Dating pegmatites to constrain the exhumation of granulite-facies mid crust, Central Gneiss Belt, western Grenville Province of Ontario: Dealing with inherited zircon

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Recent tectonic models for the hinterland of the Grenville Province distinguish domal-shaped regions of granulite-facies crust metamorphosed at ~1080 Ma (Ottawan orogenic phase) from adjacent basinal-shaped regions of crust comprising the Orogenic Lid that escaped penetrative Ottawan deformation and high-grade metamorphism. Juxtaposition of these Ottawan crustal levels is interpreted to have occurred during exhumation of the granulite-facies mid crust by post-convergent extension and to be a signal of crustal-scale orogenic collapse. The exhumed mid-crustal granulites are cut by one or more suites of undeformed to slightly deformed granite pegmatite dykes. In this study, U-Pb analyses of zircon from two pegmatite dykes, samples TR-04-11 and TR-05-11, were carried out by LA-ICP-MS to constrain the timing of exhumation of the granulite-facies rocks.

Approximately 30 zircons from each sample were imaged using back-scattered electron (BSE) and cathode luminescence (CL) methods to define rims and cores. Analyses were obtained by the wet co-aspiration method using a 10 µm laser beam, a 1 µm/s line raster. Zircon from TR-04-11 comprise on average ~ 110 by 60 µm prismatic to blocky grains, with weak oscillatory zoned cores and ~ 20–40 µm wide, high Th-U rims. The U-Pb analyses of 11 concordant rims yielded ages between ~1000 Ma and 1150 Ma, whereas the cores yielded ages between ~1129 Ma and 1270 Ma. Eight discordant analyses intersect Concordia at 1043 ± 28 Ma. The best estimate of the crystallization age of the pegmatite, from an analysis of a high Th-U rim about 20 µm wide is 1004 ± 10.6 Ma.

Zircon from TR-05-11 are on average ~ 150 by 70 µm acicular to sub-rounded; some grains have cores with sharp and continuous oscillatory zoning towards the margins, whereas others have cores with weak and irregular zoning that becomes diffuse towards the margins. A few grains have new recrystallized thin rims (≤10 µm). The core and mantle/ rim ages range between 1500 and 1050 Ma. The youngest grain is acicular, exhibits continuous diffuse zoning from core to rim and yielded a rim age of 1046 ± 10.6 Ma.

Zircon in both samples, including many small acicular grains, is predominantly inherited from the source region. Oscillatory zoning in inherited cores commonly becomes less sharp towards the grain margins, implying later modification by diffusion during melting in the source region and/or transport in the fluid-rich pegmatitic magma. Sub-populations of discordant grains that lie on a chord may signify an episode of Pb loss. The inferred age of emplacement for TR-04-11 was determined from the recrystallized rim of an inherited zircon, whereas that for TR-05-11 was determined from a diffusely zoned acicular grain. These ages are ~50–90 Ma after the metamorphic peak and provide upper estimates for the time of exhumation of the granulite-facies crust and the emplacement of the pegmatite dikes.

This study has shown that the pegmatite magmas carried abundant inherited zircon and that very little new zircon was formed during crystallization. Hence zircon may not be the most appropriate mineral to determine emplacement ages. Current work is focusing on monazite, titanite, and rutile.

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