



Sm-Nd model age of an early Proterozoic gabbro-anorthosite from the Caledonian fold belt in North-East Greenland

Ole Stecher and Niels Henriksen

Metamorphosed anorthositic and gabbro-anorthositic rocks are found as scattered occurrences in the basement gneisses of the Caledonian fold belt of North-East Greenland. A $T_{\text{DM}}^{\text{Sm-Nd}}$ model age determined on a gabbro-anorthositic sample yields a value of 2146 Ma. This model age is in agreement with the general age of crust formation in the region. The result shows that anorthosites, which are of Archaean derivation in many areas in Greenland, cannot on their own be used as an indicator of Archaean crust.

O. S. & N. H., Geological Survey of Greenland, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark.

Occurrences of metamorphosed anorthositic and gabbro-anorthositic rocks are widespread in Greenland in both Archaean and reworked Archaean regions. Their occurrence has been suggested as an indicator of Archaean age (Pulvertaft, 1973), and this relationship has proved correct for many areas in West Greenland (Nunes *et al.*, 1974; Kalsbeek, 1982, 1994; Nutman, 1984; Garde & Steenfelt, 1989).

In the Caledonian fold belt of North-East Greenland between 74° and 78°N, Rb-Sr isotope data and Sm-Nd model ages of basement gneisses indicate an early Proterozoic crust formation event around 2000 Ma ago (Kalsbeek *et al.*, 1993). Within this region anorthositic and gabbro-anorthositic rocks occur as: (1) isolated occurrences of foliated and folded rocks on a semi-nunatak about 2 × 3 km in size at the rim of the Inland Ice west of Bessel Fjord (c. 76°00'N; Henriksen *et al.*, 1989), and (2) as layers and lenses in grey gneisses south-west of Dove Bugt (c. 76°30'N) (Chadwick *et al.*, 1990; Chadwick & Friend, 1991). Both occurrences typically consist of well foliated rocks, but relict igneous textures are preserved in areas of low deformation. We interpret the anorthositic rocks as originally forming part of a major intrusive complex or complexes.

The presence of these metamorphosed gabbro-anorthositic rocks in the early Proterozoic basement gneiss complex led us to date one of these occurrences in order to test whether the hypothesis of an Archaean derivation was also valid for this part of Greenland. The analysed sample (GGU 327935) was taken from the semi-nunatak

west of Bessel Fjord (Fig. 1) which is dominated by anorthositic and gabbro-anorthositic rocks. To the east the gabbro-anorthosite is bordered by a probable fault obscured by Quaternary deposits, which separates the gabbro-anorthosites from a belt of non-migmatized mica schists.

The anorthositic and gabbro-anorthositic rocks display mesoscopic banding conformable with the regional foliation. The rocks have suffered variable degrees of deformation with alternating zones of high and low strain, and appear to be completely recrystallised. Thin sections from several samples indicate the following paragenesis: plagioclase (An₇₀) 80–90%, quartz 3–5%, hornblende 7–10%, garnet 0–2%, opaque minerals 0–2%. Epidote and chlorite are present as secondary mineral phases.

Analytical data and results

The gabbro-anorthositic rock was analysed by XRF for major elements, and Sm-Nd concentrations and isotope composition were determined by mass-spectrometry (Table 1).

A mixed ^{147}Sm - ^{150}Nd spike was added to the sample prior to dissolution. The REEs were separated on standard cation exchange resin columns, and Sm and Nd were isolated on capillary quartz columns using α -HIBA.

Isotope determinations were performed on a VG 3540 multicollector mass-spectrometer at the Geological Institute, Copenhagen University. The $^{143}\text{Nd}/^{144}\text{Nd}$ ratio is reported relative to a $^{143}\text{Nd}/^{144}\text{Nd}$ value of 0.511118 for

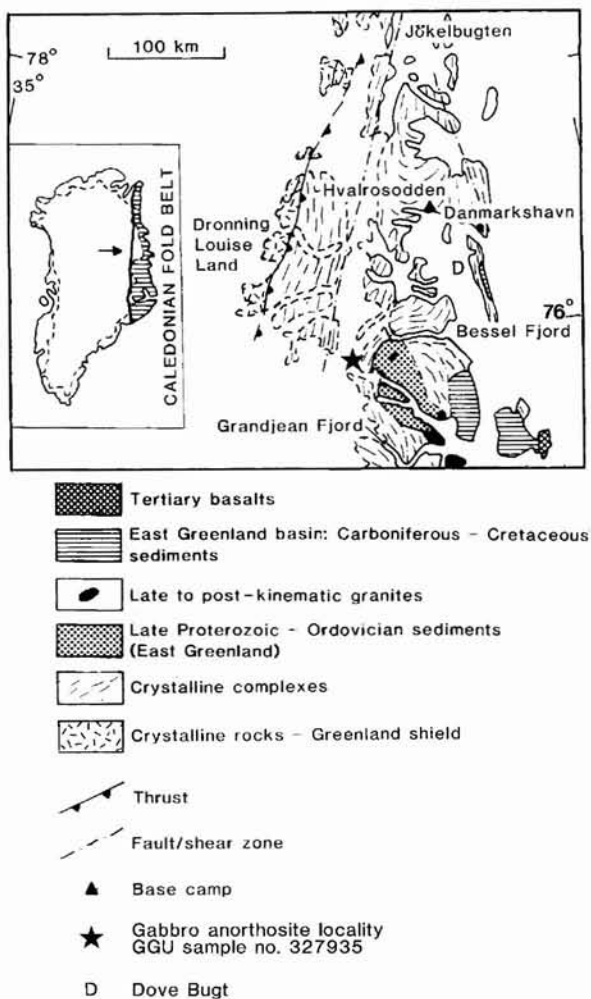


Table 1. Major elements and Sm-Nd data for anorthosite from North-East Greenland

SiO ₂	49.68	Sm	0.2690 ppm
TiO ₂	0.19	Nd	1.1347 ppm
Al ₂ O ₃	26.89	¹⁴⁷ Sm/ ¹⁴⁴ Nd	0.14328
Fe ₂ O ₃ ^{TOT}	4.12	¹⁴³ Nd/ ¹⁴⁴ Nd	0.512034±6 (2 s)
MnO	0.06	T _{Nd} ^{CHUR}	1719 Ma
MgO	2.88	T _{Nd} ^{DM}	2146 Ma
CaO	13.07		
Na ₂ O	2.78		
K ₂ O	0.08		
P ₂ O ₅	0.00		
vol.	0.39		
	100.14		

Sample GGU 327935.

Major elements given as wt % by XRF, Fe₂O₃^{TOT} is total iron analysed as Fe₂O₃; Sm and Nd concentrations determined by isotope dilution. Sm/Nd is accurate to within 0.2%.

the Johnson & Matthew Nd standard, and has been corrected for fractionation using a ¹⁴⁶Nd/¹⁴⁴Nd value of 0.7219.

The anorthositic parent rock magma is considered to have a mantle origin, and since most mafic and anorthositic Archaean and Proterozoic rocks from Greenland, in common with rocks from other Precambrian complexes, are characterised by slightly positive ε_{Nd} values (Stecher *et al.*, 1986), we believe that the T_{Nd}^{DM} model age of DePaolo (1981) gives a better indication of crust extraction age than the T_{Nd}^{CHUR} model age of DePaolo & Wasserburg (1976) for this rock sample.

The analysed gabbro-anorthositic rock has a T_{Nd}^{DM} model age of 2146 Ma, which is significantly lower than that of anorthositic rocks from the Archaean of West Greenland (Ashwal *et al.*, 1989; Stecher *et al.*, 1986), and clearly indicates an early Proterozoic origin for this anorthositic rock.

Model ages calculated from rocks with limited fractionation of Sm/Nd relative to their mantle source often prove inaccurate, but the anorthositic sample we have analysed is sufficiently fractionated in Sm/Nd relative to its mantle source that more credence can be given to its model age.

Conclusion

Gabbro-anorthositic and anorthositic rocks from Greenland are well known from Archaean and reworked Archaean areas in West Greenland, and has been suggested as potential indicators for crust of Archaean age. The Sm-Nd model age determination reported here for a sample from basement units within the Caledonian fold belt in North-East Greenland indicates an early Proterozoic (2146 Ma) model age for anorthositic rocks, which is in agreement with the general age of crust formation in the region (Kalsbeek *et al.*, 1993). We therefore conclude that the occurrence of gabbro-anorthositic and anorthositic rocks cannot on its own be used as an indicator of Archaean age crust in this region, and potentially elsewhere.

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