Thermobarometry and geochemistry of peridotite xenoliths from the southwestern margin of the Kaapvaal Craton, South Africa

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Globally, there are significant contrasts, both thermally and chemically, between peridotite xenoliths exhumed from Archean and post-Archean terranes. Studies of the thermal structure of the lithosphere, in combination with surface heat flow data, suggest that thermal gradients beneath cratonic regions (Archean blocks stabilized > 2.5 Ga) are lower than those in off-craton regions, commonly attributed to thinner lithosphere in Proterozoic domains. Although this is true to an extent for southern Africa, the contrasts appear less distinct than Archean – Proterozoic lithosphere contrasts elsewhere, and the thermal structure reflects regional disturbances which have been temporally linked to large scale tectonic processes. Mineral major and trace element data were obtained for garnet bearing peridotite xenoliths exhumed from nine Mesozoic off-craton Group II (145 – 115 Ma) and Group I (100 – 80 Ma) kimberlites located within the Proterozoic Namaqua-Natal Province and Rehoboth Province to compare the thermal and metasomatic characteristics of the lithospheric mantle beneath these terranes with the neighbouring Kaapvaal Craton. Major element P-T results from peridotite xenoliths sampled by older Group II kimberlites, which erupted through the Namaqua-Natal mobile belt, and the ~75 Ma Rietfontein and Gibeon kimberlites which erupted through the Rehoboth Province, record geothermal gradients that overlap those of the Kaapvaal Craton (40 mW/m^2). In contrast, xenoliths sampled from younger Group I kimberlites within the Namaqua-Natal mobile belt record equilibration temperatures and pressures which correspond to a 45 mW/m^2 model geotherm. Garnet and clinopyroxene trace element signatures indicate that the region experienced varying degrees of localised mantle metasomatism by carbonatitic and kimberlitic melts.

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