In situ Th–Pb dating of monazite in REE-rich carbonatites: Unraveling magmatic and mineralising histories

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Carbonatites host the world's largest REE deposits, and have been instrumental in meeting the growing demand for REEs over the past decades. However, constraining the timing and genesis of carbonatites and related mineralising events has been challenging, and remains problematic, largely due to the protracted, multi-stage magmatic and hydrothermal history of most carbonatite complexes. Monazite, as one of the main REE phosphate minerals, is ubiquitous in carbonatites, but is commonly characterised by extreme depletion of U. We applied in situ techniques, whereby monazite grains are drilled from polished thin sections, and analysed by SHRIMP ion microprobe. SHRIMP geochronology of monazites from the REE-mineralised Gifford Creek carbonatite complex in the Proterozoic Capricorn Orogen, Australia yielded robust Th–Pb age constraints for the carbonatite intrusion and hydrothermal events. Our study reveals a prolonged, multi-episode growth history of REE mineralisation and/or remobilisation from ca. 1.4 Ga to ca. 0.9 Ga. The main episodes of monazite growth predated the nearby ca. 1070 Ma Warakurna large igneous province (LIP), thus ruling out a link between the Gifford Creek carbonatite complex and REE mineralisation with emplacement of this LIP. Our study demonstrates the potential of in situ monazite Th–Pb dating by SHRIMP for unravelling the complicated magmatic and hydrothermal histories of carbonatites and associated REE mineralisation.