A Rb-Sr age and isotope study of the Ikertôq, Nordre Strømfjord, and Evighedsfjord shear belts, West Greenland – outline and preliminary results

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Project outline

In the 1977 and 1978 field seasons, samples were collected from both the Ikertôq and Nordre Strømfjord shear belts and adjacent unsheared terrains. The samples represent the main rock-forming and shear zone-forming events in these two areas. In addition, samples for preliminary study were collected by S. B. Jensen and J. Allaart from sheared and unsheared gneisses in the Evighedsfjord region. Rb-Sr total rock analyses will be carried out on all samples. Suitably banded samples of both sheared and unsheared gneisses will be cut along compositional layering to examine the Rb-Sr system on a small whole rock scale. The main Sr-bearing mineral phases of samples throughout the study area will also be analyzed.

The purpose of this study is threefold. First, it will establish the geochronological framework of the main rock-forming and shear zone-forming events in this region. Second, it will help to clarify the thermo-tectonic history of the study area (especially in its first stages), mainly through the use of Rb-Sr mineral analyses. Two mineral age traverses will be produced, one north–south traverse along the coast between Ågto and Evighedsfjord, and another east–west traverse from the coast 70 km inland along Nordre Strømfjord.

The third aim of the study is to investigate the response of the Rb-Sr isotope system to intense deformation in the shear belts. This region lends itself to such an investigation for two main reasons: (a) the age(s) of deformation can be independently established using syn- to late-tectonic intrusive rocks; (b) the time period between the origin of the gneisses and the formation of the shear belts is long, from several hundred to 1000 m.y., and thus sufficient for significant isotopic heterogeneity to develop prior to deformation.

Rock units sampled

Ikertôq region

For descriptions and discussion of this region see Grocott (this volume), Nash (this volume), Bak *et al.* (1975).

Unsheared, granulite facies gneisses were collected from three localities: the Akornga inlet (12 km north of Holsteinsborg), the town of Holsteinsborg, and at Kíngaq, a large undeformed granulite facies area within the Ikertôq shear belt. Several types of dykes intruding the gneisses were also sampled, including a 20 m wide Kangâmiut dyke in the Kíngaq area, a late- to post-Nag. 2 diorite dyke swarm at Akornga (see Davidson & Park, 1978), several ages of pegmatites, and a group of late, cross-cutting kimberlite and lamprophyre dykes.

From within the shear belt, gneisses affected by varying intensities of Nag. 1 deformation were collected from four sites near the settlement of Itivdleq, while those affected by Nag. 2 deformation were collected from three sites on the island of Ũmánârssuk.

Nordre Strømfjord region

For descriptions and discussion of this region see Olesen *et al.* (this volume), Bak *et al.* (1975).

Several suites of samples were collected outside the shear belt, in the Agto archipelago. Gneisses of the Tikerâq complex (Sørensen, 1970) are structurally the oldest rocks in the area. In addition to these, migmatitic gneisses from the settlement of Agto, the charnockite of Rifkol (Hansen, this volume), and a large metadolerite dyke were sampled.

Within the shear belt itself, suites of samples from sheared gneisses and syntectonic pegmatitic neosome were collected in three localities. Late cross-cutting intrusives, a lamprophyre and a number of pegmatite dykes, were also sampled.

Evighedsfjord region

For a description and discussion of this region see Allaart & Jensen, 1979.

Twenty-three samples, including banded gneisses for small whole rock work, from within and adjacent to the Aujassoq shear belt were collected for this study by J. Allaart and S. B. Jensen.

Preliminary results

All errors quoted are at the two sigma level. Isochron parameters were calculated using the least squares linear regression of York (1967). The decay constant used for ^{87}Rb is 1.42 $\times 10^{-11} yr^{-1}$. Results are preliminary and should be stated as such if cited.

1. Seven whole rock samples of granulite facies gneiss from the town of Holsteinsborg appear to have an age of about 3000 m.y. and a slightly elevated initial $^{87}Sr/^{86}Sr$ ratio (I.R. = 0.7034 ± 0.0003).

2. Six whole rock samples of tonalite gneiss from a minor Nag. 1 shear zone in largely undeformed granulites at Kíngaq appear not to have been isotopically disturbed by deformation, and also have an age of about 3000 m.y., but with a lower initial $^{87}Sr/^{86}Sr$ ratio (I.R. = 0.7009 ± 0.0005). The samples analyzed so far from these two areas have extremely low and restricted present-day $^{87}Sr/^{86}Sr$ ratios, ranging from 0.7015 to 0.7082, with an average of 0.7045. Thus while the ages they yield are not very precise, the initial ratios are. Further implications of these data are discussed below.

3. Six samples of aplite associated with a late-Nag. 1 pegmatite near Itivdleq have a Rb-Sr isochron age of 2500 ± 40 m.y. (I.R. = 0.7021 ± 0.0002).

4. Two whole rock samples from a syn-Nag. 2 pegmatite, occurring between boudins of a deformed Kangâmiut dyke at Søndre Strømfjord air base, yield an age of 1670 ± 150 m.y. (I.R. = 0.7190 ± 0.0001).

Consistent with this result are data from the late- to post-Nag. 2 diorite dyke complex north of Holsteinsborg, which indicate an age of about 1700 m.y.

5. Whole rock samples of amphibolite facies gneiss from an area of moderately strong Nag. 1 deformation near Itivdleq give mixed results. Of eight samples, six fall on an isochron corresponding to an age of about 3000 m.y. (I.R. = 0.7012 ± 0.0005), while those with the highest Rb/Sr ratios fall below it.

6. Data for nine samples from Nordre Strømfjord, collected for preliminary study by the Aarhus University Agto Group in 1977, are scattered, but generally form three groups on an isochron diagram, corresponding to the three sample localities. Data from each locality (Depothavn, Nûk, Sikuartût) give apparent ages in the range 1800 ± 200 m.y., but with initial $^{87}Sr/^{86}Sr$ ratios that vary widely from one locality to the next (0.703, 0.720 and 0.760).

Conclusions

1. Gneisses along the coast south of Holsteinsborg have an original age of about 3000 m.y. Samples from Holsteinsborg may have had a significant crustal history prior to that time, if their apparent slightly elevated initial $^{87}Sr/^{86}Sr$ ratio is substantiated by further work.

The extremely depleted Rb/Sr ratios and subsequently extremely low present-day $^{87}Sr/^{86}Sr$ ratios of mainly tonalitic gneisses in this region have possible implications for the usefulness of initial $^{87}Sr/^{86}Sr$ ratios as petrogenetic indicators or indicators of previous crustal residence time of continental material. The Sr isotope evolution of this crustal segment has not been significantly different from the evolution of the mantle since about 3000 m.y. ago. Granitic melts derived from such a terrain at any time up to the present would have 'mantle' initial ratios and yet could hardly be considered as new additions to the crust.

2. Nag. 1 deformation has a minimum age of 2500 ± 40 m.y., the age of the late-Nag. 1 aplites near Itivdleq. Nag. 2 deformation has an age of about 1700 m.y., based on data from a syn-Nag. 2 pegmatite and a late- to post-Nag. 2 diorite dyke swarm. These ages for the two phases of Nagssugtoqidian deformation are in agreement with the findings of Kalsbeek (this volume) and of Pedersen & Bridgwater (this volume) for other areas in the Nagssugtoqidian.

3. Moderate deformation during Nag. 1, both in a small, isolated shear zone in the Kíngaq granulites, and in the main zone of deformation around Itivdleq, failed to reset or substantially disturb the Rb-Sr isotope system on a whole rock scale in most samples. There is a suggestion from two samples near Itivdleq that a significant increase in Rb content may have accompanied deformation in their case (see Pedersen & Bridgwater, this volume; Bridgwater *et al.,* 1978, for other examples of this phenomenon).

4. The few data so far available from the Nordre Strømfjord region suggest an intense metamorphism there which was roughly contemporaneous with Nag. 2 elsewhere. This metamorphism appears to have caused local, not regional, isotopic rehomogenization on a whole rock scale. Two of the sample localities (Depothavn, Nûk) lie within the Nordre Strømfjord shear belt, and the third (Sikuartût) lies southeast of it, so the metamorphic age may or may not correspond to the age of shearing deformation in this region.

5. In comparing the Ikertôq and Nordre Strømfjord results, it is interesting that whole rock samples collected on an outcrop scale in the former region generally have not been sufficiently disturbed by any subsequent event to reset their *c.* 3000 m.y. age; certainly there

is no suggestion of a Proterozoic metamorphism such as that in Nordre Strømfjord. Thus there appears to be an isotopic age province boundary between the two regions. The relationship of this boundary to the thermal and tectonic history of the regions has yet to be defined.

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