GEOLOGIAN TUTKIMUSKESKUS – GEOLOGISKA FORSKNINGSCENTRALEN
GEOLOGICAL SURVEY OF FINLAND

Opas – Guide 26

IGCP Project 217
Proterozoic Geochemistry

IGCP Project 247
Precambrian Ore Deposits
Related to Tectonic Styles

Symposium

PRECAMBRIAN GRANITOIDS
Petrogenesis, geochemistry and metallogeny

August 14–17, 1989, University of Helsinki, Finland

Excursion C1

LATEOROGENIC AND SYNOROGENIC SVECOFENNIAN GRANITOIDS AND ASSOCIATED PEGMATITES OF SOUTHERN FINLAND

Seppo I. Lahti (Editor)

With contributions by Reijo Alviola and Mikko Nironen

Espoo 1989

Cover: Wiborgite
University of Helsinki, Mineralogical Museum, Helsinki

GEOLOGIAN TUTKIMUSKESKUS - GEOLOGISKA FORSKNINGSCENTRALEN
GEOLOGICAL SURVEY OF FINLAND

Opas - Guide 26

IGCP Project 217
Proterozoic Geochemistry

IGCP Project 247
Precambrian Ore Deposits
Related to Tectonic Styles

Symposium

PRECAMBRIAN GRANITOIDS
Petrogenesis, geochemistry and metallogeny

August 14-17, 1989, University of Helsinki, Finland

Excursion C1

LATEOROGENIC AND SYNOROGENIC SVECOFENNIAN GRANITOIDS AND ASSOCIATED PEGMATITES OF SOUTHERN FINLAND

Seppo I. Lahti (Editor)

With contributions by Reijo Alviola and Mikko Nironen

Espoo 1989

ISBN 951-690-347-9
ISSN 0781-643X

CONTENTS

GENERAL OUTLINE OF THE EXCURSION AND DAILY ROUTES

EXCURSION NO. C-1: Friday, August 18 - Tuesday, August 22

Day one: Friday, August 18 Helsinki-Tammela-Tampere

Targets: Granitic pegmatites and associated Svecofennian plutonic rocks in the Tammela-Somero area. About 60 complex pegmatites enriched in Li, Nb, Ta, Be, Sn, Cs, P and B are known in the area. Most of the pegmatite dykes occur within a large synkinematic gabbro-diorite stock surrounded by basic metavolcanics, mica schists and lateorogenic garnet-bearing microcline granite. The mineralogy of the Härksaari, Hirvikallio and Kietyönmäki spodumene-petalite pegmatites will be examined and one granite outcrop will be visited.

Day two: Saturday, August 19 Tampere-Eräjärvi-Teisko

Targets: Granitic pegmatites in the Eräjärvi area in the eastern part of the Tampere schist belt. Most of the pegmatite dykes and lenses occur in the Svecofennian mica schists close to the contact with syntectonic pegmatite granite - microcline granite bodies or within them. About 70 pegmatites with rare Be and Li phosphates and silicates, Fe-Mn phosphates, Nb-Ta and Sn oxides are known within the Eräjärvi area. The mineralogy of the Viitaniemi, Seppälänranta and Juurakko pegmatite and various granite types of the area will be examined. Visit to the mineralogical museum at Eräjärvi.

Day three: Sunday, August 20 Teisko-Hämeenkyrö-Seinäjoki

Targets: Syntectonic granitoids in the Tampere region, their mineralogy, geochemistry and emplacement. The contact features of the Värmälä stock northeast of Tampere and those of the Hämeenkyrö batholith northwest of Tampere will be examined.

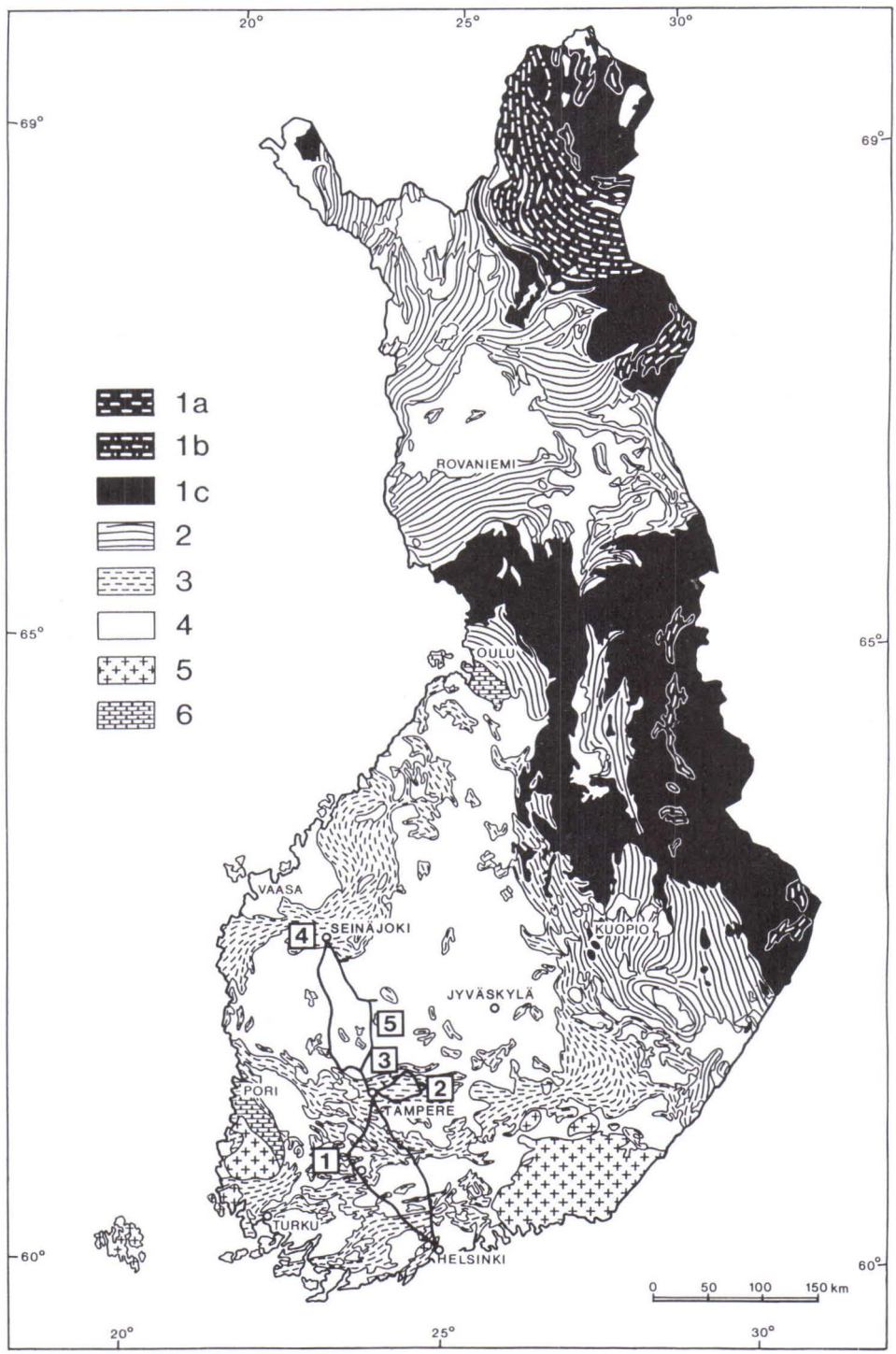


Fig. 1. Main structural units of the Precambrian in Finland. Presvecokarelidic: 1a, schist and paragneiss; 1b, granulite; 1c, orthogneiss. Svecokarelidic: 2, Karelidic schist belt; 3, Svecofennidic schist belt; 4, orogenic plutonic rocks. Postsvecokarelian: 5, rapakivi granites; 6, Jotnian sediments. After A. Simonen.

The excursion route and daily target areas (marked with numbers).

Day four: Monday, August 21 Seinäjoki-Peräseinäjoki-Virrat

Targets: Granitic pegmatites and associated rocks in the Seinäjoki district and the Haapaluoma feldspar quarry at Peräseinäjoki. Pegmatite granite bodies and scores of complex pegmatites characterized by cassiterite, beryl, Nb-Ta oxides, Fe-Mn phosphates and Li silicates are known in the Svecokarelian mica schists and associated metavolcanic rocks of the Seinäjoki district. The mineralogy of the Perälä cassiterite pegmatite dyke and various granitoids of the Seinäjoki area will be examined. Visit to the Haapaluoma feldspar quarry at Peräseinäjoki.

Day five: Tuesday, August 22 Virrat-Kuru-Helsinki

Targets: Grey granite, orbicular rock and stone industry of the Kuru area. One granite quarry will be visited and the occurrence and textures of orbicular monzonite at Pengonpohja, Kuru, will be examined.

Excursion leaders:
Seppo I. Lahti and Reijo Alviola Geological Survey of Finland, 02150 Espoo, Finland

In this guide the excursion stops are designated with two numbers, the first standing for the day and the second for the stop. Example: 4-3 means the third stop on day four. The name of the locality is given next to the numbers. The index number referring to the local map at 1 : 100 000 scale and the grid coordinates x and y of the locality are given in brackets.

GENERAL OUTLINE OF THE PRECAMBRIAN ROCKS IN SOUTHERN FINLAND

Seppo I. Lahti

Three major structural units can be recognized in the Precambrian rocks of Finland (Simonen 1980): 1) the Presvecokarelian (2.6-2.5 Ga), 2) the Svecokarelian (2.5-1.7 Ga) and 3) the Postsvecokarelian (1.7-1.27 Ga). The Presvecokarelian rocks, which are the basement of the Svecokarelian sediments and volcanic rocks in eastern and northern Finland consist of intensely deformed granitoids, greenstones and minor metasediments.

The Svecokarelian rocks, which cover the bulk of southern Finland, are divided into the Karelian and Svecofennian schist belts. The rocks of the Karelian schist belt at the margin of the Presvecokarelian basement are dominated by quartzites with minor conglomerates black schists derived from epicontinental sediments, phyllites and mica schists as topmost unit in the stratigraphy, originating from miogeosynclinal sediments (Simonen 1980, Papunen and Vorma 1985). The boundary zone between the Karelian and Svecofennian domains coincides with the north-west-trending fracture system known as the Main Sulphide Ore Belt or Raahe - Ladoga zone.

The Svecofennian schists and gneisses in western and southern Finland are geosynclinal sediments in origin. Mica schists, quartz-feldspar schists and gneisses are locally intercalated by intermediate and mafic volcanogeneous pyroclastic rocks, sills and lavas. Migmatitic gneisses predominate in some areas. Most of the Svecokarelian rocks were metamorphosed under medium-grade conditions, although metamorphic mineral parageneses of high-grade conditions have also identified in places.

During the main phase of Svecokarelidic orogeny 1.93-1.86 Ga ago the schists were intruded by a series of granitoids and mafic intrusions. According to Simonen (1980), about 80 % of the Svecokarelian area and 40 % of the Karelian area are occupied by plutonic rocks occurring as stocks of various size and larger differentiated intrusions.

The synorogenic rocks of the Svekofennian area are mainly tonalites, granodiorites and granites with minor mafic varieties. The most striking example is the Central Finland Granitoid Complex. In the Karelian area though, the predominant plutonic rock group comprises granite. Geochemically, the synorogenic Svekofennian granitoids show I-type characteristics. Subeconomic porphyry-type Cu-Mo-precious

metal mineralizations and tourmaline breccias with Cu and W mineralizations (Ylöjärvi) are associated with some intrusions in Central Finland (Nurmi and Haapala 1986).

The Svecokarelidic lateorogenic rocks (age 1.86-1.80 Ga) are microcline granites. They occur in strongly migmatizing environments. The granites are often peraluminous and show typical properties of S-type granitoids. The rocks are thought to derive from Svecokarelian metasediments by partial melting (Huhma 1986, Nurmi and Haapala 1986).

Locally, pegmatite granites and pegmatite dykes are common in the Svecokarelian synorogenic and lateorogenic granitoids and in the schists. The lateorogenic microcline granites, in particular, often grade into coarse pegmatitic varieties, or the medium-grained types are cut by younger pegmatite dykes. They tend to be simple in mineralogy, and rare-element pegmatites are encountered only in some localities. The age of many Svekokarelian pegmatites is controversial, because there are few reliable radiometric age determinations. The rare-element pegmatites are important targets of the excursion, and so their distribution, geochemistry and mineralogy are discussed at some length in the next article.

The Postsvecokarelian rocks were formed mainly 1.70-1.27 Ga ago (Nurmi and Haapala 1986). They include certain granitoids in southern Finland and in Lapland. These granitoid intrusions are small, often exhibiting a composite character.

Large rapakivi granite batholiths (e.g. those of Viborg, Laitila and Vehmaa) are anorogenic (age 1.54-1.70 Ga), and their emplacement indicates the beginning of intracontinental rifting of the Svecokarelian crust (Vorma 1976). The batholiths show large compositional variation and several intrusional phases. Geochemically the rapakivi granites exhibit A-type characteristics. The occurrence of topaz and fluorite is typical of the last-crystallized rapakivi varieties; locally subeconomic greisen-type Sn-Be-W mineralizations are also encountered, but pegmatites are rare (Haapala 1977).

The Postsvecokarelian rock unit also includes the unmetamorphosed Jotnian sandstone deposits near Pori, western Finland, and a siltstone deposit near Oulu, northern Finland. The Postjotnian diabases that cut the Svecokarelian and Postsvecokarelian rocks constitute the youngest intrusive rocks in southern Finland (Simonen 1980).

REFERENCES

Haapala, Ilmari, 1977. Petrography and geochemistry of the Eurajoki stock; a rapakivi-granite complex with greisen-type mineralizations in southwestern Finland. Geol. Surv. Finland Bull. 286, 128 p.

Huhma, Hannu, 1986. Sm-Nd, U-Pb and Pb-Pb isotopic evidence for the origin of the early Proterozoic Svecokarelian crust in Finland. Geol. Surv. Finland Bulletin 337, 48 p.

Nurmi, Pekka and Haapala, Ilmari, 1986. The Proterozoic granitoids of Finland: Granite types, metallogeny and relation to crustal evolution. Bull. Geol. Soc. Finland 58, p. 203-233.

Papunen, H. and Vorma, A., 1985. Nickel deposits in Finland, a review, p. 123-143 in Nickel-copper deposits of the Baltic Shield and Scandinavian Caledonides ed. by H. Papunen and G.I. Gorbunov. Geol. Surv. Finland Bulletin 333.

Vorma, Atso, 1976. On the petrochemistry of rapakivi granites with special reference to Laitila massif, southwestern Finland. Geol. Surv. Finland Bull. 285, 98 p.

RARE ELEMENT PEGMATITES IN FINLAND

Reijo Alviola

The major rare-element (RE)-pegmatite groups are shown on the geological map of Finland (Fig. 1 and Table 1). In fact some of the groups are made up of 2-4 subgroups. Several other minor, i.e. less intensely mineralized, smaller pegmatite groups are known, but they are not shown in the figure.

Almost all the RE-pegmatites have Svecokarelian host rocks, whereas most of the pegmatites of the Kajaani (23) and Ilomantsi (14) groups are hosted by Archaean rocks.

The parental rocks of most of the RE-pegmatites are Svecokarelian late-kinematic granitoids (age 1.80 - 1.85 Ga). However, for two groups (Nos. 1 and 2) they are post-kinematic granites (age about 1800 Ma) and for one (No 9) rapakivi granite (age 1.64 - 1.70 Ga) (Nurmi and Haapala 1986).

For six of the 26 RE-pegmatite groups, the age of the pegmatites was determined radiometrically, in most cases with U-Pb method from zircon, uraninite, titanite, gadolinite or xenotime. The age of the dated RE-pegmatites is about 1.80 Ga. It is very likely that the Ilomantsi pegmatites (No 14), although not dated yet, are Archaean. Four groups of Archaean pegmatites were dated radiometrically using U-Pb from zircon or Rb-Sr from muscovite, but no RE minerals were found.

RE-pegmatite groups in Finland can be roughly divided into three main types:

1. Ce, Y, Nb, Be and REE bearing pegmatites
2. Be, Nb (Sn)-bearing pegmatites, which may contain Fe,Mn phosphates and even Li (Fe, Mn) phosphates
3. Li-silicate pegmatites with spodumene-, petalite- and lepidolite bearing subtypes.

Many groups contain pegmatites of one type only, but often the main types are transitional to each other. For example, within a Li-silicate pegmatite group there are always portions of Be pegmatites, sometimes a corner of REE pegmatites and Li-silicate bearing pegmatites.

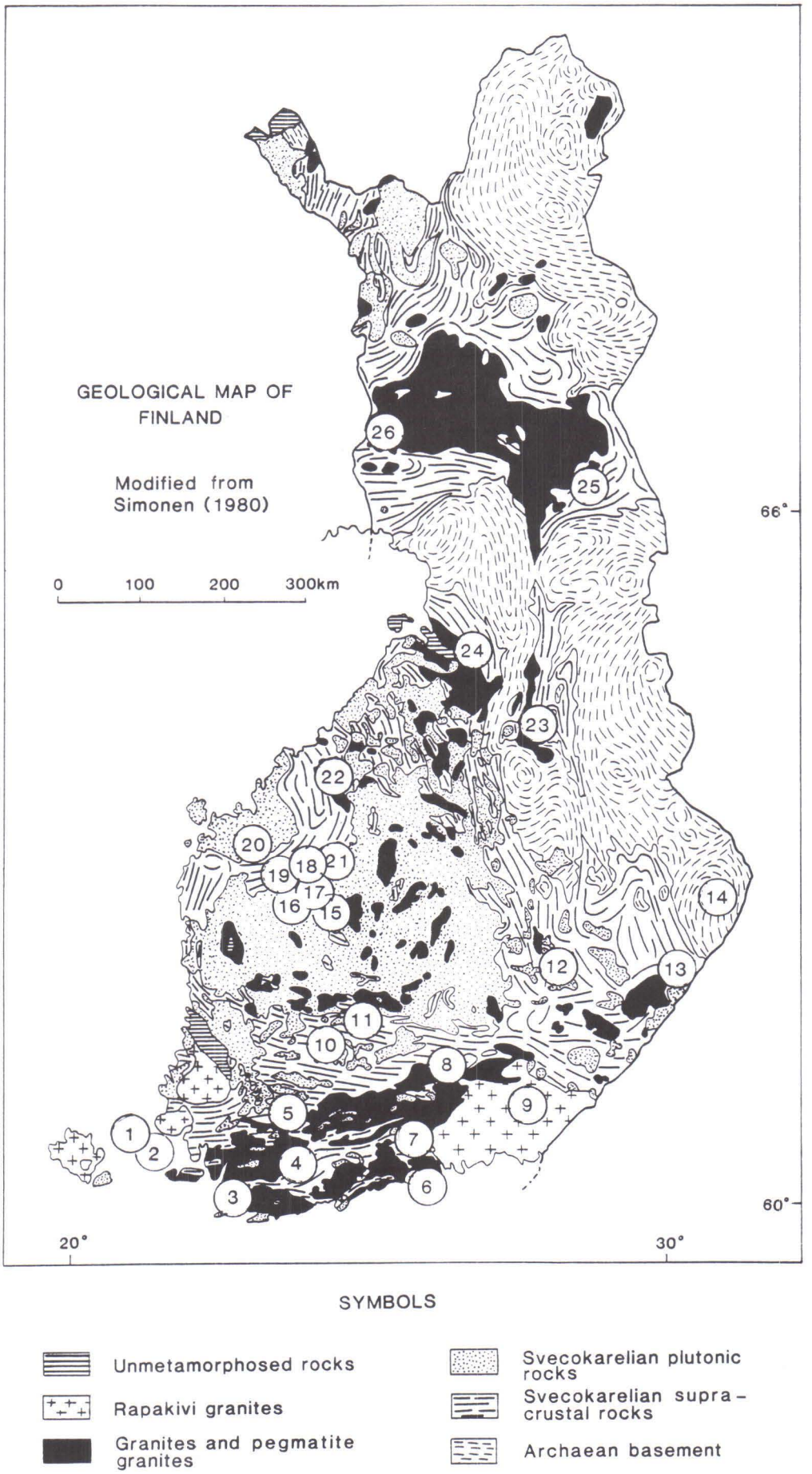


Fig. 1. Distribution of RE-pegmatites in Finland. (See table 1.)

Table 1. Rare element (RE)-pegmatite groups in Finland

	Group	Rare elements
1.	Åva	Ce, Nb, Be, REE
2.	Fjälskär	Ce, Nb, REE
3.	Kemiö	Be, Ta, Nb, Sn, Li, Y, REE
4.	Kisko	Sn, Nb, Be, Li
5.	Somero-Tammela	Li, Be, Nb, Ta, Sn, Cs, Y
6.	Helsinki	Be, Sn
7.	Pukkila	Be, Nb
8.	Heinola	Li, Sn, Be, Nb
9.	Luumäki	Be, Nb, Y
10.	Kangasala	Ce, Y, Nb, Be, REE
11.	Eräjärvi	Li, Be, Nb, Ta, Sn, Cs
12.	Rantasalmi	Be, Nb
13.	Kitee	Be, Nb, Ta, Sn, Li, Cs
14.	Ilomantsi	Be, Nb, Ta
15.	Alavus	Ce, Y, Nb
16.	Haapaluoma	Li, Be, Nb, Ta, Sn, Cs, Ce, REE
17.	Kaatiala	Li, Be, Nb, Ta, Sn
18.	Kuortane	Be, Nb
19.	Seinäjoki	Sn, Be, Li, Nb, Ta
20.	Isokyrö	Be, Nb
21.	Alajärvi	Be, Nb
22.	Kaustinen	Li, Be, Nb
23.	Kajaani	Be, Nb, Ta
24.	Utajärvi	Be, Nb
25.	Posio	Be, Y, U
26.	Pello	Be, Sc

RE minerals:

Ce, REE: allanite

Y : fergusonite, gadolinite, xenotime
Nb: columbite
Be: beryl, chrysoberyl
Ta: tantalite, tapiolite, microlite
Sn: cassiterite, nigerite
Li: spodumene, petalite, lepidolite, cookeite
Cs: pollucite
Sc: thortveitite
U : uraninite

The number of identified mineral species in Ce, REE pegmatites and Be, Nb pegmatites is 15-20 and in Li-silicate pegmatites 40-50; in phosphate-rich pegmatites, though, there may be up to 80 species (Eräjärvi group).

The start of pegmatite mining in the 18th century was linked with the launching of the iron and glass industries in Finland. More than one million metric tons of feldspar have been mined from Kemiö (No. 3) pegmatites, and mining is still going on. Haapaluoma (No. 16) and Kaatiala (No. 17) pegmatites have produced some 400 000 t of K-feldspar and the Haapaluoma plant is still operative. The Eräjärvi (No. 11) pegmatites have produced about 100 000 t of K-feldspar. Some feldspar has been extracted from the Kangasala (No. 10), Seinäjoki (No. 19) and Kajaani (No. 23) areas. In addition to K-feldspar and quartz, some beryl, Nb, Ta minerals and muscovite have been produced. Production has been based on hand picking, except at Kemiö, where a flotation plant became operational in 1966.

Chemists, geologists and mineralogists have collected and studied mineral samples, mapped pegmatites and published their findings. The most important papers are those on:

- Åva (1) by Kaitaro (1953)
- Kemiö (3) by Pehrman (1945), Lof and Hazebroek (1976)
- Somero - Tammela (5) by Mäkinen (1913) and Aurola (1963)
- Kangasala (10) by Vorma et al. (1966) and Lokka (1935)
- Eräjärvi (11) by Volborth (1954, 1956) and Lahti (1981)
- Haapaluoma (16) by Haapala (1966)
- Kaatiala (17) by Nieminen (1978), and
- Kajaani (23) by Alviola (1977).

Some minerals have been identified for the first time from pegmatites in Finland, such as

- tapiolite, lokkaite and pehrmanite from Kemiö (No. 3)
- stannomicrolite from Somero - Tammela (No. 5)
- väyrynenite, viitaniemiite, and manganotapiolite from Eräjärvi (No. 11)
- kaatialaite from Kaatiala (No. 17).

Somero-Tammela (No. 5), Eräjärvi (No. 11), Haapaluoma (No. 16) and Seinäjoki (No. 19) were chosen as target for the excursion. The Somero-Tammela and Seinäjoki areas were explored in the 1980s for Sn and Li minerals. The Eräjärvi pegmatite area and some Haapaluoma mineral specimens have recently been subjected to mineralogical research.

REFERENCES

Alviola, Reijo, 1977. Kajaanin alueen graniittipegmatiitit. Manuscript, Dept. of Geology and Mineralogy, University of Helsinki, 82 p.

Aurola, Erkki. 1963. On the pegmatites in the Torro area, south-western Finland. Bull. Comm. geol. Finlande 206, 32 p.

Haapala, Ilmari, 1966. On the granitic pegmatites in the Peräseinäjoki-Alavus area, South-Pohjanmaa, Finland. Bull. Comm. geol. Finlande 224, 98 p.

Lahti, Seppo I., 1981. On the granitic pegmatites of the Eräjärvi area in Orivesi, southern Finland. Geol. Surv. Finland, Bull. 314, 82 p.

Lof, P. and Hazebroek, H.P., 1976. Geology and petrology of some selected pegmatites of the area between Lemnästräsket and Mattkärr. Internal Report, Dept. of Ore Geology, Petrology and Mineralogy, Free University, Amsterdam, the Netherlands.

Lokka, Lauri, 1935. Über den chemismus der Minerale (Orthit, Biotit u.a.) eines feldspatbruches in Kangasala, SW-Finland. Bull. Comm. geol. Finlande 111, 40 p.

Mäkinen, Eero, 1913. Die Granitpegmatite von Tammela in Finland und ihre Minerale. Bull. Comm. geol. Finlande 35.

Nieminen, Kalervo, 1978. On the geochemistry of Kaatiala pegmatite, western Finland. Bull. Geol. Soc. Finland 50, 1-14.

Nurmi, Pekka A. and Haapala, Ilmari, 1986. The Proterozoic granitoids of Finland: Granite types, metallogeny and relation to crustal evolution. Bull. Geol. Soc. Finland 58, Part 1, 203-233.

Pehrman, Gunnar, 1945. Die granitpegmatite von Kimito (S.W. Finland) und ihre Minerale, Acta Acad. Åbo. Math. Phys. XV, 2, 84 p.

Simonen, Ahti, 1980. Prequaternary rocks of Finland 1 : 1 000 000. Suomen kallioperä 1 : 1 000 000.

Volborth, A., 1954. Phosphatminerale aus dem Lithiumpegmatit von Viitaniemi, Eräjärvi, Zentral-Finnland. Ann. Acad. Sci. Fennicae, Ser. A III, Geol.-Geogr., 39, 90 p.

Volborth, A., 1956. Die Mineralparagenese im Lithiumpegmatit von Viitaniemi (Zentral-Finnland) vom geochemischen Standpunkt. Tschermaks Mineral. Petrol. Mitt. 5, 273-283.

Vorma, Atso, Ojanperä, Pentti, Hoffren, Väinö, Siivola, Jaakko and Löfgren, Arvo., 1966. On the rare earth minerals from the Pyörönmaa pegmatite in Kangasala, SW-Finland. Comptes Rendus de la Soc. geol. Finlande. XXXVIII, pp. 241-274.

THE GRANITIC PEGMATITES OF THE SOMERO-TAMMELA AREA

Reijo Alviola

The main features of the bedrock

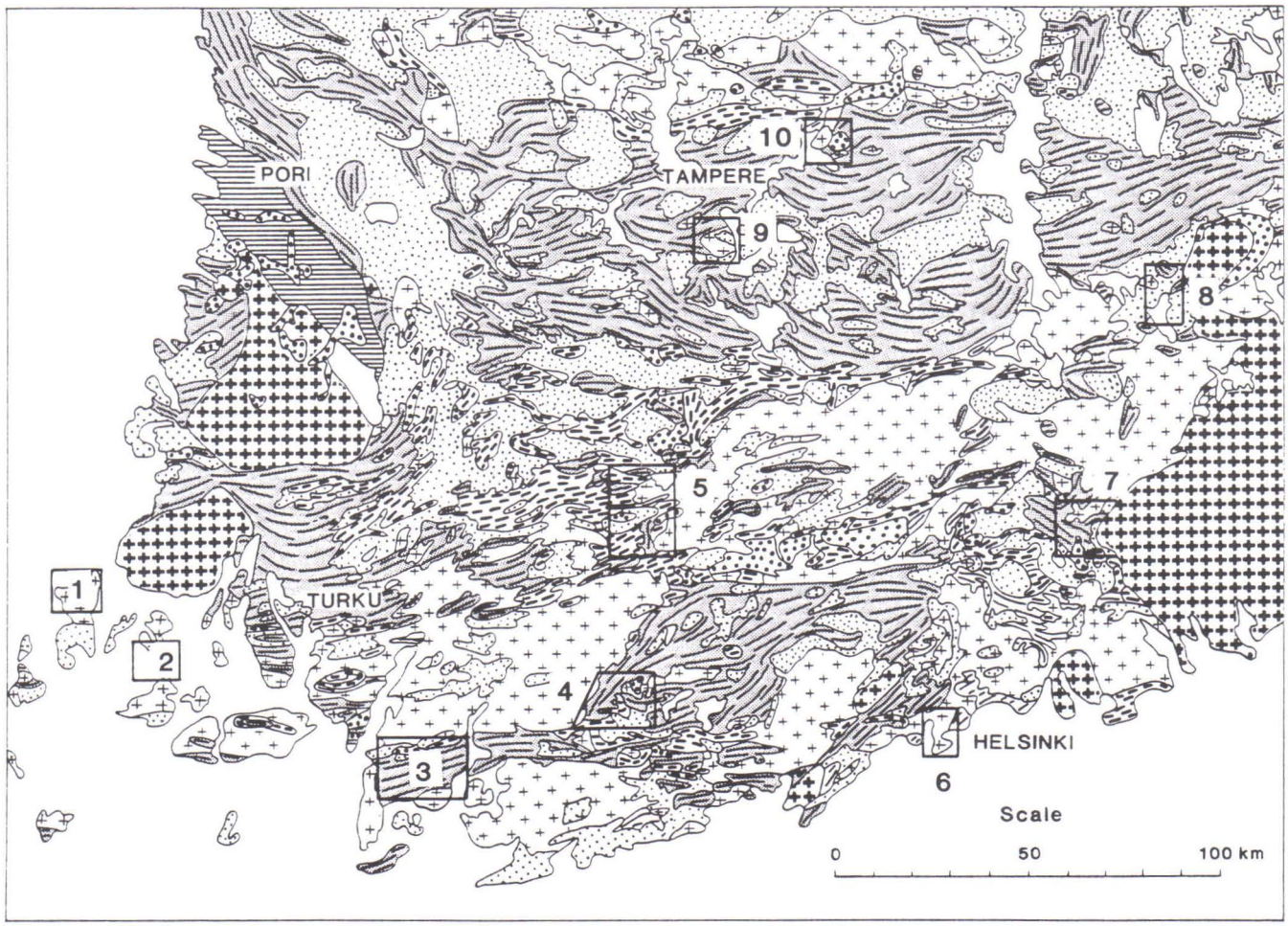
The Somero - Tammela RE-pegmatite area is at the junction of a broad zone of lateorogenic microcline granites that runs northeast from the archipelago of southwestern Finland to north of the Wiborg rapakivi massif (Fig. 1). The trend of the schist belt deviates in many places from the common east-west trend of southwestern Finland. According to Simonen (1955), diapiric updoming of the granite massif north of Lake Paimiojärvi (Fig. 2) folded and tilted the supracrustal rocks into a wide depression between Liesjärvi and Pyhäjärvi. Basic volcanics occupy the middle part of the depression, whereas quartz-feldspar schists and mica schists crop out in the marginal zones of the depression, suggesting that the sedimentary rocks are beneath the basic volcanics. It is believed that the mica schist zones represent anticlines and the amphibolites synclines.

South and west of Somero smaller granite massifs have caused arching of the schist belts with very steep bedding planes.

Supracrustal rocks

The main minerals of the mica schists are quartz, plagioclase (An_{15-23}), biotite and muscovite. Porphyroblasts of Al-rich minerals are common, but they have altered into aggregates of sericite and chlorite. The mica gneisses are very similar to the mica schists in mineral composition. Cordierite and garnet porphyroblasts are common. According to Simonen (1956), the mica gneisses are characteristic of the migmatite areas in the northeastern and southeastern parts of the Somero-Tammela area in Fig. 2.

The majority of the quartz-feldspar schists have been interpreted as arkose sandstones in origin. However, their chemical weathering has not been complete. They often grade into mica schists and mica gneisses. In two places, northwest of Lake Painiojärvi and south of Lake Hirsjärvi, the rock is very fine-grained and agglomeratic in texture and contains weakly preserved relics of blastoporphyric texture.



SYMBOLS

- Unmetamorphosed rocks
- Rapakivi granites
- Granites and pegmat. granites
- Granodiorite, quartzdiorite and diorite
- Gabbro and olivine diabase
- Volcanic rocks
- Micaschist,-gneiss,- quartz-feldspar schist and -gneiss

Pegmatite groups

1	Åva	Ce,Nb,Be,REE
2	Fjälskär	Ce,Nb,REE
3	Kemiö	Be,Ta,Nb,Sn,Li,Y
4	Kisko	Sn,Nb,Be,Li
5	Somero-Tammela	Li,Be,Nb,Ta,Sn,Cs
6	Helsinki	Be,Sn
7	Pukkila	Be,Nb
8	Heinola	Li,Sn,Be,Nb
9	Kangasala	Ce,Y,Nb,Be,REE
10	Eräjärvi	Be,Li,Nb,Ta,Sn,Cs

Fig. 1. General geology of SW Finland (modified from Simonen 1980) with the location of the main pegmatite groups.

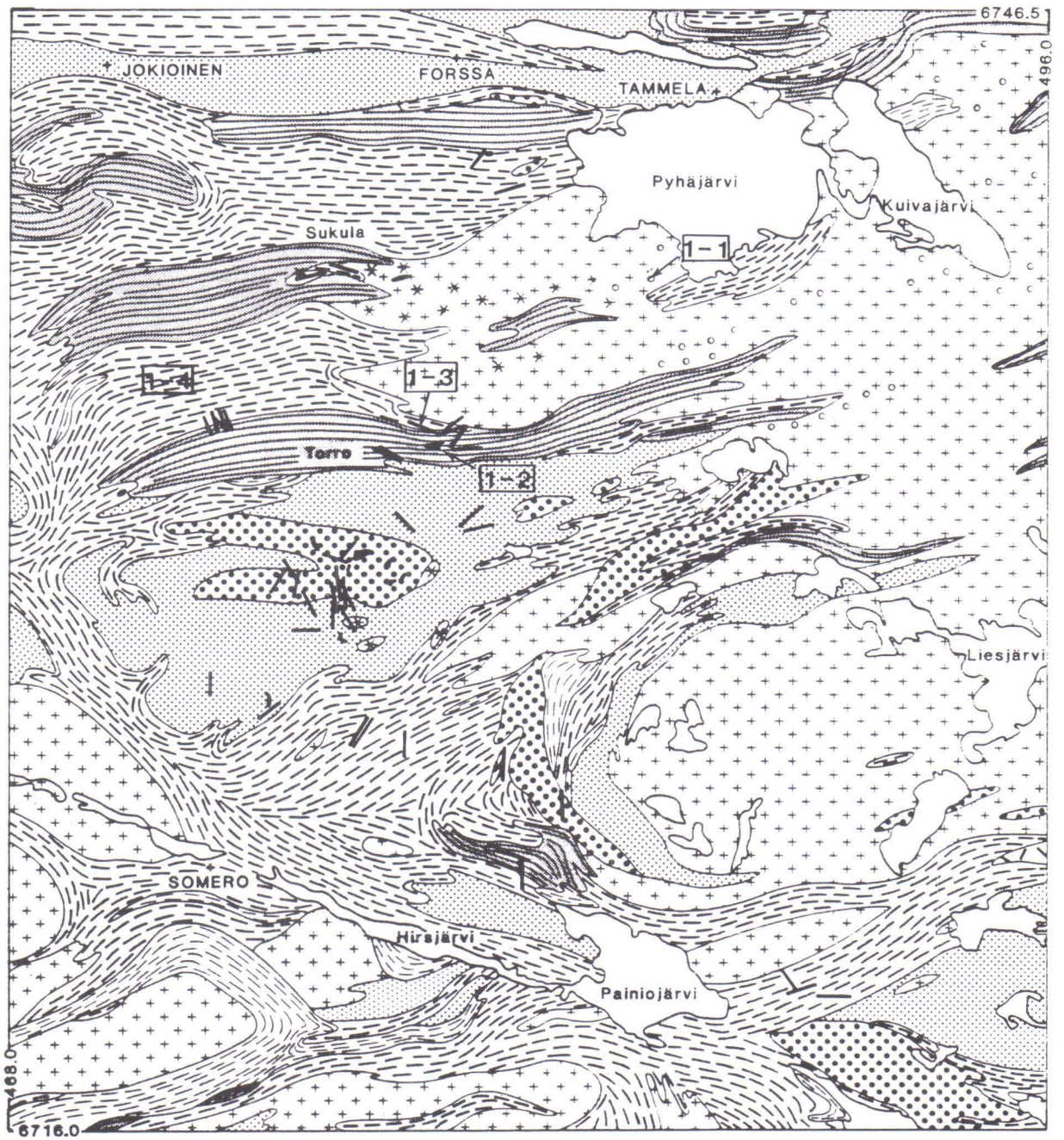


Fig. 2. Geological map of the Somero-Tammela pegmatite field. Based on the geological map sheets 1 : 100 000 Somero (Simonen 1955) and Forssa (Neuvonen 1954).

The schist belt is largely covered by amphibolites and hornblende gneisses. The amphibolites are homogeneous, granoblastic rocks, with plagioclase (An_{32-40}) and hornblende as main minerals. Many relicts indicating volcanic origin have been found. Blastoporphyric uralite and plagioclase porphyrites occur here and there in the amphibolite belt. Agglomeratic varieties are common. They contain angular fragments of basic volcanics and of a very fine-grained leptite in the amphibolitic matrix. In some localities, the fragments are rounded and the rock has the character of volcanic conglomerate. Banding due to different layers is usual in the amphibolites, the majority of which are interpreted as consisting of basic pyroclastics.

Infracrustal rocks

The peridotites, gabbros and diorites of the Somero - Tammela area are situated at the western end of a 100 km long zone of basic rocks. Their main minerals are plagioclase and hornblende. Pyroxene occurs only occasionally as strongly altered remnants.

Quartz diorites and granodiorites are massive or weakly foliated rocks. Feldspar is plagioclase, but microcline is present in the granodiorites. Hornblende is the predominant mafic mineral in the quartz diorites, but biotite is more abundant in the granodiorite.

The microcline granites are very inhomogeneous: there are coarse-grained, medium-grained, aplitic and porphyritic varieties with granitized remnants and inclusions of schists and more basic infracrustal rocks. Field observations often show that the microcline granite is an alteration product of granodiorite. The main minerals of the microcline granite are microcline, quartz and plagioclase (An_{15-20}). Biotite is the most common mafic mineral. Occasionally, minute amounts of muscovite and almandine garnet occur. The granite is always garnet-bearing when in association with garnet-bearing mica schists.

The granitic pegmatites

More than one hundred pegmatites have been found within the area of the appended geological map (Fig. 2), but only those (56) containing RE minerals are marked on it. The map is based on regional geological maps at 1 : 100 000 scale by Simonen (1955) and Neuvonen (1954). The pegmatite granites are poorly indicated on these maps, usually as coarse grained varieties of microcline granite.

The mineral species identified from the pegmatites of the Somero - Tammela area are listed in Table 1.

The distribution of the various types of RE-pegmatites is evident if they are divided into two subgroups:

- RE- pegmatites to the east of Lake Painiojärvi
- RE- pegmatites in the Painiojärvi - Torro - Pyhäjärvi area.

Within and around the basic rocks, south of Torro, there is a cluster of pegmatite granites and almost horizontal pegmatites. Two of them are petalite-bearing; three of the pegmatites show petalite altered into a spodumene + quartz intergrowth

Table 1. Comparison of the minerals of Somero-Tammela, Eräjärvi, Haapaluoma and Seinäjoki pegmatites

Silicates

		S-T	Erä	Haa	Sei
1	orthoclase		x		x
2	microcline	x	x	x	x
3	plagioclase	x	x	x	x
4	petalite	x			
5	spodumene	x	x	x	x
6	eucryptite			x	
7	pollucite	x	x	x	
8	chabazite				x
9	laumontite	x			
10	analcime	x	x	x	
11	biotite	x	x	x	x
12	muscovite	x	x	x	x
13	lepidolite	x	x	x	x
14	zinnwaldite	x			
15	chlorite		x		x
16	cookeite		x	x	x
17	bityite		x		
18	margarite		x		
19	montmorillonite	x	x	x	x
20	serpentine				x
21	kaolinite	x	x	x	x
22	tourmaline (black)	x	x	x	x
23	elbaite	x	x	x	x
24	beryl	x	x	x	x
25	bertrandite	x	x	x	x
26	garnet	x	x	x	x
27	zircon	x	x	x	x
28	thorite		x	x	
29	titanite				x
30	andalusite	x			
31	topaz	x	x		
32	epidote	x			

Phosphates

		S-T	Erä	Haa	Sei
1	apatite	x	x	x	x
2	crandallite		x		
3	triphylite-lithiophilite	x	x		x
4	ferrisicklerite-sicklerite	x	x		x
5	heterosite-purpurite	x	x		x
6	amblygonite-montebrasite		x		
7	alluaudite	x	x		x
8	triplite	x	x		
9	rockbridgeite-frondelite		x		
10	switzerite		x		
11	reddingite		x		
12	hureaulite		x		
13	strengite		x		
14	vivianite	x	x		x
15	meta-vivianite		x		
16	phosphosiderite		x		x
17	fairfieldite-messelite	x			
18	strunzite		x		
19	laueite		x		
20	jahnsite		x		
21	eosphorite		x		
22	morinite		x		
23	viitaniemiite		x		
24	beryllonite		x		
25	hurbutite		x		
26	herderite		x		
27	väyrynenite		x		
28	moraesite		x		
29	beusite		x		
30	lipscombite				x
31	monazite			x	
32	brockite			x	
33	xenotime		x		x
34	libethenite		x		x

Oxides, sulphides and other minerals

		S-T	Erä	Haa	Sei
1	quartz	x	x	x	x
2	columbite-tantalite	x	x	x	x
3	tapiolite	x	x		x
4	manganotapiolite		x		
5	microlite	x	x	x	x
6	stannomicrolite	x			
7	wodginite	x	x		
8	struverite-ilmenorutile	x			
9	samarskite	x			
10	cassiterite	x	x	x	x
11	nigerite	x			
12	ilmenite	x			
13	magnetite	x			
14	uraninite	x	x		x

		S-T	Erä	Haa	Sei
15	chrysoberyl	x	x		
16	pyrrhotite		x		
17	pyrite		x		x
18	marcasite				x
19	chalcopyrite		x		
20	sphalerite		x		x
21	löllingite	x	x	x	x
22	arsenopyrite	x	x		x
23	tetrahedrite		x		
24	molybdenite		x		
25	herzenbergite		x		x
26	bismuth		x		
27	antimony		x		x
28	Bi-antimony		x		
29	stibnite		x		x
30	kermesite		x		
31	valentinite		x		
32	senarmontite		x		
33	stibiconite		x		
34	galena		x		
35	germanite		x		
36	graphite		x		x
37	fluorite		x		x
38	calcite		x		x
39	siderite		x		x
40	malachite		x		
41	scorodite		x		x

(SQI) and one pegmatite has lepidolite and green tourmaline as the only Li silicates. All these pegmatites contain beryl and Nb, Ta minerals; some of them show cassiterite and some a little lepidolite. Only one has pollucite.

In the contact zone of mica schist with amphibolite, northwest and northeast of Torro, there are eight Li pegmatites. They are dykes with moderate to steep dips and ranging in width from 0.1 to 25 m. The excursion targets, Hirvikallio and Kietyönmäki dykes, are the largest Li pegmatites in the Somero - Tammela area. The Hirvikallio dyke and the two adjacent dykes are petalite pegmatites with subordinate spodumene. In Kietyönmäki there are half a dozen dykes, most of which contain SQI, but in a swarm of small dykes, petalite is unaltered. In both the Kietyönmäki and the Hirvikallio subareas, there are some individual pegmatite granite bodies.

On the flanks of the Painiojärvi - Torro - Pyhäjärvi subgroup, the pegmatites are mineralogically rather simple, with beryl and columbite as RE minerals. The pegmatites near Sukula contain some phosphates (triphyllite - lithophilite, alluaudite) and oxides (cassiterite, tapiolite and wodginite).

The other subgroup of RE-pegmatites, east of Lake Painiojärvi, contains about three pegmatites: two of them are rather simple beryl-columbite-pegmatites and one is a Li pegmatite with spodumene, lepidolite, elbaite, cassiterite, columbite and microlite. These dykes grade into magnetite-bearing biotite pegmatites over a distance of 1-2 km. The Li pegmatite contains an early mica that has been tentatively named zinnwaldite.

EXCURSION STOPS

1-1. Granite, Riihivalkama, Tammela (2024, x = 67385, y = 24848).

Typical lateorogenic garnet bearing microcline granite with inclusions of mica schist.

1-2. The Härksaari pegmatite, Tammela (2024, x = 67385, y = 24949).

Pegmatite granite is in the contact of amphibolite with mica schist. The pegmatite granite is a V-shaped body with about 500 m long legs dipping 75°-80° to the south. As usual the K-feldspar is graphic and biotite is the prevailing mica. The pegmatite granite has some pegmatitic patches with blocky K-feldspar, muscovite and cores of rose and smokey quartz. A narrow albitic aplite zone runs near the northern contact of the pegmatite where chrysoberyl and heterosite have been found. Another Al-rich mineral occurs in the pegmatitic patches, namely cordierite, which is always altered into the mica + chlorite-bearing pseudomorphs known as gigantolite.

The pegmatitic patches of the Härksaari pegmatite granite have been quarried for quartz and feldspar on a small scale.

1-3. The Hirvikallio pegmatite, Tammela (2024, x = 67352, y = 24795).

Pegmatite is a vertical petalite rich dyke in the contact of uralite - plagioclase porphyrite with mica schist (Vesasalo 1959). With a length of some 170 m and a width of 5-25 m, it is the largest petalite pegmatite in Finland. According to the mean Li_2O content of the deposit (1.78 %), the pegmatite is 30-40 % petalite. The contact follows the schistosity of the mica schist but cuts the bedding of the porphyrite.

The pegmatite contains petalite accumulations 0.5-2 m in size in albitic aplite. Individual petalite crystals range from 2 to 50 cm in size. Here and there quartz cores up to several square metres and blocky K-feldspar with a little muscovite around them are encountered. Otherwise there is no visible zoning.

The petalite crystals are altered into SQI from the margins and along cleavages. In the latter case, they resemble perthitic K-feldspar.

Small amounts of other minerals have been met with in the Hirvikallio pegmatite:

- triphyllite - lithiophilite with its alteration products ferrisicklerite - sicklerite and heterosite - purpurite (which is rather common in small grains measuring a few millimetres in diameter)
- some grains of poikilitically crystallized topaz
- some apatite, black tourmaline and garnet crystals.

One diamond hole was drilled through the pegmatite at a depth of about 20 m. From drilling data and detailed mapping, it can be estimated that there is about 200 000 t of petalite pegmatite, when calculated to depth of 50 m.

1-4. The Kietyönmäki pegmatite, Tammela (2024, x = 67352, y = 24739).

The Kietyönmäki swarm is composed of half a dozen Li pegmatites and some pegmatite granites in the contact of amphibolites with mica schists. They have moderate to steep dips and cut the foliation of the schists.

The Li pegmatites are very fine-grained albite pegmatites with no zoning except for that due to coarser-grained elongated patches of K-feldspar and "petalite".

In all but one of the pegmatites petalite is completely altered into SQI. In one pegmatite, fresh petalite and SQI occur together in the same dyke.

The largest Li pegmatite at Kietyönmäki is an almost vertical dyke about 200 m long and 10 m wide. In addition to the main minerals - feldspars, quartz, spodumene and muscovite - there are black tourmaline, garnet, apatite, grey beryl, cassiterite, columbite, triphylite-lithiophilite with its alteration products ferri-sicklerite-sicklerite and heterosite-purpurite.

Ten diamond holes have been drilled into the largest Li pegmatite and its immediate surroundings. Analyses of surface samples and the drill cores indicate that the average Li abundance of the pegmatite is 1.5 % Li_2O. There is about 100 000 t of pegmatite with 20 % spodumene calculated to a depth of 50 m.

REFERENCES

Neuvonen, K.J., 1954. Pre-Quaternary rocks, sheet - 2113 - Forssa, Geological map of Finland 1 : 100 000, kallioperäkartta, lehti - 2113 - Forssa, Suomen geologinen kartta 1 : 100 000.

Simonen, Ahti, 1955. Pre-Quarternary rocks, sheet - 2024 - Somero, Geological map of Finland 1 : 100 000, kallioperäkartta, lehti - 2024 - Somero, Suomen geologinen kartta 1 : 100 000.

Simonen, Ahti, 1956. Summary: explanation to the geological map, sheet - 2024 - Somero. Kallioperäkartan selitys, lehti - 2024 - Somero, 31 p.

Simonen, Ahti, 1980. Prequaternary rocks of Finland 1 : 100 000. Suomen kallioperä 1 : 100 000.

Vesasalo, Arvo, 1959. On the petalite occurrences of Tammela, SW-Finland. Bull. Comm. geol. Finlande 184, 59-74.

THE GRANITOIDS AND PEGMATITES OF THE ERÄJÄRVI AREA

Seppo I. Lahti

The Eräjärvi area is located in Orivesi, about 50 km east-northeast of Tampere in the eastern part of the Tampere schist belt. About seventy Be, Nb-Ta, and Li mineral-bearing pegmatites and some hundred simple pegmatites are known within an area of about 250 km^2 around Lake Eräjärvi (Fig. 1). Most of the pegmatites are closely associated with granitic rocks that form separate stocks in the district. The pegmatite deposits were quarried for feldspar and quartz from the early years of this century until the mid-1960s. There are about twenty small and five larger quarries in the area.

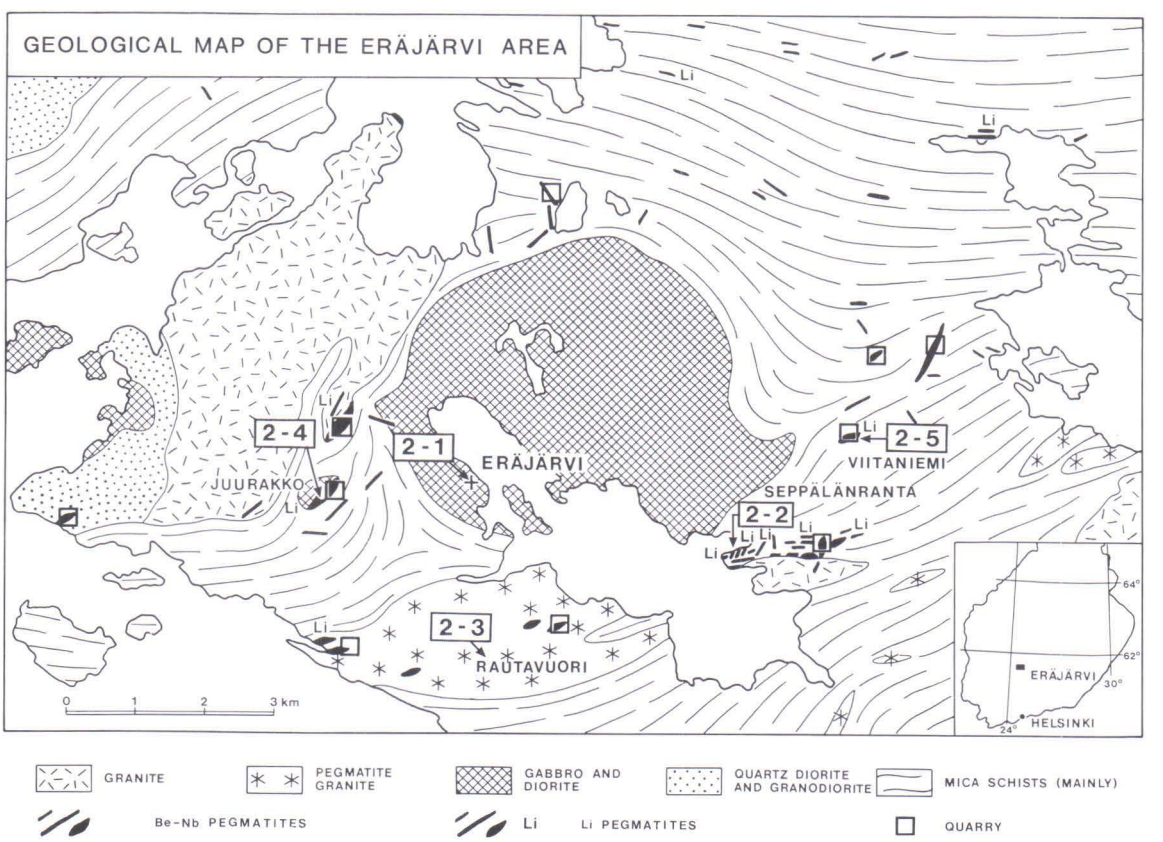


Fig. 1. Lithological map of the Eräjärvi area showing the known complex pegmatite dykes.

General geological features

The bedrock of the area is characterized by various mica schists, phyllites and greywacke schists folded and metamorphed under the Svecokarelidic orogeny 1.80 to 1.95 Ga ago. Narrow intercalations of black schists, sericite quartzites, quartz feldspar schists and metavolcanic rocks are typical, especially of the northern part of the appended map area.

The predominant trend of the schistosity is nearly east-west with subvertical dips. The schists, which are folded plastically and isoclinally, metamorphosed under medium-grade conditions. A series of plutonic rocks, ranging in composition from gabbros and diorites to granitic rocks, intruded the schists in the course of regional metamorphism and folding. The plutons are elongated, often parallel to the schistosity and vary in size. The largest of them are heterogeneous, containing several differentiates.

In the central part of the Eräjärvi district the syntectonic plutonic rocks form a complex in which two separate gabbro-diorite stocks are surrounded by quartz dioritic and granitic intrusions. The Rappuvuori granite stock west of Lake Eräjärvi is composed of grey, medium-grained microcline granite, but the lenticular Kultavuori stock south of the lake is heterogeneous. Pegmatite granite and pegmatite predominates within it, but some outcrops in the inner part of the stock and at its eastern end are of grey granite similar to that in the Rappuvuori stock.

The granitic pegmatites of the area

Most of the pegmatites occur as dyke sets in schists, often, however, in the proximity of the granitic bodies, for which reason the pegmatites are considered genetically related to the granitic magmatism. The pegmatites are post-tectonic and usually follow the east-west trending schistosity of the area. U/Pb dating on metamict zircons of the pegmatites of Viitaniemi and Eräpyhä indicates an age of almost 1.8 Ga.

Tourmaline bearing simple pegmatites are very common in the schists and in granitic intrusions. The dykes in granites are usually thin two-mica pegmatites poor in tourmaline, but within the contact area bigger pegmatite bodies with rare minerals are common. There is often a continuous pegmatite seam between the granite and the schists. The pegmatite granite in the Kultavuori granitoid

intrusion south of Lake Eräjärvi has several coarse tourmaline-bearing pegmatitic lenses or tabular zoned dykes, some of them containing rarer minerals.

On the basis of their mineralogical composition the complex pegmatites can be classified into two main groups: a) Be-Nb pegmatites and b) Li pegmatites.

Two thirds of the known complex pegmatites of the district are Be-Nb pegmatites. Sparsely distributed, they occur over the whole area. Most of the pegmatites are subvertical dykes, 1-5 m thick, but several broader lenticular pegmatite bodies are also known. Typical accessory minerals in the Be-Nb pegmatites are schorl, beryl, columbite-tantalite, apatite, garnet and zircon. In addition the dykes may have tapiolite, cassiterite, microlite, bertrandite and occasionally some other more rare minerals.

Most of the Li pegmatites of the area are concentrated in the Seppälä subarea (note appended map) around the eastern end of the Kultavuori pegmatite granite intrusion; only one-third of the Li pegmatites occur as sparsely distributed dykes in the district. The thickness of the dykes ranges from 1 to 10 metres. Typical accessory minerals besides beryl, columbite-tantalite, cassiterite, apatite and garnet, are Li-Fe-Mn phosphates (triphylite-lithiophilite, siclerite-ferrisiclerite) and their alteration products (various hydrous or hydrated Fe-Mn phosphates), amblygonite-montebrasite and Li silicates (lepidolite, elbaite and spodumene).

The pegmatites of the district are either zoned or characterized by banded or layered internal structures formed during intrusion and crystallization of the melt. The complex pegmatites in particular are distinctly zoned. The dykes or lenses are composed of border, wall and intermediate zone or zones that form the central part of the deposit. Quartz cores, which measure several metres in the larger pegmatites, are situated in the centre of the dyke. The zones differ in mineralogy, and the grain size increases from contact to intermediate zone. The complex pegmatites contain fracture fillings and replacement bodies formed during various phases of crystallization of the dyke. Beryl, Nb-Ta minerals, lithium minerals and several other more rare pegmatite minerals favour the intermediate zone, the albite-rich replacement bodies and the fracture fillings.

EXCURSION STOPS

2-1. The Mineralogical Museum at Eräjärvi.

Introduction to the geology of the area and mineralogy of the granitic pegmatites.

2-2. The Seppälänranta pegmatite (214112, x = 682925, y = 253412) and the rocks in the surrounding area.

Around the eastern end of the lenticular Kultavuori pegmatite granite - granite intrusion, numerous pegmatite dykes and lenses form a complex network in schists (Fig. 2). More than twenty rare mineral-bearing pegmatites, most of them

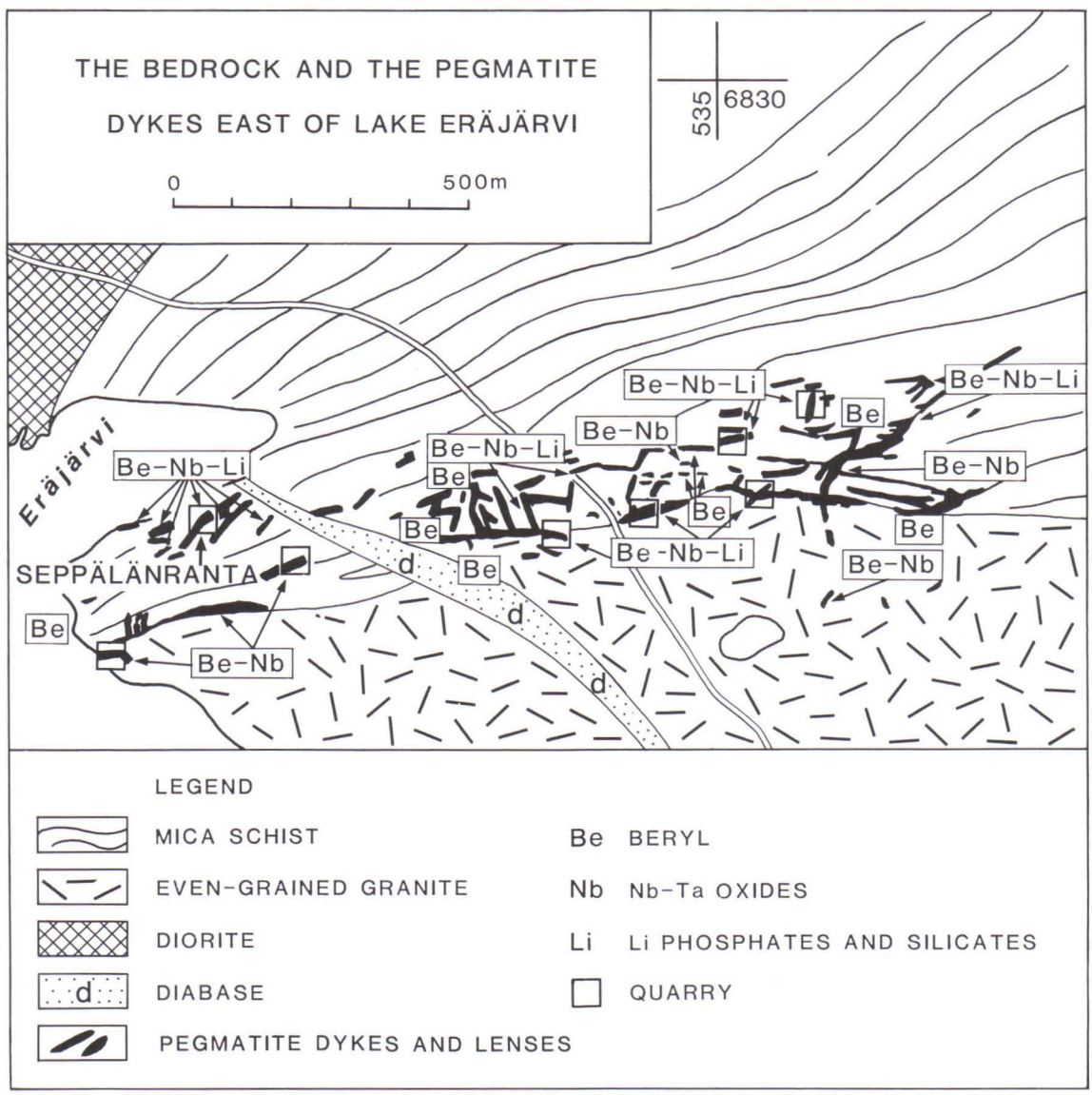


Fig. 2. The bedrock and pegmatite dykes east of Lake Eräjärvi.

Li pegmatites, are known within an area of three square kilometres. There is a continuous pegmatite zone following the contact of granite. In some places along the contact, diagonal or perpendicular dykes extend farther into the schists. These often branching dykes obviously represent the feeding channels of pegmatite magma. Banded textures that developed during crystallization of the flowing magma are typical of some dykes.

The Seppälänranta pegmatite was quarried for feldspar during the 1930s. The pit, which is very small, is in the northern part of the dyke. A small olivine diabase dyke about 1-2 m wide cuts the pegmatite in the quarry.

The pegmatite is situated about 300 m from the contact of the medium-grained microclinegranite stock. The dyke cuts the schistosity, which is nearly parallel to the contact of the granite. The pegmatite can be traced in outcrops for about 50 m. The thickness of the dyke ranges from one metre to about five metres.

There are several other Li pegmatites trending in the same direction and similar in mineralogy to the Seppälänranta dyke. The small pegmatite called Tiainen dyke, some tens of metres to the west, is a type locality of manganotapiolite - a Mn dominant end member of the tapiolite group (Lahti et al. 1983). Zoning textures of columbite-tantalite crystals of the pegmatites have been described by Lahti (1986), and the mode of occurrence of a rare Li-Be mica, bityite, by Lahti and Saikkonen (1985).

The Seppälänranta pegmatite is typical of the Li pegmatites in the area. The dyke is zoned, but late or postmagmatic replacement and albitization processes have strongly reworked the internal structure. The most coarse-grained parts of the dyke have been quarried for feldspar; the remainder is an albite rich rock.

Some parts of the pegmatite are enriched in phosphate minerals. Triphylite is common and occurs as nodules and aggregates up to 20 cm in diameter. Ferrisiclerite, heterosite, vivianite, alluaudite and a set of rarer Fe-Mn phosphates (e.g. messelite, hureaulite, switzerite, jahnsite and eosphorite) have been encountered as alteration products of this mineral. Montebrasite is rare, but occurs as white crystal plates several centimetres thick. Apatite is green or blue when rich in manganese, and occurs as small aggregates or crystals with the other phosphates.

Tourmaline is mostly black, but green, red or blue elbaitic varieties have been encountered in the southern part of the dyke associated with pink lepidolite and triphylite. Some of the tourmaline crystals are zoned having a red core and a green rim. Metasomatic processes caused by the pegmatite magma produced a seam containing brown crystals of dravitic tourmaline and phengitic muscovite in the exocontact of the pegmatite. Beryl is a common mineral in the pegmatite and occurs as crystal prisms up to 10 cm in diameter in various parts of the dyke. In colour, the mineral is light yellow, white or pinkish.

Cassiterite and columbite-tantalite are typical oxide minerals in the dyke, but tapiolite, microlite and wodginite have also been encountered here and there. Small euhedral crystals of brown metamict zircon and thucholite spherules are often associated with Nb-Ta oxides. The chemical composition of columbite varies considerably. The small, black, platy crystals near the contacts of the dyke are ferrocolumbite rich in Fe, but the bigger subhedral or rarely euhedral crystal plates are associated with Li minerals in the intermediate zone are ferrotantalite, near ferrotapiolite in composition. Dark brown crystals of cassiterite with lepidolite, elbaitic tourmaline and triphylite in albite-rich portions of the dyke are common.

2-3. The Kultavuori pegmatite granite (214112, x = 682750, y = 253050).

The Kultavuori pegmatite granite - granite stock south of Lake Eräjärvi is a complex intrusion. It mainly consists of various types of pegmatite granite, but locally grades into medium-grained granite. The pegmatite granite is slightly to strongly foliated except at the western margin of the intrusion, where coarse pegmatitic parts are common.

The coarse pegmatite granite is apparently only the narrow roof layer of a more extensive intrusion. Medium-grained microcline granite crops out in the centre of the stock. The possibly pegmatitic roof parts that are seen elsewhere in the intrusion have been denuded by erosion. The part of the stock that extends east of Lake Eräjärvi is composed of even-grained grey granite (called Seppälä granite) and represents a deeper section of the intrusion. The granite is bordered by margin pegmatites, but the pegmatitic roof is totally lacking.

The mineralogical composition and the grain size of the granitic types in the centre of the Kultavuori intrusion vary widely, and all kinds of intermediate forms between biotite granite and pegmatite granite can be recognized. Locally, the medium-grained types exhibit microcline porphyroblasts and the texture is

porphyritic. The porphyritic types pass gradually to pegmatite granite. The most common granitic types have both micas, biotite and muscovite. Garnet and schorl are very common accessory minerals, especially in pegmatite granite and pegmatitic parts of the stock.

The Kultavuori pegmatite granite is locally strongly foliated and contains fragments of overlying schists as inclusions. Irregular pegmatitic segregations in the direction of foliation or cutting pegmatite dykes are common. The dykes and lenses may be zoned and characterized by strong albitization, albite-rich replacement bodies and fracture fillings. The main minerals in the pegmatites are blocky perthitic microcline, grey or white quartz, muscovite and biotite. Muscovite is the only mica in the coarsest parts of the dykes. The pegmatites are usually simple in mineralogy, but may locally contain beryl and columbite with minor apatite, zircon, garnet, arsenides and sulphides. One Li pegmatite is known near the southwestern contact of the stock. In addition to columbite-tantalite, cassiterite and beryl, the dyke contains both Li silicates (elbaitic tourmaline, spodumene, lepidolite) and Li phosphates (lithiophilite and its alteration products).

2-4. The Juurakko pegmatite dyke (214109, x = 68290, y = 252810).

The Juurakko pegmatite dyke is situated near the southeastern contact of the Rappuvuori granite stock. The dyke, which is horizontal or subhorizontal and irregular in shape, cuts the mica schist and a small dioritic intrusion. The dyke was found in 1916 and is the first known pegmatite deposit of economic importance in the area. It was quarried for quartz and feldspar from 1930 to 1966. There are several separate pits close to each other, the biggest of them measuring 50-60 m in diameter.

The Juurakko pegmatite is well-zoned. The border zone is narrow, about 50 cm thick, and consists of fine-grained plagioclase-quartz-microcline-tourmaline pegmatite. There is, however, a microcline-poor and plagioclase-rich subzone against the wall rock. The wall zone is microcline-dominated coarse pegmatite, often rich in black tourmaline. The feldspar crystals are usually 10-50 cm long and intergrown with quartz. The wall zone is often several metres thick, but the thickness varies largely from one part of the dyke to the other. The abundance and grain size of microcline increase towards the intermediate zone, which is characterized by gigantic microcline crystals up to several metres long. The quartz cores, the biggest of them several metres in diameter, were quarried off during operations.

The rare pegmatite minerals occur in the albite+quartz+tourmaline pegmatite between the microcline crystals in the intermediate zone or they are enriched in the albite-rich replacement bodies and fracture fillings that cut the zones. The following types of intraformational fracture fillings have been established:

- albite+quartz+muscovite pegmatite dykes with abundant tourmaline
- löllingite+sphalerite dykes with abundant pyrite or pyrrhotite
- quartz dykes and quartz+tourmaline dykes

The fracture fillings are from some millimetres to a few decimetres thick. Their mutual age relations are not fully known. The löllingite, quartz and quartz + tourmaline dykes are, however, the youngest fracture fillings and cut the various zones of the pegmatite.

The following accessory minerals are characteristic of the intermediate zone or in the albite-rich intraformational dykes and replacement bodies: schorl, beryl, cassiterite, columbite, almandine-spessartine, bertrandite and zircon. Black tourmaline is ubiquitous, and the biggest crystals measure 10 cm in diameter. The mineral is sometimes replaced by phengitic muscovite. Beryl is yellowish or pinkish in colour. The crystals are prismatic up to 10-15 cm in diameter, and often altered to bertrandite, micas and clay minerals. Light green or bluish fluorapatite is often associated with beryl. Black columnar crystals or platy crystals of ferrocolumbite and manganocolumbite occur with cassiterite, garnet and zircon in the cleavelandite or sugar albite fracture fillings and replacement bodies. Cassiterite occurs as small subhedral crystals or crystal aggregates, the biggest of them some centimetres in diameter.

Mica aggregates after topaz and tourmaline characterize the intermediate zone and the albite-rich intraformational dykes. The pseudomorphs usually consist of fine-scaled massive muscovite, but they may have a margarite or topaz-margarite core (Lahti 1988). The topaz core is always replaced by Li- and Na-rich margarite that may be fibrous in appearance. The margarite zone is surrounded by massive fine-scaled muscovite and the outer part may be rimmed by coarse-scaled yellow muscovite or pink lepidolite-like manganese-bearing muscovite. Green elbaitic tourmaline and possibly lepidolite associated with topaz, cassiterite and Mn columbite have been encountered in certain part of the dyke.

Large miarolitic cavities filled with prismatic crystals of smoke quartz up to 30 cm long, euhedral crystals of white microcline and colourless albite were encountered during mining. Smaller cavities filled with feldspar and quartz

crystals, sometimes with bertrandite crystals, are common.

2-5 The Viitaniemi pegmatite (214210, x = 683086, y = 253580).

The Viitaniemi pegmatite is mineralogically the most interesting lithium pegmatite in the district (Volborth 1954, Lahti 1981). It is exceptionally rich in Li, Be and Fe-Mn phosphates, the total number of mineral species being about seventy. The pegmatite is in mica schist, two kilometres northeast of the Seppälä granite stock. According to diamond drilling data, the Viitaniemi pegmatite is a subhorizontal dyke, 100-130 m wide, up to 10 m thick and several hundred metres long. Only a random section of the dyke is exposed on the surface. The pegmatite was discovered by change in 1935 and quarried mainly for feldspar until the mid-1960s. There are three pits in the dyke, the biggest 50-100 m in diameter.

The Viitaniemi pegmatite is distinctly zoned. The albite- and often muscovite-rich border zone is some decimetres thick. The wall zone varies in thickness, but it often measures some metres. It is composed of pegmatite in which coarse grained microcline is predominant. The feldspar crystals are 5-50 cm in diameter, in addition to which the rock contains albite, quartz, large muscovite sheets, black or dark green tourmaline, random yellowish beryl and blue green apatite. The central part of the dyke is made up of an intermediate zone with huge microcline crystals and quartz cores.

The primary zonal structure has been widely destroyed by later recrystallization and albitization of the pegmatite. Replacement bodies and fracture fillings mainly composed of sugary and platy albite, quartz, lepidolite, green tourmaline, beryl and various more rare pegmatite minerals are characteristic of the intermediate zone. The replacement bodies and the quartz cores may be locally as much as several metres in diameter. With the fracture fillings they represent the last parts of the pegmatite to crystallize. Replacement phenomena and fracture fillings are less dominant in the wall and border zone, although the pegmatite shows prominent exocontact alteration.

The pegmatite is enriched in Li-, Cs-, Be-, Nb-, Ta-, Sn-, P-, F- ja B-bearing minerals. Black and green tourmaline, brownish lepidolite, light yellow or pink beryl and blue-green topaz are common silicate minerals in the dyke. Topaz and tourmaline may occur as gem quality varieties in cavities and clay mineral pockets. Pollucite has been encountered as a core weighing several tons in the eastern part of the pegmatite. Columbite-tantalite and cassiterite occur here and there in the central part of the dyke, but microlite, wodginite and tapiolite have

also been identified. The composition of columbite-tantalite varies considerably.

Brown zircon crystals and black thucholite spherules are often associated with Nb-Ta-Sn oxides.

The pegmatite is well known for the various phosphate minerals that may be sparsely distributed or locally concentrated in some parts of the dyke. Blue-green Mn-rich fluorapatite is very common throughout in the pegmatite, but several other varieties differing in colour and composition are also known. Lithiophilite and triplite occur as nodules and aggregates up to several decimetres in diameter. In places lithiophilite is altered to various hydrous or hydrated Fe-Mn phosphates or is replaced by alluaudite or siclerite and purpurite. The most common alteration products of lithiophilite are vivianite, hureaulite, fairfieldite, switzerite and phosphosiderite.

Amblygonite-montebrasite occurs as big white crystal plates, up to several decimetres long. Some parts of the replacement bodies contain montebrasite+ quartz+topaz+lepidolite-pegmatite with minor cleavelandite, apatite, tantalite and beryllium phosphates. The other aluminium-bearing phosphates of the pegmatite, i.e. morinite, viitaniemiite, crandallite and eosphorite, are later alteration and replacement products of montebrasite.

Beryllium-bearing phosphates are very common. They occur as nodules and irregular aggregates, weighing up to several kilograms, often associated with amblygonite-montebrasite. The aggregates are usually zoned. Hurlbutite, which is the most common of these phosphates, is often partly altered into herderite. The hurlbutite nodules may have remnants of beryllonite, which was the first Be phosphate to crystallize. Väyrynenite occurs as separate aggregates or nodules or replaces the other Be phosphates.

REFERENCES

Lahti, Seppo I. (1981). On the granitic pegmatites of the Eräjärvi area in Orivesi, southern Finland. Geol.Surv. Finland Bulletin 314, 82 p.

Lahti, Seppo I. (1986). Zoning in columbite-tantalite crystals from the granitic pegmatites of the Eräjärvi area, southern Finland. Geochim. Cosmochim. Acta 51, pp. 509-517.

Lahti, Seppo I. (1988). Occurrence and mineralogy of the margarite- and muscovite-bearing pseudomorphs after topaz in the Juurakko pegmatite, Orivesi, southern Finland. Bull. Geol. Soc. Finland 60, 27-43.

Lahti, Seppo I., Johanson, Bo and Virkkunen, Marjatta (1983). Contributions to the chemistry of tapiolite, manganotapiolite - a new mineral. Bull. Geol. Soc. Finland 55, pp. 101-109.

Lahti, Seppo I. and Saikkonen, Risto (1985). Bityite $2M_1$ from Eräjärvi compared with related Li-Be brittle micas. Bull. Geol. Soc. Finland 57, 207-215.

Volborth, A. (1954). Phosphatminerale aus dem Lithiumpegmatit von Viitaniemi, Eräjärvi, Zentral-Finnland. Ann. Acad. Sci. Fennicae, Ser. A 3, Geol.-Geogr. 39, 90 p.

THE SYNTECTONIC GRANITOIDS OF THE TAMPERE AREA

Mikko Nironen

The Hämeenkyrö batholith and the Värmälä stock are located in the Tampere Schist Belt. The east-west trending belt is narrow and discontinuous, with a length of about 200 km. The central part of the belt (Fig. 1) has been studied repeatedly, with the emphasis on the volcanic and sedimentary rocks and their well-preserved primary structures. The discovery of the tourmaline breccia type Ylöjärvi Cu-W deposit shifted interest to include the adjacent Hämeenkyrö batholith, which was regarded as the host of the ore-forming fluids (Himmi et al. 1979, Gaál et al. 1981).

The metavolcanics of the belt were originally mafic to felsic rocks, with calc-alkaline intermediate pyroclastic rocks prevailing (Kähkönen 1987). The metasedimentary rocks are turbidites (greywackes, mudstones and conglomerates) with predominantly volcanic provenances. The rocks were metamorphosed near the greenschist facies - amphibolite facies transition.

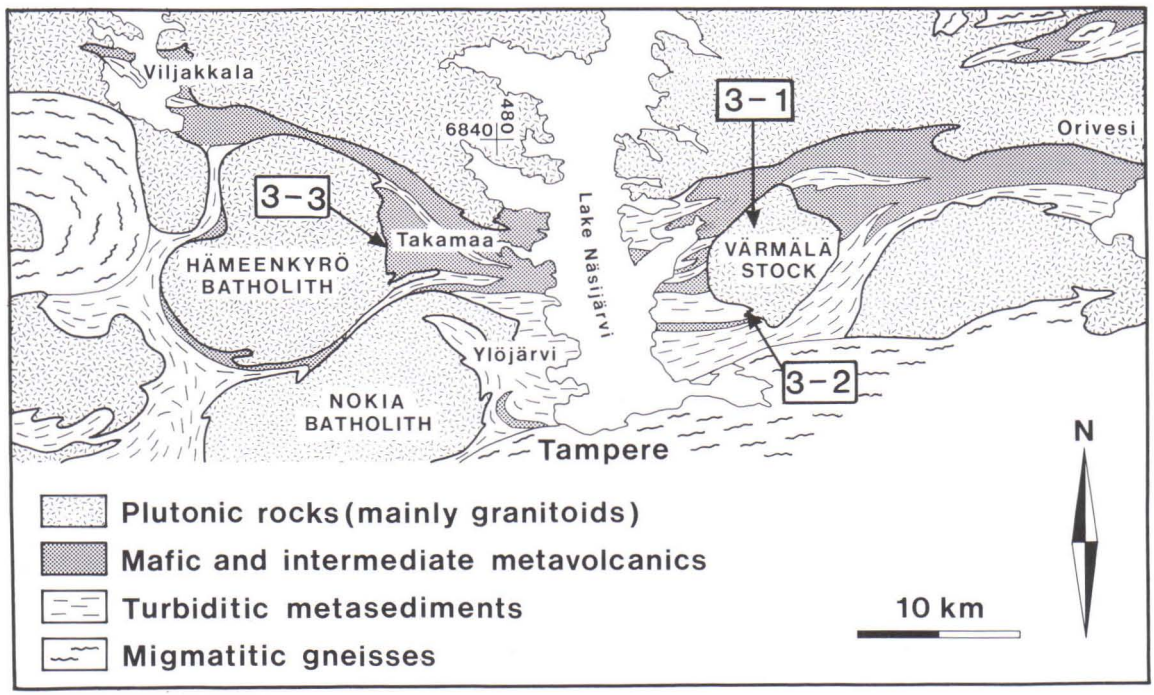


Fig. 1. Generalized geological map of central Tampere Schist Belt.

Top-of-strata directions indicate that there is a major east-west trending D_1 syncline in the northern part of the Tampere Schist Belt (Fig. 1), with minor synclines and anticlines in the limb areas. The attitude of primary layering (S_0) varies from subhorizontal to vertical, whereas the dip of penetrative S_1 schistosity is steep to vertical. Mesoscopic F_1 folds are upright or slightly overturned and vary from open to isoclinal. Dextral F_2 folds with subvertical, east-west to northeast-southwest striking crenulation cleavage overprint S_1. D_3 kinking and fracturing are restricted to narrow zones.

The Hämeenkyrö batholith shows normal zoning, the most mafic tonalite being at the margins. Granodiorite is the predominant rock type, and granite occupies the centre of the batholith. Both the granodiorite and the granite are medium- to coarse-grained and equigranular or slightly porphyritic, with plagioclase and K-feldspar phenocrysts. Small microgranitoid enclaves occur throughout the pluton. A feldspar porphyry, characterized by euhedral albite phenocrysts, is encountered along the eastern margin. A plagioclase porphyry occurs here and there on both sides of the eastern contact. The tourmaline breccia extends from the batholith into the wall rocks.

The Värmälä stock is reversely and asymmetrically zoned, with granodiorite as the prevailing rock type and granite occurring along the western and northern margins. Granodiorite is medium-grained, and equigranular or slightly porphyritic. Oval-shaped microgranitoid enclaves occur mostly in the marginal areas. There is a separate quartz monzodioritic phase in the centre of the pluton.

The U-Pb zircon ages of the Hämeenkyrö and Värmälä plutons are 1.885 Ga and 1.878 Ga, respectively. The initial $^{87}Sr/^{86}Sr$ ratios of the phases in the Hämeenkyrö batholith range from 0.7030 to 0.7033. The ages, the low I_{Sr} values and the calc-alkaline affinity of the plutons are typical of synkinematic Svecofennian granitoids. The felsic/intermediate composition of the plutons, and the microgranitoid enclaves suggest mixing and mingling between felsic and mafic magmas.

The two granitoid plutons truncate S_0 where the latter is at high angles to the contact (Fig. 2 and Fig. 3). In these areas, primary structures are well preserved near the contacts, and S_1 is weakly developed. Elsewhere, S_1 is pronounced, and S_0 curves toward parallelism with the contacts. The foliation within the plutons shows a general lenticular pattern, and in places S_1 continues into the plutons across the contact. The Värmälä stock contains foliated (S1) wall rock xenoliths.

Both plutons are surrounded by a contact metamorphic aureole, with a maximum width of 300 m. The contact metamorphic minerals, which were altered during retrogressive metamorphism, occur as mica-rich pseudomorphs in silty and muddy units of the metaturbidites. The existence of foliated wall rock xenoliths, the sporadic continuation of S_1 into the plutons, and the orientation of the pseudomorphs parallel to S_1 indicate that the plutons are syntectonic with respect to D_1, and that the progressive D_1 continued after the emplacement. The plutons were initially emplaced rather passively, and subsequently more forcefully with continued injection of magma.

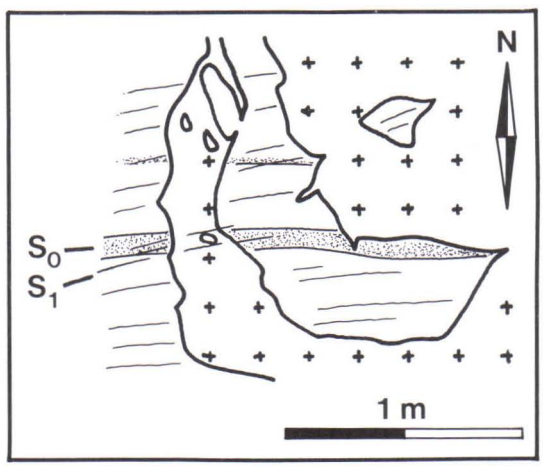


Fig. 2. Granodiorite (marked by crosses) brecciates metaturbidite. Southwestern contact of the Värmälä stock.

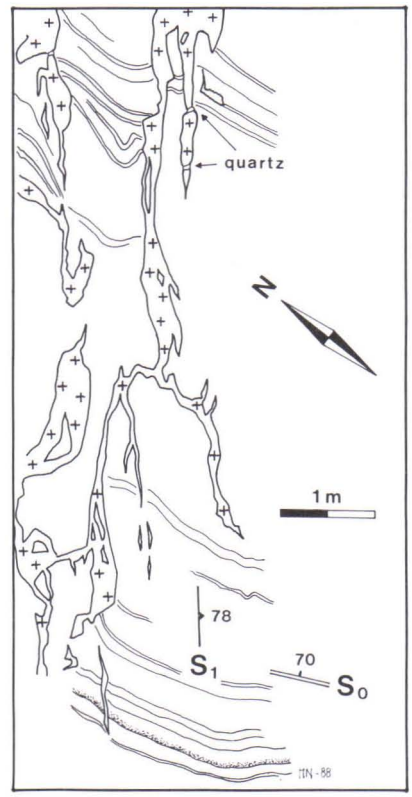


Fig. 3. Granodiorite apophyses (marked by crosses) injected parallel to S_1. Southwestern contact of the Värmälä stock.

EXCURSION STOPS

3-1. Northern part of the Värmälä stock, Pohtola (212410, x = 683556, y = 249596).

Typical granitic and granodioritic varieties of the stock.

3-2. Southwestern contact of the Värmälä stock, Sorila (1 and 2: 212312, x = 682923, y = 249527; 3: 212312, x = 682936, y = 249574).

1) Rotated wall rock xenoliths in granodiorite/granite.
2) Granodiorite brecciates metaturbidite (Fig. 2). S1 continues across the contact. Pseudomorphs of contact metamorphic andalusite(?) elongated parallel to S1.
3) Granodiorite apophyses injected parallel to S1 and slightly boudinaged (Fig. 3).

3-3. Eastern contact of the Hämeenkyrö batholith, Paroinen (1: 212404, x = 683466, y = 247293; 2: 212404, x = 683323, y = 247285).

1) Felsic tuffite/metaturbidite, with well-preserved cross bedding and pseudomorphs of contact metamorphic porphyroblasts. S1 is weakly developed.
2) Intrusive breccia, with tourmaline in the matrix.

REFERENCES

Gaál, G., Front, K. & Aro, K., 1981. Geochemical exploration of a Precambrian batholith, source of a Cu-W mineralization of tourmaline breccia type in southern Finland. In: A.W. Rose & H. Gundlach (Editors), Geochemical Exploration, 1980. J. Geochem. Explor. 15, 683-698.

Himmi, R., Huhma, M. & Häkli, T.A., 1979. Mineralogy and metal distribution in the copper-tungsten deposit at Ylöjärvi, southwest Finland. Econ. Geol. 74, 1183-1197.

Kähkönen, Y., 1987. Geochemistry and tectonomagmatic affinities of the metavolcanic rocks of the early Proterozoic Tampere Schist Belt, southern Finland. Precambrian Res. 35, 295-311.

THE GRANITIC PEGMATITES OF THE SEINÄJOKI AND HAAPALUOMA GROUPS

Reijo Alviola

Main features of the bedrock

The Ostrobothnia schist belt, which is the continuation of the Tampere schist belt, lies to the west of the granitoid complex of central Finland (Fig. 1). Similar schists are met with on the Swedish side of the Gulf of Bothnia, about 100 km west of the coast of Finland.

Regional mapping at 1 : 100 000 scale does not yet cover the Ostrobothnia schist belt and therefore its stratigraphy is poorly understood. According to Saksela (1935), the supracustal rocks can be divided into two subgroups:

- the (upper) sedimentogenic subgroup, which is composed of mica schists, quartzites with biotite-plagioclase gneisses and hornblende-biotite gneisses. These rocks are underlain by black schists and basic volcanics
- the (lower) volcanogenic subgroup, which contains acid to mafic volcanics with biotite-plagioclase gneisses and dolomites.

Supracrustal rocks

The 40 - 50 km broad schist belt consists mainly of mica shists and gneisses. Quartzites are very rare as they are in the schist belt of southern Finland. Intensely recrystallized cherty beds with Fe and Mn mineralization are associated with basic volcanics 10 - 20 km north and west of Seinäjoki. Limestones or dolomites are known in two places only. Black schists are often met with volcanogenic amphibolites and skarns or quartzites. In some places biotite - plagioclase schists grade into mica schists, which sometimes show an aluminium excess, having garnet, staurolite, cordierite, andalusite or sillimanite porphyroblasts.

The marginal parts of the schist belt and the mica schists inside the infracrustal rocks are heavily migmatized and altered into mica gneiss.

Infracrustal rocks

Diorites, gabbros and more basic rocks are very rare and occur only as small intrusions, except in the area northeast of Kaustinen. Two major olivine diabase dykes are located in the archipelago, some 30 km southwest of Vaasa.

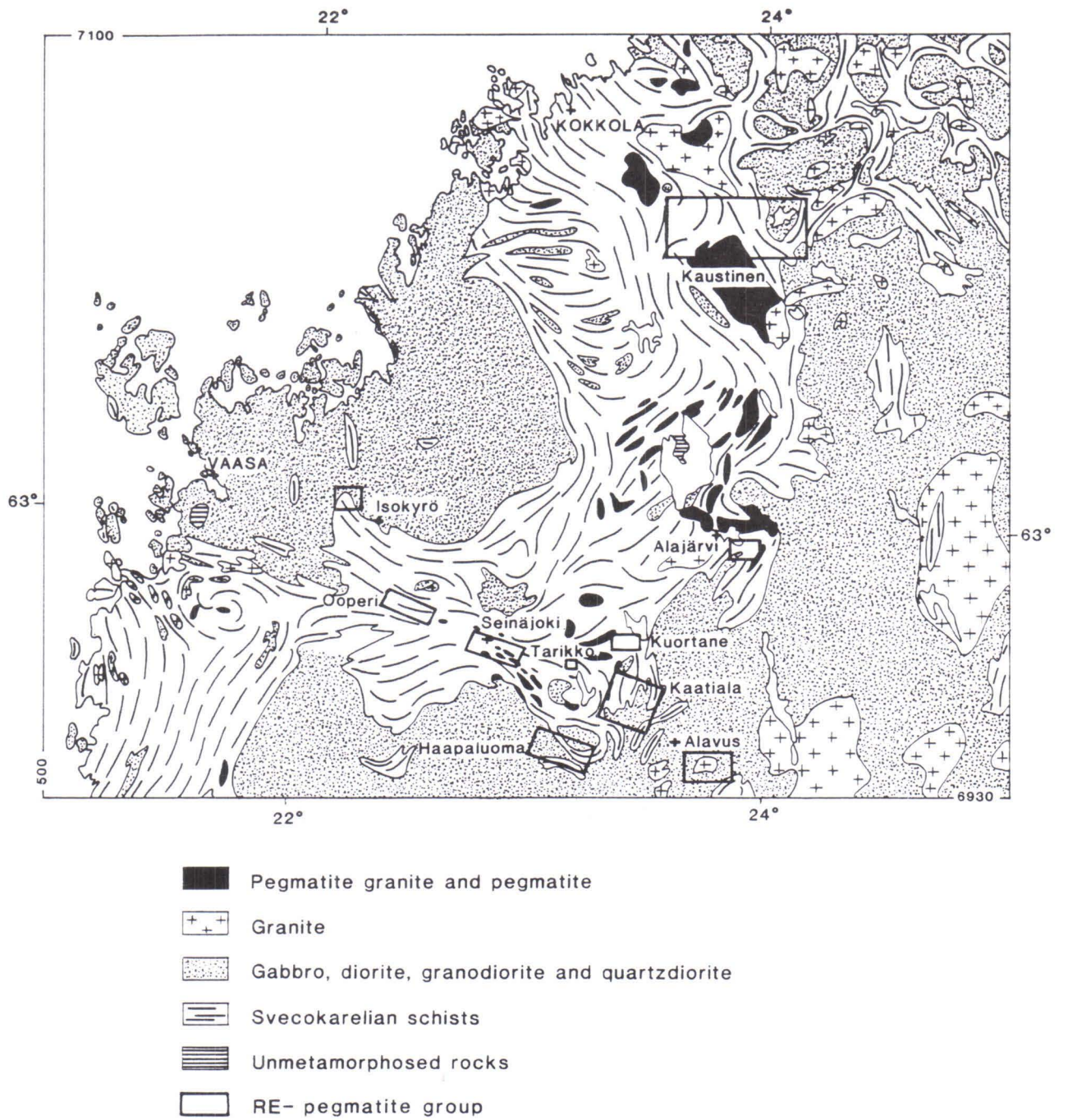


Fig. 1. Geology of the Ostrobothnia schist belt (modified from Simonen 1980) and the location of the main pegmatite groups.

Most of the infracrustal rocks are quartz dioritic to granodioritic in composition. Quartz diorite often grades into granodiorite, but sometimes granodiorite is distinctly younger. Characteristic of quartz diorite and the associated granodiorite are the abundant basic inclusions from a few cm to a few dm in diameter. A typical quartz diorite is weakly orientated, and gneissose to some extent (Tyrväinen 1984).

The Vaasa granite, which is surrounded by the schist belt, is in fact a porphyric granodiorite.

Granites, pegmatite granites and pegmatites

The infracrustal rocks within the schist belt are mostly granites, pegmatite granites and pegmatites. In the north- western part of the schist belt, the granites and pegmatite granites are associated with granodiorites. In some places, the granites contain inclusions of mica schist. Both the mica schist and the adjacent granite may contain garnet. Sometimes there are remnants of concretions in the granite.

Each swarm of pegmatite granite is surrounded by a group of pegmatites. Some pegmatite granites cover large areas because they are horizontal dykes and the country is flat.

The major RE-pegmatite groups of the schist belt are shown in Fig. 1. Both the Isokyrö and Ooperi groups consist of beryl and columbite bearing pegmatites. The Kuortane and Alajärvi groups contain triphyllite and some other phosphate minerals in addition to beryl and columbite. The Seinäjoki pegmatites are characterized by cassiterite, spodumene and tapiolite with beryl, columbite and phosphates. The Tarikko group is like a miniature copy of the Seinäjoki group. The Haapaluoma and Kaatiala groups are very similar to each other in mineral composition. Some Ce and REE minerals have been found in Haapaluoma. In the Alavus group, the pegmatites are predominantly biotite-bearing allanite pegmatites with a few grains of fergusonite and subordinate muscovite. The majority of the Kaustinen RE pegmatites are homogeneous spodumene pegmatites with some beryl and columbite, but there are also petalite pegmatites and some rather simple pegmatites with beryl, columbite and some phosphates only. The Kaustinen group is evidently composed of several subgroups, but their areal distribution has not yet been established.

The minerals identified from the Seinäjoki and Haapaluoma pegmatites are listed in Table 1, page 20-22. The geological map of the Seinäjoki, Pajuluoma area with excursion stops 4-1, 4-2 and 4-3 is Fig. 2.

EXCURSION STOPS

4-1. Pegmatite granite, Keskussairaala, Seinäjoki (2222, x = 69608, y = 24402).

An irregular body of pegmatite granite in mica schist. The rock often contains alternating layers of coarse pegmatite and fine grained aplite. Later cutting tourmaline pegmatite dykes are typical. The pegmatitic parts are characterized by large crystals of graphic K-feldspar. Microcline porphyroblasts crystallized after or simultaneously with layering are common in aplitic parts of the rock.

4-2. Pegmatite granite, Hallilanvuori, Seinäjoki (2222, x = 69629, y = 24425).

An elongated pegmatite granite body (200 x 1000 m) that lies roughly parallel to the schistosity of the greywacky schist, is discordant in detail. The eastern end of the body is flat, dip being 30 SE. The texture is porphyritic: large, corroded, anhedral crystals of graphic K-feldspar are embedded in a matrix composed of plagioclase, K-feldspar, biotite + muscovite, quartz and accessory black tourmaline, apatite, garnet and arsenopyrite. Biotite and muscovite often appear as large and thin, mixed crystals. In the southeastern part, the pegmatite granite is banded. There are alternating K-feldspar-rich and more fine-grained K-feldspar poor bands, which are often rich in tourmaline and garnet; some of the bands are aplitic. In the pegmatite granite, the pegmatite veins are mainly parallel to the longitudinal axis of the body but some are perpendicular to it. The pegmatites contain blocky K-feldspar, plagioclase, quartz, muscovite, black tourmaline and sometimes beryl.

4-3. The Perälä pegmatite dyke, Seinäjoki (2222, x = 69608, y = 24447).

The first cassiterite-bearing pegmatite in the Seinäjoki area, spotted in 1979, led to three years of tin exploration. More than a hundred RE-pegmatites were met with, about 50 of them cassiterite-bearing. Cassiterite pegmatites usually contain columbite and sometimes tapiolite. Only one pegmatite is rich in spodumene, but four others are spodumene-bearing. There are several dykes with triphyllite and its alteration products and only a few with alluaudite or other phosphates. Antimony or stibnite have been met with in five pegmatites.

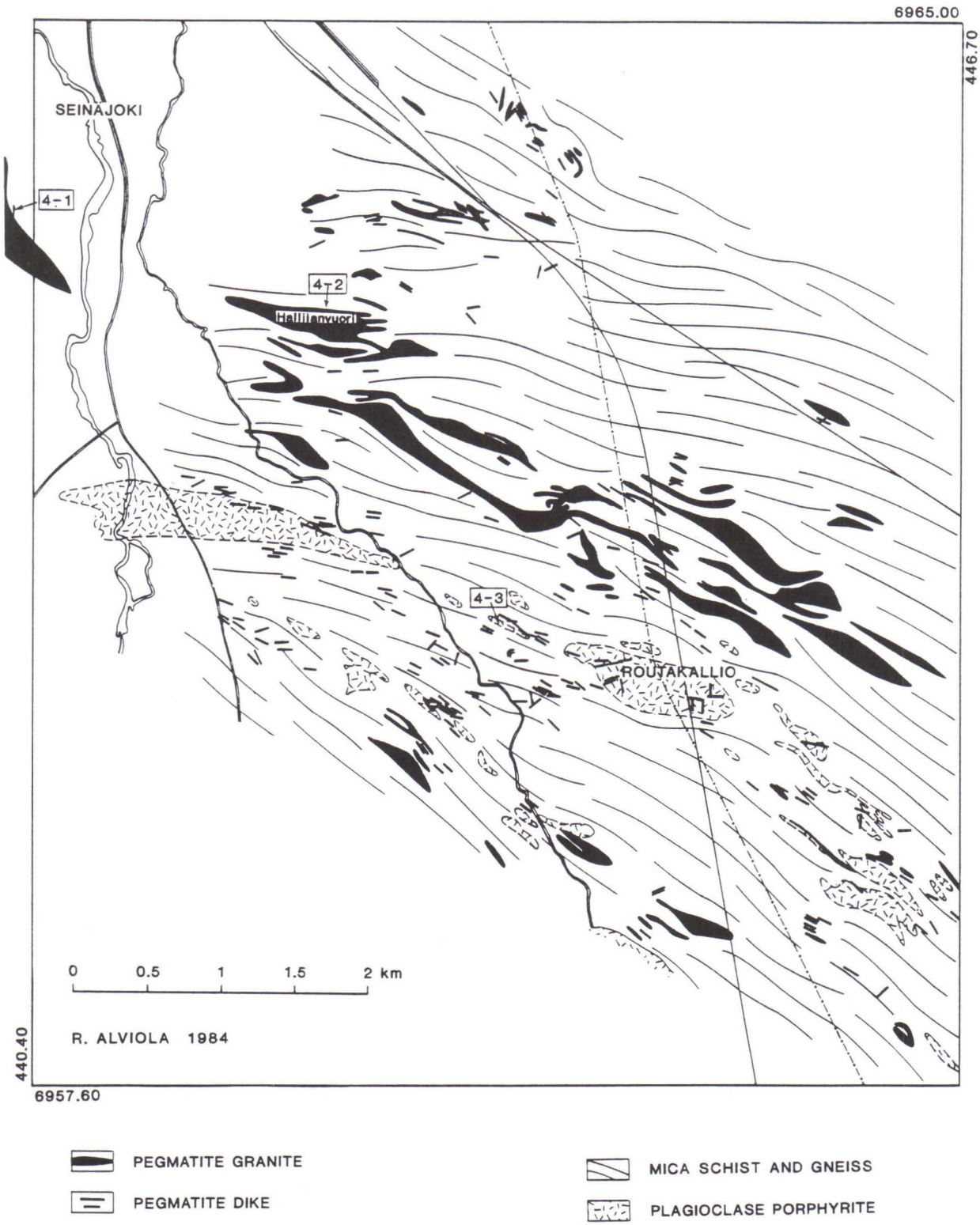


Fig. 2. Geological map of the Seinäjoki Pajuluoma pegmatite area.

Most of the pegmatites are rather fine-grained, small dykes. Many of them, especially those with RE minerals, are intensely albitized. Some of the RE-pegmatites are tourmaline-bearing and some are rich in tourmaline, but there is no tourmaline at all in the largest RE-pegmatite with the highest cassiterite content.

The largest of the Sn pegmatites is called the Perälä dyke after Mr. Perälä, who found it. About 130 m long and 10 m wide on average, the pegmatite lies at the contact of andalusite-mica schist and meta-volcanite, intercalated with plagioclase - porphyrite sills. It has been dismembered into several lens-like bodies dipping 60 SE and plunging 30 NW. The pegmatite is almost concordant with the strike, but cuts the dip of the foliation of the country rocks.

Perhaps the most prominent feature of the Perälä dyke is its intense deformation, amounting almost to foliation. Primary zoning is poorly preserved. Small patches of quartz are surrounded by coarser-grained K-feldspar and muscovite. Bodies of quartz-muscovite rock are seen here and there. Other parts of the pegmatite are rich in albite and contain cassiterite.

Some twenty minerals have been identified from the Perälä dyke:

- K-feldspar, albite, quartz, muscovite
- apatite, garnet, graphite,
- cassiterite, columbite, beryl, tapiolite, triphyllite, ferri-sicklerite, heterosite, zircon, uraninite, chlorite, montmorillonite, cookeite, sphalerite, pyrite, hertzenbergite, calcite.

On the basis of surface sampling, the pegmatite averages 0.3 % Sn. From the data on 28 holes (2700 m) drilled in 10 profiles it has been calculated that the Perälä dyke contains about 100 000 t of pegmatite with 0,3 % Sn. The Nb content is about 0.1 % and the Ta content lower.

4-4. Quartz monzonite, Varpahaiskylä, Ilmajoki (2222, x = 69499, y = 24258).

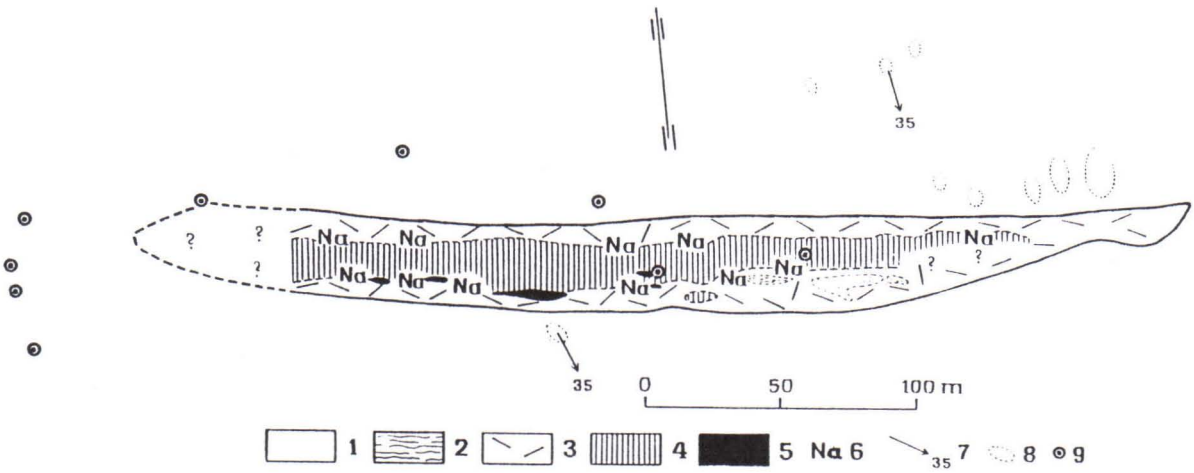
The Ilmajoki quartz monzonite stock is situated about 20 km SW of Seinäjoki at the margin of the Central Finland Granitoid Complex. The intrusion of the quartz monzonite magma has caused high grade contact metamorphism (minimum temperature about 620°C and pressure 5.7 kb) and the surrounding schists are garned-cordierite-sillimanite gneisses and hypersthene gneisses. Small pegmatitic

veins and segregations are common in gneisses. Towards Seinäjoki, the grade of metamorphism decreases. Quartz monzonite brecciates the surrounding synorogenic tonalites and granites. Pegmatitic dykes have not been observed within the intrusion.

The fresh surface of quartz monzonite is greenish grey. Intense preglacial weathering is, howewer, often associated with the rock and it is covered by a saprolitic layer. The main minerals of the quartz monzonite are K-feldspar, andesine, quartz, ortho- and/or clinopyroxene, biotite, hornblende and fayalite (fa > 95 %) in the darker varieties. The rock is porphyritic and the phenocrysts are composed off crypto- or microperthitic orthoclase. Orthopyroxene is rich in iron (fs 70-90 %), clinopyroxene is ferroaugitic and hornblende ferrrohastingsitic in composition.

4-5. The Haapaluoma feldspar quarry, Peräseinäjoki (2222, x = 69417, y = 24612).

The first hints of feldspar came to light in the course of forest ditch digging (Haapala 1966) and the pegmatite was located soon thereafter in 1955. The pegmatite consists of two parallel zigzag dykes. The dykes dip 50-60 N and cut the lineation of the granodioritic country rock (Fig. 3).



The zoned structure of the Haapaluoma pegmatite. The eastern dike. 1. Granodiorite; 2. Mica gneiss (inclusions); 3. Wall zone; 4. Intermediate zone; 5. Core; 6. Na- (and Li-) stage replacement bodies; 7. Lineation; 8. Outcrop; 9. Bore hole.

Fig. 3. The structure of the Haapaluoma pegmatite. (Haapala 1966).

The main dyke is about 1/2 km long and 10 - 30 m wide, the other dyke is much smaller. Both dykes are within granodioritic country rock but near the contact of a schist zone.

Haapala (1966) has roughly delineated the primary zones of the pegmatite. The bulk of the dyke is composed of gigantic K-feldspar crystals, some of which are several metres long. The K-feldspar crystals grew with their longitudinal axis perpendicular to the walls of the dyke. Quartz, black tourmaline and some large beryl crystals occur in the zone. Greyish quartz lenses, 1 - 15 m long, are met with generally at the boundaries between the wall zone and intermediate zone.

Albite-rich replacement bodies also follow the boundary between the wall zone and the intermediate zone. Their main minerals are albite, quartz and black tourmaline. The accessory minerals identified are beryl, columbite, cassiterite, muscovite, spodumene, apatite, Mn garnet, elbaite, lepidolite, monazite, xenotime and brockite. The albite-rich replacement bodies are usually rather irregular in shape and vary considerably in size. There are also thin Na-stage fracture fillings with the same mineral composition as the replacement bodies.

Sometimes the Na-stage replacement bodies grade into Li-stage fracture replacement bodies, that are richer in spodumene, lepidolite and elbaite. The Li-stage fracture fillings cut the Na-stage bodies. Bluish sugar albite is met with in fracture fillings and bluish cleavelandite in replacement bodies of the Li stage.

The minerals identified from Haapaluoma pegmatite are listed in Table 1, page 20-22.

Feldspar production in Haapaluoma started in 1961. Some 250 000 t of K-feldspar have been produced from the main dyke and Baby Haapaluoma.

REFERENCES

Haapala. Ilmari, 1966. On the granitic pegmatites in the Peräseinäjoki - Alavus area, South Pohjanmaa, Finland. Bull. Comm. geol. Finlande 224, 98 p.

Saksela, M. 1935. Uber den geologischen Bau Sud-Ost bothniens. Bull. Comm. geol. Finlande 110, 35 s.

Tyrväinen, Aimo, 1984. Explanation to the maps of pre-Quaternary rocks, sheets 2223 and 2224. Alavuden ja Kuortaneen kartta-alueiden kallioperä. Kallioperä-karttojen selitykset, lehdet 2223 ja 2224, 36 p.

THE GRANITIC ROCKS AND STONE INDUSTRY OF THE KURU AREA

Seppo I. Lahti

The Kuru area, an important area for the stone industry in Finland, is located at the southern margin of the Central Finland Granitoid Complex. The bedrock of the area is composed of a set of synorogenic plutonic rocks, with large irregular diorite-gabbro intrusions being surrounded by various granitoids. Preliminary radiometric age determinations (oral communication by Dr. Olavi Kouvo) indicate that the grey even-grained granite of the area is somewhat younger than the common synkinematic granitoids of Central Finland with an age of 1.88 Ga. Beautiful orbicular rock monzodioritic in total composition occurs at one locality (Simonen 1966).

Field studies indicate that the mafic plutonic rocks form the oldest plutonic rock group in the area and that the granitoids are younger. Closely associated with the mafic plutonic rocks are quartz-diorites (tonalites) and granodiorites. Both the dioritic-gabbroic and the granodioritic-quartz dioritic rocks are medium-grained and homogeneous. The charasteristic mafic minerals are hornblende and biotite, but some varieties also contain hypersthene (Matisto 1961).

Two main granite types occur in the area: a) a grey medium-grained variety and b) a red coarse-grained variety. The contact between these two types is either gradual or quite sharp. Some field observations indicate that the red granite is younger than the grey granite. The grey variety has some subtypes that differ in colour, but not in composition or mineralogy (Aurola 1967).

Locally the granitoids are slightly foliated with the main trend being east-west. In the inner parts of the intrusions the foliation forms ringed structures indicating diapiric uplifting of granite bodies during their emplacement. The geochemical properties of the rocks indicate an I-type character. The grey granite has radioactive minerals (thorianite) as accessories and therefore the rock can be clearly recognized on low-altitude radioactivity maps.

The rocks of the Kuru area have been quarried since the 1850s mainly for building stone and other purposes. Nowadays there are several granite quarries in operation and various kinds of stone industry are carried on in the area. Sheeting is well developed in the granites and the rock breaks easily into large blocks. The grey granite is very hard, and its exceptional physical properties make it useful for special applications, e.g. for the press rolls of paper machines.

EXCURSION STOPS

5-1. A granite quarry at Niemikylä (212409, x = 685910, y = 248880).

A typical grey granite of the Kuru area. Sheeting is well-developed in the rock.

5-2. An orbicular rock at Pengonpohja (212409, x = 685302, y = 248011).

The orbicular rock occurs as a lenticular body in the contact between granite and tonalite. The only known outcrop measures about 20x30 m in size. Chemical analyses show that the rock is monzodiorite in total composition. Radiometric U-Pb dating on zircons indicates an age of 1.883 Ga. The Pengonpohja occurrence is the only orbicular rock in Finland that has been quarried for commercial purposes.

The orbicules in the rock are rather large, often 5-15 cm in diameter. The core of the orbicules consists of K-feldspar, plagioclase and quartz with sporadic hornblende. The light grey core passes gradually outwards into a very dark grey shell of plagioclase. The outer shell, when present, is composed of pink K-feldspar, sometimes in a radial arrangement. The matrix between the orbicules is usually granodioritic, but it may pass gradually to quartzdioritic or granitic.

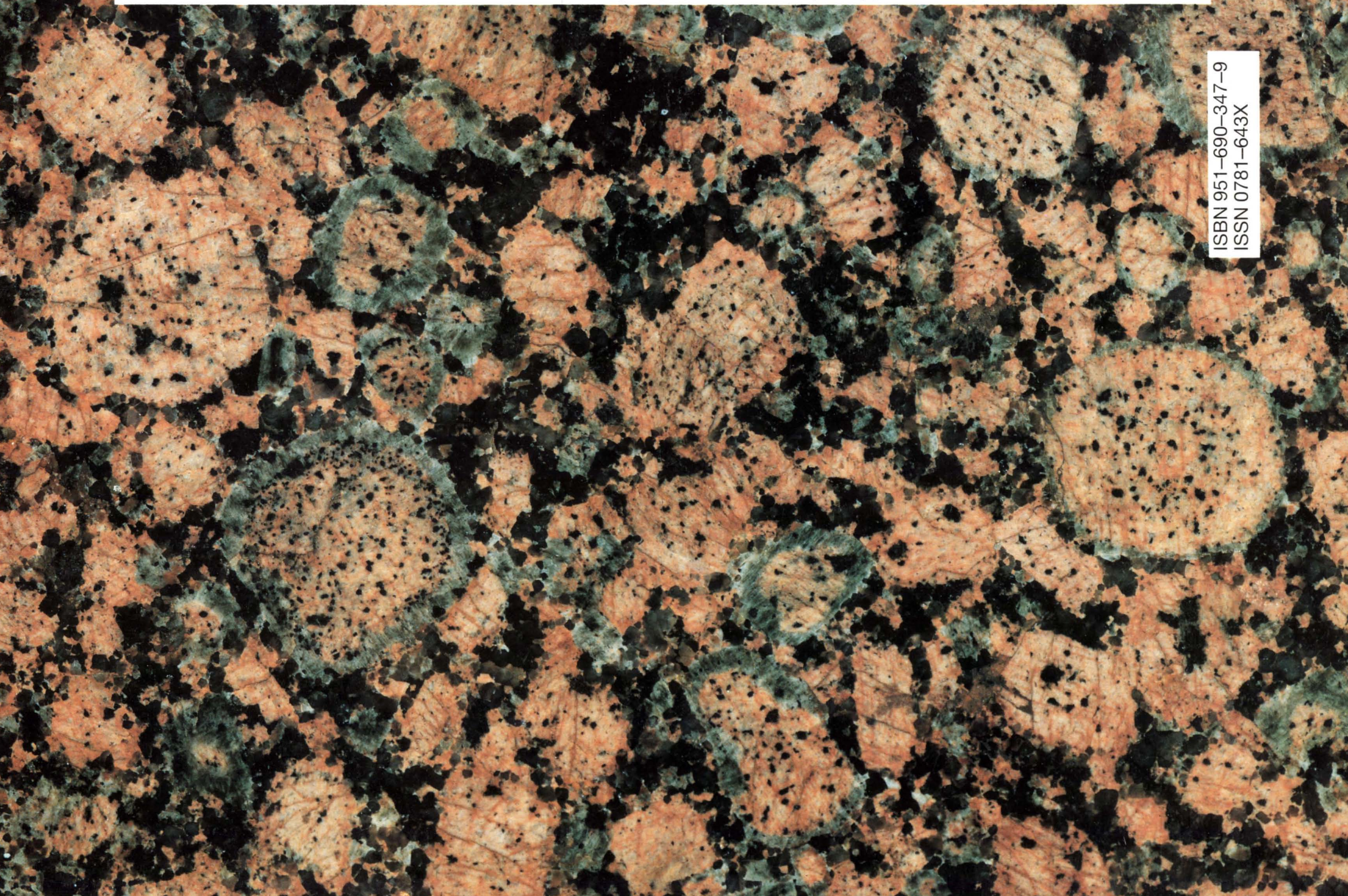
REFERENCES

Matisto, Arvo, 1961. Kallioperäkartan selitys. Lehti - sheet 2213, Kuru. English summary: Explanation to the map of rocks. Suomen geologinen kartta 1 : 100 000.

Aurola, Erkki, 1967. Kurun alueen rakennuskivet. Enlish summary: Building stones of Kuru. Geoteknillisiä julkaisuja no. 71. 64 p.

Simonen, Ahti, 1966. Orbicular rock in Kuru, Finland. Bull. Comm. geol. Finlande 38, 93-107.

GEOLOGICAL SURVEY OF FINLAND, Opas – Guide 26, Seppo I. Lahti (Editor)



ISBN 951–690–347–9
ISSN 0781–643X