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ISOTOPIC AGE DETERMINATIONS IN BERGSLAGEN, SWEDEN: II. THE FILIPSTAD-TYPE GRANITE OF ROCKESHOLM, GRYTHYTTAN AREA[1]

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Oen, I. S. 1982 Isotopic age determinations in Bergslagen, Sweden: II. The Filipstad-type granite of Rockesholm, Grythyttan area - Geol. Mijnbouw 61: 305-307.

The Younger Granites in the Filipstad and Grythyttan areas (OEN & VERSCHURE, 1982) represent a segment of the NNW belt of 1.7–1.6 Ga old Småland-Värmland granites which separates the Svecokarelian leptite region of central Sweden from the Sveconorwegian gneiss region in SW Sweden (LUNDQVIST, 1979; WILSON, 1980). The Småland-Värmland granite belt comprises several batholitic complexes, each showing a variety of granitic rocks. The predominant Värmland Group granite in the Filipstad and Grythyttan areas is generally referred to as Filipstad granite (SUNDIUS, 1923, MAGNUSSON, 1925). The typical Filipstad granite is a coarse-grained, porphyritic, hornblende-bearing granite with up to 3–5 cm large microcline crystals. Locally, this granite shows a rapakivi-like facies with tabular or ellipsoidal, plagioclase-mantled microcline.

According to WELIN ET AL. (1977) the Värmland Group of granites comprises the Filipstad granite complex and the Hagfors-Kristinehamn granite complex. The hornblende-biotite-rich Hagfors granite occupies large areas to the north of the Filipstad granite complex, while the petrographically similar Kristinehamn granite occurs in small areas within the southern part of the Filipstad granite complex. Each of the two complexes consists of differentiated intrusions, also including basic members. Granites of the Filipstad complex show lower Mg/Fe, Ca/K and K/Rb ratios than the granites of similar SiO_2-contents of the Hagfors-Kristinehamn complex. WELIN ET AL. (1977) give Rb-Sr whole rock isochron ages of 1665 ± 36 Ma with an initial $^{87}Sr/^{86}Sr$ value of 0.7068 ± 0.0006 for granites of the Filipstad complex and 1655 ± 30 Ma with an initial $^{87}Sr/^{86}Sr$ value of 0.7021 ± 0.0006 for granites of the Hagfors-Kristinehamn complex. The Värmland Group granites show shear zones and 1000-850 Ma old dolerite dike swarms (PATCHETT, 1978).

This paper reports the isotopic dating of a Filipstad-type granite with rapakivi facies, exposed around the village of Rockesholm, about 20 km S of Grythyttan. Ten samples were taken from the river bed at Rockesholm dam site and two from nearby exposures (Fig. 1). The analyses were carried out in the ZWO-Laboratory of Isotope Geology, Amsterdam.

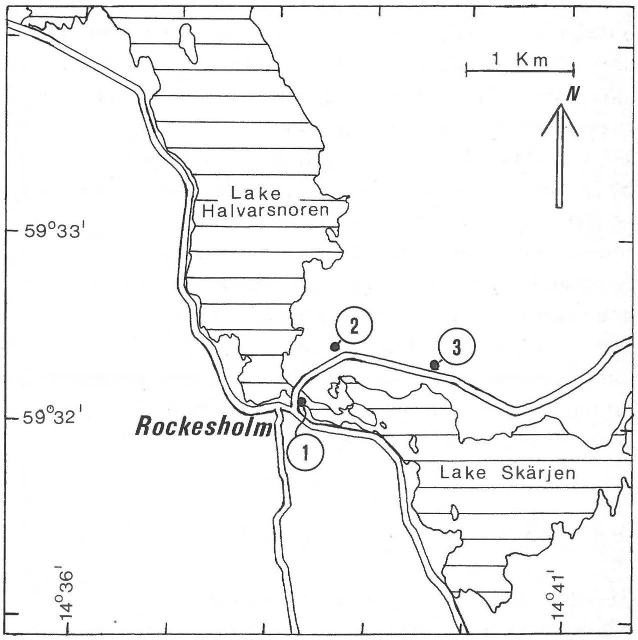

Fig. 1
Map of the environs of Rockesholm. The whole map area is occupied by the Filipstad-type granite of Rockesholm; samples 75 BRL 3A, 3B, 5C, 6A, 6B, 7B, 8A, 9 and 76 BRL 54, 55 were taken at locality 1, sample 76 BRL 56 at locality 2, and sample 76 BRL 57 at locality 3.

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PETROGRAPHY

The coarse-grained granite of Rockesholm displays incipient cataclasis and low-grade retrogressive metamorphic recrystallization. Quartz, perthitic orthoclase, plagioclase and greenisch brown biotite are the major igneous components. Blue-green hornblende is a minor component. Accessories are zircon, apatite, allanite and ilmenite. Green biotite, chlorite, stilpnomelane, epidote-group minerals, albite, microcline, prehnite, sphene and fluorite are low-grade, late alteration minerals.

Quartz is present as high-temperature pseudomorphs enclosed by plagioclase and orthoclase and as low-temperature crystals showing strongly undulose extinction and mortar-like zones, mainly along crystal edges. Along annealed cracks trails of fluid and microcrystalline inclusions can be observed. Orthoclase shows vein and patch perthite and has largely been replaced by microcline. Both K-feldspars likewise contain annealed cracks with trails of fluid and crystalline inclusions. perthitic albite is apparent in the microcline, sometimes showing the swapped boundary phenomenon between two crystals. Plagioclase (An 20-25) has albitic rims and contains antiperthitic microcline; some crystals are mantled by microcline. The plagioclase is replaced by fine-grained epidote-group minerals, colourless mica, fine-grained green biotite and albite. Bent and broken twin-lamellae in the plagioclase testify to deformation. The greenisch brown biotite is fringed by secondary, fine-grained green biotite and contains inclusions of ilmenite, zircon, apatite, allanite and, occasionally, lenses of K-feldspar and prehnite. The mineral is deformed and displays 'border pleochroism' (VERSCHURE & BON, 1972), i.e. dark, pleochroic zones of radiation damage along grain boundaries. Pleochroic haloes occur around zircon, allanite, sphene, ilmenite, apatite and also around stilpnomelane. The blue-green hornblende is largely replaced by fine-grained green biotite and chlorite. The zircon is zoned and shows metamict rims. Sphene forms strings of small rounded grains inside biotite. Allanite forms large, brownish, completely metamict crystals. Stilpnomelane replaces biotite and hornblende and is surrounded by dark pleochroic haloes. Where stilpnomelane is in contact with fluorite the latter mineral shows violet colouration; such radiation damage around stilpnomelane seems to be a common phenomenon in metamorphic rocks (VERSCHURE & MAIJER in prep.).

EXPERIMENTAL PROCEDURES AND CONSTANTS

The Rb and Sr concentrations and Rb/Sr ratios of the whole-rocks were determined by X-ray fluorescence spectrometry, using a Philips PW 1450/AHP automatic spectrometer. All samples were measured as pressed-powder pellets; the mass-absorption corrections for both sample and external standard are based upon the Compton scattering of the Mo-Kα primary beam (VERDURMEN, 1977). The biotite was analysed for Rb and Sr by mass-spectrometric isotope dilution. Sr isotopic compositions were determined directly on unspiked Sr for whole-rocks and calculated from the isotope dilution runs for the biotite. The isotope measurements were made on a computer-controlled Varian CH5 mass-spectrometer with Faraday cage collector and digital output. The analytical accuracies are estimated at 1% for XRF Rb/Sr, 1% for isotope dilution Rb and Sr and 0.05% for $^{87}Sr/^{86}Sr$. These overall limits of relative error are the sum of the known sources of possible systematic error and the precision (2σ) of the total analytical procedures. The best-fit line through the suite of Rb-Sr data was calculated according to YORK (1966, 1967). The value of the Mean Squares Weighted Deviation (MSWD) was calculated according to MCINTYRE ET AL. (1966).

The ^{87}Rb decay constant used for the age calculations is 1.42 $\times 10^{11} a^{-1}$.

RESULTS AND DISCUSSION

The Rb-Sr whole rock data of the samples from the Filipstad-type granite at Rockesholm are listed in Table I and plotted in the $^{87}Sr/^{86}Sr - {}^{87}Rb/^{86}Sr$ diagram of Fig. 2. The biotite data and

Table I
Rb-Sr whole-rock data of the Filipstad-type granite at Rockesholm

Sample Nr.	Rb^+ (ppm Wt)	Sr^+ (ppm Wt)	Rb/Sr^+ (Wt/Wt)	$^{87}Sr/^{86}Sr$	$^{87}Rb/^{86}Sr$
75 BRL 3A	256	66.8	3.827	0.99074	11.39
75 BRL 3B	256	63.9	4.004	1.0014	11.93
75 BRL 5C	145	114	1.273	0.81157	3.725
75 BRL 6A	181	78.6	2.307	0.88160	6.796
75 BRL 6B	194	79.5	2.432	0.88430	7.166
75 BRL 7B	121	40.9	2.963	0.91143	8.754
75 BRL 8A	177	94.4	1.877	0.84273	5.508
75 BRL 9	176	123	1.435	0.79970	4.194
76 BRL 54	166	109	1.528	0.82479	4.471
76 BRL 55	224	74.5	3.012	0.91966	8.896
76 BRL 56	187	111	1.686	0.82899	4.934
76 BRL 57	171	126	1.354	0.80258	3.953

$^+$ X-Ray fluorescence spectrometry

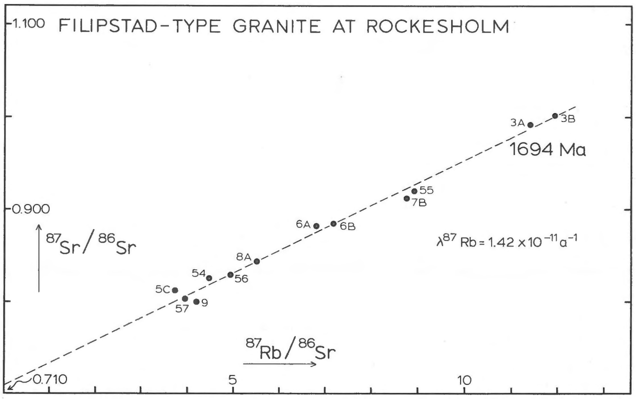

Fig. 2
Plot of Rb-Sr data of the Filipstad-type granite of Rockesholm.

Table II
Rb-Sr data of biotite from the Filipstad-granite at Rockesholm

Sample Nr.	Rb^+ (ppm Wt)	Sr^+ (ppm Wt)	$^{87}Sr/^{86}Sr$	Calculated age^{++}(Ma)
75 BRL 8A	864	4.79	24.105	951 ± 20
	864	4.78	24.292	

$^+$ Isotope dilution
$^{++}$ Calculated with reference to the whole-rock data. Error based on estimated errors of 1% for Rb and Sr, and 0.05% for $^{87}Sr/^{86}Sr$.

calculated age are given in Table II. The whole-rock data show a roughly linear correlation, but they do not produce an isochron relationship (MSWD = 34). The best-fit line corresponds to an age of 1694 ± 191 Ma with an initial $^{87}Sr/^{86}Sr$ ratio of 0.70984 ± 0.01531 (errors at 95% confidence level as computed from the scatter of the data about the regression line).

From the Rb-Sr whole-rock data it is concluded that the Filipstad-type granite at Rockesholm has been emplaced about 1700 Ma ago, at about the same time as the other granites of the Småland-Värmland granite groups (e.g. WELIN ET AL., 1977). The scatter of the whole-rock data-points about the best-fit line may be related to the tectonization and retrogradation displayed by the granite. The age of about 950 Ma of the greenish brown, coarse-grained biotite, along with several other biotite and hornblende ages in the Filipstad area (VERSCHURE, 1981; in prep.), indicate that a regional resetting of biotite and hornblende ages occured around 1000 Ma ago, presumably under conditions of greenschist facies metamorphism. Apparently, the influence of the Sveconorwegian orogeny reaches about 30 km to the west of the alleged 'Sveconorwegian Front' (VERSCHURE, 1981).

The lowest grade of retrogradation, evidenced by the assemblage stilpnomelane + fine-grained green biotite, might also by related to the Sveconorwegian orogeny or, alternatively, to a younger metamorphic event. Incipient low-grade retrogradation has been reported from many places elsewhere in the Baltic shield (e.g. ZECK ET AL., 1971, NYSTRÖM & LEVI, 1980, VERSCHURE ET AL., 1980) and it has been postulated by VERSCHURE (1981) that this retrogradation could very well be related to the Caledonian orogeny. In southwestern Norway it has been demonstrated that the low-grade retrogradation in the basement in front of the overthrust Caledonian nappe system is indeed of Caledonian age (VERSCHURE ET AL., 1980).

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