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Petrographic and mineralogical evolution of the alkaline and aluminous associations of the Graciosa A-type granites, Brazil

G.A.R. GUALDA[1,2] AND S.R.F. VLACH[1]

[1] Instituto de Geociências, Universidade de São Paulo, Rua do Lago 562, 05508-080, São Paulo, SP

[2] Presently at: Dept. Geophysical Sciences, The University of Chicago, 5734 S. Ellis Ave. #3W (ggualda@uchicago.edu)

The Graciosa granites comprise five distinct granitic massifs in southern Brazil and belong to a larger province of A-type granites that was formed during the Brasiliano/Pan-African orogeny. Petrography and mineral chemistry of the major and accessory minerals was studied in detail, with the intent to unravel the evolution of these A-type magmas.

Four distinct petrographic associations can be recognized: (1) *Alkaline I*, composed of amphibole-bearing alkali feldspar syenites ranging from calcic (clinopyroxene, olivine, allanite) to calcic-sodic (chevkinite-perrierite) and sodic; post-magmatic biotite and sodic amphibole substitute primary calcic-sodic amphibole; (2) *Alkaline II*, characterized by amphibole-bearing alkali feldspar granites, with limited modal variations but similar amphibole compositions; (3) *Aluminous*, with biotite granites and alkali feldspar granites containing minor amphibole; (4) *Monzodiorites*, typically with biotite, calcic amphibole and augitic clinopyroxene, partially mingled with granitic magmas. The mafic minerals present in all the associations are, in general, Fe-rich with correspondingly low Mg and Al contents. The amphiboles are important indicators of the chemical evolution of the magmas. In the *Alkaline I* association, the amphiboles crystallized in progressively more oxidizing and alkaline conditions. In the *Alkaline II* association, the initial conditions were somewhat more oxidizing and shifted to reducing in the final stage. In the *Aluminous* association, the amphiboles are calcic and comparatively homogeneous, while the Mg-rich amphiboles in the *Monzodiorites* are varying in composition, as are their clinopyroxenes.

The crystallization pressure was estimated at 2 ± 0.6 kbar for the *Monzodiorites* (Al-in-hornblende). The liquidus and solidus temperatures of the granitic magmas were 800-900 ºC and 700-750 ºC, respectively, both for the *Alkaline* (T_{Zr} and feldspar thermometry) and *Aluminous* associations (T_{Ap} and hornblende-plagioclase). For the *Monzodiorites*, the best values are 1000 ºC (T_{Ap}) and 750 ºC (hornblende-plagioclase). The contrasting evolution of the associations implies at least four coeval magmatic series. In particular, the absence of mafic varieties is noteworthy and thus a connection with basic-intermediate primary magmas is uncertain.

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'Anorogenic' granites in a convergent plate-tectonic setting: A review of the Palaeoproterozoic rapakivi suite in South Greenland

A.A. GARDE[1], M.A. HAMILTON[2], B. CHADWICK[3], J. GROCOTT[4] AND K.J.W. MCCAFFREY[5]

[1] Geol. Survey of Denmark and Greenland DK (aag@geus.dk)

[2] Univ. Toronto, Canada (mhamilton@geology.utoronto.ca)

[3] UK (Brian@chadwick.evesham.net)

[4] Univ. Kingston, UK (j.grocott@kingston.ac.uk)

[5] Univ. Durham, UK (k.j.w.mccaffrey@durham.ac.uk)

The c. 1755-1725 Ma rapakivi suite in South Greenland was emplaced into the upper crust during a late transpressive stage of the Ketilidian orogeny. The plutons were intruded along the boundary between the juvenile, calc-alkaline Julianehåb batholith (c. 1855-1795 Ma) in the core of the orogen and its erosion products in the forearc on its outboard, south-eastern side. The batholith was accreted in a sinistral transpressive setting during subduction of oceanic crust under the Archaean craton of southern Greenland. Most rapakivi suite members are coarse, K-feldspar-megacrystic, iron-rich monzonites; some have rapakivi textures, and noritic members occur. It was previously argued that the rapakivi suite was generated and emplaced as a consequence of extensional collapse following accretion of the Ketilidian orogen. Moreover, it was assumed that the prominent HT-LP metamorphism and flat-lying structure in its south-eastern part were developed during this extensional phase.

However, both detailed structural and precise U-Pb geochronological studies in the late 1990s have shown that high-grade conditions were established rapidly following forearc basin deposition (evidenced by 1790-1785 Ma extensive partial melting and S-type granite production) during continued transpression. The oldest rapakivi members were emplaced some 30 Ma later during continued or renewed sinistral transpression. Furthermore, the rapakivi magmas were not, as previously suggested, intruded into active extensional shear zones but formed >2 km thick, tabular bodies in the upper crust. They were fed by narrow vertical dykes and were emplaced either by lifting their roofs or depressing their floors, with narrow (a few tens of metres thick) contact aureoles. Subsequent folding into broad, 10 km-scale domes and accompanying narrow cusps attended waning stages of transpression.

The heat source(s) of both the HT-LP metamorphism and the 30-60 Ma younger rapakivi suite is not known with certainty; detachment or rollback of the subducted oceanic slab and replacement by hot mantle underplating has been proposed. It is conceivable that magmas parental to the rapakivi suite staged in the lower crust for a long interval before they were tapped, but this possibility remains to be tested.