Rb-Sr whole-rock age of the Ilivertalik Granite and other rocks from the Fiskenæsset area

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Fifteen samples of the Ilivertalik granite define an isochron with an apparent age of 2770 ± 23 m. y. and $(^{87}Sr/^{86}Sr)_0 = 0.7021 \pm 0.0002$. Samples of both older and younger rocks plot very near to the 2770 m. y. isochron and probably are of comparable age.

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In the Fiskenæsset area (fig. 1) rocks of different relative age can be distinguished in the field (Kalsbeek & Myers 1973; Myers 1976).

(a) The oldest rocks recognized are amphibolites and associated rocks, often of supracrustal origin, into which the anorthosites, leucogabbros and gabbros of the 'Fiskenæsset Complex' were intruded.

(b) After at least one phase of deformation these oldest rocks were intruded by various generations of quartzo-feldspathic rocks, now forming the gneisses and migmatites which cover most of the area.

(c) After continued deformation and migmatisation these in turn were intruded by the 'Ilivertalik Granite', a mass of often very homogeneous augen gneisses mainly of granitic to granodioritic composition, which forms vast outcrops in the area between Fiskenæsfjorden and Sermilik.

(d) The youngest quartzo-feldspathic rocks in the area are sheets of fine grained granites and tonalites cutting the metamorphic fabric of the Ilivertalik granite, but which themselves also were gneissified and migmatised. All these rocks have undergone high grade metamorphism (amphibolite to hornblende-granulite facies).

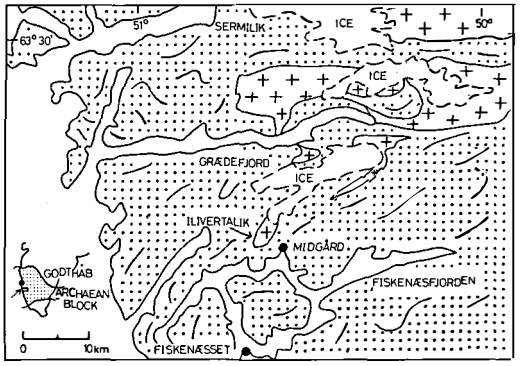

Fig. 1. Sketch map of the Fiskenæsset area showing the main outcrops of the Ilivertalik granite (crosses). The other rocks are various gneisses with layers and inclusions of amphibolite and with local occurrences of anorthositic rocks.

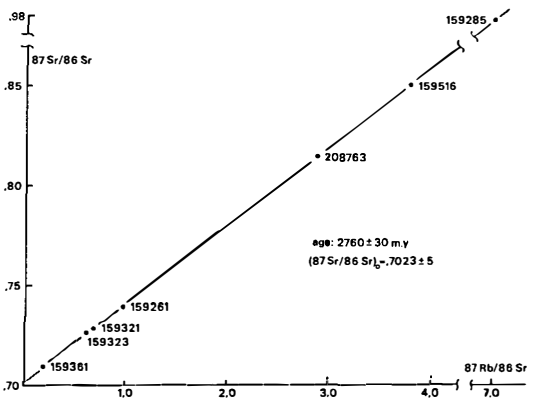

Fig. 2. Rb-Sr whole-rock isochron for Ilivertalik granite samples from the area around the head of Grædefjord.

Rb-Sr isotope work was done on two groups of Ilivertalik granite samples, one from the area at the head of Grædefjord where most of the rocks are in amphibolite facies, and one from Ilivertalik mountain, north-west of

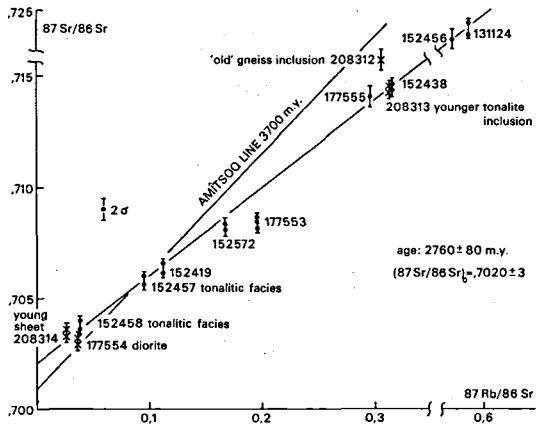

Fig. 3. Rb-Sr whole-rocks isochron for Ilivertalik granite samples and some other rocks from Ilivertalik mountain. The error bars extend to 2σ on either side of single measurements or the average of several measurements. For comparison the line is shown along which the 3700 m.y. old Amîtsoq gneisses from the Godthåbsfjord area plot. For detailed explanation see the text.

the Greenland Geological Survey base Midgård where the rocks are in granulite facies (figs. 2,3).

The samples from the Grædefjord area are granitic to granodioritic in composition. Biotite and hornblende are the normal mafic minerals; hypersthene occurs in sample GGU 159321. Sample 159361 is a hornblende-rich tonalite associated with the granite.

Most of the samples from Ilivertalik mountain are also rich in K-feldspar, but towards the boundary with the surrounding gneisses, the rock grades into a medium grained tonalitic gneiss without K-feldspar augen (samples 152457, 152458). Hypersthene and locally diopside occur together with hornblende and biotite. Biotite may be absent.

Other samples that were investigated for comparison with the Ilivertalik granite include, in order of relative age: one grey amphibolite (208784) from an outcrop where the amphibolites show evidence of a supracrustal origin (stage a in the introduction); two 'old' slightly porphyritic gneisses (159366, 208773) – the 'Grædefjord gneiss' of Myers (1976) (stage b in the introduction); two samples of mylonitised Ilivertalik granite from the Grædefjord area (159302, 159303); two sheets of younger granitoid rocks, cutting Ilivertalik granite (159263, 159299) – the 'Qánguartoq gneiss' of Myers (1976) (stage d in the introduction).

From Ilivertalik mountain the following samples were also investigated: two samples from a single angular inclusion in the Ilivertalik granite – a fine grained hypersthene bearing tonalitic rock (208313) cutting the foliation of an older hypersthene gneiss (208312) (both stage b); one inclusion (?) of a hypersthene-rich diorite (177554) with diffuse boundaries towards the granite (stage b or c) and one younger granitoid sheet (208314) cutting the metamorphic fabric of the Ilivertalik granite (stage d in the introduction).

The $^{87}Sr/^{86}Sr$ ratios were measured on the Varian MAT TH5 mass-spectrometer at the Institute of Petrology of Copenhagen University, on unspiked Sr. From 20 double determinations a precision of ± 0.0005 (2σ) for single determinations was estimated. Eight measurements on the Eimer & Amend $SrCO_3$ standard ranged from 0.70751 to 0.70830 (average 0.70799). Rb/Sr ratios were measured on the Philips PW 1410 X-ray fluorescence spectrometer at the Institute of Petrology on two tablets from each sample. The precision was ± 1 % (2σ) for the average of the two determinations for samples with Rb/Sr > 0.1. For samples with Rb/Sr < 0.1 differences between the two tablets up to several per cent occurred. Measurements on U.S.G.S. standards G–2, GSP–1, AGV–1 and BCR–1 agreed within 1 % with the isotope dilution results of Pankhurst & O'Nions (1973). The isochron calculations were done by the method of York (1966). Ages were calculated using $\lambda_{Rb} = 1.39 \times 10^{-11}$/year.

On a $^{87}Sr/^{86}Sr$ versus $^{87}Rb/^{86}Sr$ diagram (fig. 2) the seven samples of Ilivertalik granite from the area at the head of Grædefjord (amphibolite facies) define an isochron with an apparent age of 2760 ± 30 m.y. and initial $^{87}Sr/^{86}Sr$ ratio of 0.7023 ± 0.0005. The samples from Ilivertalik mountain (granulite facies) have considerably lower $^{87}Rb/^{86}Sr$ ratios. Eight out of the nine samples from the 'granite' define an isochron with apparent age 2760 ± 80 m.y. and initial $^{87}Sr/^{86}Sr$ = 0.7020 ± 0.0003 (fig. 3). Sample 177553 plots

considerably off the isochron; a new Sr separation, however, gave the same result. Considered together, the Ilivertalik granite samples (except 177553) define an isochron with age 2770 ± 23 m.y. and initial $^{87}Sr/^{86}Sr$ = 0.7021 ± 0.0002. This agress well with Rb/Sr ages of Nûk type gneisses from the area between Fiskenæsset and Godthåb, recently reported by Moorbath & Pankhurst (1976).

It is not certain whether the age of 2770 m.y. refers to the time of emplacement of the granite or the time of the subsequent metamorphism. Pidgeon, Aftalion & Kalsbeek (1976) reported an age of 2835 ± 10 m.y. for zircons from the Ilivertalik granite on Ilivertalik mountain (sample 131124, also included in this study) and interpreted this as the age of the emplacement of the granite. Black, Moorbath, Pankhurst & Windley (1973) interpret a Pb-Pb age of 2850 ± 100 m.y. as that of the regional granulite facies metamorphism. However, these two ages are not directly comparable with the Rb/Sr results since the various decay constants are not known well enough.

Most of the other samples analyzed plot on or very near to the 2760 m.y. isochron (fig. 4). The grey amphibolite (208784) and one 'old' gneiss (208773) plot slightly above the line. The hypersthene gneiss 308312 (fig. 3) plots considerably above the 2760 m.y. isochron. The significance of these deviations is not certain. This good agreement of the other samples with the isochron defined by the Ilivertalik granite samples, and the low initial $^{87}Sr/^{86}Sr$ ratio of this isochron, probably indicates that all these rocks were formed and metamorphosed in a relatively short time span not long before 2760 m.y. ago. For comparison, in figs 3 and 4 the line is shown along which the Amîtsoq gneisses from the Godthåbsfjord area (age c. 3700 m.y., Moorbath, O'Nions, Pankhurst, Gale & McGregor 1972) would plot. Clearly, none of the samples studied (with the exception perhaps of 208312) shows evidence of an age comparable to that of the Amîtsoq gneisses. This agrees with the observations of Moorbath & Pankhurst (1976) that there is hardly any overlap of the Amîtsoq and Nûk gneiss plots in the $^{87}Sr/^{86}Sr$ versus $^{87}Rb/^{86}Sr$ diagram, except for rocks with very low Rb/Sr ratios. It seems now possible, with the help of Rb-Sr isotope measurements on single specimens, to differentiate between Amîtsoq type and Nûk type gneisses, provided that their Rb/Sr ratio is not too low.

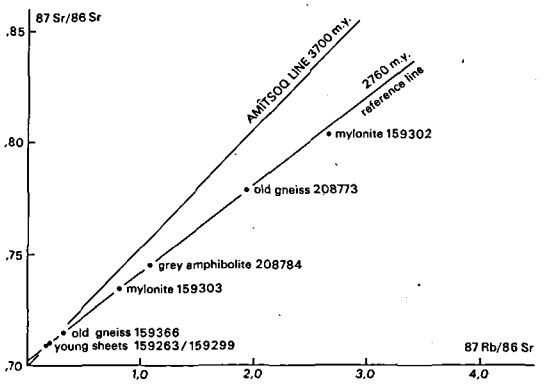

Fig. 4. Rb-Sr isotope results for various rocks from the Fiskenæsset area compared with the Ilivertalik granite isochron of fig. 2. Amîtsoq line as in fig. 3. For further information see the text.

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Dansk sammendrag

Ilivertalik graniten fra Fiskenæsset området er blevet dateret v. h. a. Rb-Sr 'whole-rock' metoden. To prøveserier, en fra et område hvor bjergarterne er i amphibolitfacies og en fra et område hvor de er i granulitfacies, gav samme resultat. Set under et viser prøverne en alder på 2770 ± 23 millioner år. En række prøver, som på grund af feltobservationer vides at være delvis ældre og delvis yngre end Ilivertalik graniten, gav resultater, som ret nøje overensstemmer med resultaterne for graniten. Sandsynligvis har alle disse bjergarter stort set samme alder.

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