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Anatexis of mafic and felsic lower crust: Geochemistry and Nd, Sr and Pb isotopes of late-orogenic granodiorites and leucogranites (Damara orogen, Namibia)

Lennart Osterhus and Stefan Jung

Mineralogisch-Petrographisches Institut, Universität Hamburg, Grindelallee 48, 20146 Hamburg, Germany (lennart.osterhus@googlemail.com)

The Damara orogen (Namibia) represents a well-exposed and deeply eroded orogenic mobile belt consisting of the north-south trending Kaoko belt and the northeast-southwest trending intracontinental Damara belt. The latter has been subdivided into a Northern, a Central and a Southern Zone based on stratigraphy, metamorphic grade, structure and geochronology. The late-orogenic granodioritic to leucogranitic Gawib pluton is a cross-cutting, pear-shaped post-tectonic stock within the southern Central Zone which is elsewhere dominated by basement rocks, high-grade metasedimentary rocks of the Tinkas Formation and syn-orogenic granites (Salem-type). The non-foliated granodiorites consist of plagioclase, quartz, microcline, hornblende and biotite whereas the leucogranites consist of microcline, quartz, plagioclase and biotite. Major element variation of the granodiorites show two distinct magma types were some samples have high TiO_2, MgO and Fe_2O_3 and low Al_2O_3 and others have low TiO_2, MgO and Fe_2O_3 and high Al_2O_3. Based on high REE, Nb, Zr and Y concentrations some granodiorites can be classified as A-type granitoids. Strontium concentrations are high in the granodiorites (up to 939 ppm) and decrease to $<$ 200 ppm in the leucogranites. Rb/Sr ratios are low ($<$0.34) in the granodiorites and high ($>$1) in the leucogranites. Granodiorites have moderately radiogenic initial $^{87}Sr/^{86}Sr$ ratios (0.7088-0.7132), strongly negative initial ε Nd values (ca. -12) and comparatively unradiogenic Pb isotope data, the latter obtained on acid-leached feldspar separates. Leucogranites have more radiogenic initial $^{87}Sr/^{86}Sr$ ratios (0.7223-0.7336) and more negative initial ε Nd values (ca. -18). Pb isotopes tend to be less radiogenic than in the granodiorites. The mean crustal residence ages of the granodiorites, expressed as depleted mantle Nd model ages, are ca. 2.0 Ga but the leucogranites tend to have older Nd model ages (2.5 Ga). Therefore, a likely source for the granodiorites and leucogranites is a sequence of mafic to intermediate or felsic lower crust. In a plate-tectonic context, a correlation between lower crustal magmatism and changes in the direction of micro-plate movements between the central and the southern part of the Damara orogen can be suggested, provoking re-activation of lithospheric shear zones. If such reactivation caused a reversal in the sense of movement, the associated faults opened and propagated as tensional faults. This would have allowed fracturing through the continental crust causing pressure release, channeling of volatiles, partial melting and generation of magmas from the lower crust. This suggestion is confirmed by the intrusion of the pluton along a major crustal shear zone, the Okahandja Lineament. The intrusion was probably accompanied by a change in the stress field which renewed transcurrent movements along this lithospheric shear zone.