Using U-Th-Pb monazite geochronology to constrain emplacement ages and melt production rates of leucocratic granites

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Zircon is the most widely used geochronometer in granites but it can be unreliable for low-temeprature, leucocratic crustal melts. For these granites U-Pb dates may reflect just the ages of surviving xenocrystic zircons. In the Capricorn Orogen of Western Australia, leucocratic muscovite-biotite(-tourmaline) granites and barren and rare-element pegmatites crop out over ~420 km^2 in the hanging wall of a major shear zone. Initial SHRIMP U-Pb zircon dating suggested that the granites are Paleoproterozoic in age. However, subsequent dates of 1030–990 Ma for metamorphic monazite in schists intruded by the granites indicates that the main zircon population in the granite is xenocrystic. We used SHRIMP U-Th-Pb monazite geochronology and targeted SHRIMP U-Pb zircon geochronology to obtain reliable igneous crystallisation ages in order to determine the duration of magmatism and the processes responsible for melt generation. Our dating shows that the pegmatites and granites are coeval and were emplaced from c. 1025 to c. 890 Ma. Magmatism outlasted medium-grade (500–550°C and 3–4 kbar) regional metamorphism in the region by ~100 Ma. The long duration of magmatism combined with the relatively small volume of leucocratic granite and pegmatite requires very low melt production rates (~15 km^3/Ma). Field observations of *in situ* melting in older metagranite and the single age (c. 1650 Ma) component of the zircon xenocrysts suggest some of the melt is from an igneous source. However, temperatures attained during regional metamorphism were insufficient to induce dehydration melting reactions. Therefore, an external source of fluid was required to trigger melting, possibly from sedimentary rocks in the footwall of the shear zone. Melt generation appears to have been episodic and may have been related to long-lived, sporadic reactivation along the crustal-scale shear zone.

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