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Rb-Sr isochron ages from east Milne Land, Scoresby Sund, East Greenland

B. T. Hansen and H. Tembusch

A prominent NNE–SSW trending fault in central Scoresby Sund, separates the eastern part of Milne Land geologically from the rest of the island. This east Milne Land fault block, comprises metasediments bounded by a variety of post-kinematic intrusions in which three

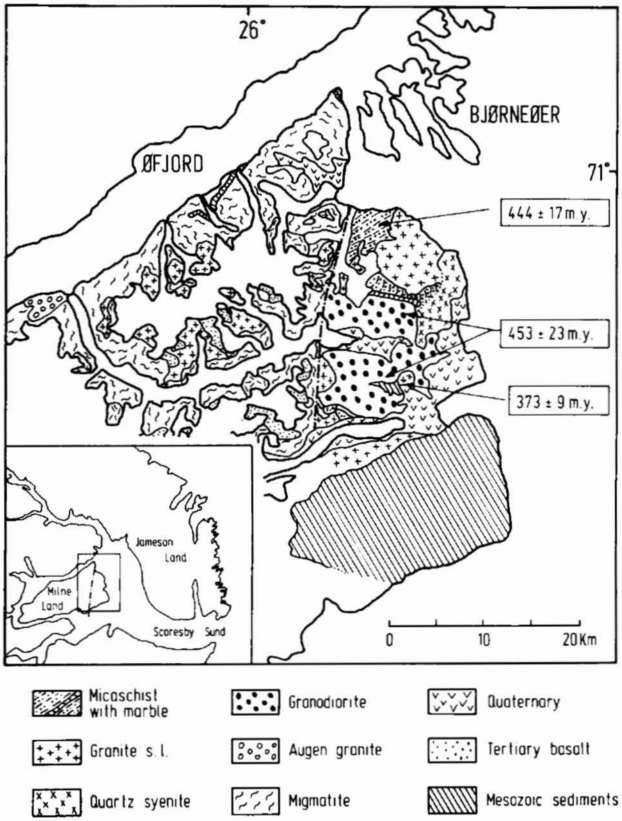

Fig. 33. Geological map of the east Milne Land fault block, showing locations of dated samples. Geology after Henriksen & Higgins (1971).

major plutonic rock types are found. Field investigations indicate the oldest plutonic rock to be a granodiorite, followed by a coarse-grained mafic, quartz syenite, and the youngest bodies to be of granitic composition. In the southern part a large area is covered by Mesozoic sediments which cross the fault-line without displacement. Locally, outliers of Tertiary plateau basalts rest on the Mesozoic rocks (fig. 33).

The geology has been outlined by Henriksen & Higgins (1971, 1973) and preliminary age determinations were published by Hansen *et al.* (1972) and Hansen & Steiger (1976). This more extensive study deals with Rb-Sr whole-rock and mineral analyses on samples from two post-kinematic intrusions and from the metasediments in the northern area.

Metasediments

The main outcrops occur in the north. They include quartzites, mica quartzites, mica schists and marbles. The sediments are extremely well banded and ripple marks and cross-bedding are preserved.

The isolation of the east Milne Land metasedimentary sequence from other sedimentary

Table 7. Rb-Sr isotope data from mica schists, east Milne Land

GGU sample no.	Location	Rock type	Rb ppm	Sr ppm	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	Age m.y.
108761	70°57'07"N, 25°37'13"W	Mica schist	138	235	1.70	0.7500	
108763	70°57'22"N, 25°38'47"W	" "	127	97	3.80	0.7638	
108766	70°56'47"N, 25°38'26"W	" "	136	77	5.15	0.7737	444±17
142381*	70°58'08"N, 25°38'36"W	" "	145	263	1.60	0.7378	
166851	70°58'07"N, 25°34'15"W	" "	137	38	10.54	0.8069	
166853	70°58'07"N, 25°34'15"W	" "	134	31	12.64	0.8145	
166852	70°58'07"N, 25°34'15"W	Aplite in mica schist	158	131	3.49	0.7524	411±10
166852 Bi	70°58'07"N, 25°34'15"W	" "	791	3	1358	8.684	

Decay constant: $1.42\times10^{-11}\ y^{-1}$ — *Not included in isochron age calculation

$^{87}Rb/^{86}Sr$ ± 2%, $^{87}Sr/^{86}Sr$ ± 0.02%. Errors quoted at 2σ level — Bi: biotite

sequences in the inner fjord zone makes correlation difficult, but it is in some respects comparable to parts of the Krummedal supracrustal sequence. Six samples were taken from the northern mica schists to reveal the stratigraphy of the metasediments. The isotopic ratios are tabled and plotted (Table 7 and fig. 34). Five of the six samples plot along an isochron with a slope corresponding to an age of 444±17 m.y. The initial ratio is 0.7395±0.0008. It is believed this reflects a complete resetting during Caledonian times. The initial ratio is higher than the 0.725 ratio obtained for Caledonian reset sediments of the Krummedal supracrustal sequence (Hansen *et al.,* 1978). Thus the sediments of east Milne Land might be correlated with the ones of the Krummedal supracrustal sequence, of which the first metamorphism has been dated to 1122 m.y. There is some petrological evidence for an earlier metamorphism of the east Milne Land sequence. The micas are very often arranged in polygonal arches around microscopic folds of a later phase indicating that there was recrystallization subsequent to folding (Higgins, personal communication). One sample (142381) has been omitted from isochron calculation because it is slightly chloritisised, which may have caused loss of radiogenic strontium. Sample 166853 also falls slightly below the isochron.

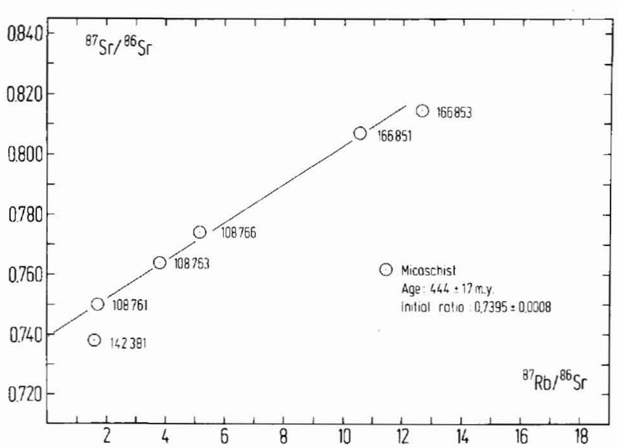

Fig. 34. Rb-Sr whole-rock isochron diagram for mica schists from the northern part of east Milne Land.

Table 8. Rb-Sr isotope data from the granodiorite, east Milne Land

GGU sample no	Location	Rock type	Rb ppm	Sr ppm	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	Age m.y.
135501 Bi	70°49'23"N, 25°34'53"W	Granodiorite	606	34	53.1	1.0145	405±10
135501	70°49'23"N, 25 34'53"W	"	136	442	0.890	0.7130	405±10 / 453±23
135503*	70°49'10"N, 25°34'55"W	"	88	457	0.559	0.7117	453±23
135627	70°52'04"N, 25°44'31"W	"	107	565	0.547	0.7106	453±23
135676	70°48'38"N, 25°43'50"W	"	119	530	0.649	0.7113	453±23
135678	70°47'35"N, 25°43'42"W	"	169	427	1.145	0.7142	453±23
135686	70°47'37"N, 25°42'14"W	"	128	520	0.712	0.7118	453±23
166834	70°52'24"N, 25°31'18"W	"	145	432	0.972	0.7133	453±23
166835	70°52'28"N, 25°30'54"W	"	150	471	0.925	0.7132	453±23
166836	70°52'42"N, 25°31'26"W	"	134	485	0.801	0.7122	453±23
166838	70°48'43"N, 25°31'43"W	"	86	435	0.575	0.7106	453±23
166832	70°52'34"N, 25°31'28"W	Aplite in granodiorite	352	52	19.7	0.8318	425±28
166833	70°52'31"N, 25°31'28"W	"	269	83	9.39	0.7694	425±28

Decay constant: 1.42 ± 10^{-11} y^{-1} — *Not included in isochron calculation

$^{87}Rb/^{86}Sr$ ± 2%, $^{87}Sr/^{86}Sr$ ± 0.02%. Errors quoted at 2σ level — Bi: biotite

A loss of radiogenic strontium might be related to the intrusion of an aplite (166852) at this location. The aplite shows no sign of metamorphism thus suggesting a whole-rock biotite age of 411±10 m.y. The age of the intrusion of the aplite and also a lower time limit for the last metamorphism of the mica schists is shown.

Granodiorite

The granodiorite is the oldest of the plutonic rocks found in east Milne Land. It forms a thick sheet-like body and is bordered by a marble to the north and the south. The granodiorite is mesocratic and medium-grained, comprising hornblende, biotite, plagioclase dominant over microcline, and quartz. Mafic inclusions of igneous origin are regularly distributed, but are concentrated locally (?) in zones.

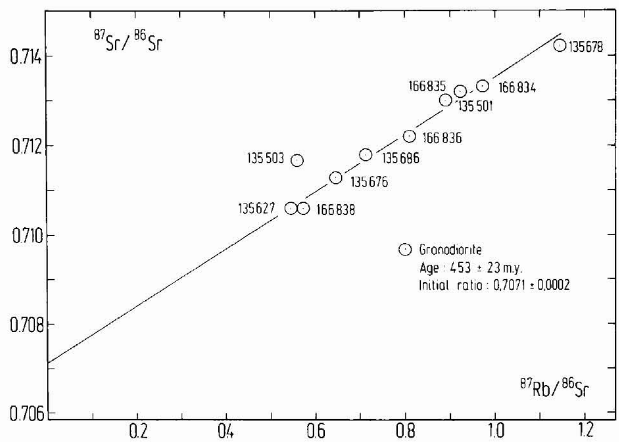

Fig. 35. Rb-Sr whole-rock isochron diagram for the granodiorite, east Milne Land.

Table 9. Rb-Sr isotope data from the pink biotite granite, east Milne Land

GGU sample no.	Location	Rock type	Rb ppm	Sr ppm	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	Age m.y.
166839	70°48'18"N, 25°33'24"W	Pink bi-granite	319	123	7.53	0.7571	
166840	70°48'22"N, 25°33'02"W	" "	341	112	8.87	0.7638	
166841	70°48'29"N, 25°32'52"W	" "	334	109	8.89	0.7634	
166842	70°48'43"N, 25°32'47"W	" "	332	108	8.96	0.7638	373±9
166843	70°48'40"N, 25°32'03"W	" "	356	97	10.66	0.7734	
166844	70°48'38"N, 25°32'22"W	" "	348	103	9.81	0.7671	
166848	70°48'29"N, 25°34'20"W	" "	283	192	4.26	0.7389	
166845	70°48'18"N, 25°32'42"W	Basic inclusion	89	303	0.852	0.7125	406±13
166846	70°48'19"N, 25°32'59"W	" "	541	182	8.63	0.7575	

Decay constant: 1.42×10^{-11} y^{-1}

$^{87}Rb/^{86}Sr$ ± 2%, $^{87}Sr/^{86}Sr$ ± 0.02%. Errors quoted at 2σ level

Six samples from within the granodiorite have been collected in the south and four in the north (fig. 33). The Rb-Sr isotope date is tabled and plotted in Table 8 and fig. 35. Nine of the ten points lie on an isochron with a slope corresponding to an age of 453±23 m.y. and with an initial ratio of 0.7071±0.0002. This age is regarded as the time of intrusion during an early stage of the Caledonian orogeny. However, this contradicts a preliminary biotite age of 1460±20 m.y. (sample 135501) published by Hansen *et al.* (1972). The discrepancy was tested by separating a new biotite concentrate from the original specimen and the whole-rock biotite age obtained on this sample (135501) is 405±10 m.y., which is interpreted as a cooling age. This age is believed reliable, as further microscopic studies have shown that the first sample has contained a fine network of hydrothermal veins, thus the rock may not have acted as a closed system with respect to rubidium and strontium. The first biotite determination showed an unusually low content of rubidium. The position of the whole-rock data point for sample 135503 might also be related to open system behaviour. This sample, collected a few hundred metres further north, also shows fine hydrothermal veins and is therefore excluded from the isochron calculation.

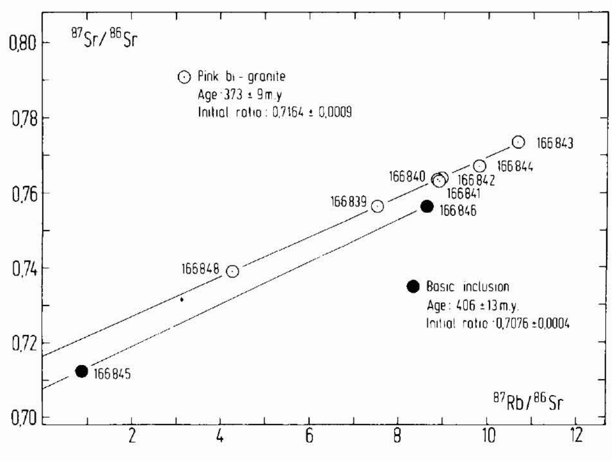

Fig. 36. Rb-Sr whole-rock isochron diagram for samples from the pink granite and the basic inclusion, east Milne Land.

A lower time limit for the intrusion of the granodiorite is given by two whole-rock analyses on a discordant aplite giving an age of 425±28 m.y. (Table 8).

Pink biotite granite

Two different types of granites are found in east Milne Land. The first type in the north of the area is medium-grained, leucocratic biotite granite comparable to many of the major plutons of the Stauning Alper (Henriksen & Higgins, 1969). The second occurs in the south, mainly as small circular plugs punching up through the granodiorite. One of the southern granite plugs, about 1500 m in diameter, has an inclusion of basic rock near the centre. Samples from the granite and the basic inclusion have been analysed and the isotopic data are tabled and plotted in Table 9 and fig. 36. The seven granite samples plot on an isochron with an age of 373±9 m.y. The figure is lower than a preliminary age published by Hansen & Steiger (1976) and clearly confirms that the plugs intruded at a very late stage of the Caledonian orogeny. An age of 373±9 m.y. is identical, within limits of error, to the K-Ar biotite ages of post-tectonic intrusive granites reported by Haller & Kulp (1962) and a biotite K-feldspar age of 386±5 m.y. for a pegmatite reported by Hansen & Steiger (1971).

Two samples from the basic inclusion gave an age of 406±13 m.y. This body is now interpreted as a large inclusion of older material, having undergone isotopic rehomogenization and recrystallization when the granite intruded.

The above results offer evidence that the main plutonic activity and metamorphic overprinting of the rocks in east Milne Land took place during Caledonian times.

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Institut für Mineralogie,
Gievenbecker Weg 61, D-4400 Münster,
W. Germany.