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Coupled crust-mantle isotope signatures in pre- to late orogenic granites (Damara orogen, Namibia)?

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The distribution of continental lithosphere has changed constantly through geological time, with larger continental masses periodically fragmenting into smaller crustal blocks and later re-amalgamating in different configurations to form new supercontinents. The apparent stochastic nature of this process complicates reconstruction of ancient crustal terranes. Precambrian high-grade metamorphic terranes may contain young granites derived from reworked older continental crust. Alternatively, these granites may represent differentiation products of juvenile material that originated directly from the mantle. Another possibility is the derivation of orogenic granitic magmas from an ancient source that contained both juvenile and older crustal components. Since granitoids often inherit geochemical and isotopic characteristics from their sources, their isotopic compositions can be used to reconstruct the geochemical composition of granite-dominated terranes and provide useful information about inaccessible parts of crustal provinces.

The Damara Orogen (Namibia) formed during the early Proterozoic Pan-African orogenic event and is characterised by large-scale granitoid intrusions. Plutons of the Damaran Northern Central Zone investigated here range in age from ca. 570 Ma, ca. 525 Ma to ca. 485 Ma and are of granodioritic to granitic composition. They have high calculated zircon saturation temperatures in excess of 900°C and show no signs of shallow crustal contamination. Generally, the granodiorites and granites have variable K_2O contents (3.1-5.9 wt.%), high HFSE and LREE abundances (up to 900 ppm Zr and 400 ppm Ce), and are strongly enriched in LREE over HREE (La/Yb: 9-49) with variable negative Eu anomalies (Eu/Eu*: 0.82-0.19). Initial $^{87}Sr/^{86}Sr$ isotope ratios vary from 0.704 to 0.707, and initial ? Nd values have a spread of 6 ? units (±0.0 to -6.1). Sr (200-600 ppm) and Nd (25-140 ppm) concentrations are high, with the highest Nd concentrations occurring in the most primitive rocks. Modeled AFC (Assimilation-Fractional-Crystallization) paths are incompatible with the assimilation of pre-existing crust.

These observations suggest that the granodiorites and granites have a mixed mantle-crust provenance. There is no correlation of elemental and isotope composition with age or position within the orogen. It is therefore impossible to distinguish between remelting of pre-existing Mid-Proterozoic crust that itself contains a mantle component or the involvement of a lithospheric mantle source coupled with intracrustal melting during the Pan-African orogeny. Synorogenic ne-normative syenites of the Damara Orogen have unradiogenic $^{87}Sr/^{86}Sr$ ratios and ? Nd values between -3 and -5 suggesting that the underlying lithospheric mantle is isotopically evolved and may have served as a heat source only at ca. 520 Ma. Here, it appears significant that the granites with the strongest mantle signature intruded at 525 Ma. The observation that the Nd model ages (T_{DM}: 1.1-1.5 Ga) are significantly younger than the rare 1.7 Ga-old restitic zircons suggest either mantle-crust mixing or a generation of these granodiorites/granites from juvenile, mafic to intermediate igneous lower crustal sources that retained their mantle isotopic signature.