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ISOTOPIC AGE DETERMINATIONS IN BERGSLAGEN, SWEDEN: III. THE HYTTSJÖ SUITE OF GABBRO-DIORITES AND TONALITE-GRANITES, FILIPSTAD AREA

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ABSTRACT

Oen, I.S. & U. Wiklander 1982 Isotopic age determinations in Bergslagen, Sweden: III. The Hyttsjö suite of gabbro-diorites and tonalite-granites, Filipstad area – Geol. Mijnbouw 61: 309-312.

Rb-Sr whole-rock isotope analyses of five granite and two diorite samples of the Hyttsjö Suite of intrusions in the Filipstad region, Central Sweden, yield an isochron age of 1841 ± 55 Ma with an initial $^{87}Sr/^{86}Sr$ ratio of 0.70217 ± 0.00098. This age is regarded as the emplacement age of the Hyttsjö Suite of gabbros-diorites-tonalites-granites, which thus represents an intrusive subdivision of the 1.9-1.8 Ga Bergslagen Supracrustal Series.

INTRODUCTION

In MAGNUSSON's (1925) classic work on the Filipstad region a number of granitic and dioritic intrusions are referred to as Hyttsjö granites and diorites (Fig. 1). The Hyttsjö granites are fine-grained, equigranular biotite granites. The Hyttsjö granite stock of Nordmark, which occupies an area of about 8 km^2 North of Filipstad, is traversed by metadiorite dikes that are in turn veined and fragmented by the granite. Several smaller stocks of Hyttsjö granite and diorite are found in a NNW trending zone of locally strongly sheared leptitic rocks extending from Lake Hyttsjö near Långban to the South of Lake Yngen (Fig. 1). The Hyttsjö intrusions in this zone include stocks of Hyttsjö granite (often grading into tonalite), stocks and dikes of Hyttsjö diorite (often grading into gabbro), dioritic breccia dikes with gabbroic and hornblenditic fragments, and composite stocks of Hyttsjö granite-tonalite and diorite-gabbro. The rocks in the composite stocks show gradual transitions at some places and sharp mutual contacts elsewhere. The Hyttsjö diorites in the zone of sheared leptites are often strongly sheared along their contacts. Hyttsjö diorites are also found as discordant intrusions cutting across the folded sedimentary formations of the Saxån basin near Långban, Gåsborn and Gruvåsen; the slates and other rocks around these diorites are intensely contact-metamorphosed. Dikes of Hyttsjö diorite also occur in the Horssjö Granite, which belongs to the 'Urgraniter' or Older Granites (OEN ET AL., 1982; OEN & VERSCHURE, 1982). These dikes consist mostly of metadioritic rock showing a foliation and lineation parallel to that in the Horssjö Granite. Some Hyttsjö dikes occur as synplutonic, net-veined dioritic complexes in the Horssjö Granite. In the Nordmark and Långban areas the Hyttsjö intrusions are discordantly cut of, contact-metamorphosed and veined by Younger Granite of the Filipstad complex.

From the close spatial association and the occurrence of composite stocks it is concluded that the Hyttsjö intrusions represent a differentiated suite of rocks ranging from basic (gabbro-diorite) to acid (granite-tonalite). The field relations indicate the emplacement of the Hyttsjö intrusions after the Older Granites (Horssjö Granite) and before the 1.7 – 1.6 Ga (WELIN ET AL., 1977, OEN, 1982) Younger Granites (Filipstad granite complex). MAGNUSSON (1925) has clearly distinguished two associations of gabbro-dioritic rocks in the Filipstad region: (1) Hyttsjö diorites and minor gabbros associated with Hyttsjö granites, and (2) gabbros and minor peridotites and diorites occurring within the complexes of Younger Granites. The basic rocks associated with Younger Granites were considered as petrogenetically related, basic precursors of these granites. A similar origin was assumed for the Hyttsjö

[1] Manuscript received:1982-06-17.
Revised manuscript accepted: 1982-09-17.
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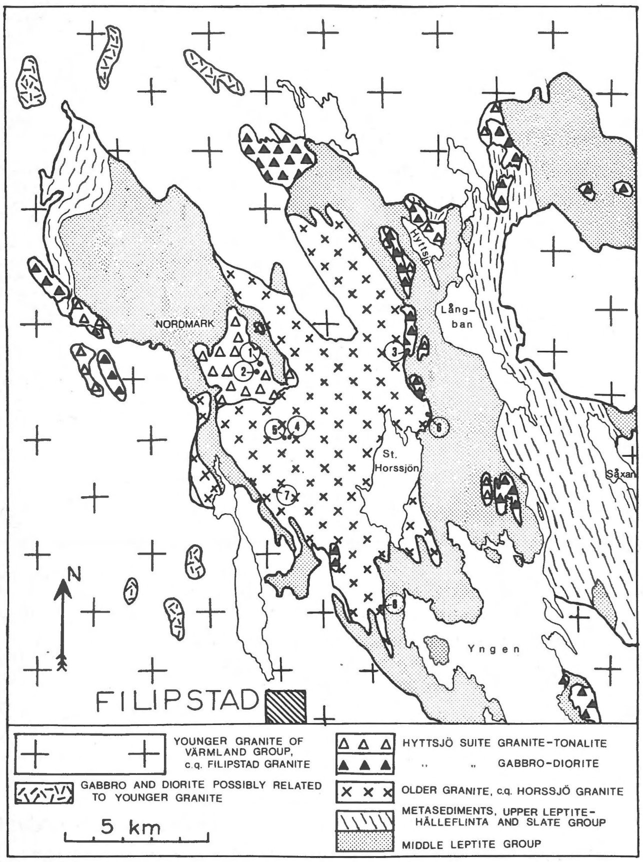

Fig. 1
Geological sketch map of the area North of Filipstad. Encircled numbers indicate sample localities. Hyttsjö Suite Nordmark granite: (1) 77 BRL 172, 175, (2) 77 BRL 180, 181, 182; Hyttsjö Suite diorite near Långban: (3) 77 BRL 231, 233. Localities (4) to (8) refer to samples of Horssjö Granite, which will be the subject of a subsequent communication.

diorites and consequently all Hyttsjö granite and diorite intrusions were regarded as satellitic precursors of the Younger Granites (MAGNUSSON, 1925). However, synplutonic, net-veined Hyttsjö diorite dikes in the Horssjö Granite suggest that the Hyttsjö intrusions may be temporally related to the Horssjö Granite. According to OEN ET AL., (1982) the Hyttsjö intrusions are unrelated to the 1.7 – 1.6 Ga Younger Granites and their basic precursors, but they should belong together with the Horssjö Granite to the Post-rift Stage of the Bergslagen Supracrustal Series, which is defined as a 1.9 – 1.8 Ga chronostratigraphic unit (table 1 in OEN ET AL., 1982). The protoclastically deformed Horssjö Granite is believed to be essentially pre- and synkinematic with regard to shearing movements during the Post-rift Stage compressive tectonic events, whereas the Hyttsjö intrusions are essentially syn- and post-kinematic with regard to these movements.

This paper reports isotopic age determinations on Hyttsjö suite rocks, five samples of Hyttsjö granite (77 BRL 172, 175, 180, 181, and 182) collected in 1977 near Nordmark and two samples of Hyttsjö diorite (77 BRL 231 and 233) collected in the same year near Långban (Fig. 1). The analyses were carried out in the Z.W.O. Laboratory of Isotope Geology, Amsterdam.

PETROGRAPHY

The samples of the Hyttsjö granite (77 BRL 172, 175, 180, 181, and 182) display the effects of shearing and recrystallization. Quartz, perthitic orthoclase, plagioclase (An 20) with antiperthitic microcline and greenish brown biotite are the main components. Accessories are zircon, apatite, allanite, fluorite and ilmenite. Secondary minerals are albite, coarse-grained epidote-group minerals and sericite, mainly as alteration products of plagioclase. Other secondary minerals are myrmekitic albite, calcite and sphene. Fine-grained, green secondary biotite has been observed in one sample (77 BRL 172) in subordinate amounts, but stilpnomelane is completely lacking in all investigated samples.

The samples of the Hyttsjö diorite (77 BRL 231 and 233) are slightly sheared and recrystallized. They contain quartz, normally zoned plagioclase (An 40 to 20), perthitic orthoclase, bluish green hornblende and greenish brown biotite with sphene inclusions and needle-like inclusions with a sagenitic pattern. The biotite is often intergrown with the hornblende. Accessories are allanite, apatite, ilmenite and zircon. Secondary albite, epidote-group minerals and sericite are alteration products of plagioclase, microcline, myrmekitic albite, sphene and calcite.

Table I
Rb-Sr whole-rock data of the Hyttsjö diorites and granites

Sample Nr	Type of rock	Rb (ppm m)	Sr (ppm m)	Rb/Sr (m/m)	$^{87}Sr/^{86}Sr$	$^{87}Rb/^{86}Sr$
77 BRL 172	granite	79.9	188	0.4250	0.73404	1.2327
77 BRL 175	granite	78.5	195	0.4040	0.73374	1.1718
77 BRL 180	granite	108	147	0.7380	0.75896	2.1458
77 BRL 181	granite	100	185	0.5411	0.74384	1.5709
77 BRL 182	granite	114	148	0.7741	0.76229	2.2515
77 BRL 231	diorite	113	428	0.2633	0.72210	0.7628
77 BRL 233	diorite	40.3	341	0.1183	0.71149	0.3424

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 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 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 by means of a least-squares regression analysis according to YORK (1966, 1967). The value of the Mean Squares Weighted Deviation (MSWD) was calculated acoording to MCINTYRE ET AL. (1966). The ^{87}Rb decay constant used for the age calculation is $1.42 \times 10^{-11} a^{-1}$.

RESULTS AND DISCUSSION

The Rb-Sr whole-rock data of five samples of Hyttsjö Suite Nordmark granite and two samples of Hyttsjö Suite diorite near Långban are listed in Table 1 and plotted in the $^{87}Sr/^{86}Sr$ – $^{87}Rb/^{86}Sr$ diagram of Fig. 2. The data show a good linear correlation (MSWD = 1). The best-fit line corresponds to an age of 1841 ± 55 Ma with an initial $^{87}Sr/^{86}Sr$ ratio of 0.70217 ± 0.00098 (errors at 95% confidence level as computed from the scatter of the data about the regression line).

The results indicate that the Hyttsjö Suite of gabbro-diorite-tonalite-granite was emplaced about 1840 Ma ago. This age places it in the 1.9 – 1.8 Ga Bergslagen Supracrustal Series, along with the Horssjö Granite (OEN ET AL., 1982). A group of gabbros and diorites occurring within the 1.7 – 1.6 Ga Filipstad and other granite complexes of the Värmland Group of post-tectonic Younger Granites have not yet been dated; these possibly younger gabbros and diorites may be genetically related to the latter granites (MAGNUSSON, 1925) and should not be confused with gabbros and diorites of the Hyttsjö Suite.

In the Filipstad area the 1.9 – 1.8 Ga Bergslagen Supracrustal Series has been subjected to several younger metamorphic events: (1) during the emplacement of the Filipstad and other Värmland Group granites 1.7 – 1.6 Ga ago, (2) during the Sveconorwegian orogeny about 1.0 Ga ago, and (3) possibly also during the Caledonian Orogeny (VERSCHURE, 1982). Mineral age determinations have not been performed on the samples described here, but K-Ar and Rb-Sr ages of 1.0 – 0.9 Ga of hornblendes and biotites in other Hyttsjö diorite samples from the same area testify to the Sveconorwegian metamorphic influence (paper in prep.). The samples of the Hyttsjö Suite display an excellent isochron relationship, contrary to the Filipstad-type Rockesholm granite (OEN, 1982). This difference may possibly be attributed to the late phase of incipient low-grade metamorphism, characterized by the development of biotite, stilpnomelane and prehnite in the latter granite, which is conspicuously absent in the Hyttsjö Suite. Apparently, such a low-grade metamorphism is rather effective in initiating an open-system behaviour with regard to Rb and Sr (see also PRIEM ET AL., 1978).

ACKNOWLEDGEMENTS

The authors are much indebted to the staff members of the ZWO-Laboratory of Isotope Geology, particularly R. H. Verschure for his substantial share in the preparation of the manuscript, N. A. I. M. Boelrijk, E. H. Hebeda and E. A. Th. Verdurmen for supervising separation of Sr, the mass-spectrometric analyses and the X-ray fluorescence analyses, respectively, and H. N. A. Priem for critical comments and review of the manuscript. This work forms part of the research program of the 'Stichting voor Isotopen-Geologisch Onderzoek', supported by the Netherlands Organization for the Advancement of Pure Research (Z.W.O.).

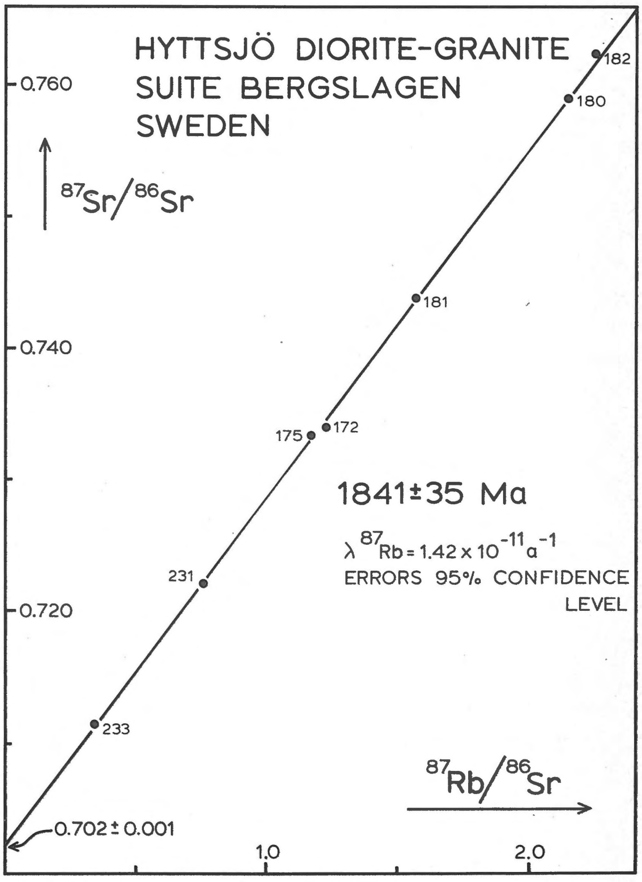

Fig. 2
Isochron plot of the Rb-Sr data of the samples of Hyttsjö Suite diorites and granites.

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