Tectonic significance of Australian rare earth element deposits

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Australia is host to a diverse range of rare earth element (REE) ore deposits, and therefore is well placed to be a major supplier of REE into the future. This paper presents a review of the geology and tectonic setting of Australia's hard-rock REE resources. The deposits can be classified into four groups: 1. Carbonatite associated; 2. Peralkaline volcanic associated; 3. Unconformity related, and; 4. Skarns and iron-oxide-copper-gold (IOCG) related. With the exception of the unconformity related deposits, all of these deposit groups are directly or indirect related to continental alkaline magmatism. Extensive fractional crystallisation and/or igneous accumulation of REE minerals were essential ore-forming processes for carbonatite-associated and peralkaline volcanic-associated deposits, while hydrothermal transport and concentration of REE sourced from basement rocks was responsible for producing ore in unconformity-related, skarns and, potentially, IOCG deposits.

All of Australia's REE deposits formed in an intracontinental setting in association with crustal-scale fault zones or structures that acted as transport conduits for ore-forming magmas or fluids. Most deposits formed in the Neoproterozoic under conditions of relative tectonic quiescence. There is little evidence for the involvement of mantle plumes, with the exception of the Cenozoic peralkaline volcanic systems of eastern Australia, and possibly the IOCG deposits. Instead, ore productive magmas were generated by melting of previously-enriched mantle lithosphere in response to disruption of the lithosphere-asthenosphere boundary due to fault activation. REE minerals in many deposits also record episodes of recrystallisation/resetting due to far-field effects of orogenic activity that may significantly postdate primary ore formation. Therefore, REE orebodies can be effective recorders of intracontinental deformation events.

In general, Australia's inventory of REE deposits is similar to global record. Globally, the Mesoproterozoic appears to be a particularly productive time period for forming REE orebodies, due to favourable conditions for generating ore-fertile magmas, and favorable preservation potential due to a general lack of aggressive continental recycling (i.e., active plate tectonics).