Pb age determinations on a zircon from a MARID sample from the Wesselton kimberlite pipe, thereby dating the metasomatism directly.

The xenolith studied from the Wesselton kimberlite (W7-1) consists of phlogopite, K-richterite, clinopyroxene and rutile partly mantled by ilmenite. Orthopyroxene, which is rarely encountered in MARIDs, appears as an accessory phase. An intense veining of the xenolith by kimberlitic material and partial melting of the MARID assemblage is observed. Solid solution melting of K-richterite explains the appearance of orthopyroxene and enrichment in the amphibole of Ti and F. The analysed zircon occurs as an approximately 450 x 500 µm rounded grain with inclusions of lath-shaped apatite and drop-like rutile, the latter is unaltered and has no ilmenite rims.

U-Pb isotopic ratios and abundances were measured at 13 points on zircon W7-1 using the SHRIMP ion probe at the Australian National University in Canberra with reference zircon SL13 used as a standard. Ages were calculated from $^{206}Pb/^{238}U$ ratios with the contribution of common non-radiogenic lead estimated from both the measured ^{204}Pb and ^{207}Pb. There is a small background of common ^{206}Pb present in each analysis, ca. 0.4 fg, that comes from the polished thin-section surface.

Ages range from 113±3 Myr to 142±2 Myr which exceeds the dispersion expected from known errors of precision. The individual values correlate broadly with variable U and Th concentrations in irregular zones revealed by cathodoluminescence. The oldest ages occur within a euhedral zone close to the zircon rim which also shows the highest U contents. Compared to megacrystic zircons (Kresten et.al., 1975) zircon W7-1 is highly enriched in both U and Th (maximum contents of U and Th 283 and 222 ppm) but with abundances less than those obtained by Kinny & Dawson (1992) (sample BD3024, average 340 ppm U and 1190 ppm Th). This enrichment in U and Th relative to megacrystic zircons excludes the possibility of zircon W7-1 being a megacryst entrained into the MARID xenolith during kimberlite infiltration. The high Cr content of the rutile inclusions (2.5 wt.% Cr_2O_3) rules out a crustal origin.

All analyses yield ages considerably older than the intrusion age of the Wesselton kimberlite (84±3 Myr) (Allsopp &Barrett, 1975) and all other kimberlites from the Group I Kimberley cluster but they do coincide with Group II kimberlite ages which range from 114 Myr (Newlands) to 147 Myr (Swartruggens) (Smith, 1983). This provides chronological evidence for relating the MARID suite of xenoliths to the same process that produced the Group II kimberlites and provides support for petrological models (Sweeney et al., 1993) suggesting that MARIDs represent crystallisation in a lithosphere invaded by Group II kimberlitic magma to be sampled later by the Group I kimberlitic event .

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