

GEOCHEMICAL FINGERPRINTING: VARIATIONS IN LITHOSPHERIC MANTLE SIGNATURES WITHIN AND BETWEEN TERRANES

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Abstract

Geochemical signatures in mantle xenoliths reflect a range of processes including initial formation, melting history, and the type and extent of metasomatic processes affecting a specific mantle volume. Geochemical signatures may vary both within and between domains of different tectonic style mapped in the overlying crust, and between lithospheric sections affected by different geodynamic regimes. Detection and recognition of geochemical signatures in mantle samples, including whole-rock and mineral major, trace-element and isotopic chemistry is an essential part of unravelling the history of different mantle processes through time on a variety of scales.

A suite of mantle xenoliths from the easternmost structural element of central eastern Australia (the New England Orogen) has been studied in order to characterise the composition, architecture and evolution of sub-continental lithospheric mantle underlying the region. The New England Orogen represents a Palaeozoic-Early Mesozoic convergent margin setting, and is typically divided into two crustal domains separated by a fault system and delineated by a serpentinite belt, interpreted to represent the suture along which subduction took place. The eastern domain is considered to represent a microcontinent accreted to the Australian margin during subduction, and the western domain consists of continental shelf material inboard of the subduction zone. Mantle-derived peridotite xenoliths from six widely spaced localities across the orogen have been used to help understand the composition, architecture and evolution of sub-continental lithospheric mantle beneath the region, to assess regional mantle heterogeneity, and to determine if there are systematic differences in the lithospheric mantle underlying the two crustal domains.

Geochemical signatures of clinopyroxenes in the xenoliths indicate variations in the melting history and the type and extent of metasomatism in the lithospheric mantle both within and between the two crustal domains. Xenoliths from one locality in the western domain can be divided into two groups showing distinctly different metasomatic characteristics – one has been metasomatised by a dominantly silicate agent, the other a carbonatitic agent. Samples from another locality < 80 km distant, also in the western domain, have clinopyroxene trace-element signatures indicating progressive chromatographic metasomatism by an evolving silicate fluid at low fluid-rock ratios. The presence of amphibole in xenoliths from a third locality (~200 km away, in the eastern domain) provides evidence for modal metasomatism. In these samples, amphibole is a significant 'other' host phase for many trace-elements (other than clinopyroxene), allowing the bulk rock to contain higher concentrations of (for example) high field-strength elements than the amphibole-free mantle wall-rock peridotites, and affecting the geochemical signature of the coexisting clinopyroxene due to its strong partitioning of certain elements.

In situ and whole-rock Re-Os isotopic data have been used to provide age constraints on the New England sub continental lithospheric mantle. Rhenium depletion model ages based on in situ analysis of sulfide grains suggest different localities have different age signatures, and show that lithospheric mantle beneath the New England region contains material of at least Proterozoic age. Comparisons between whole-rock and sulfide in situ Re-Os data show that multiple populations of sulfides may be present in a given sample, and consequently, that whole-rock Re-Os data represent a mixture of these populations and must be regarded as giving only minimum age constraints.