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Australian carbonatites: insights on geological characteristics, exploration proxies and the national prospectivity for undiscovered carbonatites and associated critical metal mineralisation

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Australia hosts nineteen carbonatite and carbonatite-like occurrences, four of which have associated REE deposits (Fig. 1) [1, 2, 3]. Continent-wide carbonatite magmatism spans a time period of >2.5 Ga and all known examples occur in areas of Proterozoic or older crust, which resembles the global distribution of carbonatites [4].

The majority of Australia's carbonatites occur within three 'belts', namely the East Yilgarn, Halls Creek and Arunta belts. Within these belts, carbonatite magmatism is associated with large, crustal-scale structures and commonly display significant age gaps despite close spatial associations. This arrangement into belts and the lack of carbonatite magmatism in other, geologically similar areas of the continent suggests that the lithospheric mantle underlying these three regions may be distinct to that underlying other, carbonatite-free regions in the continent.

Based on their geological features, Australia's carbonatites can be grouped into distinct classes, all which may display REE mineralisation. These are:

1. Carbonatites within alkaline mafic-ultramafic and syenite complexes;
2. Carbonatites temporally associated with regional ultramafic lamprophyres and kimberlite;
3. Carbonatites without any associated silicate rocks;
4. Carbonatite-related vein-hosted REE deposits and prospects

Exploration for new carbonatite complexes and the associated REE mineralisation should focus on the identified belts as these are proven to have underlying mantle capable of producing carbonated liquids upon melting. The most prospective areas for carbonatites within these belts occur along major faults and structures that can facilitate both mantle melting (upon fault movement) and rapid transportation of reactive carbonated melts to facilitate emplacement at shallow crustal positions. Locally, magnetic and radiometric anomalism associated with carbonatite complexes are useful tools for the remote sensing of undiscovered complexes. Post emplacement weathering processes are critical to the secondary REE enrichment of carbonatite complexes, thus areas of deep weathering with preserved weathering profiles are particularly prospective in the search for economic REE mineralisation associated with carbonatite complexes.

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[4] Woolley & Kjarsgaard. (2008). *Geological Survey of Canada, Open File 5796.*