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Proterozoic post-orogenic plutonism in SE Greenland: geochemical evidence for mantle-crust interaction

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The Nagssugtoqidian Mobile Belt of East Greenland forms a well defined structural province centred around Angmagssalik (Fig. 1), consisting of prevalent Archean gneisses and very subordinate Proterozoic basic dykes and syn-post-tectonic intrusions (BRIDGWATER, 1976). The latter represent the last event in the Nagssugtoqidian belt, after the major tectonic phase 1900 Ma old (BRIDGWATER & MYERS, 1979).

The investigated Proterozoic intrusive complex of the Angmagssalik District mainly consists of a stratigraphic lower mafic-ultramafic rock sequence (peridotites, norites, gabbro-norites) and an upper intermediate-acidic sequence (monzonites to granites).

Basal ultramafics are mainly characterized by ol + px cumulus rocks showing the crystallization order: ol (+ sp) — opx — cpx with interstitial phlogopite and plagioclase.

Opx (+ pl)-phyric mafic dykes crosscut the mafic-ultramafic sequence. The intermediate-acidic rocks outcrop as large bodies, dykes and veins, showing complex intrusive relationships with both metamorphic basement and ultramafic unit.

Rb-Sr dating of mafic and intermediate intrusive samples (VANNUCCI et al., 1987) is in good agreement with the 1570 ± 20 Ma age (whole-rock isochron) obtained by TAYLOR et al. (1984) for the Angmagssalik granites. From the relatively low Sr_i value (≅ .703), it follows that contamination of a mantle-derived magma with unradiogenic Sr from lower crust (low Rb/Sr ratios) cannot be excluded.

The investigated rocks define two major

Fig. 1. — Index map showing main structural outlines of Greenland. Open square: Angmagssalik District.

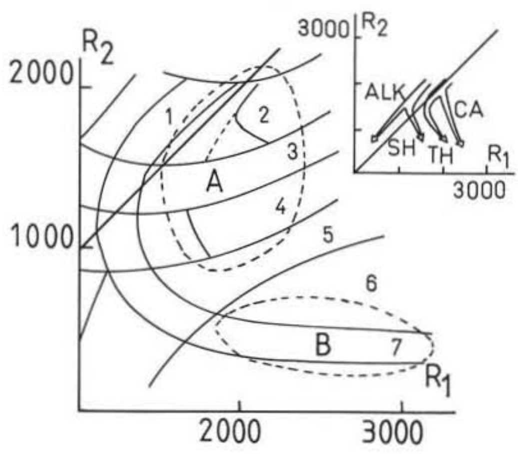

Fig. 2. — R1-R2 diagrams (De La Roche et al., 1980) for investigated rocks. A = mafic to intermediate intrusives and dykes; B = granite and rhyolite dykes. Numbers from 1 to 7 refer, respectively, to the following compositional fields: ol-gabbro, gabbro-diorite, diorite, tonalite, granodiorite, granite. The trends of alkaline (ALK), shoshonitic (SH), tholeiitic (TH) and calcalkaline (CA) rocks series are reported for comparison.

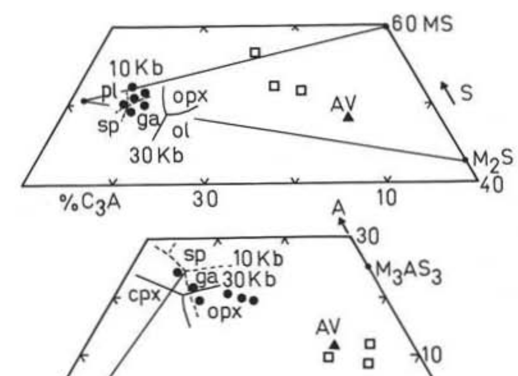

Fig. 3. — Mafic dykes (solid circles) and cumulates (squares) in CMAS system (projections from olivine onto CS-MS-A plane and from diopside onto C_3A-M-S plane). 10-30 Kbar phase boundaries are reported from O'Hara (1968). AV is average peridotite.

groups in the R1-R2 diagram (Fig. 2): i) mafic to intermediate intrusives and dykes (from tholeiite to andesite compositions); ii) granites and rhyolite dykes. A major compositional gap exists between intermediate and acidic compositions. As a whole, the rock sequence defines a calcalkaline trend starting from

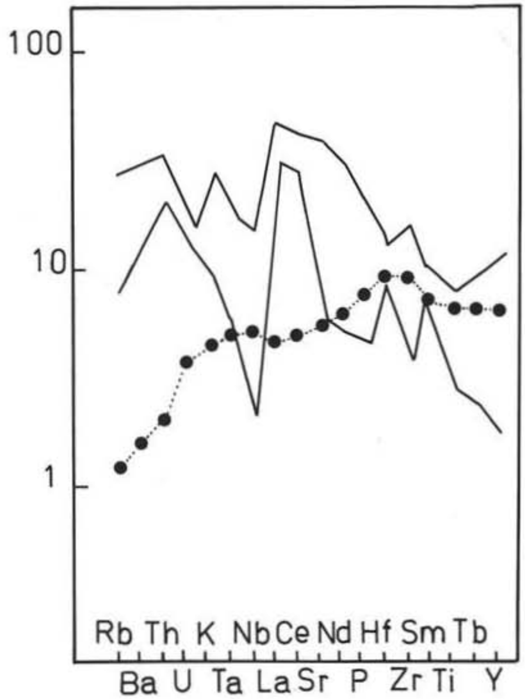

Fig. 4. — HYG element distribution in mafic dykes from Angmagssalik District. HYGE distribution pattern of N-MORBs (solid circles) is reported for comparison.

basaltic compositions.

Representative points of most primitive liquids in the Di-Fo-An-SiO_2 system (Presnall et al., 1979) fall in the plagioclase field near the 9 Kbar cotectic, suggesting extensive fractional crystallization at great depth. Further evidence of evolution by fractional crystallization under high P conditions may be derived from the projections of cumulates and most primitive dykes in the CMAS systems (O'Hara, 1968). Liquid compositions for 10-30 Kbar conditions, most primitive dykes and cumulates are co-linear with enstatite representative point in the olivine projection and with intermediate composition between enstatite and olivine in the diopside projection (Fig. 3).

On this ground we interprete the dykes as residual liquids derived from a more mafic parent (probably generated under high P conditions), moving away from olivine + liquid or orthopyroxene + liquid primary fields.

HYG element distribution of the less

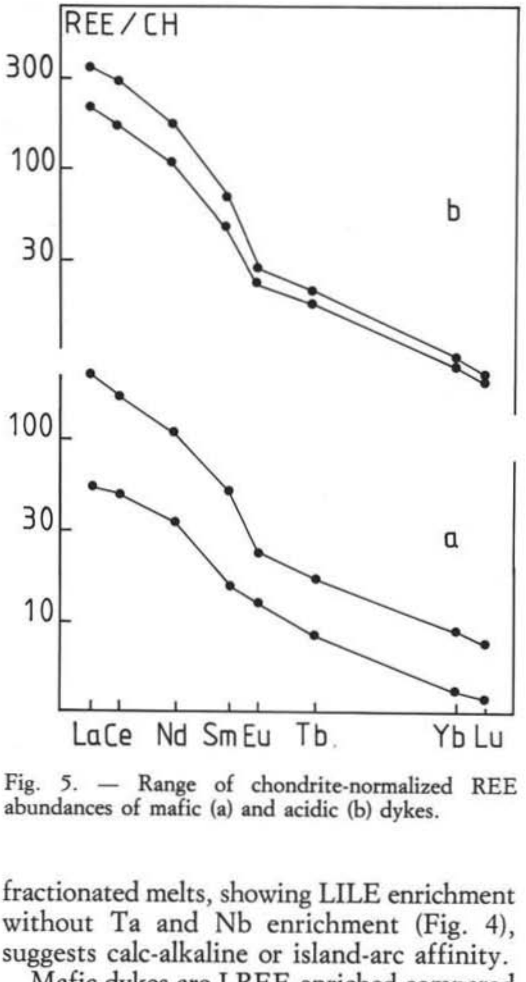

Fig. 5. — Range of chondrite-normalized REE abundances of mafic (a) and acidic (b) dykes.

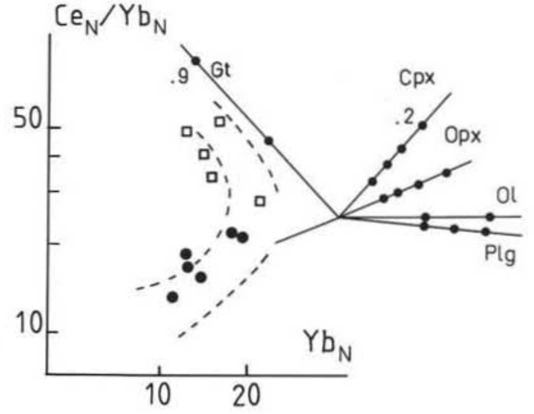

Fig. 6. — Plot of Ce_N/Yb_N vs. Tb_N for analyzed rocks. Solid circles: dykes characterized by D.I. values < 65 and Th contents < 15 ppm; squares: dykes showing D.I. values > 65 and Th contents > 25 ppm. Intrusive rocks plot between the dashed lines. Element variation during fractional crystallization (lines) and proportion of melt remaining (numbers along lines) are reported.

fractionated melts, showing LILE enrichment without Ta and Nb enrichment (Fig. 4), suggests calc-alkaline or island-arc affinity.

Mafic dykes are LREE-enriched compared to HREE and display both LREE and HREE fractionated patterns (Fig. 5). The more evolved dykes show increasing LREE contents and similar HREE values, with little or no Eu anomaly and strongly REE fractionated patterns.

Analysed samples define two different trends in the Ce_N/Yb_N vs. Yb_N diagram (Fig. 6). Mafic dykes define a positive correlation suggestive of fractional crystallization processes (mainly olivine and pyroxene), whilst acidic dykes are characterized by a negative correlation indicative of partial melting processes leaving some garnet in the residual. Most of the intrusive rocks fall along these main trends.

The resulting petrogenesis is highly complex, suggesting the contemporaneous presence of two different magma types both from mantle and deep crustal sources:

— ultramafic-mafic rocks and dykes were derived by crystal fractionation starting from a magnesium-rich basaltic magma;

— most of the diorite-granite rock sequence was produced by partial melting of lower crust (granulite-amphibolite facies conditions).

The mantle-derived magmas probably provided the high heat flow responsible for melting of the lower crust.

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