

Age of Gneissic Rocks in the Caledonian Nappes of the Alta District, Northern Norway

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Results of a Rb-Sr geochronological investigation are presented which confirm the Precambrian age of gneisses forming parts of the Skillefjord and Nalganas Nappes of the West Finnmark Caledonian allochthon. In the case of the Skillefjord Nappe, granodiorite dykes which cut tonalitic gneisses have yielded an isochron age of ca. 3,000 Ma B.P., thus indicating the presence of Archaean elements tectonically incorporated in the nappe pile during the Finnmarkian orogenesis.

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Introduction

The Caledonides of Finnmark are characterized by a series of relatively thin allochthonous nappes, some of which contain a distinctive basement-cover couplet (Ramsay et al. 1985). These nappes are separated from the autochthon by a complex of duplex thrust packets grouped traditionally as the Gaissa Nappe (Roberts 1985). The main tectonometamorphic development in the allochthon, and the principal *mise-én-place* of the nappes occurred during the Finnmarkian orogeny dated to 535 - 485 Ma (Sturt et al. 1978, Roberts 1985). The discovery of a major unconformity at the base of the lowest stratigraphic unit, the Klubben Group, in a number of nappes within the Kalak Nappe Complex showed the substrate to comprise both Precambrian orthogneiss and paragneiss complexes (Ramsay & Sturt 1978, Ramsay et al. 1979, 1985). The present contribution provides results of a Rb/Sr geochronological investigation of the rocks of the basement plinths in two of these nappes.

Analytical procedure

Rb and Sr were determined by X-ray fluorescence. Mass spectrometry was performed using a VG Micromass 30 mass spectrometer at the Mineralogical Museum in Oslo. Variable mass discrimination was corrected by normalizing the $^{87}\text{Sr}/^{86}\text{Sr}$ to 8.3752. The ^{87}Rb decay constant used was 1.42×10^{-11} per year. Regression lines were calculated using the technique of York (1969). In assigning errors to the regression points the

coefficient of variance for Rb/Sr is taken to 1%. All errors quoted in this paper are at the 2-sigma confidence level.

The gneissic plinth of the Skillefjord Nappe

The lowest allochthonous unit of the Kalak Nappe Complex in the area west of the Komagfjord tectonic window is the Skillefjord Nappe. This nappe is separated from the Svecokarelian Raipas rocks of the window and their thin autochthonous cover by a parautochthonous nappe (Kviby Nappe) consisting predominantly of Svecokarelian supracrustals (Ramsay et al. 1984). The Skillefjord Nappe comprises a basement-cover pair separated by a primary stratigraphic unconformity (Sturt et al. 1981). The rocks above the unconformity are dark psammites and semi-pelites which have strong resemblance to the dark sandstones of the Alta tectonic window and may possibly be of Svecokarelian age. The cover sequence has been affected by garnet-grade Caledonian metamorphism.

The basement plinth comprises a series of tonalitic gneisses with a complex tectonic fabric which is cut by innumerable granodioritic dykes. These dykes are excellently exposed at the roadside on the north side of Skillefjord (856832) where they locally form net-vein complexes. A series of specimens was collected of the dykes and of the background gneiss complex that they intrude.

Eight samples from the dykes of granodiorite together with eight samples from the background gneiss complex were analysed and the results are listed in Table 1 and plotted in Fig. 1. Regression of all eight dyke samples falls on a line (MSWD 2.4) which defines an age of 3044 ± 50 m.y. with an initial $^{87}\text{Rb}/^{86}\text{Sr}$ ratio of 0.69915 ± 0.00082 . This initial ratio appears to be on the low side and since it depends strongly on the sample with the lowest $^{87}\text{Rb}/^{86}\text{Sr}$ ratio, this sample was excluded from the regression analysis. The remaining 7 samples define an age of 2784 ± 302 m.y. with an initial ratio of 0.70488 ± 0.0066 (MSWD = 2.4).

As can be seen from Fig. 1, the samples from the background gneiss complex do not define a line and they all lie below the isochron defined by the dykes. An average model age for the background complex is calculated to 2414 m.y. by assuming an initial ratio of 0.7000. This suggests that not only was the background complex opened with respect to Rb and Sr, but indicates also that all samples of the background complex

have lost Sr^{87} or gained Rb. This open system behaviour of the background gneisses throws some doubt on the Archaean age attained for the dykes as one may suspect the dykes to have gained Sr^{87} released from the background gneisses or released Rb to the gneisses. It is therefore urgent to verify this Archaean age by separate dating methods, preferably U-Pb on zircons. This would show whether the age is significant or that the obtained isochron is rotated due to Sr^{87} addition or Rb depletion. Until then this work can only be considered as an indication of an Archaean age for the gneisses in the Skillefjord Nappe. It is of interest that I.R. Pringle obtained a preliminary age of 2706 ± 150 Ma for dykes in the same unit, though further along strike (Ramsay & Sturt 1977).

Regardless of the age of the dykes, this work has important implications for Rb-Sr systematics. It leaves one with a choice between discharging well defined dykes as meaningless in terms of age or to admit that whole-rock model ages may give systematically wrong results.

The gneissic plinth of the Nalganas Nappe

A small window through the cover sequence of the Nalganas Nappe exposes the gneissic plinth of that nappe at Eibyelv (865445). The contact between the cover and basement is not a locus of high strains and appears to be a primary unconformity; this latter observation has been confirmed by K.B. Zwaan (pers. comm. 1983) who has demonstrated the presence of a basal conglomerate. The basement unit consists of variably migmatitic gneisses which exhibit complex deformational patterns. The penetrative foliation in these gneisses is cut by a series of sheets of tonalite up to 2 m thick. These tonalite sheets are variably affected by subsequent Caledonian strains.

Eight specimens from the tonalites were analysed and the results are listed in Table 1 and plotted in Fig. 2. A regression analysis of all eight samples gives a result of 1175 ± 537 Ma (MSWD = 85, I.R. = 0.70855 ± 0.00258). The very high MSWD value of 85.0 is to a large extent caused by one sample, which plots away from the trend defined by the remaining seven samples (Fig. 2). If this sample is excluded, for which we have no geological reason, the remaining samples indicate an age of 1533 ± 329 Ma (MSWD = 13.6, I.R. = 0.70655 ± 0.00166). In spite of the large error this result suggests a mid-

Table 1. Rb, Sr analytical data from the granodiorite dykes.

Sample no.	Rb(ppm)	Sr(ppm)	$^{87}\text{Rb}/^{86}\text{Sr}$	$^{87}\text{Sr}/^{86}\text{Sr}$	SE(2)
KD 78	88.9	178.9	1.445	0.76292	± 0.00012
KD 79	102.6	556.6	0.534	0.72270	" 0.00016
KD 80	88.3	197.5	1.300	0.75750	" 0.00314
KD 81	99.3	178.2	1.622	0.77044	" 0.00016
KD 82	113.9	227.6	1.456	0.76576	" 0.00014
KD 83	94.0	173.7	1.574	0.76727	" 0.00016
KD 84	87.8	163.7	1.560	0.76858	" 0.00016
KD 85	87.6	171.0	1.489	0.76391	" 0.00022
KD 86	108.8	135.7	2.335	0.77133	" 0.00014
KD 87	127.1	173.1	2.139	0.77976	" 0.00012
KD 88	131.8	203.0	1.889	0.76831	" 0.00010
KD 89	106.5	168.2	1.841	0.76103	" 0.00016
KD 90	120.0	149.0	2.344	0.77319	" 0.00024
KD 91	125.7	133.0	2.758	0.79663	" 0.00018
KD 92	135.7	221.7	1.782	0.77345	" 0.00012
KD 93	90.2	121.6	2.160	0.76948	" 0.00020
Average	118.2	163.1	2.111	0.7736*	

* Weighed average of $^{87}\text{Rb}/^{86}\text{Sr}$.

Rb, Sr analytical data from tonalite sheet

KD 64	55.7	350.2	0.460	0.71618	± 0.00007
KD 65	46.1	341.6	0.391	0.71543	" 0.00009
KD 66	41.9	433.7	0.281	0.71236	" 0.00007
KD 67	37.8	502.2	0.218	0.71394	" 0.00009
KD 68	43.9	367.7	0.345	0.71462	" 0.00007
KD 69	55.0	421.1	0.379	0.71464	" 0.00009
KD 70	54.8	394.1	0.402	0.71554	" 0.00006
KD 71	39.1	417.0	0.272	0.71266	" 0.00005

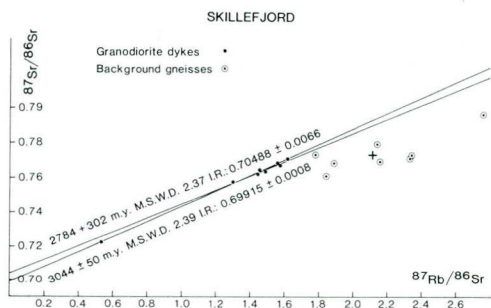


Fig. 1. Isochron plot for granodiorite dykes and background gneisses from the Skillefjord Nappe at Skillefjord, W. Finnmark. The cross (+) indicates the average of all eight samples of background gneisses.

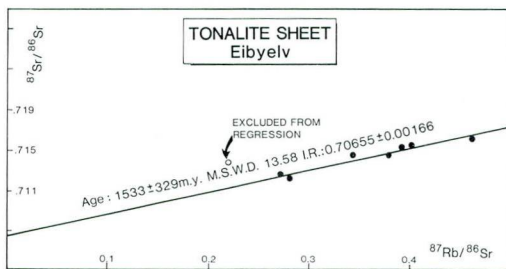


Fig. 2. Isochron plot for tonalite sheet in the basement plinth of the Nalganas Nappe, Eibyelv, W. Finnmark.

Proterozoic age for the tonalite sheets, and provides a minimum age for the background gneiss.

Conclusions

The results of this investigation confirm the Precambrian age of gneissic rocks in two of the Finnmarkian nappes. The indication of an Archaean age of rocks of the basement plinth to the Skillefjord Nappe is of particular interest as this is the only example where basement as old as Archaean has been identified in the allochthonous nappes of the Scandinavian Caledonides.

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