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The geochronology and geochemistry of the ferroan, A-type granites on the eastern margin of the Namaqua Sector, Namaqua-Natal Metamorphic Province, southern Africa

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Numerous granites occur on the eastern margin of the Proterozoic Namaqua Sector of the Namaqua-Natal Metamorphic Province at its contact with the Archean Kaapvaal Craton. These intruded syn- to post-tectonically during the 1.20-1.07 Ga Namaquan Orogeny. The granites have been poorly studied in the past having little geochemical or geochronological data and were previously grouped as the poorly defined Keimoes Suite. Recent studies ([1], [2]) suggest two possible age subdivisions. This study investigates the geochemistry and geochronology of these granites in order to test these age subdivisions and determine their overall petrogenesis. An examination of these previously grouped granites will help to resolve the geodynamic evolution of the eastern Namaqua Sector.

Eight granites were sampled to supplement previous geochronology. U-Pb zircon dating was undertaken by laser ablation – single collector – magnetic sector field – inductively coupled plasma – mass spectrometry (LA-SF-ICP-MS). Four of the dated granites belong to an older, syn-tectonic group varying from 1.19-1.13 Ga overlapping with the previously established age of peak D_2 deformation and peak M_2 metamorphism at ~1.16 Ga. $\varepsilon_{Nd(t)}$ values range from -1.91 to +4.23, with initial Sr values ranging from 0.7139 to 0.7950, with some high values of up to 0.9766 suggesting derivation from a depleted source with variable degrees of an enriched, crustal component as indicated by the large range in T_{DM} model ages, which vary from 2.04 to 3.62 Ga, along with enrichment in Pb, Th and U in these rocks. Model ages in excess of 3.0 Ga are attributed to multi-stage Nd evolution.

A younger age grouping, comprising two granites dated in this study, along with previously dated granites ([1], [2]), falls into the range 1.12-1.07 Ga and mark a late- to post-tectonic magmatic episode. $\varepsilon_{Nd(t)}$ values are more strongly negative than the syn-tectonic group varying from -3.08 to +2.1, with a smaller variability in the initial Sr range (0.718-0.798) suggesting less isotopic disturbance. These were derived from an enriched, crustal source by crustal anatexis with a small and variable depleted component, as reflected in model ages of 2.14 to 3.50 Ga.

Despite a broadly syn-tectonic and late- to post-tectonic age grouping the granites reflect a broad continuum in terms of emplacement ages and largely similar geochemical characteristics, and no distinction in terms of geochemical characteristics can be made. Both age groupings show similar trace element patterns and rare earth element (REE) plots. The granites are characterised by LILE enrichment relative to the HFSE, depletions in Ba, Sr, P, Eu, Ti, along with Nb and Ta, and enrichments in Th, U and Pb, with strong LREE enrichment relative to flat HREE patterns. Fractionation played a secondary role, but the general lack of samples per pluton precludes any interpretations being made; peritectic

assemblage and accessory mineral co-entrainment possibly contributed to the trace element compositions of the granites. The metaluminous, ferroan, alkali-calcic to alkalic A_2-type nature of the granites, along with a collisional to continental rift-type tectonic setting, suggests derivation from melting of a depleted source with a greater degree of crustal involvement over time over a protracted time period. Emplacement occurred into a thinned, rifting environment likely associated with transcurrent shearing and thinning of the crust.

References:

[1] Bailie R et al. (2011) J Afr Earth Sci 60: 153-174

[2] Cornell D et al. (2012) S Afr J Geol 115: 465-484