SVERIGES GEOLOGISKA UNDERSÖKNING

SERIE C NR 741 AVHANDLINGAR OCH UPPSATSER ÅRSBOK 72 NR 3

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ISBN 91-7158-138-3

Kartan på s. 9 är godkänd ur sekretessynpunkt för spridning.
Statens lantmäteriverk 1978-03-29.

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Schmidts Boktryckeri AB
Helsingborg 1978

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ABSTRACT

Postorogenic, quartz monzonitic, quartz monzodioritic and granitic intrusions from the western parts of the Province of Ångermanland, central Sweden, are described. From a study of their field relationships, mineralogy and major element chemistry, it is concluded that the Sörvik granites represent an early crystallized variant of the Revsund plutonic suite and were intruded at a high level in the form of several small stocks. A monzonitic massif near the village of Nordsjö is younger than the Revsund—Sörvik rocks. The main mass of Revsund granite probably was intruded at temperatures exceeding 800°C, producing hornfelses in the surrounding metasediments. The Sörvik granites were intruded at a high temperature as indicated by the existence of orthoclase. This became partially ordered in the direction of microcline, while the K-feldspar remained monoclinic in the surrounding quartz monzodioritic to quartz monzonitic differentiates of the Revsund suite. Olivines, pyroxenes, amphiboles and biotites of the Revsund suite rocks are extremely Fe-rich, and both in this respect and regarding the whole rock chemistry, the rocks are closely related to the Finnish rapakivis. Similar extensive intrusives are of world-wide occurrence in the period 1 000—1 800 Ma. This period is characterized by high thermal gradients and by a magmatic activity of considerable importance.

INTRODUCTION

The rocks of the Revsund suite are described in this paper, which also concerns the age relationships between the Revsund and Sörvik granites. It is proposed that the Sörvik granites represent an early intrusive phase of the Revsund plutonic suite.

The county of Västernorrland (pre-1974 borders), made up of the Provinces of Ångermanland and Medelpad, is currently being petrologically remapped under the coordination of Thomas Lundqvist as a project at the Geological Survey of Sweden (SGU). A map at the scale of 1:200 000 of the whole county with a description will be published by Lundqvist. This is the first comprehensive mapping since that carried out by Lundbohm (1899).

During the summer of 1974 and parts of the summer of 1975 the westernmost parts of the Province of Ångermanland along the border to Jämtland (Fig. 2) were mapped by the author. Much of the bedrock of this area is occupied by a large granite body, termed the Revsund granite, a Svecokarelian intrusion generally considered to be serorogenic (Magnusson et al. 1960). Lundqvist (1968), however, considered that there are different facies which have given rise to transitions between serorogenic and postorogenic granites. Approximately 8 % of the Svecokarelian territory in Sweden, an area some 24 000 km^2, is occupied by this rather homogeneous granite. In the southwestern parts of the Province of Ångermanland and neighbouring parts of Jämtland there are some small intrusions of a later granite, the anorogenic Ragunda granite (Fig. 1). R. Gorbatschev (1972) subdivided the granites in Jämtland County into two main groups on the basis of the K-feldspar obliquity. These comprised: 1. orogenic to postorogenic plutonics (including the Revsund granite) and 2. Ragunda and Sörvik types. The Sörvik granite was thus interpreted to be younger than the huge Revsund granite massif and to occur in the form of a dozen small stocks along the Ångermanland—Jämtland border (Gorbatschev 1972, p. 219).

GENERAL GEOLOGY

The main part of the bedrock in Västernorrland County belongs to the Svecokarelian orogenic zone. The oldest rocks are thick deposits of supracrustals (arenites and argillites, mostly of metagreywacke type). Basaltic intercalations occur, which have been transformed to amphibolites (Lundqvist 1973). The age of this sedimentary sequence is not known but has been estimated to be about 2 000 Ma (Welin 1970, p. 447). The supracrustals were intruded by synorogenic dif-

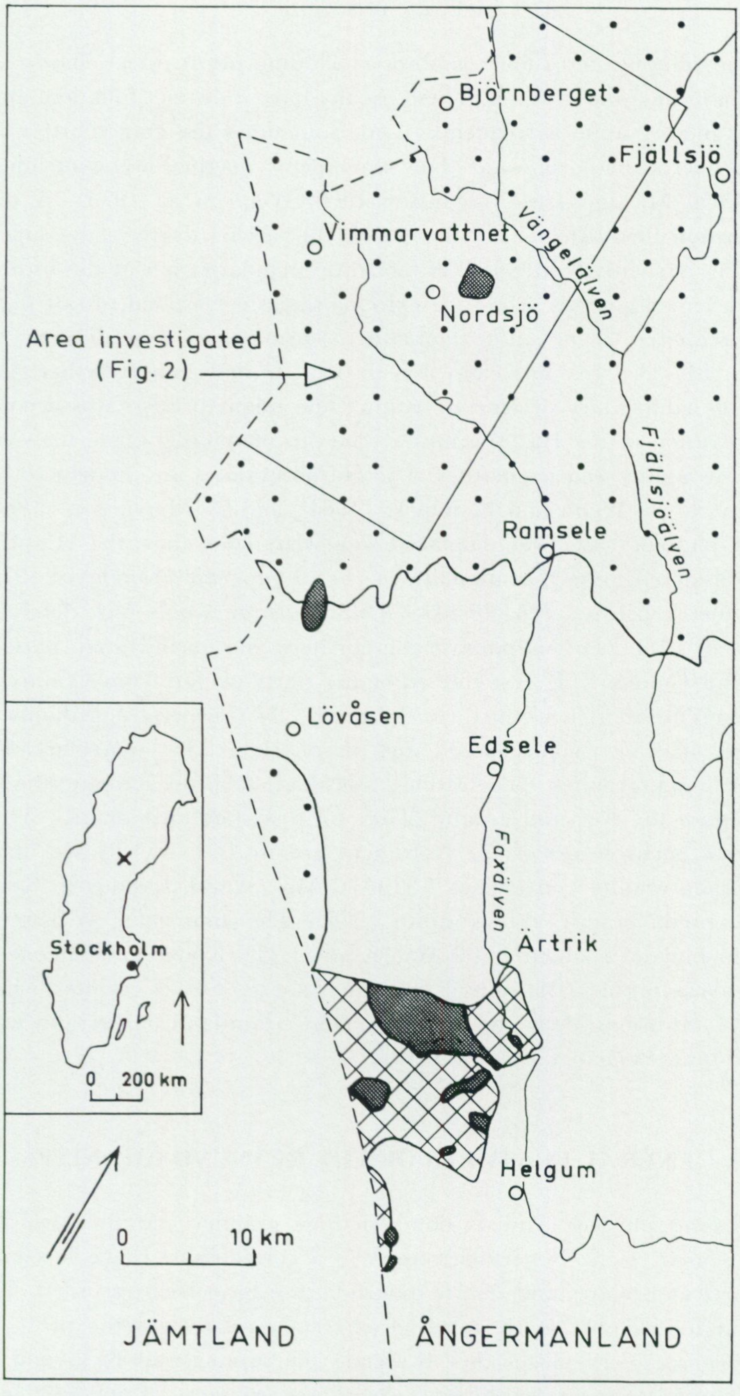

Fig. 1. Schematic geological map and location map after Lundbohm (1899). Checkered area = Ragunda intrusives, shadowed area = basic intrusives, dotted area = Revsund granites, and white area = other rocks (pre-, syn- and serorogenic Svecofennian rocks).

ferentiated plutonic intrusions: gabbros (including ultrabasites), diorites, tonalites, granodiorites, and granites. These usually have a distinct foliation, and hence the term gneiss-granite is frequently used. Sometimes the granodiorites and granites are microcline-porphyritic. The synorogenic magmas were intruded about 1 950—1 850 Ma ago (see Magnusson 1960, Welin et al. 1970). A period of migmatization then affected all these rocks to varying degrees; the supracrustal rocks being particularly affected. A moderate migmatization of the supracrustals produced veined gneisses, while the extreme stages correspond to raft migmatites or even schlieren or nebulitic migmatites (terminology according to Mehnert 1968, pp. 10—11). In some cases it is difficult to determine whether the paleosome is of sedimentary or igneous origin. The migmatization was accompanied by the intrusion of the Härnö granites (fine- to medium-grained, massive, salic) and various aplites and pegmatites. The Härnö granites are thought to be about 1 800 Ma old by Welin and Blomqvist (1964) and by Magnusson (1960). The Revsund plutonic suite was emplaced somewhat later than the Härnö granite and is considered to be transitionally ser- to postorogenic (Lundqvist 1973, p. 5). Its radiometric age is 1 785±40 Ma (Rb/Sr isochron whole rock determination; Welin et al. 1971). It is situated in the northern and northwestern parts of Västernorrland County (Fig. 1) and adjoining parts of Jämtland County (to the west) and Västerbotten County (to the north). It is generally medium- to coarse-grained, massive (non-foliated) and porphyritic. The anorogenic Ragunda and Nordingrå granites, penetrating associated gabbros and anorthosites, are younger than the Revsund granite. They form well-defined massifs. The Rb/Sr whole rock isochron age of the Nordingrå granite is 1 445±20 Ma, the age of the Ragunda granite and syenite 1 320±30 Ma (Welin, Lundqvist, Kornfält in prep.; Ragunda granite also Kornfält 1976). The anorogenic Wiborg rapakivi granite in Finland is about 1 700 Ma (Kouvo 1958, Kouvo and Simonen 1967). A particularly problematic suite of intrusions are the Sörvik granites, which form a series of intrusions along the Ångermanland—Jämtland border and whose age relationships are debated in this paper.

GENERAL FEATURES OF THE REVSUND GRANITES

The Revsund plutonic suite is dominated by granites and the term Revsund granite is used freely. Nevertheless there is a considerable range in composition and quartz monzonites and quartz monzodiorites have been recorded. The Revsund granites have a clearly intrusive character relative to the pre-, syn- and serorogenic rocks. In places they brecciate the supracrustal rocks and in some regions hornfelses have developed near to the contacts (Lundqvist in prep.). Most earlier authors, however, considered the Revsund granite to have been formed through metasomatism and mobilization of sedimentary rocks (cf. Gavelin 1955, p. 47, Svensson 1970) or of synorogenic granitic material (Åhman 1967). Svensson (1970) presented a broad geochemical investigation from Västerbotten County, interpreting the Revsund granite as originating from the phyllite series by granitization. Gavelin (1955, p. 13) and Grip (1946, p. 17) stress the genetic connection between the granites and the metasediments. Near the metagreywackes and meta-argillites the Revsund granites may contain garnet, cordierite and orthopyroxene (Gorbatschev 1972, p. 214, Gavelin 1955, p. 40).

The Revsund granite is typically a massive, grey, reddish grey or greyish red, coarsely medium-grained, K-feldspar porphyritic rock. The K-feldspar megacrysts generally make 25—35 % of the total rock volume, and they have a length of 1 to 6 cm (cf. Fig. 3). The shape may be quadratic to rectangular but is usually more or less rounded. Högbom (1937, p. 32) noted that small-grained types also occur. The K-feldspar may be occasionally mantled by plagioclase, but there is also a distinct antirapakivi texture. The wiborgite texture with K-feldspar mantled by plagioclase is, however, not diagnostic for rapakivis (cf. Volborth 1962, p. 816). As an example, the pyterlites do not contain mantled ovoids even if they are texturally related to the wiborgites (Vorma 1971, p. 10). Near the synorogenic granites and granodiorites, which are usually gneissose, the Revsund granite may also be slightly foliated, this possibly being a flow fabric, and especially if the synorogenic rocks are porphyritic the two rock types may be difficult to distinguish from each other (Högbom 1937, p. 17, Lundqvist 1973, p. 25). This phenomenon is especially apparent near the contacts. Nevertheless the Revsund granites clearly postdate migmatization. In some cases a non-porphyritic Revsund granite contact facies has been seen as the matrix of a breccia with xenoliths of metagreywacke.

GENERAL FEATURES OF THE SÖRVIK GRANITES

The Sörvik granites occur in a dozen small stocks along the Ångermanland—Jämtland border, mostly in Jämtland. Högbom (1894) considered many of these granites as structural modifications of the Revsund granite and not as separate intrusions. However, he did consider some of the stocks (near Borgvattnet, Mårdsjö and Strömsund—Lövberga) to be related to the Ragunda plutonic complex. The intrusion at Strömsund, termed the Strömsund granite, was also described by Frödin (1919).

The Sörvik granites have recently been investigated by Gorbatschev (1972). He considered them to be related to the Ragunda granite because of the obliquity of the K-feldspar. They would therefore be anorogenic, probably younger than the Revsund granite. According to Gorbatschev (1972, p. 217) the Sörvik granite is a homogeneous, medium-grained rock with only small compositional variations. It is a biotite granite with abundant pyroxene. Porphyritic, rounded quartz grains are typical for the Sörvik granite, and can be 4 to 10 mm in diameter. The intrusions in Ångermanland tend to be more varied in composition and texture.

The Ragunda complex has been described by Högbom (1909, 1920). These rocks have been compared to the rapakivi intrusions in Finland. Postorogenic or anorogenic igneous rocks with low K-feldspar obliquity have been described by Lundqvist (1968, Los—Hamra region), Kornfält (1969, Ragunda massif), Vorma (1971, Wiborg rapakivi massif in Finland), Gorbatschev (1972, Jämtland County), and Lundqvist (1973, Nordingrå area). Kornfält (1969, p. 22) states that the K-feldspar of the Revsund granite shows low obliquity values near the contacts to the Ragunda massif, as a consequence of the thermal influence from the massif. According to Gorbatschev (1972, p. 226) a large area in northern Jämtland is characterized by low obliquity of K-feldspar. He suggests that the numerous intrusions of the Ragunda and Sörvik type have had a strong thermal influence on the surrounding Revsund granite. Extremely low obliquity exists in the contact zones, while the Ragunda and Sörvik granites themselves are characterized by mixed monoclinic and triclinic states (Kornfält 1969, Gorbatschev 1972). The inversion of low to high obliquity K-feldspar is promoted by the presence of volatiles and occurs at 300—500°C (Goldsmith and Laves 1954b, Tomisaka 1962). Marmo, Hytönen and Vorma (1963) showed that there are distinct areas in Finland with monoclinic K-feldspar. This may be the result of thermometamorphism from rapakivi intrusions (Gorbatschev 1972).

THE ROCKS OF THE AREA INVESTIGATED

MACROSCOPICAL FEATURES

Four main zones of intrusive rocks can be distinguished (Fig. 2). These zones are from east to west: 1. Normal coarse-grained, porphyritic Revsund granites, 2. Small-porphyritic, grey to greyish black, rather dark Revsund intrusives, 3. Dark, greyish black Revsund intrusives with a few and rather small feldspar phenocrysts, and 4. Sörvik granites. In addition there is a small body of monzonite, the Nordsjö monzonite.

Zone 1. The Revsund granite (1) covers the greater part of the area. It is apparently homogeneous, but small differences always exist from outcrop to outcrop. It is generally coarse- to medium-grained. K-feldspar megacrysts make up 30—35 % of the total rock volume (Fig. 3). They range in length between 1 and 6 cm (normally 3—4 cm) and have a rounded quadratic to rectangular form. They are usually grey to greyish white in colour, although pink, and occasionally red, varieties can be found. The red feldspar megacrysts are usually associated with mylonites and other deformation zones. Granite xenoliths, some

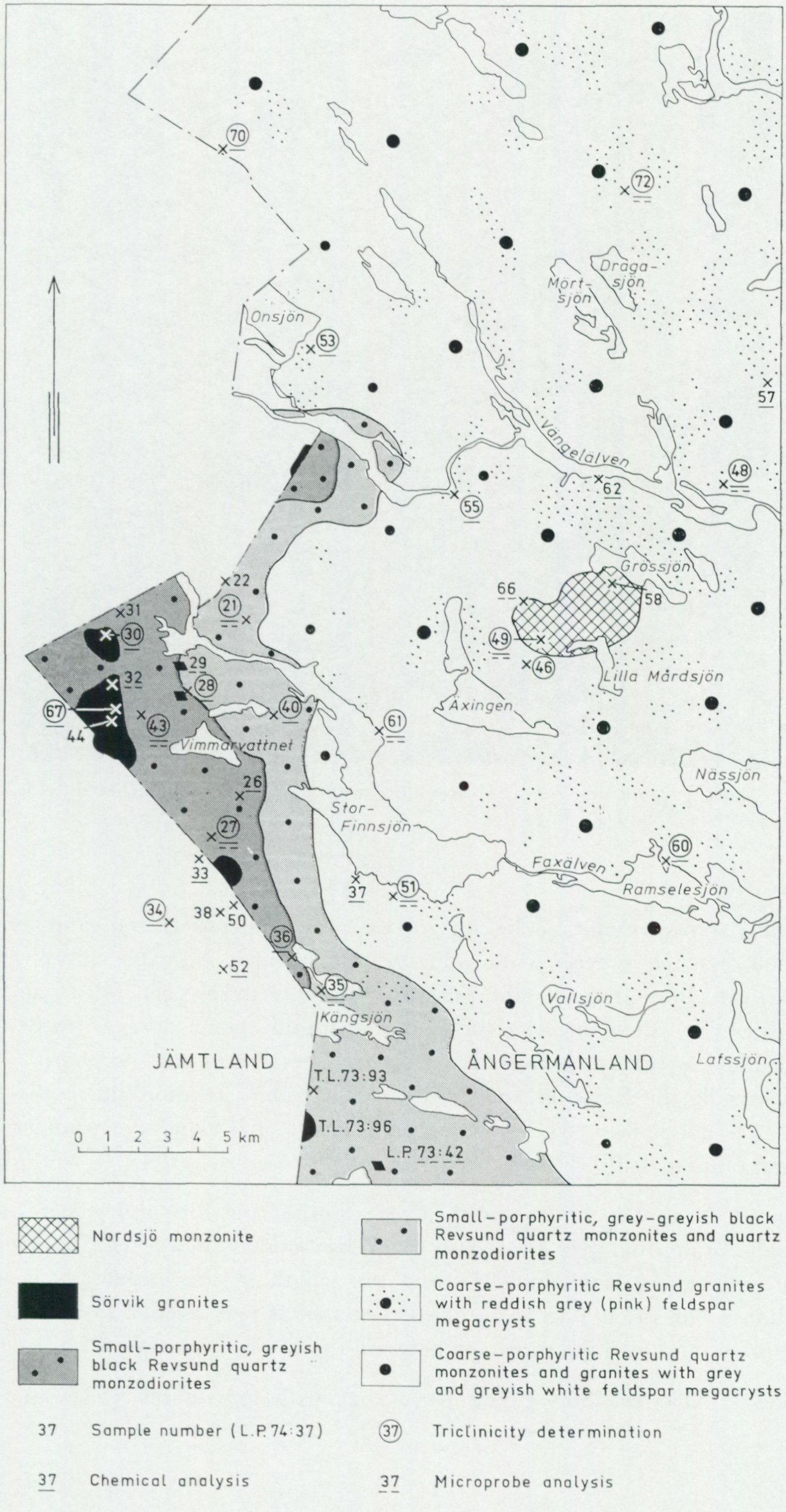

Fig. 2. Petrological map of the western parts of the Province of Ångermanland.

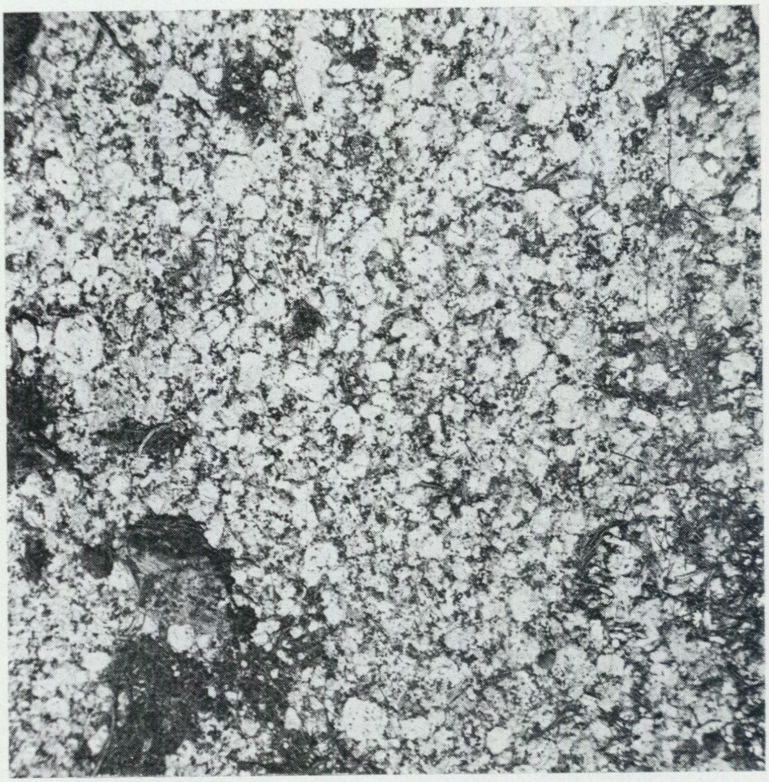

Fig. 3. Coarse-porphyritic, "normal" Revsund granite with white-weathered feldspar megacrysts. Sample L. P. 74 :60.

2—3 dm across, occur and belong to two rock types: a. Härnö granites (fine-grained, massive, greyish white, salic granites) and b. probable Sörvik granites (fine- to medium-grained, salic granites). Dolerite dykes (generally 1 m or less in width) very often intersect the Revsund granite. Some dykes of rather dense (aphanitic), syenitic to granitic rocks occur. They are in part porphyritic. These dykes intrude the Revsund and Nordsjö rocks. Their relationship to the Sörvik granites is not known. They are especially common around the younger Nordsjö monzonite massif.

Zone 2. Near the contacts of the coarse-porphyritic Revsund granites a zone of small-porphyritic, grey to greyish black Revsund rocks (2) can be seen. The megacryst content is about 25 % and the length of the megacrysts is usually less than 3 cm, often 1 to 3 cm. This rock type is very similar to the "normal" Revsund granite, and the transition between the two is successive.

Zone 3. Near the Sörvik granites a zone with greyish black Revsund rocks

(3) exists (cf. Fig. 2). This rock type is of a quartz monzodioritic composition and contains 5 to 10 % grey feldspar megacrysts of small size (1 to 2 cm). It may have a weak flow structure marked by mafic schlieren (Fig. 4). Similar observations have been made in rapakivi granites from Åland, southwestern Finland, where this type of mafic schlieren is interpreted as a gravity stratification due to magmatic currents in the roof zone of the magma (Ehlers 1974, pp. 145—149). This variety of Revsund granite is unusually rich in xenoliths, which make up 10—15 % of the total rock volume (Fig. 5). These are dark grey, fine-grained and less than 1 dm long.

Zone 4. The Sörvik intrusions (4) comprise a sequence of granites with considerable macroscopic variations. The most typical variety is grey, fine- to medium-grained, salic to intermediate in composition with abundant quartz phenocrysts 2 to 10 mm across (Fig. 6). However, both fine-grained and coarse-grained varieties occur. Colour can be red, as for example 4.7 km northwest of the western point of Sör—Vimmarvattnet, whitish grey or greyish black. A parallel structure, not always easily seen, is at close examination obvious in the Sörvik granites. This structure was probably caused by the intrusive Revsund plutonics. Pegmatites and feldspar-dominant aplites are infrequent. The granites contain more or less isolated, 1 to 3 cm long feldspar crystals, sometimes aggregated into lenses, schlieren or ribbons. These rather large feldspars seem to have

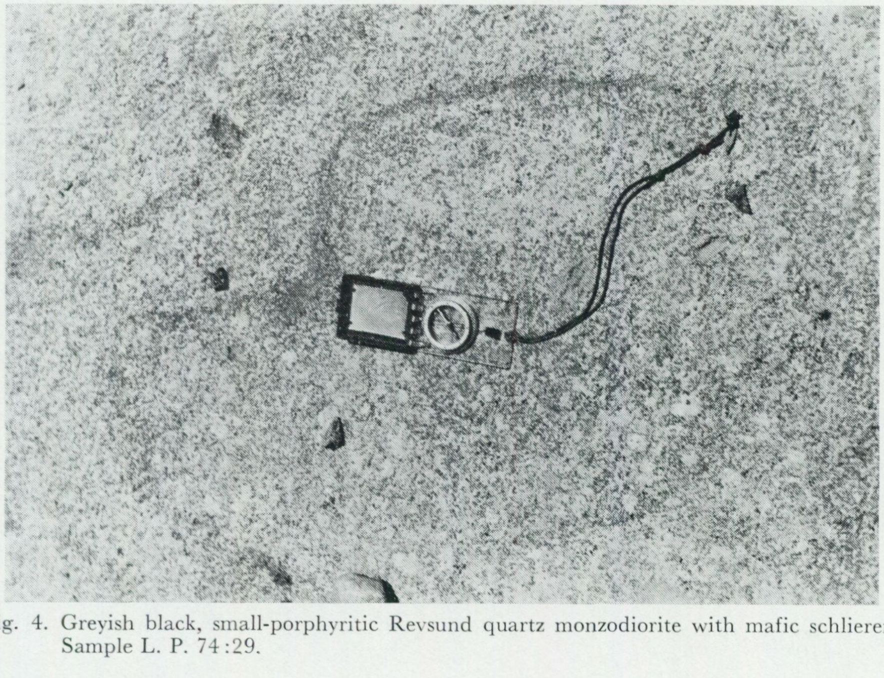

Fig. 4. Greyish black, small-porphyritic Revsund quartz monzodiorite with mafic schlieren. Sample L. P. 74:29.

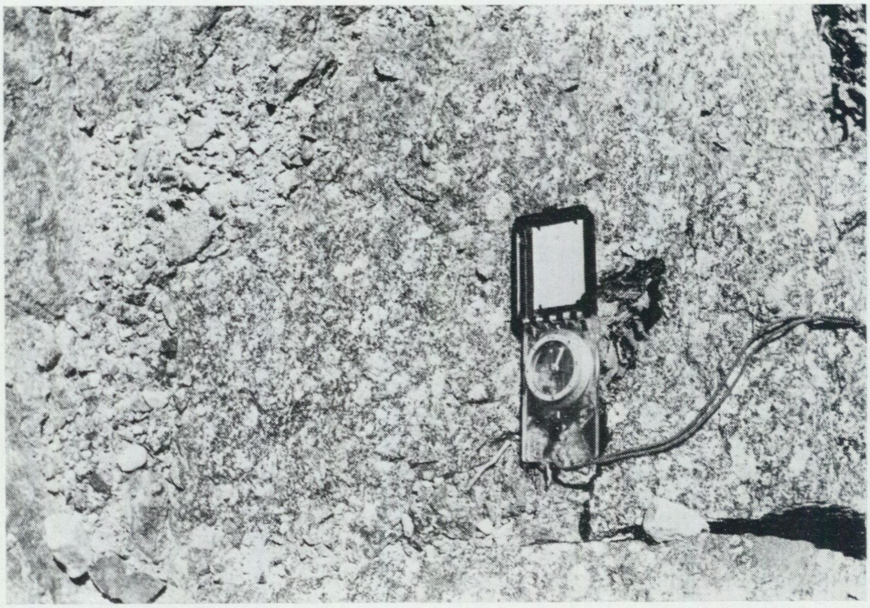

Fig. 5. Greyish black, small-porphyritic Revsund quartz monzodiorite with fine-grained rock inclusions. Sample L. P. 74:36.

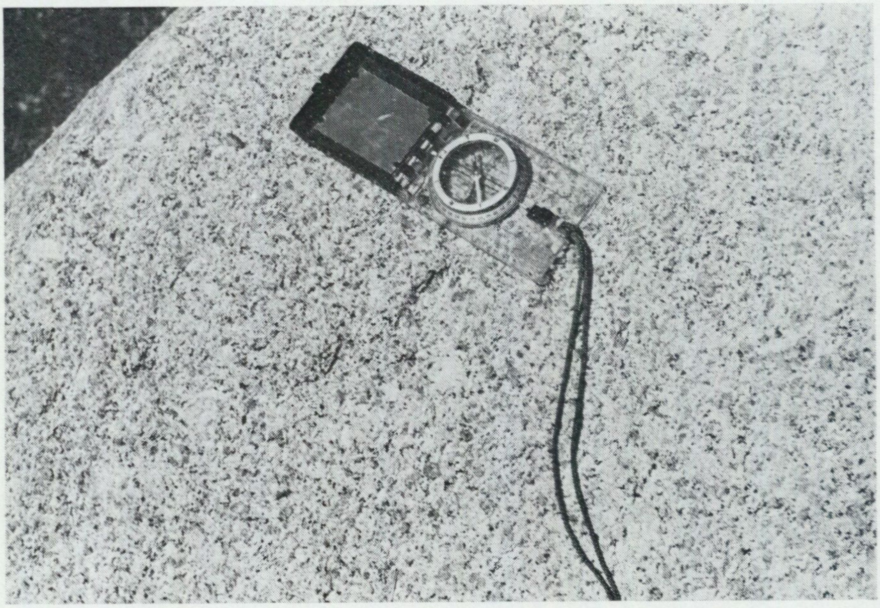

Fig. 6. Sörvik granite. Note the dark grey coloured quartz megacrysts. Sample L. P. 74:45, 705975/150165.

originated from the Revsund granites. The Sörvik granites are usually deeply weathered (10 cm or more) to a reddish brown colour. The quartz phenocrysts can be missing macroscopically and the rock can be spotty through the aggregation of dark minerals. Sharp contacts may occur with the Revsund granites, but they give no clue to age relations. The intrusions of Sörvik granite are much more irregular in form than those of the Ragunda granite, which are well-defined. In the latter case, the topographic relief is much more pronounced within the massiv than in its surroundings.

Critical evidence of the Sörvik—Revsund age relationship can be seen in some boulders, in which grey to black Revsund granites have been seen cutting a salic Sörvik type granite (e.g. a dyke 1 to 2 dm wide and 2 to 3 m long, see Fig. 7). The same Sörvik type occurs as xenoliths in an outcrop (Fig. 8). These xenoliths are of varying sizes (1 to 2 dm or 3 to 4 m long).

Near the village of Nordsjö and between the two lakes Lilla Mårdsjön and Grössjön (Fig. 2) another small rounded massif 4.5 × 2.5 km occurs. The rock of the massif is monzonitic, and in a fresh condition greenish grey, medium-grained and massive. Usually it is white- or red-weathered (Fig. 9). This massif is rather well defined, but in the eastern parts the grain size is very close to that of the surrounding Revsund granites. The Nordsjö monzonite is probably younger than the Revsund—Sörvik intrusions.

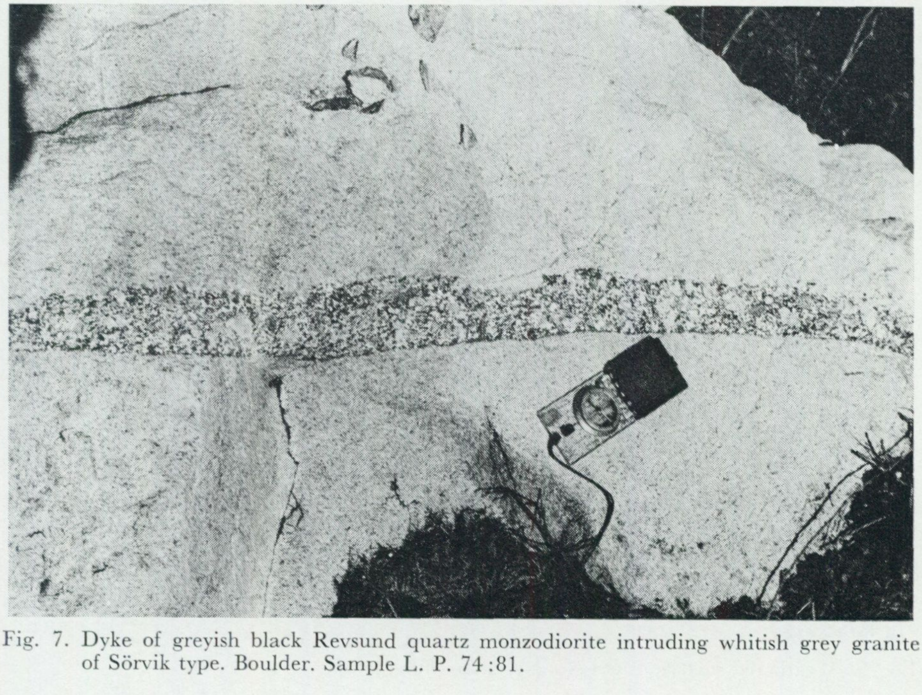

Fig. 7. Dyke of greyish black Revsund quartz monzodiorite intruding whitish grey granite of Sörvik type. Boulder. Sample L. P. 74:81.

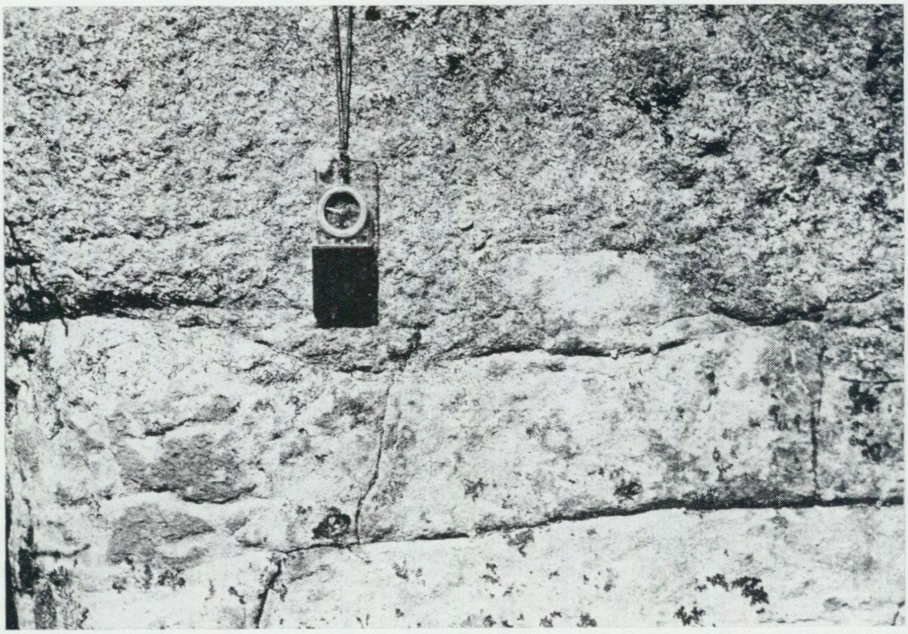

Fig. 8. Xenoliths of whitish grey Sörvik granite (rock type as in Fig. 7) occurring in greyish black Revsund quartz monzodiorite. Sample L. P. 74:29.

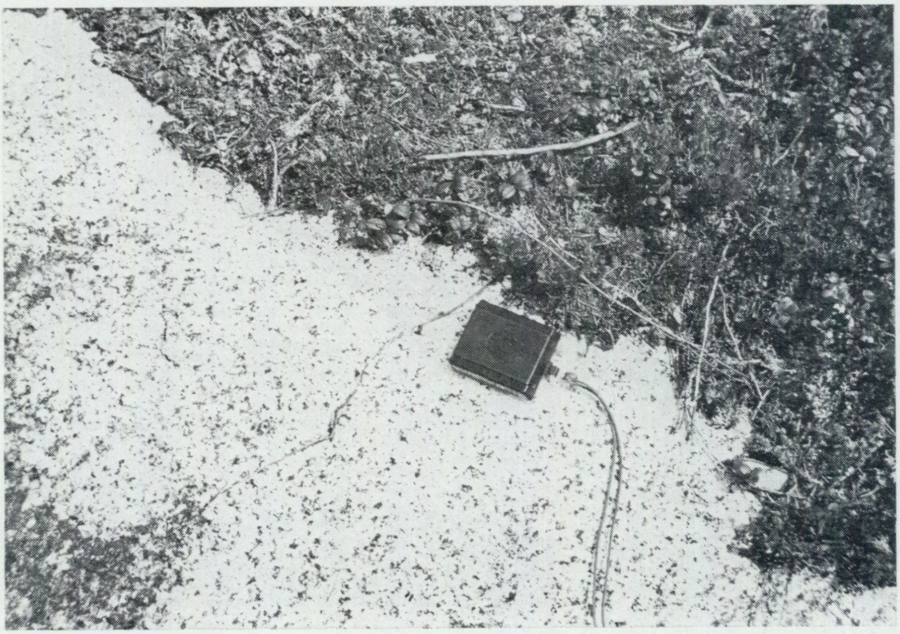

Fig. 9. Weathered surface of the Nordsjö monzonite. Sample L. P. 74:49.

MICROSCOPICAL FEATURES AND TRICLINICITY DATA ON THE K-FELDSPARS

The K-feldspars of the coarse-porphyritic Revsund granites were separated by hand picking, and those from the Sörvik and Nordsjö rocks were separated using heavy liquids. The feldspars have been investigated according to the method of Goldsmith and Laves (1954a), using the (131) and ($1\bar{3}1$) reflections. The interpretation of the diffraction traces follows among others Gorbatschev (1972) and Lundqvist (1973).

(1) COARSE-PORPHYRITIC ("NORMAL") REVSUND QUARTZ MONZONITES AND GRANITES. Hypidiomorphic, uneven-grained texture.

Main mineral (> 25 %): K-feldspar (microcline with distinct cross-hatching; somewhat perthitic i.e. film, string, vein and patch perthites; cf. Spry 1969, p. 182; $\triangle$ =0.83—0.95; Table 3).

Essential minerals (5—25 %): 1, plagioclase (sodic oligoclase—sodic andesine, 15—38 % An, usually calcic oligoclase—sodic andesine; sericitized, epidotized, albitized, normal zoning; abundant albite and pericline twins), 2, quartz and, 3, biotite (X=yellowish brown Y=Z=brown or reddish brown, rarely brownish green).

Subordinate minerals (1—5 %): 1, amphibole (colourless to yellowish green, fibrous, also green or brownish green, sometimes with colourless or light green cores). The mineral is poikiloblastic, with quartz and apatite inclusions, shows abundant polysynthetic twins; is frequently chloritized and sometimes surrounded by biotite, 2, chlorite (yellowish green, brownish green and green colours).

Accessories (< 1 %): epidote group minerals, opaque minerals, apatite, sphene, zircon, calcite, fluorite, prehnite, and tourmaline (cf. Tables 7a and 7b).

In total there are about 15—20 % dark minerals. Myrmekitic intergrowths between quartz and plagioclase exist but are less than 1 % of the whole rock (essentially rim and intergranular types cf. Phillips 1974, p. 183). There is only slight tectonic crushing.

COARSE-PORPHYRITIC ("NORMAL") REVSUND QUARTZ MONZONITES NEAR THE CONTACTS TO SMALL-PORPHYRITIC ROCKS. The mineralogy is essentially similar to that of the rock described above. Orthopyroxene has been observed near the contacts with the Nordsjö monzonite (sample L. P. 74:66). Concerning the triclinicity, monoclinic-triclinic mixed states prevail near the contacts towards the Sörvik granite and the Nordsjö monzonite ($\triangle$ =0 and 0+0.68 to 0.95).

(2) SMALL-PORPHYRITIC, GREY TO GREYISH BLACK REVSUND QUARTZ MONZONITES TO QUARTZ MONZODIORITES. Hypidiomorphic to allotriomorphic, uneven-grained texture.

Main mineral: plagioclase (25—38 % An, most commonly sodic andesine, An_{36}; sericitized, albitized, normal zoning, pigmented; abundant albite and pericline twins).

Essential minerals: 1, K-feldspar (orthoclase, mostly as megacrysts; evident cross-hatching at the borders of the crystals; fine-perthitic to crypto-perthitic in a veil-like way), 2, quartz and, 3, biotite (X = yellowish brown Y = Z = dark brown and reddish brown).

Subordinate minerals: 1, amphibole (yellowish green to green, also bluish green and green to brownish green, often with colourless or light green cores; polysynthetic twins; poikiloblastic with quartz and apatite inclusions; surrounded by biotite), 2, pyroxene (ortho- and clinopyroxene; the former surrounded by the latter, which is in turn surrounded by amphibole) and, 3, chlorite (green, yellowish green).

Accessories: opaque minerals, apatite, zircon, epidote group minerals, calcite and prehnite (cf. Table 6).

Altogether there are about 25—35 % dark minerals. Myrmekitic intergrowths between quartz and plagioclase make 1—2 % of the total rock volume (essentially rim and intergranular types). The tectonic crushing is conspicuous.

(3) SMALL-PORPHYRITIC, GREYISH BLACK REVSUND QUARTZ MONZODIORITES. Allotriomorphic (-hypidiomorphic), uneven-grained texture.

Main mineral: plagioclase (usually 33—38 %, more rarely 40—46 % An i.e. sodic—calcic andesine; sericitized, albitized, normal zoning, pigmented; bent crystals; abundant albite and pericline twins).

Essential minerals: 1, K-feldspar (orthoclase as megacrysts; sometimes also cross-hatched, indicating the existence of microcline; fine-perthitic to crypto-perthitic in a veil-like way), 2, pyroxene (mostly orthopyroxene but also clinopyroxene surrounding the former), 3, biotite (X = yellowish brown Y = Z = reddish brown and dark brown), and, 4, quartz.

Subordinate minerals: 1, amphibole (yellowish green to green, also bluish green and green to brownish green, often with colourless or light green cores; polysynthetic twins; surrounded by biotite; apatite inclusions), 2, chlorite (yellowish green, green, yellowish brown), 3, ore minerals and, 4, apatite.

Accessories: zircon, epidote group minerals and calcite (cf. Table 5).

The dark minerals make 25—35 % of the total rock volume. Myrmekitic intergrowths between quartz and plagioclase (rim and intergranular types) exist to about 1—2 %. The tectonic crushing is severe.

The above mentioned abundant fine-grained xenoliths (cf. Fig. 5) have the

TABLE 1. Summary of mineralogical and petrological features of Sörvik and Revsund rocks

	SÖRVIK GRANITES	REVSUND SUITE					
		Small-porphyritic	Small-porphyritic	Coarse-porphyritic	Coarse-porphyritic	Coarse-porphyritic	Coarse-porphyritic
Colour of feldspar megacrysts		Greyish black	Grey—greyish black	Grey	Grey	Greyish white	Pink
K-feldspar structure	M + T[1] (0 + 0.85—0.95)	M	M	M + T (0 + 0.68—0.95)	T	T	T
Fe-Mg minerals	Olivine Pyroxene Amphibole Biotite	Pyroxene Amphibole Biotite	Pyroxene Amphibole Biotite	Amphibole Biotite	Amphibole Biotite	Amphibole Biotite	Amphibole Biotite
Composition[2]	Granitic	Quartz monzodioritic	Quartz monzodioritic—quartz monzonitic	Quartz monzonitic	Quartz monzonitic—granitic	Quartz monzonitic—granitic	Granitic
Width		2 km	2—3 km	3—4 km			

[1] M = monoclinic; T = triclinic

[2] According to normative values
Terminology IUGS (1973)

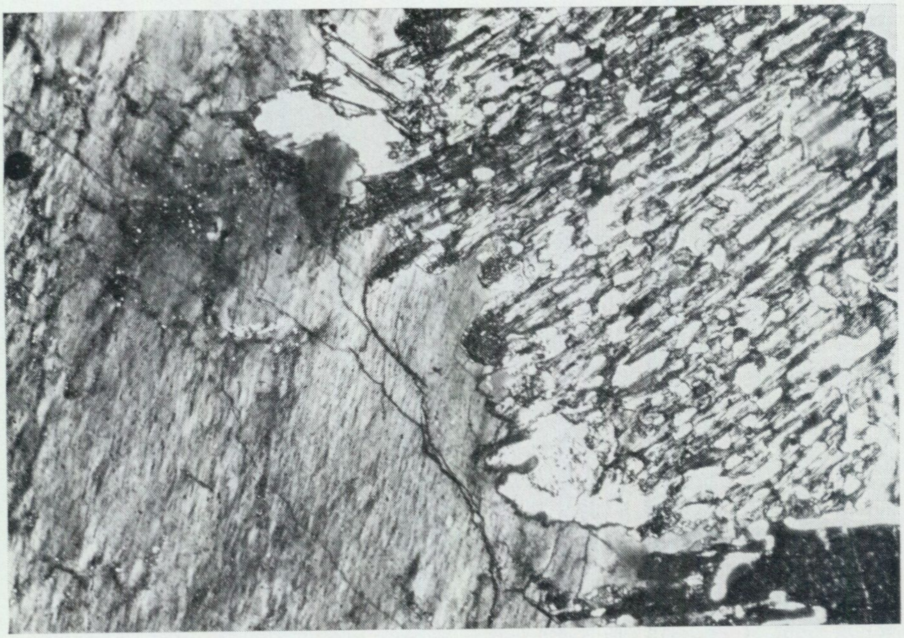

Fig. 10. Fine-perthitic — "crypto"-perthitic K-feldspar with a low triclinicity and yellowish brown—chestnut brown botite with quartz inclusions. Sörvik granite. Sample L. P. 74:50b. 2 nic. 78x.

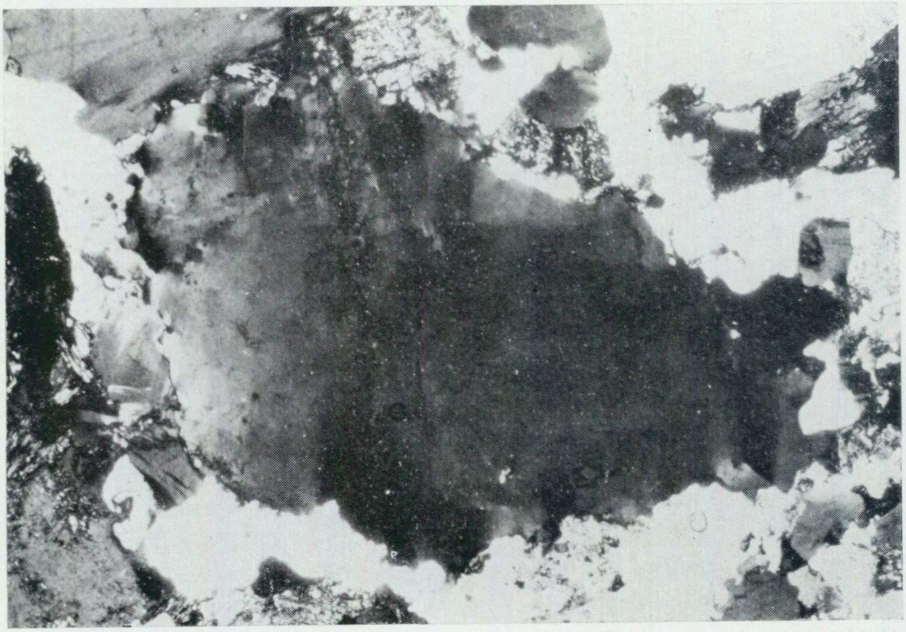

Fig. 11. Undulatory extinction in quartz megacryst. Matrix of quartz, perthite and plagioclase. Sörvik granite. Sample T. L. 74:55. 2 nic. 34x.

same mineralogy as the host rock type. Usually the size of the matrix mineral constituents is between 0.1 to 0.4 mm, normally 0.1 to 0.2 mm. The borders of the xenoliths are coarser than the cores, and enriched in quartz and myrmekite but also in pyroxenes and amphiboles.

(4) SÖRVIK GRANITES. Allotriomorphic, uneven-grained texture.

Main minerals: 1, K-feldspar [orthoclase + microcline: four examined samples have $\Delta = 0 + 0.85$ and 0.95, 0.90 and 0.91 respectively; fine-perthitic—"crypto"-perthitic in a veil-like way (Fig. 10) as well as cross-hatched microcline, most often perthitic forming film, string, vein and patch perthites] and, 2, quartz (undulose, also as megacrysts, Fig. 11).

Essential mineral: plagioclase (20—28 % An, more rarely 36—43 % An, sericitized, albitized, epidotized, normal zoning and pigmented; abundant pericline and albite twins).

Subordinate minerals: 1, biotite (X = yellowish brown Y = Z = dark brown, greenish brown and reddish brown) and, 2, secondary chlorite (yellowish green and light brown).

Accessories: amphibole (colourless to yellowish green, to green, also bluish green and green or brownish green types; poikiloblastic with inclusions of quartz (Fig. 12), ore minerals, apatite, zircon, calcite, epidote group minerals, tourmaline, fluorite and prehnite. In some samples orthopyroxene, clinopyroxene and olivine (Fig. 13; cf. Table 4) have been observed.

Dark minerals make about 7 % and myrmekitic intergrowths about 2 % of the total rock volume. Essentially there are rim, intergranular and bulbous myrmekitic types (cf. Phillips 1974, p. 183). The tectonic crushing is quite conspicuous.

Concerning mineralogical and petrological features of the above mentioned rocks a summary is given in Table 1.

(5) NORDSJÖ MONZONITE. Allotriomorphic, rather even-grained texture.

Main mineral: plagioclase (17—21 % An but ranging from albite to intermediate oligoclase; sericitized, normal zoning; albite twins) and K-feldspar (orthoclase and microcline: $\Delta = 0$ (0.82); symplectitic intergrowths with plagioclase).

Essential minerals: 1, bitotite (X = yellowish brown Y = Z = dark brown), 2, amphibole (yellowish green to green or brownish green, often with colourless to light green or brown cores; see Figs. 14 and 15) and, 3, ore minerals.

Subordinate minerals: 1, olivine (Fig. 16; altered to iddingsite) and, 2, quartz.

Accessories: secondary chlorite (yellowish green, green), clinopyroxene, apatite, zircon, calcite and epidote group minerals.

About 19 % dark minerals exist. The tectonic crushing is quite conspicuous.

Fig. 12. Quartz-poikiloblastic, fibrous yellowish green—brownish green amphibole with rims of massive, green to bluish green amphibole. In the corner yellowish brown —chestnut brown biotite with quartz and ore mineral inclusions. Sörvik granite. Sample L. P. 74:29. 1 nic. 89x.

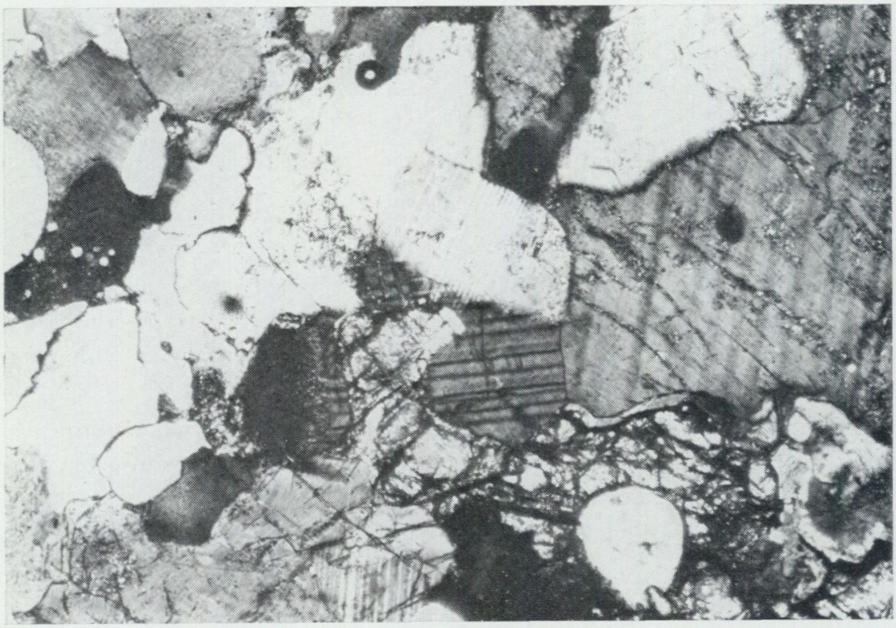

Fig. 13. Olivine with thin rim of green amphibole. Crushed plagioclase laths. Besides K-feldspar and quartz. Sörvik granite. Sample L. P. 74:32. 2 nic. 85x.

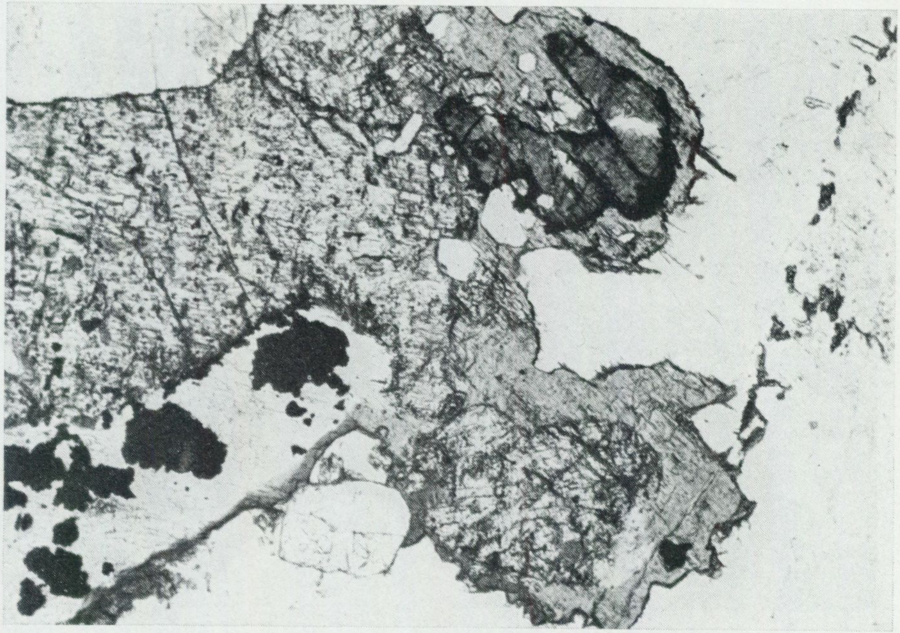

Fig. 14. Colourless to yellowish green amphibole (core), green to brownish green amphibole (rim) and fibrous, colourless amphibole (lower left) with ore mineral inclusions. Besides apatite and feldspar in the matrix. Nordsjö monzonite. Sample L. P. 74:49. 1 nic. 90x.

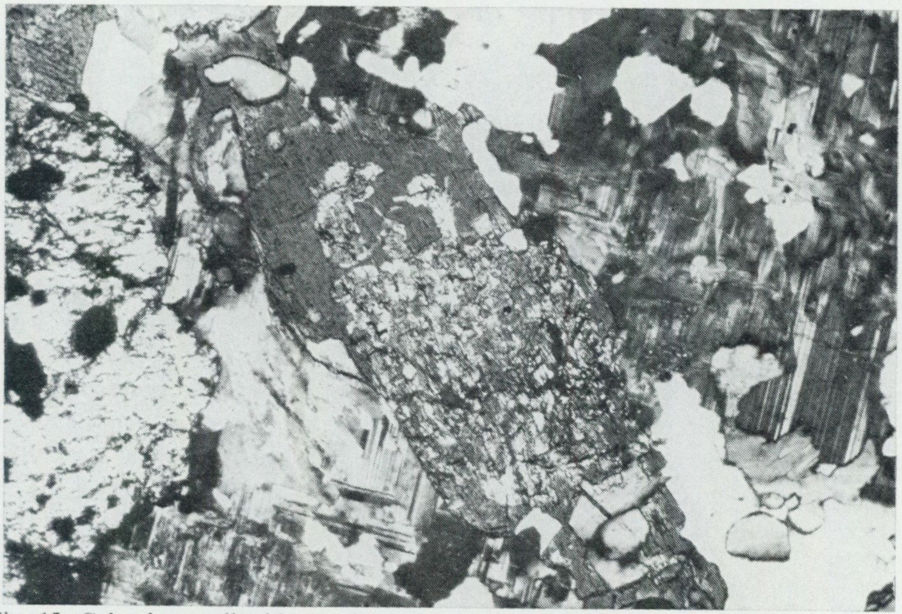

Fig. 15. Colourless—yellowish green amphibole (core) and yellowish green to green or brownish green amphibole (rim). Quartz, perthite and plagioclase make the matrix. Nordsjö monzonite. Sample L. P. 74:49. 2 nic. 89x.

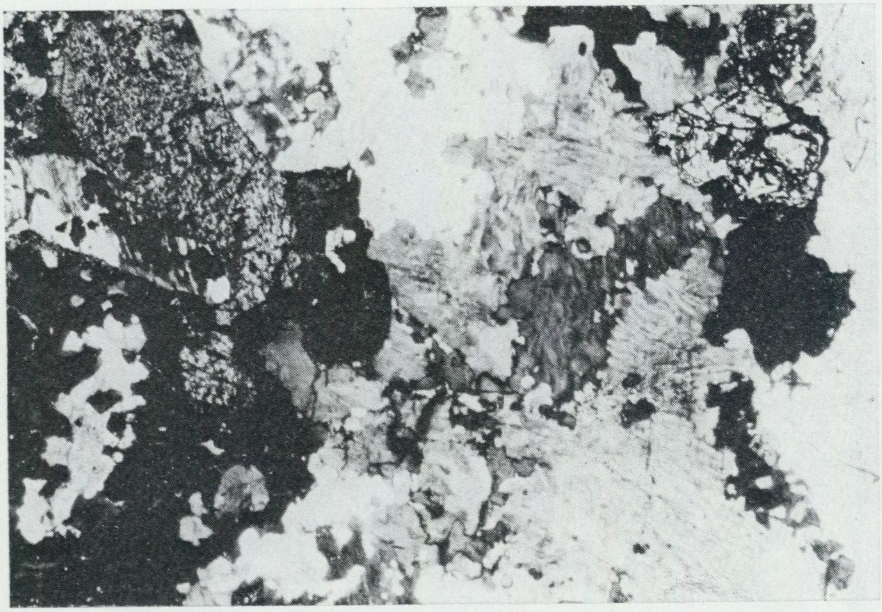

Fig. 16. Olivine (upper right) and amphibole (left). Matrix constituents are perthite, plagioclase and quartz. Nordsjö monzonite. Sample L. P. 74:49. 2 nic. 30x.

THE NOMENCLATURE OF THE ROCKS INVESTIGATED

Modal analyses have been made only on fine- and medium-grained plutonics, i.e. the Sörvik and Nordsjö intrusions (Table 4). Modal estimates have been made on the Revsund granites (Tables 5—7b). According to Streckeisen's terminology (1967) the Sörvik granites are mostly syenogranites, but in part monzogranites (Fig. 17). According to the nomenclature of IUGS (1973) one rock type is a quartz monzonite. The Nordsjö massif is monzonitic.

All rocks chemically analysed (Table 16) have been plotted in a q—or—(ab +an) triangle (CIPW norms). Here the Sörvik granites and "normal" Revsund granites are monzogranites (IUGS 1973). Grey, coarsely porphyritic Revsund rocks near the contacts to dark, small-porphyritic Revsund rocks are quartz monzonites (IUGS 1973). Other coarse-porphyritic Revsund plutonics vary from quartz monzonites to granites. The small-porphyritic, greyish black Revsund rocks are quartz monzodioritic, while the small-porphyritic grey or greyish black Revsund rock types are quartz monzodioritic or quartz monzonitic (Fig. 18).

The analysis from the Nordsjö massif shows a monzonitic composition. Microscopical investigations of several thin sections from the Nordsjö massif support the view that this rock type is a monzonite.

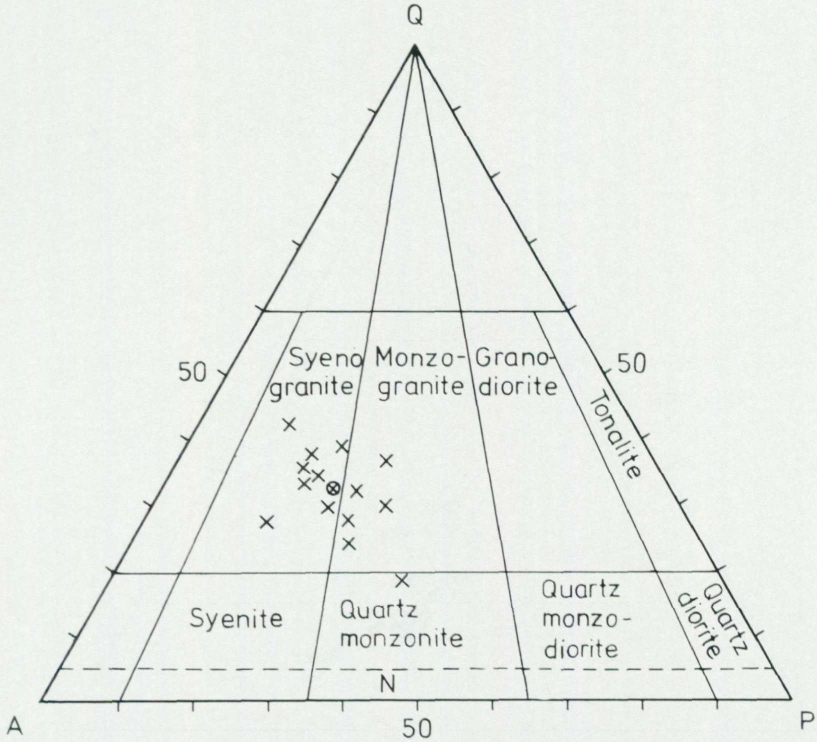

Fig. 17. Modal quartz-alkali feldspar-plagioclase compositions in Sörvik—Nordsjö plutonics. Crosses = Sörvik granites, a cross with a circle = the average of all Sörvik granites, and N = Nordsjö monzonite. Terminology according to IUGS (1973).

The Revsund—Sörvik trend is rather steep from syeno- and monzogranites over quartz monzonites to quartz monzodiorites. In comparison, the synorogenic Svecokarelian rocks display a syenogranitic—monzogranitic—granodioritic—tonalitic trend (cf. Gorbatschev 1971, Persson 1976, p. 12).

The Ragunda rocks vary from monzogranitic to quartz monzonitic compositions. They display a still steeper trend line compared to the Revsund—Sörvik rocks. The Ragunda rocks have been plotted from chemical analyses published by Kornfält (1976). Some of them are syenites, representing an early magmatic phase, followed by a later granitic phase (Kornfält 1976).

MINERAL ANALYSES

The FeMg-minerals of investigated rock types were analysed and compared with each other.

Biotite. The biotites of all rock types generally have the pleochroism X = light yellowish brown and Y = Z = reddish brown or dark brown. More seldom green

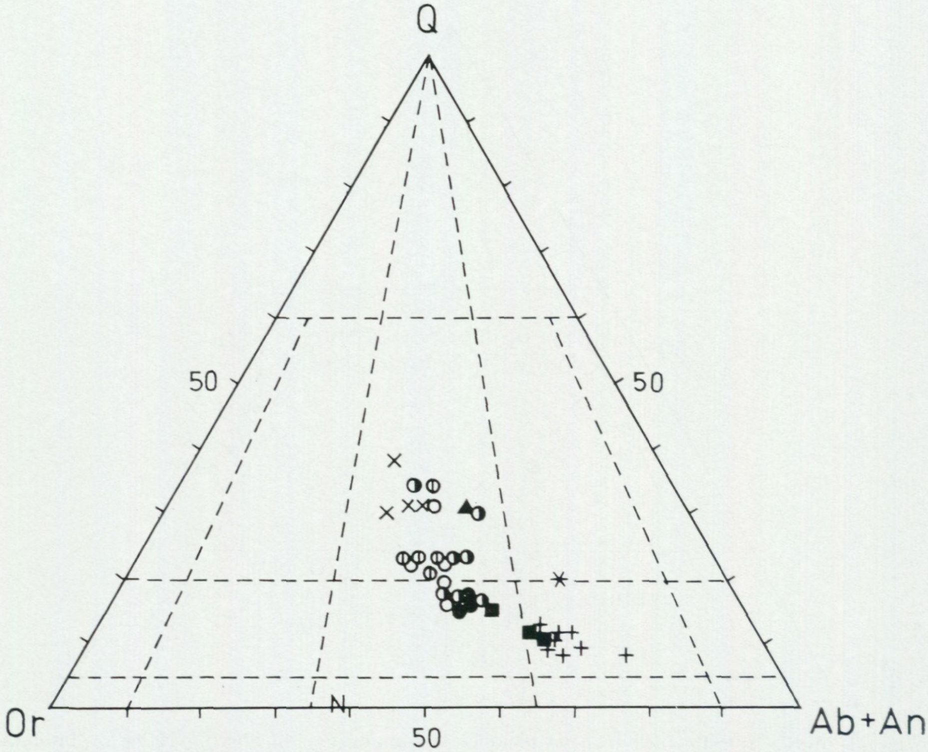

Fig. 18. Normative q-or-ab + an compositions (weight per cent) in Revsund—Sörvik—Nordsjö plutonics. Star = greyish black rock inclusion in Revsund granite, upright crosses = greyish black Revsund rocks, filled squares = grey-greyish black Revsund rocks, dots = coarse-porphyritic Revsund rocks near the contacts to grey—greyish black Revsund rocks, half-filled circles = coarse-porphyritic Revsund rocks with grey feldspar megacrysts, open circles = as former rock type but with greyish white megacrysts, open circles with a vertical line = as former rock type but with pink to red megacrysts, crosses = Sörvik granites, N = Nordsjö monzonite, and filled triangle = the average of chemical analyses of Revsund granites from Västerbotten County according to Svensson (1970).

varieties occur. The biotites are chloritized and sometimes contain secondary prehnite (cf. Hjelmqvist 1937, Phillips and Rickwood 1975). All analysed minerals (Tables 8—9) are Fe-rich biotites. The compositions are similar in the different rock types except for the younger Nordsjö monzonite, a phenomenon also valid for other analysed minerals (Fig. 19). In general the biotites are relatively MgO-rich in the greyish black and grey or greyish black Revsund plutonics, while being FeO-rich in the Nordsjö monzonite. A light brown biotite, a green biotite and a greenish brown biotite have comparatively low TiO_2-values (Table 9). The biotites (lepidomelanes) in rapakivis from Finland (Simonen and Vorma 1969) generally have lower values of TiO_2, MgO and K_2O. Nockolds (1947) concluded that the chemical composition of biotites is a function of the

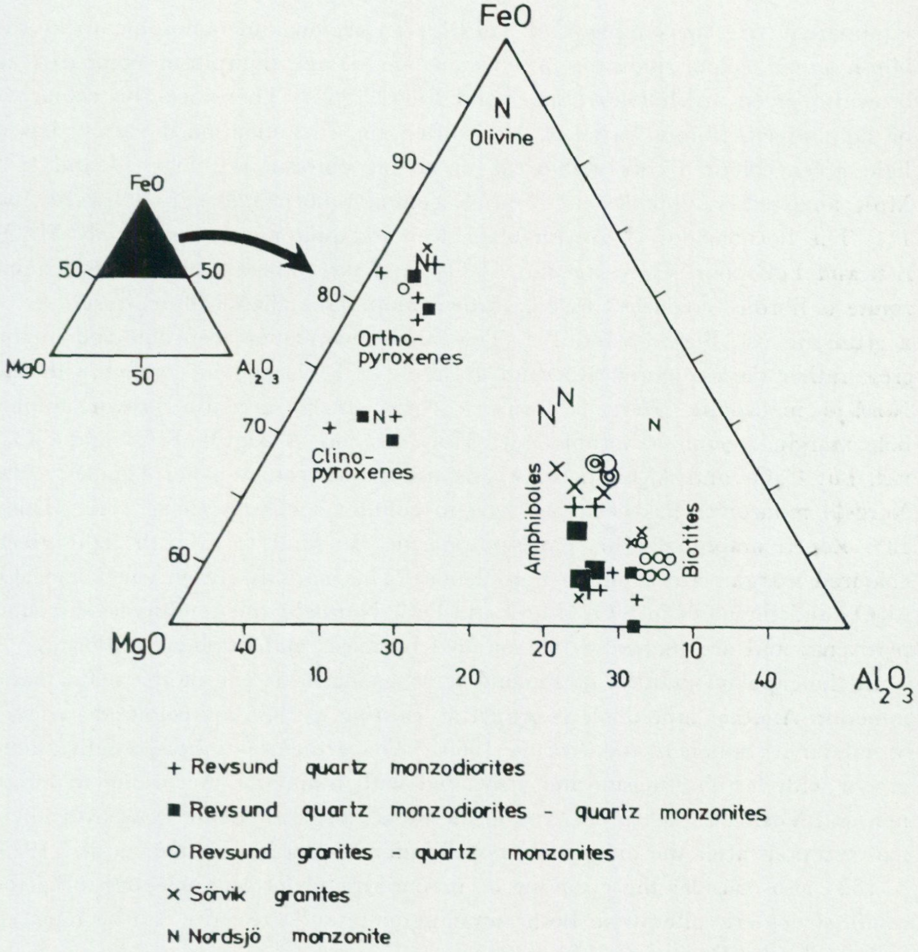

Fig. 19. Fe_{total} = FeO-MgO-Al_2O_3 (weight per cent) plot of ferromagnesian minerals from Revsund—Sörvik—Nordsjö rocks. The signs of the amphiboles are enlarged.

associated ferromagnesian minerals which occur in the rock. Gokhale (1968) suggested a distinction between magmatic and metamorphic-metasomatic plutonics on the basis of the chemical composition of the biotites. In a MgO—Al_2O_3—FeO-triangle magmatic biotites were proposed to show MgO-values below 15 %. All analysed Revsund—Sörvik—Nordsjö biotites produce a mean value of 11 % i.e. indicating a magmatic origin (Fig. 19). Gorbatschev (1969, 1970) showed biotite analyses from igneous rocks, falling in the metamorphic field. Especially the Rätan granite biotites show relatively high MgO-values. The Rätan granite is considered to be magmatic (Lundqvist 1968).

Amphibole. Amphiboles also occur in all investigated rock types. Normally it is yellowish green to green or brownish green. Sometimes a bluish green colour is apparent (e.g. in sample L. P. 74:61). In regional metamorphic rocks the bluish green colour indicates a lower grade of metamorphism compared to brownish green amphiboles (Engel and Engel 1962). There are also colourless or light green, fibrous varieties. Very often the first mentioned variety has a light green coloured core with weak or no pleochroism (cf. Figs. 14 and 15). Most analysed amphiboles are Fe-rich common hornblendes (Tables 10 and 11). The hornblendes of greyish black Revsund plutonics are relatively MgO-rich and FeO-poor. They are also Al_2O_3- and CaO-rich. In the Nordsjö monzonite a fibrous, colourless to pale brown amphibole chemically corresponds to a grunerite (cf. Figs. 14 and 15). The same mineral has been observed in the grey, rather dark-coloured Revsund granite (L. P. 74:66) in contact with the Nordsjö monzonite. Here it forms a core with a greenish brown amphibole margin (common hornblende). Thus the core is MgO-, FeO- and SiO_2-rich but CaO- and Al_2O_3-poor. A greenish brown common hornblende in the Nordsjö monzonite has been observed to contain a clinopyroxene core (Table 12). Zoned amphiboles in coarse-porphyritic Revsund rocks with light green coloured margins are common hornblendes. The margins are enriched in CaO, Al_2O_3 and the cores in SiO_2, MgO and FeO. Normally the amphiboles surround pyroxenes and are themselves surrounded by micas and secondary chlorites.

In the rapakivi granites of Finland ferrohastingsite is one of the main mafic minerals. Another amphibole is grunerite, existing in the dark-coloured varieties of rapakivi (Simonen and Vorma 1969). The grunerite is homoaxially intergrown with ferrohastingsite and associated with iddingsite. According to Simonen and Vorma (1969, p. 24) the grunerite is caused by deuteric or hydrothermal reactions after the magmatic crystallization of rapakivi. Barker et al. (1975, p. 132) also consider the grunerite occurring around ferrohornblendes to be the result of deuteric alteration. Both cummingtonite and grunerite can be replaced by hornblende (Deer et al. 1965, p. 245).

Olivine. This mineral occurs in the Sörvik and Nordsjö rock types (cf. Figs. 13 and 16). It is a fayalite (Table 13) and is partly altered to iddingsite. The fayalite of the Nordsjö monzonite is richer in MgO and poorer in FeO compared with that of the other rocks. Fayalite is also found in Finnish rapakivi rocks (Simonen 1961).

Pyroxenes. Orthopyroxenes are abundant in the Sörvik granites and in the dark-coloured members of the Revsund suite. More subordinate is clinopyroxene, which often surrounds the orthopyroxene. In turn, clinopyroxene is surrounded by amphibole. Compositionally, the orthopyroxene is an eulite (-orthoferrosilite). The analysed sample from the Sörvik granite is comparatively rich in FeO and SiO_2, but poor in MgO (Table 14). The clinopyroxenes are colourless. Compositionally they are ferroaugites characterized by low TiO_2-values (Table 15). The MgO-values of a Nordsjö clinopyroxene are low and the mineral is comparable to those of other rocks but richer in TiO_2.

Mentioned minerals are all Fe-rich. The assemblage is close to that of rapakivis, even if not exactly the same. The paragenesis is typical for post- or anorogenic plutonics. Fayalite, orthopyroxene (En_{40}), clinopyroxene and grunerite are also reported from adamellites associated with anorthosites in the Labrador Peninsula (Wheeler 1969) and from the Pikes Peak, Colorado (Barker et al. 1975).

WHOLE ROCK CHEMISTRY OF THE ROCKS

Chemical analyses, Niggli values and CIPW norms are given in Table 16. Some diagrams will be presented here, showing characteristic features of the Revsund—Sörvik rocks. Comparisons have been made with rapakivi rocks in Finland and the Ragunda granites. The Revsund—Sörvik rocks are similar to the Finnish rapakivis, whereas the Ragunda rocks in part show a different pattern, although in part common features exist with the Revsund—Sörvik suite.

Four diagrams (Figs. 20—23) show the close connection between the Revsund—Sörvik plutonics and the Finnish rapakivis. The Niggli values *alk, c, al,* and *fm* contra *si* have been plotted. The east Fennoscandian rapakivi trend line has been transferred from Sahama (1945). Chemical analyses of the Ragunda rocks have been published by Kornfält (1976).

Fig. 24 shows the atomic proportions Mg/Mg+Fe contra *si.* The Ragunda trend line falls near $mg=0.15$, the Revsund—Sörvik rocks around $mg=0.2$—0.25. The "Gothian" trend according to Gorbatschev (1971) is around $mg=0.3$, while the "Svecofennian" trend is between 0.35 and 0.5. East Fennoscandian rapakivis show Niggli *mg* values below the Revsund—Sörvik trend line and generally also below 0.15 (Sahama 1945). Representative granites from the Wiborg rapakivi massif in Finland come close to the Ragunda trend line, thus around 0.15 (Vorma 1971, pp. 8—9).

With lower CaO-values and a higher K_2O/Na_2O-ratio (Fig. 25) a transition is obvious from greyish black Revsund rocks over grey to greyish black small-porphyritic, grey coarse-porphyritic, white coarse-porphyritic to pink coarse-porphyritic Revsund plutonics. The Sörvik granites provide the lowest CaO-values and the highest K_2O/Na_2O ratio. The Nordsjö monzonite has a low K_2O/Na_2O ratio and an inferred CaO-value. The Revsund rock sample with grey feldspar megacrysts, which has a K_2O/Na_2O ratio of only 1.35, is situated in immediate contact with hornfelses (contact metamorphosed greywackes).

In Fig. 26, showing $Fe_2O_3:(Fe_2O_3+FeO)$—SiO_2, the lowest ratio (0.025—0.15) is represented by the Revsund—Sörvik rocks, the highest (0.2—0.3) by the Ragunda rocks, an intermediate value characterizing the Finnish rapakivis.

In the same way there is a typical separation concerning the $CaO:(CaO+Na_2O)$—SiO_2 relations (Fig. 27). The Ragunda trend line is the lowest (0.15—

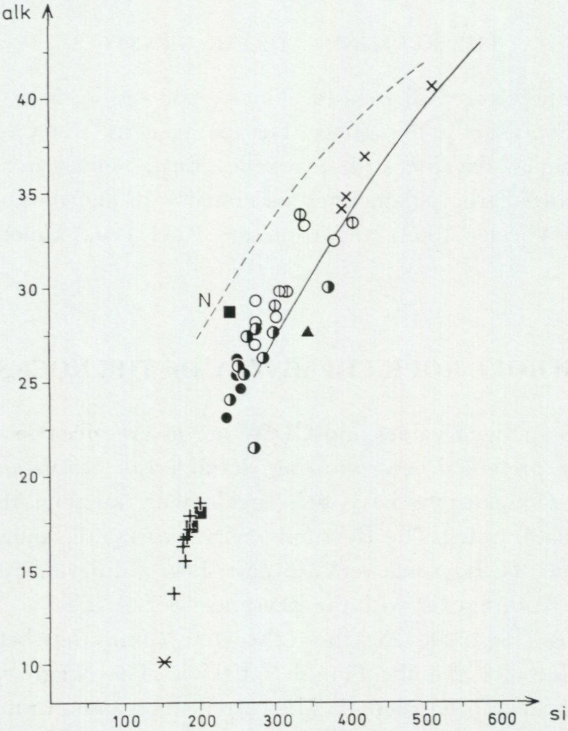

Fig. 20. Differentiation diagram based on Niggli values *alk* and *si*. Full line = East Fennoscandian rapakivi granites according to Sahama (1945), broken line = Ragunda trend (chemical analyses published by Kornfält 1976). Other symbols see Fig. 18.

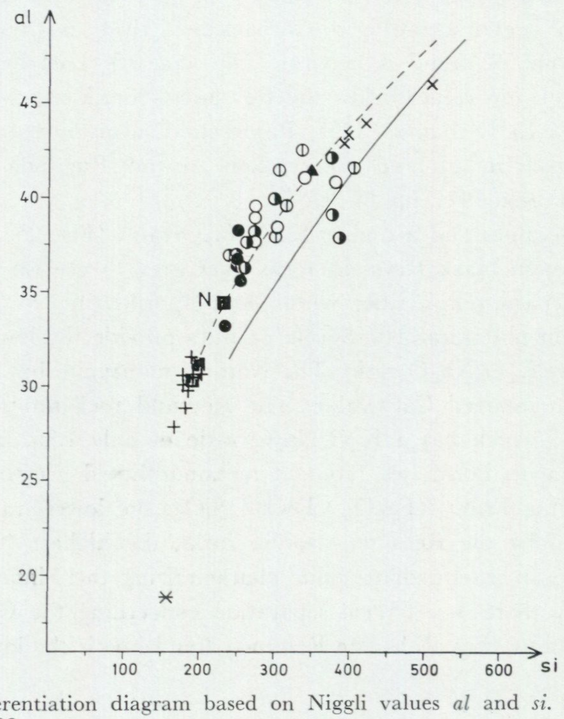

Fig. 21. Differentiation diagram based on Niggli values *al* and *si*. Symbols see Figs. 18 and 20.

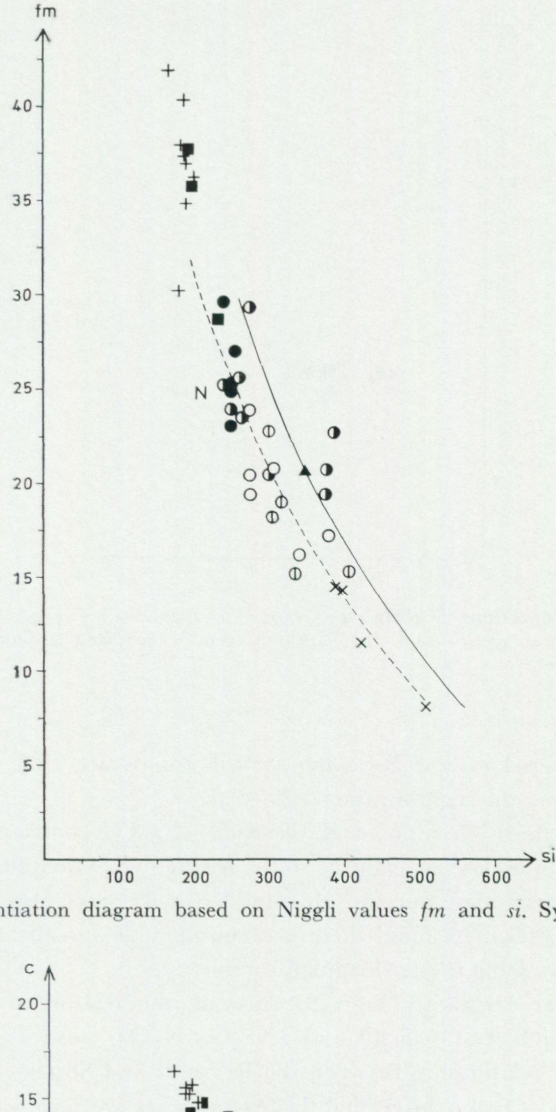

Fig. 22. Differentiation diagram based on Niggli values *fm* and *si*. Symbols see Figs. 18 and 20.

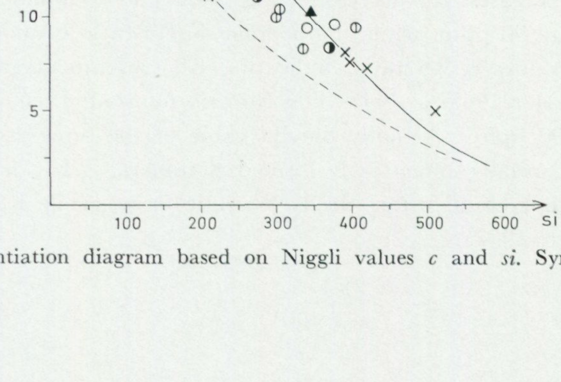

Fig. 23. Differentiation diagram based on Niggli values *c* and *si*. Symbols see Figs. 18 and 20.

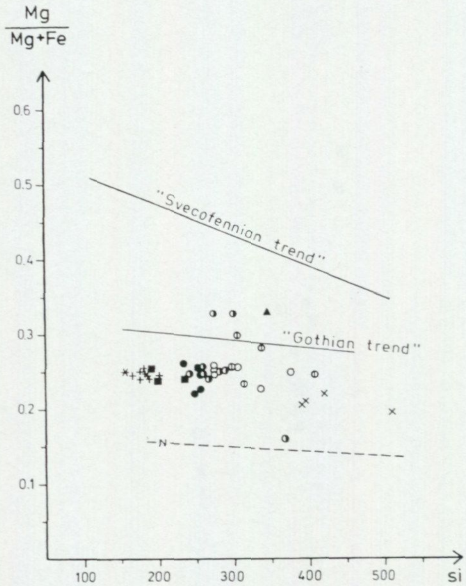

Fig. 24. Atomic proportions Mg/Mg + Fe contra *si*. Symbols see Figs. 18 and 20. The "Svecofennian trend" and the "Gothian trend" according to Gorbatschev (1971) are indicated.

0.4), while the rapakivi and Revsund—Sörvik trends are close to each other, the rapakivis having the highest ratio (0.25—0.6).

Fig. 28 shows the high ratio of K_2O:($K_2O + Na_2O$) contra SiO_2. The Ragunda granites come close to Daly's granite avarage (Sahama 1945). The rapakivi K_2O-values are high but the Revsund—Sörvik rocks also represent high values (ratio 0.5—0.7). As usual there is a considerable spread of the potassium contents, probably owing to post-magmatic activity.

Three triangular diagrams (Fig. 29) showing the relations between CaO—Na_2O—K_2O, MgO—CaO—K_2O and ($Na_2O + K_2O$)—tot.Fe—MgO are presented. The close relationship between the Revsund and Sörvik rocks is evident, while the Ragunda rocks differ slightly. Actually, as we have earlier seen, the Revsund—Sörvik rocks come closer to the rapakivis than the Ragunda rocks.

When K/Rb increases, Rb decreases (Fig. 30). The abundance of Rb in the crust is in average 90 ppm, while the average K/Rb ratio is about 230 (Taylor 1965, p. 144). A low K/Rb ratio, indicating Rb enrichment can be found in late granites (Taylor 1965, p. 144). The Nordsjö monzonite has indeed a rather low Rb value (90 ppm). Actually the Ba value of the same rock type is high (1950 ppm). Ba usually enters early formed K-minerals (Taylor 1965, p. 155). With increasing degree of fusion, the K/Rb ratio grows while Rb decreases (cf. Dupuy and Allegre 1972).

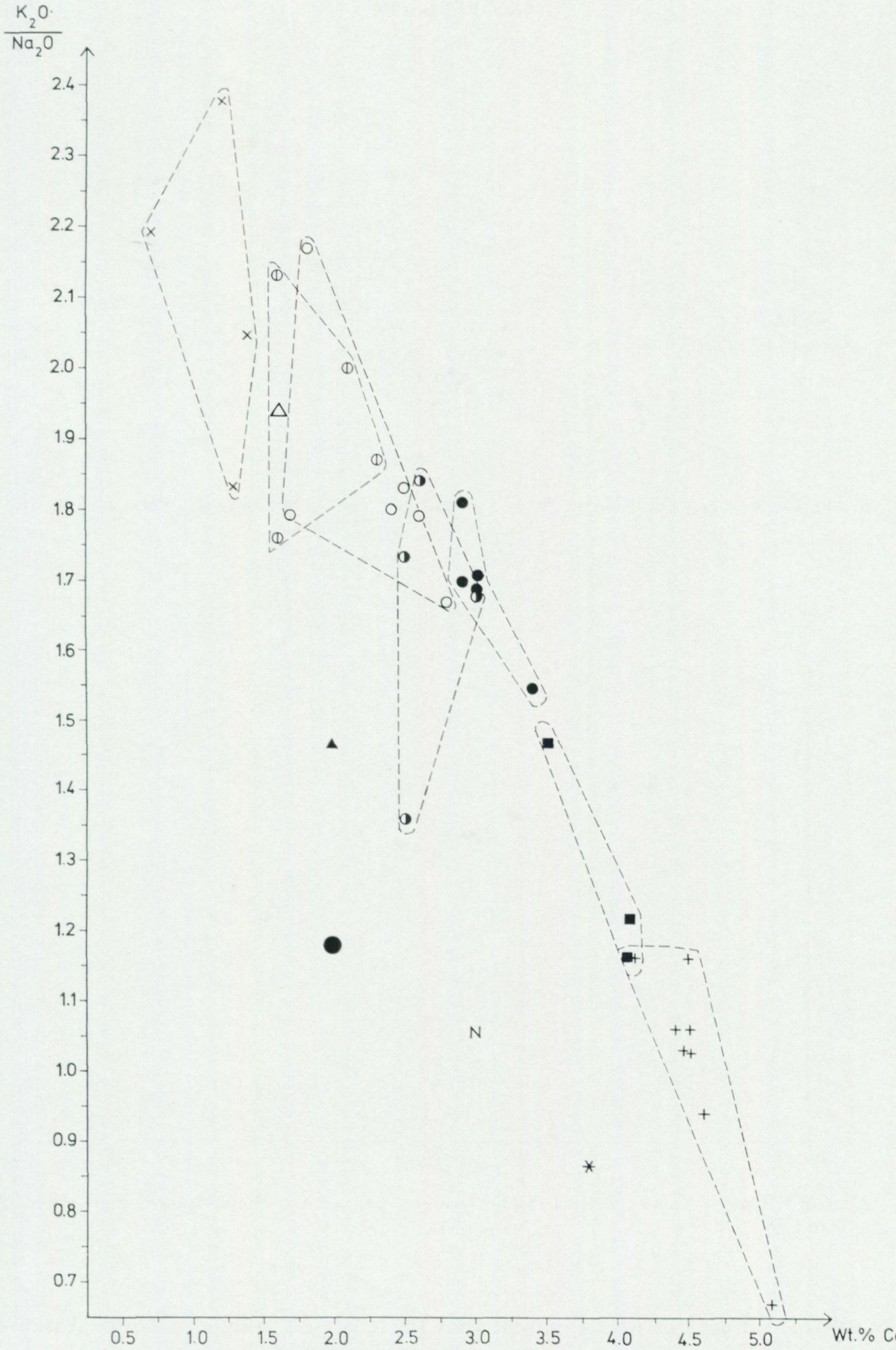

Fig. 25. K_2O/Na_2O ratio contra CaO (weight per cent). Open triangle = average of the East Fennoscandian rapakivi granites according to Sahama (1945), open big circle = Sederholm's rapakivi average according to Sahama (1945), and filled big circle = Daly's granite average according to Sahama (1945). Other symbols see Figs. 18 and 20.

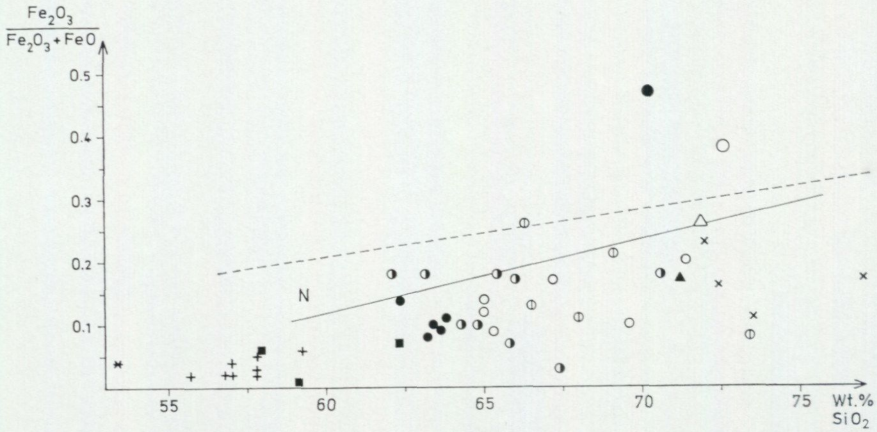

Fig. 26. Fe_2O_3/Fe_2O_3+FeO contra SiO_2 (weight per cent). Symbols see Figs. 18, 20 and 25.

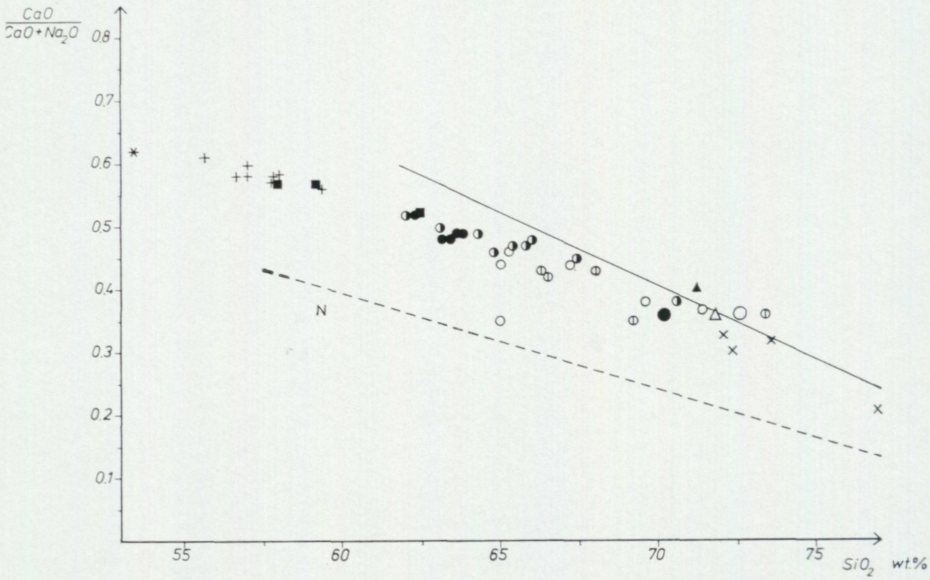

Fig. 27. $CaO:(CaO+Na_2O)$ contra SiO_2 (weight per cent). Symbols see Figs. 18, 20 and 25.

In all these diagrams it is apparent that the analysed sample of Nordsjö monzonite falls outside the Revsund—Sörvik as well as the rapakivi trends. Actually, it comes in many respects closer to the Ragunda rocks. There are reasons for believing it to be younger than the Revsund—Sörvik granites in age. A differentiation trend exists from dark, small-porphyritic Revsund quartz monzodiorites

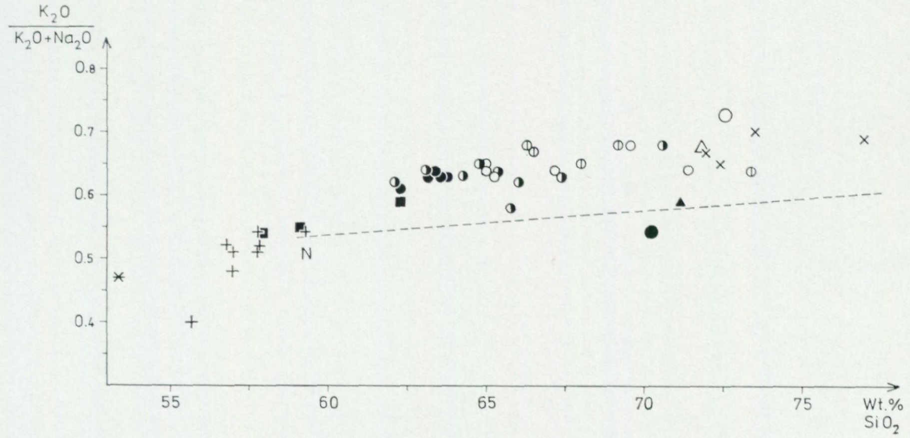

Fig. 28. $K_2O:(K_2O+Na_2O)$ contra SiO_2 (weight per cent). Symbols see Figs. 18, 20 and 25.

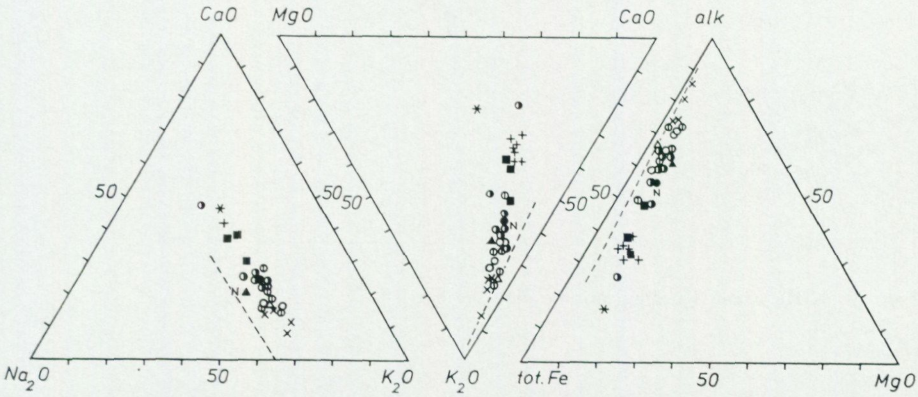

Fig. 29. CaO-Na_2O-K_2O, MgO-CaO-K_2O and alk—total Fe-MgO (weight per cent) triangular diagrams. Symbols see Figs. 18 and 20. Filled circle = the average of five chemical analyses. In the left diagram plus sign = the average of eight chemical analyses.

to coarse-porphyritic Revsund granites. As the Sörvik granites, according to field observations, are older than the Revsund granites, it follows that they should be interpreted as comagmatic, acid differentiates, intruded by the main Revsund granite magma. It is highly probable that the early Sörvik rock types have their compositions altered owing to assimilation of salic wall-rocks.

DISCUSSION AND SUMMARY

During postorogenic Svecokarelian and the following anorogenic time great masses of granitic to quartz monzonitic rocks were emplaced in central and south

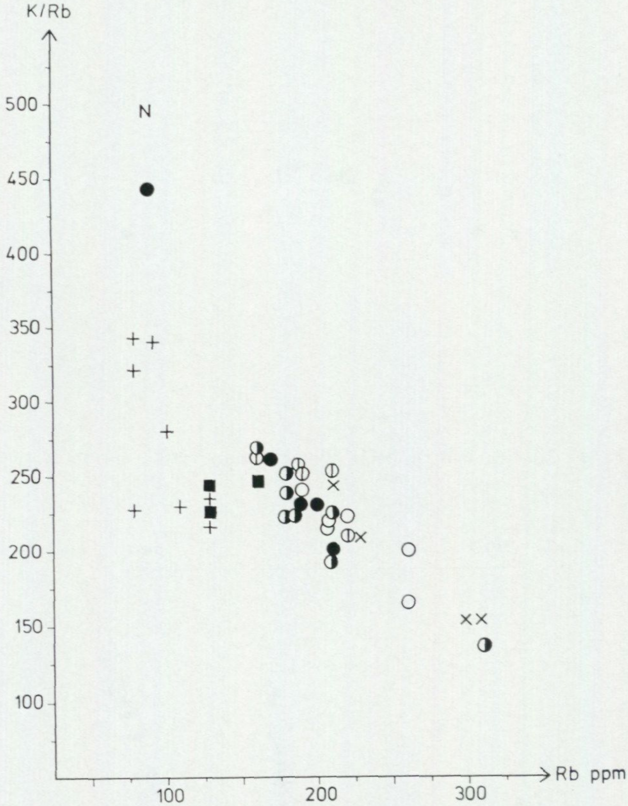

Fig. 30. K/Rb versus Rb diagram. Symbols see Fig. 18.

Sweden (e.g. Revsund, Rätan, Småland—Värmland, Ragunda and Nordingrå granites).

As detailed investigations are sparse concerning the post- and anorogenic granites, comparisons have in this paper been made between the investigated Revsund granites, Ragunda plutonics and the Finnish rapakivis. Chemically these two granite types show apparent similarities, as has been shown in Figs. 19—29. The Revsund suite, however, differs from the neighbouring Ragunda granites, even if all these rock types (including the Finnish rapakivis) have characteristic common features compared to "normal" granites (cf. Kornfält 1976). Thus, it is evident that, during the final stages of the Svecokarelian orogeny and the following anorogenic time, there were several large-scale intrusions of massive, porphyritic granitic—quartz monzonitic—quartz monzodioritic plutonics. According to Bridgwater and Windley (1973) there was a major rise of considerable amounts of material derived from the mantle in the period 1 000 to 2 000 Ma ago. In this association of rocks there may also be anorthosites. This period and province is characterized by tectonic instability, high thermal gradients and considerable magmatic activity (Bridgwater and Windley 1973, p. 311; cf. Isachsen 1969, p. 445). Bridgwater et al. (1974; cf. Vorma 1976) demonstrated that a basic magma melted the lower crustal rocks with the consequence that secondary magmas formed, which rose along graben-like structures. Differentiation trends are reported from anorthosites and norites to monzonitic, syenitic and granitic rocks (jotunites, mangerites, charnockites, adamellites etc., e.g. de Waard 1969, Kranck 1969, Olmsted 1969, Wheeler 1969). The more acidic rocks are generally intrusive in the more calcic ones, and the presence of orthopyroxene or fayalite and quartz is not restricted to any specific rock group (de Waard 1969, p. 72).

Vorma (1972) states that the emplacement temperature of the rapakivitic magma exceeded 800°C, which leads to the formation of hornfelses and orthoclase in the surrounding rocks, a fact also valid for the Revsund granites. Sviridenko (1968) has estimated the crystallization temperature of the Salmi rapakivi rocks to 880—940°C by means of the composition of the titaniferous magnetite. Vorma (1975) considers a cratonization and denudation of about 10 km of the crust after the development of the Svecokarelian rocks. After that, deep fractures were formed and later the rise of rapakivitic magma about 1 700 Ma ago took place. Vorma (1971, p. 60, 1975, p. 6) considers the present erosion level to represent an intrusion depth of rapakivi of about 3 km.

Barker et al. (1975) introduced a model of the genesis of rapakivi associations. A convecting alkali olivine basalt from the mantle (at or slightly above the Moho) reacts with K_2O-poor lower crust material and produces a quartz--syenitic liquid, in turn reacting with granodioritic and granitic intermediate crust producing fayalite-free biotite and biotite-hornblende granites. The syenitic magma may also erupt and differentiate producing fayalite granites and riebeckite granites. This early crystallization of magnesian olivine and clinopyroxene rapidly depleted the magma in MgO. Thus later crystallized magmas show the fayalite-rich (Fe-rich) clinopyroxene-amphibole paragenesis.

There is a special evolution among the Revsund plutonics. A differentiation exists from the small-porphyritic, greyish black rocks over small-porphyritic, grey to greyish black types to coarse-porphyritic granites with grey, white and pink K-feldspar megacrysts. The compositions are quartz monzodioritic to quartz monzonitic and granitic. In the area investigated, the Sörvik granites are situated in the belt of greyish black, small-porphyritic Revsund granites (Fig. 2) but in other places Sörvik granites may occur with "normal" coarse-porphyritic Revsund granites as surrounding rocks. The fayalite-pyroxene-amphibole-bearing Sörvik and Nordsjö rocks are of highly varying character. The Sörvik type granites in different outcrops show great variations. The quartz-porphyritic structure and texture are, however, typical. As mentioned above the field relationships speak for the Sörvik granites being older than the Revsund granites. The former should thus represent early crystallized differentiates near the roof of the Revsund granite magma, later affected, deformed and intersected by the main intrusions of Revsund granites. The Sörvik granites evidently occur as small, more or less irregular bodies of varying size in the Revsund granites. This occurrence and the genesis explain the often existing parallel structure in the Sörvik granites. The Nordsjö monzonite forms a small, rounded massif. The chemistry resembles that of the Ragunda plutonics, which are younger than the Revsund granites. It is generally coarser near the contacts to the Revsund granites. The minerals are the same as those of the Sörvik granites. Many reasons suggest that it is younger than the Revsund—Sörvik granites.

The high original temperatures of the Sörvik and Nordsjö types are indicated by the presence of orthoclase, and by the mineralogy. The monoclinic K-feldspar of the greyish black and grey—greyish black, small-porphyritic Revsund suite rocks remained unchanged, while mixed states i.e. ordered in the direction of microcline, occurred in the Sörvik and Nordsjö rocks.

Especially around the Nordsjö monzonite massif and also inside it (but also in some cases near the Sörvik granites) some unusual dykes have been found. Except for dolerites and dolerite porhyrites (Fig. 31), greyish black, fine-grained, monzodioritic, pyroxene- and amphibole-bearing dykes with plagioclase phenocrysts (0.2—2 mm across) occur. Monzonitic, pyroxene- and amphibole-bearing,

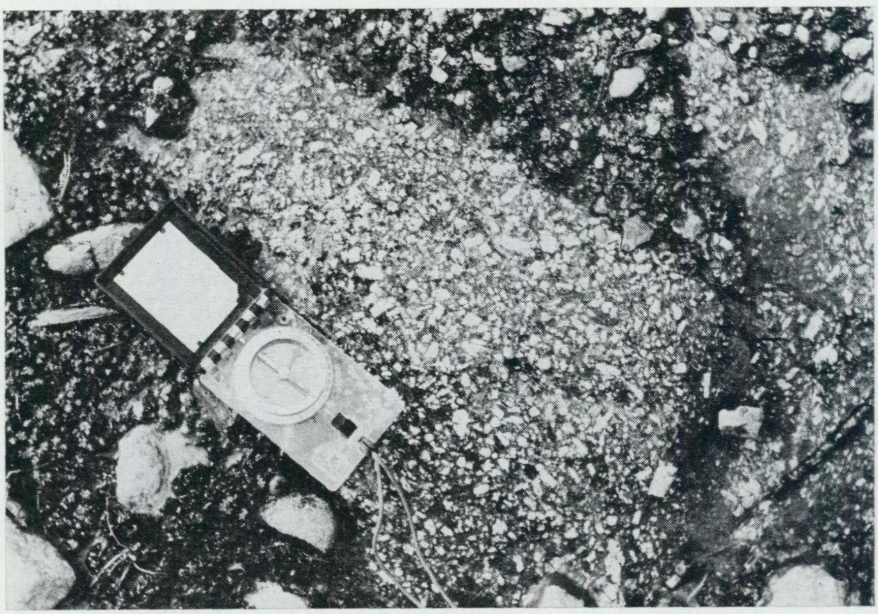

Fig. 31. Dolerite porphyrite dyke (width 4 dm) with plagioclase phenocrysts. Sample L. P. 74:65b, 706390/151840.

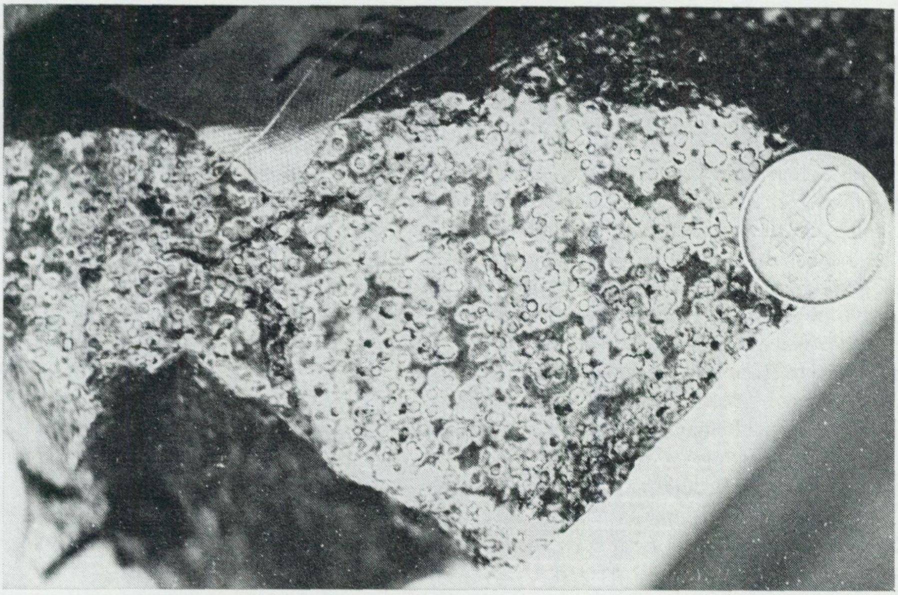

Fig. 32. Acid, spherulitic dyke (width 4 dm). Veinlets with fluorite. Diameter of coin is 15 mm. Sample L. P. 74:63, 706090/151255.

greyish black or green, fine-grained rock types with megacrysts of K-feldspar and plagioclase (1—12 mm across) also exist. Other dyke rocks are (quartz) syenitic to granitic. The latter are fine-grained, greyish black or brown rocks, usually with abundant K-feldspar and plagioclase megacrysts, usually 1—5 mm across. One special greyish green, brown or black granitic dyke rock is spherulitic. The spherulite aggregates are 0.5—1 mm across. Abundant feldspar megacrysts are 0.5—5 mm across (Fig. 32). Fluorspar is common in all salic dyke rocks. According to Vorma (1971, p. 13) granite porphyries, porphyry aplites, aplites and quartz porphyries cut the rapakivi granites and surrounding rocks. In British Columbia spherulitic, alkali rhyolite dykes have been seen occurring in and adjacent to a granitic—quartz-monzonitic batholith (Mathews and Watson 1953, p. 432). Dykes also occur around the Ragunda massif (Kornfält 1976), the Rödö massif (Holmquist 1899) and the Nordingrå massif (Sobral 1913). Persson (1974) investigated an area in the Province of Småland and considered that there was a close relationship between volcanics, plutonics and hypabyssal rocks. The hypabyssal rocks reflect an early tectonic fracturing, which partly predates the extrusion of the volcanics. The fractures were used by the volcanics and allowed uplift in connection with the intrusion of the plutonics. In the Province of Ångermanland the dykes cut both the Revsund granites and the Nordsjö monzonite. The dyke rocks seem to be genetically related to the Nordsjö monzonite.

ACKNOWLEDGEMENTS

I would like to express my gratitude to Dr. Thomas Lundqvist, Geological Survey of Sweden, for making it possible for me to do the field work in connection with the Geological Survey mapping of the bedrock in Västernorrland County, for stimulating discussions throughout the working time and for critically reading the manuscript suggesting many valuable improvements, further to Dr. Göran Stålhös, Geological Survey of Sweden for correcting the manuscript suggesting many valuable improvements, to Prof. Roland Gorbatschev at the Department of Mineralogy and Petrology in Lund, and to Dr. Kennert Röshoff at the Technical High School in Luleå for reading the manuscript.

The chemical analyses and the X-ray work were undertaken at the laboratories of the Geological Survey of Sweden, Stockholm. Electron microprobe analyses were carried out by Claes Ålinder.

The diagrams and maps have been prepared by Ulla Skarin and Agneta Bonnevier. Erika Göransson typed the manuscript and the tables.

Dr. Michael Wilson corrected the English and suggested many valuable improvements.

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SGU = Sveriges geologiska undersökning

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TABLE 2. Sample numbers and corresponding locality positions in the Swedish National Coordinate System.

B.R.72:31	707280/162065	L.P.74:48	706655/152255
T.L.72:77	707470/160065	L.P.74:49	706190/151690
L.P.73:42	704345/151150	L.P.74:50	705260/150645
L.P.73:45	704735/153940	L.P.74:51	705280/151210
T.L.73:1	707060/153955	L.P.74:52	705060/150625
T.L.73:54	707425/153720	L.P.74:53	707125/150890
T.L.73:86	706305/154335	L.P.74:55	706655/151380
T.L.73:87	706165/153190	L.P.74:57	707040/152480
T.L.73:93	704690/150945	L.P.74:58	706355/151925
T.L.73:96	704520/150915	L.P.74:60	705440/152105
L.P.74:21	706225/150670	L.P.74:61	705875/151125
L.P.74:22	706345/150605	L.P.74:62	706740/151870
L.P.74:26	705645/150670	L.P.74:66	706300/151635
L.P.74:27	705525/150595	L.P.74:67	705935/150275
L.P.74:28	705990/150470	L.P.74:70	707790/150575
L.P.74:29	706030/150435	L.P.74:71	708860/151060
L.P.74:30	706175/150155	L.P.74:72	707655/151950
L.P.74:31	706245/150250	L.P.74:73	708675/150730
L.P.74:32	706015/150240	L.P.74:74	708665/151430
L.P.74:33	705425/150535	L.P.74:77	709140/150940
L.P.74:34	705210/150425	L.P.74:81	706000/150550
L.P.74:35	704975/150965	L.P.74:82	705525/150265
L.P.74:36	705100/150835	T.L.74:55	709825/151055
L.P.74:37	705365/151065	T.L.74:58	708970/152265
L.P.74:38	705300/150650	T.L.74:61	708665/153675
L.P.74:40	705915/150775	T.L.74:67	707660/159410
L.P.74:43	705895/150310	T.L.74:68	707675/159540
L.P.74:44	705910/150220	T.L.74:69	708075/160915
L.P.74:46	706100/151645		

TABLE 3. Triclinicity values for potash feldspar megacrysts.

Sample no	Triclinicity Δ	Rock type
L.P.74:28a	0+0.95	Sörvik
L.P.74:30	0.90	granites
T.L.74:55	0.91	-"-
L.P.74:67	0+0.85[2)]	-"-
L.P.74:49	0(0.82)[1)]	Nordsjö monzonite
L.P.74:27	0	Greyish black Revsund
L.P.74:28b	0	quartz monzodiorites
L.P.74:34	0	- " -
L.P.74:36	0	- " -
L.P.74:43	0	- " -
L.P.74:21	0	Small-porphyritic, grey -
L.P.74:35	0	greyish black Revsund quartz
L.P.74:40	0	monzodiorites - quartz monzonites
L.P.74:46	0	Coarse-porphyritic
L.P.74:48	0.91	Revsund quartz monzonites -
L.P.74:53	0.97(0?)	granites
L.P.74:51	0+0.68	-"-
L.P.74:55	0(0.86)	-"-
L.P.74:60	0+0.95	-"-
L.P.74:61	0(0.93)	-"-
L.P.74:70	0.95	-"-
L.P.74:72	0.95	-"-
L.P.74:73	0.98	-"-
L.P.74:74	0.83	-"-
T.L.74:67	0.95	-"-

1) Brackets = subordinate amounts

2) Plus sign = subequal amounts

TABLE 4. Modal (vol. %) analyses and modal estimates of Sörvik granites and Nordsjö monzonites. See also the next two pages.

Rock type, colour	Greenish 3)	Greenish 3)	Grey	Reddish grey	Grey
Sample number	L.P.74:49	L.P.74:58	L.P.73:42b	T.L.73:96a	L.P.74:28a
Quartz	++	1	33	37	34
K-feldspar	++++	42	30	37	45
Plagioclase 1)	++++	36	24	19	17
Olivine	++	1			
Pyroxene	+	1	6		
Amphibole	+++	4	+	+	
Biotite	++	8	4	3	3
Muscovite	+	++	++	++	++
Epidote minerals	+			1	
Sphene					
Opaque minerals	+	5	1	1	+
Chlorite	+	+	2	2	1
Apatite	+	1	+	+	+
Zircon	+	+	+	+	+
Calcite		+	+		
Fluorite					
Prehnite					
Tourmaline					
N 2)		1 133	749	837	1 455
Nomenclature IUGS (1973)		Monzonite	Monzo-gr.	Syeno-gr.	Syeno-gr.

1) Including secondary sericite
2) Number of points counted
3) Nordsjö type
++++ = main minerals > 25%
+++ = essential minerals 5-25%
++ = subordinate minerals 1-5%
+ = accessories < 1%

Rock type, colour	Grey	Red	Reddish grey	Grey	Grey
Sample number	L.P.74:29	L.P.74:30	L.P.74:32	L.P.74:38	L.P.74:44
Quartz	28	35	26	36	32
K-feldspar	54	46	42	40	44
Plagioclase[1)]	15	16	25	16	17
Olivine			1		
Pyroxene			+		
Amphibole	1	+	+		
Biotite	2	+	5	7	1
Muscovite	++	++	++	++	++
Epidote minerals	+	+			+
Sphene					+
Opaque minerals	+	1	1	+	1
Chlorite	+	3	1	+	5
Apatite	+	+	+	+	+
Zircon	+	+	+	+	+
Calcite	+				
Fluorite	+				
Prehnite	+			+	
Tourmaline					
N[2)]	1 116	1 883	1 276	1 101	1 145
Nomenclature IUGS (1973)	Syeno-gr.	Syeno-gr.	Monzo-gr.	Syeno-gr.	Syeno-gr.

Rock type, colour	Reddish grey	Grey	Grey	Greyish white	Grey	Grey
Sample number	L.P.74:50b	L.P.74:67	L.P.74:77b	L.P.74:81	L.P.74:82	T.L.74:55
Quartz	29	23	14	42	27	30
K-feldspar	45	42	30	45	34	38
Plagioclase[1)]	22	26	28	10	28	24
Olivine						
Pyroxene						
Amphibole	+	1	16		1	
Biotite	4	5	6	2	6	6
Muscovite	++	++	++	++	++	++
Epidote minerals	+		+	+	+	
Sphene		+	2			
Opaque minerals	+	1	1	+	1	1
Chlorite	+	2	4	1	2	1
Apatite	+	+	+		+	+
Zircon	+	+	+	+	+	+
Calcite	+	+	+			
Fluorite		+				
Prehnite	+	+	+		+	+
Tourmaline						+
N[2)]	1 286	1 430	1 294	1 360	1 427	1 554
Nomenclature IUGS (1973)	Syeno-gr.	Monzo-gr.	Quartz monz.	Syeno-gr.	Monzo-gr.	Monzo-gr.

Sample number	L.P.74:26	L.P.74:27	L.P.74:28b	L.P.74:31	L.P.74:33	L.P.74:34
Quartz	++	11	++	++	++	+++
K-feldspar	++	13	+++	++	+++	+++
Plagioclase[1)]	++++	44	++++	++++	++++	++++
Pyroxene	+++	17	+++	+++	+++	+++
Amphibole	+++	2	++	+++	++	++
Biotite	+++	7	+++	+++	++	++
Muscovite	+	++	+	+	++	+
Epidote minerals	+	+				+
Sphene						
Opaque minerals	+	4	+	+	+	+
Chlorite	++	1	++	++	++	++
Apatite	+	1	++	+	+	+
Zircon	+	+	+	+	+	+
Calcite	+		+		+	
Number of points counted		1 074				

TABLE 5. Modal (vol. %) analyses and modal estimates of small-porphyritic, greyish black Revsund rocks. Symbols see Table 4.

L.P.74:36	L.P.74:43	L.P.74:50a	L.P.74:52	L.P.74:77c
+++	+++	++	++	+++
+++	+++	+++	+++	+++
++++	++++	++++	++++	++++
+++	+++	+++	+++	
++	++	+++	++	++++
++	+++	+++	++	++
++	++	++	+	+++
	+			++
				++
++	+	+	+	+
++	+	++	++	+++
+	+	+	+	+
+	+	+	+	+
+	+			++

TABLE 6. Modal estimates of small-porphyritic, grey—greyish black Revsund rocks. Symbols see Table 4.

Sample number	L.P.74:21	L.P.74:22	L.P.74:35	L.P.74:40	T.L.73:93
Quartz	+++	+++	+++	+++	+++
K-feldspar	+	++++	+++	++++	++++
Plagioclase 1)	++++	+++	++++	+++	++++
Pyroxene	+++		+++		+++
Amphibole	++		++	++	++
Biotite	+++	+++	++	++	++
Muscovite	+	++	++	++	+
Epidote minerals			+	+	
Sphene					+
Opaque minerals	+	+	+	+	++
Chlorite	+	++	++		+
Apatite	+	+	+	+	+
Zircon	+	+	+	+	+
Calcite		++			
Prehnite				+	

TABLE 7a. Modal estimates of coarse-porphyritic, grey Revsund rocks. Symbols see Table 4.

Sample number	T.L.73:1a	T.L.73:54a	T.L.73:87	T.L.74:69	L.P.74:37	L.P.74:46
Quartz	+++	+++	++++	+++	+++	+++
K-feldspar	++++	++++	+++	++++	+++	+++
Plagioclase 1)	+++	++++	++++	+++	+++	+++
Pyroxene						
Amphibole	+++	++	+++		+++	+++
Biotite	+++	+++	+++	++	++	+++
Muscovite	++	++	++	++	++	++
Epidote minerals	++		+	+	+	
Sphene	+		+		+	+
Opaque minerals	++	+	+	+	+	+
Chlorite	+		+	+		+
Apatite	++	+	+	+	+	+
Zircon	+	+	+	+	+	+
Calcite	+	+	+	+		+
Prehnite	+	+	+	+		+
Tourmaline						

Sample number	L.P.74:48	L.P.74:51	L.P.74:53	L.P.74:55	L.P.74:60	L.P.74:61	L.P.74:66 2)
Quartz	+++	+++	+++	+++	+++	+++	+++
K-feldspar	++++	++++	++++	++++	+++	++++	+++
Plagioclase 1)	+++	+++	+++	+++	+++	+++	+++
Pyroxene							+
Amphibole	++	+++	+	+++	++	++	+++
Biotite	++	+++	++	+++	+++	++	++
Muscovite		++	+	++	++	++	++
Epidote minerals		+	+	+		+	+
Sphene		+	+		+	+	+
Opaque minerals	+	+	+	+	+	+	+
Chlorite	+	+	+		+	+	+
Apatite	+	+	+	+	+	+	+
Zircon	+	+	+	+	+	+	+
Calcite	+	+	+	+			+
Prehnite		+	+			+	
Tourmaline			+			+	

2) Rather dark rock type situated in contact with the Nordsjö monzonite

TABLE 7b. Modal estimates of coarse-porphyritic pink, pinkish grey and greyish white Revsund rocks. Symbols see Table 4.

Sample number	T.L.73:86	T.L.74:58	T.L.74:67	T.L.74:68	L.P.74:62	L.P.74:57
Quartz	+++	+++	+++	+++	+++	+++
K-feldspar	++++	++++	++++	++++	++++	++++
Plagioclase[1)]	++++	+++	+++	+++	+++	+++
Amphibole	+++	++	++		+	+
Biotite	++	++	+++	+++	+	++
Muscovite	+	+	++	++	++	++
Epidote minerals	+	+			++	
Sphene	+	+			+	++
Opaque minerals	+	+	++	+	+	+
Chlorite	+		++	+	++	+
Apatite	+	+	+	+	+	+
Zircon	+	+	+	+	+	+
Calcite	+	+	+	+	++	+
Fluorite		+		+		+
Prehnite	+	+				+
Tourmaline	+	+				
Colour of feld-spar megacrysts	Pinkish grey	Pinkish grey	Pink	Pink	Pink	Greyish white

Sample number	L.P.74:70	L.P.74:71	L.P.74:72	L.P.74:73
Quartz	+++	+++	+++	+++
K-feldspar	++++	++++	++++	++++
Plagioclase[1)]	+++	+++	+++	+++
Amphibole	++		+	++
Biotite	+++	++	+++	++
Muscovite	++	++	++	++
Epidote minerals	+	+	+	+
Sphene	+	+	+	+
Opaque minerals	+	+	+	+
Chlorite	+	++	+	++
Apatite	+	+	+	+
Zircon	+	+	+	+
Calcite	+	+	+	+
Fluorite		++	+	+
Prehnite		+	+	+
Tourmaline	+			
Colour of feld-spar megacrysts	Greyish white	Greyish white	Greyish white	Greyish white

TABLE 8. Microprobe analyses of brown biotite.

	L.P. 74:29	L.P. 74:32	L.P. 73:42b	L.P. 74:49	L.P. 74:27	L.P. 74:43	L.P. 74:66	L.P. 74:21	L.P. 74:35	L.P. 74:48	L.P. 74:51	L.P. 74:61	L.P. 74:72	L.P. 74:73
SiO_2	35.42	35.83	36.23	33.32	34.93	35.52	35.18	35.86	34.85	35.08	34.87	35.17	35.30	34.84
Al_2O_3	13.16	11.91	12.78	12.35	13.87	12.37	13.24	15.04	13.94	13.91	14.45	14.57	13.13	15.08
FeO	29.12	25.76	28.15	35.46	26.30	26.21	27.77	25.95	28.10	27.96	28.80	29.63	28.56	29.30
MgO	4.81	7.77	5.42	2.61	6.34	6.68	6.48	6.67	5.93	5.00	5.54	5.40	5.33	4.51
TiO_2	3.79	3.73	5.17	3.27	5.08	5.08	3.33	4.91	4.41	3.11	4.03	3.75	2.45	3.28
K_2O	9.04	9.19	9.54	8.77	9.22	9.21	9.51	9.37	9.43	9.34	9.32	9.75	9.29	9.00
	95.34	94.20	97.30	95.78	95.74	95.06	95.51	97.81	96.65	94.42	97.02	98.28	94.06	96.00
mg[1)]	0.23	0.35	0.26	0.12	0.30	0.31	0.29	0.31	0.27	0.24	0.26	0.25	0.25	0.22

1) $\frac{Mg}{Mg+Fe}$; atomic ratios

TABLE 9. Microprobe analyses of biotite.

	L.P.74:48		L.P. 74:61
SiO_2	35.56	35.52	33.98
Al_2O_3	13.88	14.34	15.03
FeO	28.55	29.07	28.53
MgO	4.90	6.32	5.19
TiO_2	2.51	0.36	2.35
K_2O	9.14	8.94	9.71
	94.54	94.55	94.78
mg	0.23	0.28	0.24
Colour (Y=Z)	Light brown	Green	Greenish brown

TABLE 10. Microprobe analyses of brownish green amphibole.

	L.P. 74:29	L.P. 73:42b	L.P. 74:49	L.P. 74:27	L.P. 74:43	L.P. 74:21	L.P. 74:61	L.P. 74:72	L.P. 74:73
SiO_2	44.32	44.58	42.46	42.94	44.93	42.17	42.33	42.95	42.45
Al_2O_3	8.45	8.52	7.26	10.81	8.75	10.58	9.86	8.80	9.93
FeO	28.35	25.60	28.65	22.91	24.66	23.88	27.03	26.64	27.88
MgO	5.40	4.47	4.39	5.82	5.24	5.81	4.24	4.20	4.16
CaO	10.58	11.04	10.32	11.23	10.95	11.24	11.45	11.37	10.73
Na_2O	0.91	1.17	1.71	1.02	1.10	1.09	1.18	1.21	1.33
	98.01	95.38	94.78	94.72	95.62	94.77	96.08	95.16	96.49
mg	0.25	0.24	0.21	0.31	0.27	0.30	0.22	0.22	0.21

TABLE 11. Microprobe analyses of amphiboles.

	L.P. 74:32	L.P. 74:27	L.P. 74:21	L.P. 74:35	L.P. 74:51	L.P. 74:49	L.P 74:61
SiO_2	42.56	42.96	42.58	42.92	42.71	47.61	43.54
Al_2O_3	9.30	11.05	10.95	10.13	9.68	1.32	9.46
FeO	25.53	22.68	23.81	25.49	26.73	38.48	27.59
MgO	4.37	6.05	5.79	5.74	4.91	6.43	4.40
CaO	11.26	11.42	11.36	11.36	11.39	0.70	11.19
Na_2O	1.48	0.89	1.20	1.07	1.26	0.02	1.09
	94.51	95.06	95.70	96.71	96.67	94.56	97.27
mg	0.23	0.32	0.30	0.29	0.25	0.23	0.22
Colour	Green	Green	Green	Green	Green	fibrous colour-less	Bluish green

TABLE 12. Microprobe analyses of zoned amphiboles and a clinopyroxene core.

	L.P. 74:49		L.P. 74:66		L.P. 74:48		L.P. 74:51	
	margin	core	margin	core	margin	core	margin	core
SiO_2	42.91	49.08	42.84	45.45	42.02	42.58	41.97	49.46
Al_2O_3	7.33	1.30	9.58	1.63	9.57	8.87	9.75	1.37
FeO	28.47	24.75	25.65	46.07	26.84	26.67	26.63	35.99
MgO	3.79	4.40	4.91	8.03	4.37	4.51	4.43	7.28
CaO	10.18	20.13	10.93	1.07	11.54	11.38	11.25	6.97
Na_2O	1.72	2.69	1.23	0.09	1.15	1.34	1.20	0.24
	94.39	102.36	95.14	102.34	95.49	95.36	95.23	101.31
mg	0.19	0.24	0.25	0.24	0.22	0.23	0.23	0.26
	brownish green	clino-pyroxene	brownish green	grunerite		brownish green	green	brownish green

TABLE 13. Microprobe analyses of olivine.

	L.P. 74:49	L.P. 74:32	
SiO_2	29.83	30.06	31.78
Al_2O_3	1.32		
FeO	63.99	65.36	64.81
MgO	2.30	1.53	1.53
MnO	0.28	1.44	1.56
	97.72	98.40	99.67
mg	0.06	0.04	0.04

TABLE 14. Microprobe analyses of orthopyroxene.

	L.P. 73:42b	L.P. 74:27		L.P. 74:43	L.P. 74:21	L.P. 74:35
SiO_2	49.32	46.19	48.40	47.30	47.32	48.60
Al_2O_3	1.38	2.28	2.11	0.57	2.31	1.25
FeO	43.21	38.33	40.52	40.87	39.97	40.83
MgO	6.67	8.70	8.18	8.28	8.27	7.89
CaO	1.13	1.11	1.10	1.42	1.46	1.43
TiO_2	0.16	0.24	0.17	0.17	0.17	0.16
MnO	0.64	0.71	0.83	0.66	0.77	0.80
	102.51	97.55	101.31	99.27	100.27	100.95
mg	0.22	0.29	0.26	0.27	0.27	0.26

TABLE 15. Microprobe analyses of clinopyroxene.

	L.P. 74:49	L.P. 74:27	L.P. 74:43	L.P. 74:21	L.P. 74:35
SiO_2	49.36	50.34	48.58	50.16	50.44
Al_2O_3	1.81	2.24	0.96	2.46	1.38
FeO	20.50	23.39	20.28	21.97	20.81
MgO	6.59	7.15	7.62	7.19	6.86
CaO	21.20	20.44	20.51	21.45	20.50
TiO_2	0.50	0.17	0.15	0.13	0.13
MnO	0.60	0.47	0.32	0.36	0.40
	100.56	104.19	98.42	103.72	100.52
mg	0.36	0.35	0.40	0.37	0.37

TABLE 16. Chemical analyses (contents of major elements in weight per cent and contents of trace elements in ppm), Niggli values and CIPW norms of Revsund—Sörvik—Nordsjö plutonics. See also the following six pages.

	T.L.74:61	L.P.74:26	L.P.74:27	L.P.74:28b	L.P.74:33	L.P.74:34
SiO_2	53.4	57.0	57.0	55.7	57.8	57.8
TiO_2	3.1	1.7	1.7	1.9	1.6	1.6
Al_2O_3	11.0	15.4	16.2	15.8	16.5	15.8
Fe_2O_3	0.7	0.5	0.4	0.3	0.2	0.3
FeO	17.5	10.8	10.4	12.2	9.5	10.3
MnO	0.22	0.16	0.15	0.18	0.14	0.15
MgO	3.3	2.1	1.9	2.3	1.7	1.9
CaO	3.8	4.5	4.6	5.1	4.5	4.5
Na_2O	2.3	3.0	3.3	3.3	3.2	3.2
K_2O	2.0	3.1	3.1	2.2	3.7	3.3
P_2O_5	1.23	0.50	0.48	0.45	0.42	0.43
$H_2O > 105^o$	1.1	0.8	0.4	0.3	0.4	0.3
$H_2O < 105^o$	0.2	0.3	0.1	0.1	0.1	0.2
Total	99.85	99.86	99.73	99.83	99.76	99.78
Ba	200	1 000	1 250	700	1 450	1 150
Rb		100	80	80	90	80
Sr		180	210	190	210	180
si	156	181	180	167	188	186
qz	15	19	15	12	17	19
al	19	29	30	28	32	30
fm	59	40	38	42	35	38
c	12	15	16	16	16	15
alk	10	16	16	14	18	17
k	0.36	0.40	0.38	0.30	0.43	0.40
mg	0.24	0.24	0.23	0.24	0.23	0.24
ti	7	4	4	4	4	4
p	1.51	0.67	0.64	0.57	0.57	0.58
q	10.6	8.7	7.2	6.3	7.3	8.0
c	1.1	0.1	0.2		0.1	
or	11.9	18.4	18.4	13.0	21.9	19.6
ab	19.5	25.5	28.0	28.0	27.2	27.2
an	10.9	19.1	19.8	21.9	19.6	19.1
wo				0.2		0.2
en	8.2	5.3	4.7	5.7	4.2	4.8
fs	26.9	17.0	16.3	19.4	14.9	16.4
fo						
fa						
mt	1.0	0.7	0.6	0.4	0.3	0.4
il	5.9	3.2	3.2	3.6	3.0	3.1
ap	2.9	1.2	1.1	1.1	1.0	1.0

TABLE 16. Continued.

	L.P.74:36	L.P.74:43	L.P.74:52	L.P.74:21	L.P.74:35	L.P.74:40
SiO_2	59.3	56.8	57.8	59.1	57.9	62.3
TiO_2	1.5	1.6	1.6	1.5	1.6	1.1
Al_2O_3	15.5	16.4	15.9	15.8	15.9	15.7
Fe_2O_3	0.6	0.2	0.5	0.1	0.6	0.5
FeO	9.1	10.2	9.8	9.5	9.8	6.5
MnO	0.15	0.15	0.14	0.14	0.15	0.10
MgO	1.7	2.0	1.8	1.7	1.9	1.2
CaC	4.1	4.5	4.4	4.1	4.1	3.5
Na_2O	3.2	3.2	3.2	3.1	3.1	3.2
K_2O	3.7	3.4	3.4	3.8	3.6	4.7
P_2O_5	0.37	0.45	0.41	0.36	0.41	0.29
$H_2O > 105^o$	0.3	0.6	0.5	0.5	0.6	0.5
$H_2O < 105^o$	0.2	0.2	0.3	0.1	0.2	0.1
Total	99.72	99.70	99.75	99.80	98.86	99.69
Ba	1 350	1 350	1 250	1 350	1 050	1 450
Rb	130	100	130	130	130	160
Sr	210	230	210	210	180	190
si	200	180	188	198	189	233
qz	26	13	19	25	20	41
al	31	31	30	31	31	35
fm	36	37	37	36	38	29
c	15	15	15	15	14	14
alk	18	17	17	18	17	23
k	0.43	0.41	0.41	0.44	0.43	0.49
mg	0.23	0.25	0.23	0.23	0.24	0.23
ti	4	4	4	4	4	3
p	0.52	0.60	0.56	0.51	0.56	0.45
q	10.1	6.5	8.4	9.4	8.8	13.0
c		0.4			0.4	
or	22.0	20.2	20.2	22.5	21.3	27.9
ab	27.2	27.2	27.2	26.3	26.3	27.2
an	17.1	19.5	19.1	18.0	17.7	14.7
wo	0.4		0.1			0.4
en	4.3	5.0	4.5	4.2	4.7	3.0
fs	14.1	16.1	15.3	15.2	15.2	9.9
fo						
fa						
mt	0.9	0.3	0.7	0.1	0.9	0.7
il	2.9	3.2	3.1	2.9	3.0	2.1
ap	0.9	1.1	1.0	0.9	1.0	0.7

TABLE 16. Continued.

	L.P.74:37	L.P.74:51	L.P.74:53	L.P.74:55	L.P.74:61	B.R.72:31
SiO_2	63.6	63.4	63.8	62.3	63.2	70.6
TiO_2	0.96	0.86	0.98	1.2	0.97	0.54
Al_2O_3	15.7	16.4	15.1	14.8	15.7	13.7
Fe_2O_3	0.5	0.5	0.7	1.0	0.5	0.7
FeO	5.2	4.7	5.6	6.0	5.5	3.1
MnO	0.08	0.08	0.09	0.11	0.09	0.05
MgO	1.0	0.95	0.97	1.3	0.91	0.37
CaO	3.0	2.9	2.9	3.4	3.0	1.5
Na_2O	3.1	3.1	3.0	3.1	3.2	2.5
K_2O	5.3	5.6	5.1	4.8	5.4	5.2
P_2O_5	0.22	0.19	0.23	0.30	0.25	0.19
$H_2O > 105^o$	0.7	0.6	1.0	1.2	0.9	0.7
$H_2O < 105^o$	0.3	0.3	0.2	0.2	0.1	0.3
Total	99.66	99.58	99.67	99.71	99.72	99.45
Ba	1 350	1 600	1 250	1 350	1 450	900
Rb	190	200	210	90	170	310
Sr	·180	190	170	130	170	130
si	253	252	256	237	249	369
qz	51	48	57	45	46	149
al	37	38	36	33	36	42
fm	25	23	27	30	25	19
c	13	12	12	14	13	8
alk	25	26	25	23	26	30
k	0.52	0.54	0.52	0.50	0.52	0.57
mg	0.23	0.24	0.21	0.24	0.21	0.14
ti	3	3	3	3	3	2
p	0.37	0.31	0.39	0.48	0.41	0.42
q	14.6	13.8	16.2	14.3	13.3	31.2
c		0.4				1.7
or	31.5	33.3	30.3	28.5	32.0	31.0
ab	26.4	26.4	25.5	26.4	27.2	21.3
an	13.4	13.2	12.7	12.4	12.6	6.3
wo	0.1		0.1	1.1	0.3	
en	2.5	2.4	2.4	3.3	2.3	0.9
fs	7.7	7.0	8.3	8.5	8.3	4.4
fo						
fa						
mt	0.7	0.7	1.0	1.5	0.7	1.0
il	1.8	1.6	1.9	2.3	1.8	1.0
ap	0.5	0.5	0.5	0.7	0.6	0.5

TABLE 16. Continued.

	T.L.73:1	T.L.73:54a	T.L.73:86	T.L.73:87	T.L.74:69	L.P.73:45a
SiO_2	62.1	63.1	66.0	65.4	67.4	65.8
TiO_2	0.88	0.88	0.85	0.75	0.74	0.92
Al_2O_3	16.2	15.8	14.8	15.7	15.3	15.6
Fe_2O_3	1.1	1.0	0.8	0.8	0.1	0.4
FeO	4.9	4.5	4.0	3.7	3.6	5.3
MnO	0.09	0.08	0.07	0.07	0.05	0.09
MgO	1.0	0.96	0.82	0.76	1.0	1.5
CaO	3.3	3.1	2.8	2.7	2.5	2.5
Na_2O	3.1	3.1	3.0	3.1	3.0	2.8
K_2O	5.0	5.5	4.9	5.6	5.2	3.8
P_2O_5	0.23	0.24	0.20	0.19	0.19	0.17
$H_2O > 105^\circ$	0.9	0.1	0.7	0.6	0.6	0.8
$H_2O < 105^\circ$	0.1	0.1	$\leq$0.1	$\leq$0.1	0.1	0.1
Total	98.90	98.46	99.04	99.47	99.78	99.78
Ba	1 250	1 350	1 150	1 250	1 250	900
Rb	185	180	210	210	160	130
Sr	200	220	225	210	250	160
si	241	251	287	277	299	274
qz	45	47	82	66	89	88
al	37	37	38	39	40	38
fm	25	24	23	21	20	29
c	14	13	13	12	12	11
alk	24	26	26	28	28	21
k	0.51	0.53	0.51	0.54	0.53	0.47
mg	0.22	0.23	0.23	0.23	0.32	0.31
ti	3	3	3	2	2	3
p	0.37	0.40	0.36	0.34	0.35	0.29
q	14.1	14.2	20.9	17.4	21.3	24.3
c	0.2			0.1	0.6	2.8
or	29.9	33.0	29.3	33.3	30.8	22.5
ab	26.5	26.7	25.7	26.4	25.5	23.8
an	15.0	13.2	12.6	12.2	11.2	11.3
wo		0.4	0.1			
en	2.5	2.4	2.1	1.9	2.5	3.7
fs	6.9	6.2	5.5	5.1	5.4	8.1
fo						
fa						
mt	1.6	1.5	1.2	1.2	0.1	0.6
il	1.7	1.7	1.6	1.4	1.4	1.8
ap	0.6	0.6	0.5	0.5	0.5	0.4

TABLE 16. Continued.

	L.P.74:48	L.P.74:60	1)	T.L.72:77	T.L.74:58	T.L.74:67
SiO_2	64.8	64.3	71.2	66.3	68.0	69.2
TiO_2	0.87	0.96	0.3	0.70	0.64	0.47
Al_2O_3	15.5	15.3	14.6	15.3	14.6	14.9
Fe_2O_3	0.5	0.6	0.6	0.9	0.4	0.6
FeO	4.7	5.2	3.0	2.6	3.4	2.2
MnO	0.08	0.09		0.06	0.05	0.04
MgO	0.88	1.0	0.9	0.71	0.62	0.55
CaO	2.6	3.0	2.0	2.1	2.3	1.6
Na_2O	3.1	3.1	3.0	2.8	3.0	3.0
K_2O	5.7	5.2	4.4	5.9	5.6	6.4
P_2O_5	0.21	0.22		0.19	0.17	0.11
$H_2O > 105^o$	0.7	0.6		0.7	0.9	0.4
$H_2O < 105^o$	0.1	0.1		0.3	0.1	0.2
Total	99.74	99.67	100.0	98.56	99.78	99.67
Ba	1 150	1 500		1 250	1 000	1 150
Rb	210	180		190	220	210
Sr	130	180		310	140	190
si	267	258	343	305	314	335
qz	58	57	133	86	94	100
al	38	36	41	41	40	43
fm	23	26	21	18	19	15
c	11	13	10	10	11	8
alk	27	25	28	30	30	34
k	0.54	0.52	0.49	0.58	0.55	0.58
mg	0.23	0.23	0.31	0.26	0.22	0.26
ti	3	3	1	2	2	2
p	0.36	0.37		0.37	0.33	0.22
q	15.6	15.9	29.2	21.4	21.7	22.1
c			1.3	1.0		0.4
or	33.8	30.9	26.0	35.5	33.2	38.0
ab	26.3	26.3	25.4	24.1	25.5	25.5
an	11.6	12.5	9.9	9.3	9.9	7.3
wo		0.4			0.2	
en	2.2	2.5	2.2	1.8	1.5	1.4
fs	7.0	7.7	4.5	3.0	5.0	2.9
fo						
fa						
mt	0.7	0.9	0.9	1.3	0.6	0.9
il	1.7	1.8	0.6	1.4	1.2	0.9
ap	0.5	0.5		0.5	0.4	0.3

1) Average composition of Revsund granites of Västerbotten County according to Svensson (1970, p. 25)

TABLE 16. Continued.

	T.L.74:68	L.P.74:62	L.P.74:57	L.P.74:70	L.P.74:71	L.P.74:72
SiO_2	73.4	66.5	69.6	67.2	71.4	65.3
TiO_2	0.43	0.80	0.52	0.71	0.50	0.79
Al_2O_3	12.8	14.4	14.3	14.6	13.1	15.8
Fe_2O_3	0.2	0.6	0.3	0.7	0.6	0.4
FeO	2.3	4.0	2.8	3.5	2.4	4.0
MnO	0.04	0.08	0.05	0.07	0.04	0.07
MgO	0.44	0.83	0.48	0.74	0.50	0.78
CaO	1.6	2.1	1.8	2.4	1.7	2.8
Na_2O	2.9	2.9	2.9	3.1	2.9	3.3
K_2O	5.1	5.8	6.3	5.6	5.2	5.5
P_2O_5	0.09	0.20	0.10	0.15	0.08	0.15
$H_2O > 105^o$	0.4	1.3	0.5	0.7	0.7	0.6
$H_2O < 105^o$	0.1	0.2	0.1	0.2	0.2	.0.1
Total	99.80	99.71	99.75	99.67	99.32	99.59
Ba	650	1 250	1 000	1 350	650	1 350
Rb	160	190	260	210	260	190
Sr	140	170	110	180	100	170
si	406	298	339	300	378	273
qz	172	81	106	83	148	61
al	42	38	41	38	41	39
fm	15	23	16	21	17	20
c	9	10	9	11	10	13
alk	34	29	33	29	32	28
k	0.53	0.56	0.58	0.54	0.54	0.52
mg	0.23	0.24	0.21	0.23	0.23	0.23
ti	2	3	2	2	2	2
p	0.21	0.37	0.20	0.28	0.17	0.26
q	31.8	19.8	22.7	20.2	29.4	15.9
c						
or	30.2	34.4	37.4	33.3	31.0	32.7
ab	24.6	24.7	24.6	26.4	24.8	28.1
an	6.9	9.2	7.4	9.4	7.4	12.1
wo	0.2		0.4	0.6	0.2	0.4
en	1.1	2.1	1.2	1.9	1.3	2.0
fs	3.4	5.7	4.1	4.8	3.2	5.9
fo						
fa						
mt	0.3	0.9	0.4	1.0	0.9	0.6
il	0.8	1.5	1.0	1.4	1.0	1.5
ap	0.2	0.5	0.2	0.4	0.2	0.4

TABLE 16. Continued.

	L.P.74:73	L.P.74:74	T.L.74:55	L.P.74:28a	L.P.74:30	L.P.74:67	L.P.74:49
SiO_2	65.0	65.0	72.4	77.0	73.5	72.0	59.3
TiO_2	0.87	0.72	0.34	0.23	0.35	0.38	1.1
Al_2O_3	15.2	16.0	13.5	11.8	13.1	13.5	16.8
Fe_2O_3	0.6	0.6	0.4	0.2	0.2	0.6	1.1
FeO	4.5	3.6	2.1	1.0	1.7	2.0	6.1
MnO	0.08	0.06	0.04	0.02	0.04	0.05	0.16
MgO	0.93	0.74	0.35	0.15	0.29	0.35	0.70
CaO	2.5	2.6	1.3	0.7	1.2	1.4	3.0
Na_2O	3.0	3.3	3.0	2.6	2.6	2.8	5.1
K_2O	5.5	5.9	5.5	5.7	6.2	5.7	5.4
P_2O_5	0.19	0.17	0.07	0.01	0.04	0.15	0.22
$H_2O > 105^o$	1.1	0.7	0.8	0.3	0.4	0.6	0.4
$H_2O < 105^o$	0.2	0.2	0.1	0.1	0.1	0.2	0.2
Total	99.67	99.59	99.90	99.81	99.72	99.73	99.58
Ba	1 150	1 450	650	250	700	800	1 950
Rb	210	220	300	310	210	230	90
Sr	170	200	80	30	80	100	230
si	274	273	394	510	420	389	207
qz	66	56	154	247	172	152	-10
al	38	40	43	46	44	43	35
fm	24	19	14	8	12	15	25
c	11	12	8	5	7	8	11
alk	27	29	35	41	37	34	29
k	0.54	0.54	0.54	0.59	0.61	0.57	0.41
mg	0.24	0.23	0.19	0.18	0.21	0.19	0.14
ti	3	2	1	1	2	2	3
p	0.33	0.30	0.16	0.02	0.09	0.34	0.32
q	17.4	14.9	29.5	37.9	30.8	29.7	
c	0.2		0.4	0.1		0.5	
or	32.7	35.1	32.6	33.8	36.8	33.8	32.1
ab	25.5	28.1	25.4	22.1	22.1	23.8	43.4
an	11.2	11.5	6.0	3.4	5.7	6.0	7.0
wo		0.2					2.7
en	2.3	1.9	0.9	0.4	0.7	0.9	1.4
fs	6.5	5.1	3.0	1.3	2.5	2.7	7.1
fo							0.2
fa							1.3
mt	0.9	0.9	0.6	0.3	0.3	0.9	1.6
il	1.7	1.4	0.6	0.4	0.7	0.7	2.1
ap	0.5	0.4	0.2		0.1	0.4	0.5

PRISKLASS E

Distribueras genom
LiberKartor
162 89 VÄLLINGBY

Schmidts Boktryckeri AB
Helsingborg 1978

ISBN 91-7158-138-3