

ISOTOPIC AGE DETERMINATIONS IN BERGSLAGEN, SWEDEN: V. THE HORSSJÖ GRANITE, FILIPSTAD AREA¹

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ABSTRACT

Oen, I.S., R.H. Verschure & U. Wiklander 1984 Isotopic age determinations in Bergslagen, Sweden: V. The Horssjö granite, Filipstad area—Geol. Mijnbouw 63: 085-088.

Rb-Sr whole rock data of 17 Horssjö granite samples from 5 localities show a best-fit line corresponding to an age of 1.76 ± 0.04 Ga. This result is unsatisfactory in view of the presumed age of the Horssjö granite, which is coeval with the 1.84 ± 0.06 Ga Hyttsjö Suite of rocks. Six samples from one locality give a best-fit line corresponding to 1.86 ± 0.12 Ga; three samples from another locality show a best-fit line corresponding to 1.84 ± 0.44 Ga. These two localities presumably represent relic domains of Horssjö granite that have escaped post-emplacement, metamorphic Rb-Sr isotopic resettings of whole-rock samples. The data show a large geological variance in excess of the analytical variance. This may be due to variation in initial $^{87}\text{Sr}/^{86}\text{Sr}$ in the samples, possibly caused by contamination of the granite magma by basic magma and/or seawater.

INTRODUCTION

The largest body of Svecokarelian Older Granite exposed in the Filipstad-Grythyttan-Hjulsjö region (OEN ET AL., 1982) is the Horssjö granite, which occupies a NNW-elongated area of about 15 by 6 km, North of Filipstad. The Horssjö granite shows gradations from medium-grained, massive granite to strongly granulated and foliated biotite granite with steep to vertical NNW-foliation and steeply NNW-plunging to vertical lineation. The foliation wraps in a flow pattern around large fragments of net-veined, synplutonic Hyttsjö diorite dikes in the granite (OEN & WIKLANDER, 1982). The diorite fragments are veined with massive granite that passes without discontinuity into the enveloping foliated granite. Apparently, net-veining of the diorite and foliation of the granite are both due to synplutonic or protoclastic processes in the consolidating granite magma. According to MAGNUSSON (1925) protoclastic deformation has caused granulation of feldspars and

quartz and the formation of streaks of fine-granular microcline-albite-quartz aggregates in the foliated Horssjö granite. Granophyric granites are found in the border zones of the Horssjö granite. The contacts of the granite with the leptitic wall rocks are usually obscured by shear zones that are marked by fine-grained, NNW-foliated quartzo-feldspathic gneisses, enclosing granitic, granophyric and leptitic pods and slices.

The Horssjö granite is considered by MAGNUSSON (1925) as syntectonic with regard to the folding of the Supracrustal Series (OEN & VERSCHURE, 1982, Table I). From the resemblance in petrochemistry SUNDIUS (1923) and MAGNUSSON (1925) have suggested that a petrogenetic relationship exists between the Older Granites and the encasing supracrustal acid volcanics. OEN ET AL. (1982) have interpreted the Older Granites as members of supracrustal volcano-plutonic complexes. The granites are thought to have ascended into the earlier volcanic piles of the same magma during the Rift Stage (OEN & VERSCHURE, 1982, Table I). They either consolidated as massive Older Granites, or persisted as magma until they were consolidated as protoclastic Older Granite of the Horssjö-type during Post-rift Stage compressive tectonic events and shearing movements. As has been reported previously (OEN & WIKLANDER, 1982), the Horssjö granite is synplutonic with the earliest Post-rift Stage diorite dikes of the 1841 ± 55 Ma Hyttsjö Suite of gabbro-diorites and tonalite-

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Table I Rb-Sr whole-rock data of the Horssjö granites

Sample No.	Locality	Rb (ppm Wt)	Sr (ppm Wt)	Rb/Sr (Wt/Wt)	$^{87}\text{Sr}/^{86}\text{Sr}$	$^{87}\text{Rb}/^{86}\text{Sr}$
77 Brl 185	4	91.6	18.7	4.894	1.0630	14.65
77 Brl 186	4	91.4	17.9	5.106	1.0727	15.30
77 Brl 187	4	73.6	14.5	5.089	1.0830	15.27
77 Brl 189	4	68.3	17.8	3.842	1.0077	11.44
77 Brl 190	5	112.0	13.9	8.044	1.3257	24.69
77 Brl 191	5	74.5	15.9	4.682	1.0635	14.02
78 Brl 281	6	18.0	23.1	0.7777	0.76348	2.262
78 Brl 285	6	5.88	23.9	0.2466	0.72413	0.7146
78 Brl 292	8	7.88	10.0	0.7801	0.76674	2.270
78 Brl 293	8	1.76	23.7	0.0739	0.71123	0.2139
78 Brl 295 ⁺	8	18.2	10.9	1.673	0.83348	4.900
78 Brl 296	7	60.8	25.3	2.400	0.8803	7.061
78 Brl 297	7	96.7	17.6	5.510	1.1377	16.62
78 Brl 298	7	90.1	23.1	3.911	1.0089	11.65
78 Brl 299	7	54.0	32.2	1.680	0.82581	4.917
78 Brl 300	7	89.6	17.9	5.014	1.0957	15.06
78 Brl 301 ⁺	7	62.4	27.9	2.238	0.87796	6.583

⁺ Mean of two measurements

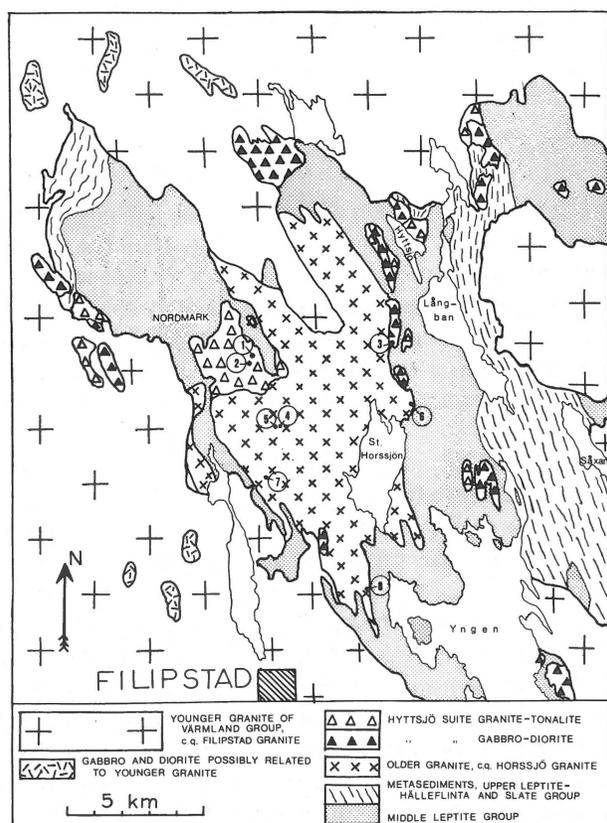


Fig. 1. Geological sketch map of the area North of Filipstad. Sampling localities of Horssjö granite are indicated by encircled numbers: 4, 77 BRL 185, 186, 187, 189; 5, 77 BRL 190, 191; 6, 78 BRL 281, 285; 7, 78 BRL 296, 297, 298, 299, 300, 301; 8, 78 BRL 292, 293, 295. The numbers 1, 2 and 3 indicate sampling localities of Hyttisjö Suite rocks described in Oen & Wiklander (1982).

granites. A model is proposed according to which the Hyttisjö Suite of rocks, the Older Granites and the volcano-sedimentary sequence belong to a single 1.9-1.8 Ga old chronostratigraphic unit, i.e. the Bergslagen Supracrustal Series (OEN & VERSCHURE, 1982, Table II).

This paper reports the results of Rb-Sr whole rock analyses of 17 samples of Horssjö granite. The samples were collected from 5 localities, shown in Fig. 1.

PETROGRAPHY

At the sample localities the Horssjö granite is a medium-grained granite showing weak to distinct foliation. The weakly foliated rocks are poor in biotite and consist of about 35-40 vol. % plagioclase, 30-35 vol. % K-feldspar, and 30-35 vol. % quartz. The plagioclase often forms aggregates of subhedral grains (3-5 mm long) of albite-sericite-saussurite pseudomorphous after a more calcic plagioclase. The K-feldspar occurs in 2-3 mm long subhedral crystals of veinperthitic microcline-albite intergrowths and as anhedral grains of microcline. The feldspars and quartz show recrystallization in fine-granular masses. Mortar textures are common. In the distinctly foliated rocks the foliation is caused by bands and streaks of recrystallized fine-granular albite, microcline and quartz and by an increased amount of biotite in streaky aggregates. Myrmekitic and granophyric intergrowths are frequent. The brown biotite is often replaced by green biotite, chlorite and sphene. Other secondary minerals are epidote, zoisite, carbonate, muscovite and stilpnomelane. Apatite, zircon, magnetite and fluorite are accessories. Hornblende is sometimes present.

Table II

Location (Fig. 1)	Map coordinates	Number of samples	Age in Ga (best-fit line)	Initial $^{87}\text{Sr}/^{86}\text{Sr}$	MSWD
4	08.3/32.5	4	1.27 ± 0.45	0.798 ± 0.091	4.2
5	08.1/32.4	2	1.71	0.719	
6	13.0/33.1	2	1.77	0.706	
7	07.4/30.2	6	1.86 ± 0.12	0.696 ± 0.013	4.6
8	11.5/26.0	3	1.84 ± 0.44	0.706 ± 0.010	3.9

EXPERIMENTAL PROCEDURES AND CONSTANTS

Procedures and accuracies involved in the X-ray fluorescence determination of Rb and Sr contents and Rb/Sr ratios and the mass-spectrometric measurement of $^{87}\text{Sr}/^{86}\text{Sr}$ ratios have been given in a preceding paper (OEN & WIKLANDER, 1982), where calculation methods for the best-fit line through suites of data-points and the Mean Squares Weighted Deviation (MSWD) are also indicated. All errors are given at the 95% confidence level as computed from the scatter about the best-fit regression line. The ^{87}Rb decay constant used for the age calculation is $1.42 \times 10^{-11} \text{a}^{-1}$.

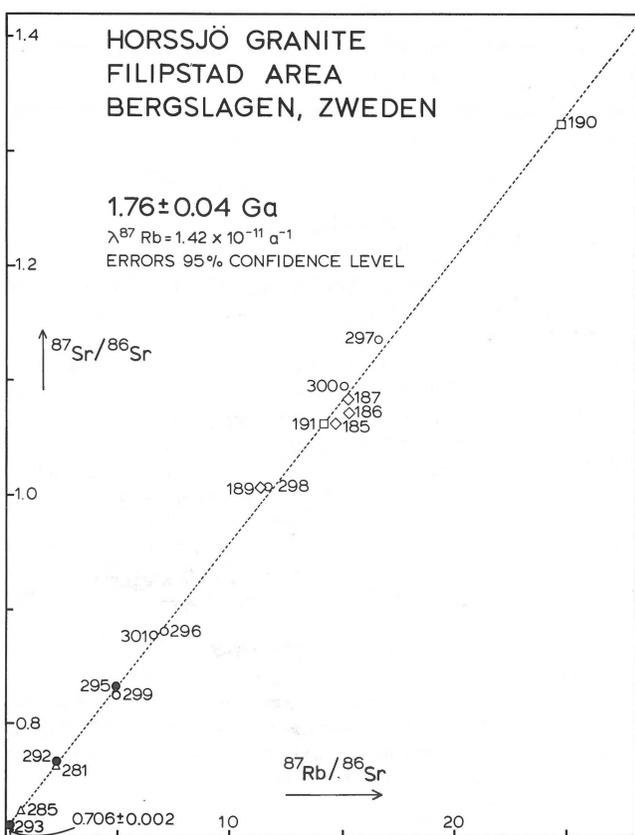


Fig. 2. Plot of whole-rock Rb-Sr data of all 17 samples from the Horrsjö granite. Diamonds, samples from locality 4; squares, samples from locality 5; triangles, samples from locality 6; circles, samples from locality 7; dots, samples from locality 8.

RESULTS AND DISCUSSION

The whole-rock Rb-Sr data of the 17 Horrsjö granite samples are listed in Table I and plotted in Fig. 2. The data-points show a poor linear correlation (MSWD=9). A best-fit regression line through all points would correspond to an age of $1.76 \pm 0.04 \text{ Ga}$ with initial $^{87}\text{Sr}/^{86}\text{Sr} = 0.706 \pm 0.002$. This age is in poor agreement with the age presumed for the Horrsjö granite on geological grounds. The Horrsjö granite is synplutonic with diorite dikes belonging to the $1841 \pm 55 \text{ Ma}$ old Hyttisjö Suite of gabbro-diorites and tonalite-granites (OEN & WIKLANDER, 1982). The latter assumption is supported by the U-Pb upper-intercept age of a suite of zircons from the Horrsjö granite recently obtained by G. ÅBERG in Stockholm (written communication).

When the Rb-Sr data of the Horrsjö granite are considered separately for each sampling site, the line through each pair or suite of samples yields the results shown in Table II.

The best-fit regression lines defined by the samples from locations 7 and 8 (Figs. 3 and 4) define ages corresponding to the $1841 \pm 55 \text{ Ma}$ age of the Hyttisjö Suite of gabbro-diorites and tonalite-granites, although location 7 does not show a true isochron arrangement and the large error of location 8 precludes any definitive conclusion.

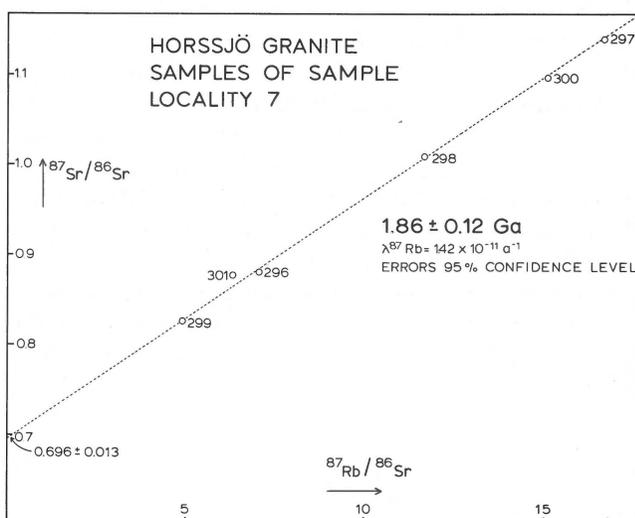


Fig. 3. Plot of whole-rock Rb-Sr data from locality 7.

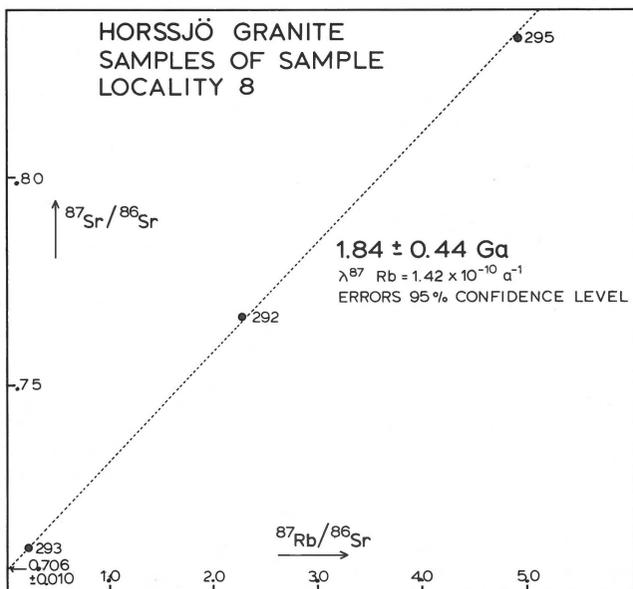


Fig. 4.
Plot of whole-rock Rb-Sr data from locality 8.

It is assumed that the best-fit regression lines defined by the Rb-Sr systems of the samples from the locations 7 and 8 approach the emplacement age of the Horssjö granites. The rocks of both these locations (outcrops of a few tens of metres) could represent relic domains of relatively little disturbed whole-rock Rb-Sr systems, whereas the other locations would have suffered much more intense resetting of the whole-rock Rb-Sr systems.

The Rb-Sr data from the two relic domains, however, also show a geological variance in excess of the analytical variance. Both the Horssjö granite and the Hyttsjö Suite rocks have been subjected to two, or possibly three events of metamorphism: (1) 1.7-1.6 Ga ago, in relation to the intrusion of the Värmland Group granites, (2) about 1.0 Ga ago, in relation to the Sveconorwegian orogeny, and (3) possibly a very-low-grade metamorphism in relation to the Caledonian orogeny (VERSCHURE, 1981). Since a good whole-rock Rb-Sr isochron relationship was obtained for suites of samples from the Hyttsjö-suite of rocks (OEN & WIKLANDER, 1982), whereas the scatter of the data-points about the best-fit regression lines suggests that throughout the Horssjö granite the rocks have been affected in varying degrees by disturbance of the Rb-Sr systems, it may be assumed that the Horssjö granite has been more susceptible to metamorphic disturbance of the whole-rock Rb-Sr systems. Also, some variation in initial $^{87}\text{Sr}/^{86}\text{Sr}$ may be possible: the Horssjö granite is synplutonic with the Hyttsjö diorites and shows widespread protoclastic recrystal-

lization during emplacement in a shallow, sub-seafloor environment (OEN ET AL. 1982); contamination with strontium from basic magma and/or seawater prior to the consolidation of the granitic magma is therefore possible.

The Rb-Sr data presented in this paper do not provide a conclusive answer as to the age of emplacement of the Horssjö granite. They can be interpreted, however, as consistent with, or at least not contradicting the age of about 1.84 Ga presumed on the basis of the geological relationships, and the inclusion of the Older Granite Suite in the 1.9-1.8 Ga old Bergslagen Supracrustal Series (OEN ET AL., 1982).

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