Subducted sediments as a source for REE in mineralised post-collisional alkaline-carbonatite systems

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Many of the world's largest known REE deposits are associated with post-collisional alkaline-carbonatite magmatic complexes (e.g., the Minanning-Dechang belt, China). These systems are potassic to ultrapotassic in composition and contain LREE-dominated mineralisation associated with F and Ba-rich carbonatite breccias, carbonatite dykes and carbo-hydrothermal veins. They are typically emplaced through major shear zones during a period of ‘relaxation’ that post-dates continental collision by up to 75 Ma. The subduction of sediment during continental collision is potentially a key control on the ‘fertility’ of the mantle source, and understanding the role of sediment is a crucial step towards better exploration models. However, the identification of sediment source components to alkaline systems has not been straightforward because their petrological complexity precludes traditional methods such as trace-element ratios and major-element modelling of crystal fractionation. We use a global database of Sr, Nd and Hf isotope compositions for alkaline and carbonatite systems, alongside geodynamic reconstructions to identify favourable source components for mineralisation and to provide direct information about the origin of the metals of interest. Subduction of shale and carbonate sequences is likely to introduce REE + HFSE and potentially mineralising ligands (F^-, CO_3^{2-}) into the mantle source for post-collisional alkaline systems; clastic sediments are poorer in these vital components. This research provides a framework through which the mineral exploration industry can identify tectonic environments that are predisposed to form REE mineralisation, providing regional-scale (100–1000 km) guidance especially for systems hidden beneath sedimentary cover.

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