GEOLOGINEN TUTKIMUSLAITOS

BULLETIN
DE LA
COMMISSION GÉOLOGIQUE
DE FINLANDE
N:o 191

PRE-QUATERNARY ROCKS IN FINLAND

BY
AHTI SIMONEN

WITH 26 FIGURES IN TEXT, ONE TABLE AND ONE MAP

HELSINKI 1960

GEOLOGINEN TUTKIMUSLAITOS
BULLETIN DE LA COMMISSION GÉOLOGIQUE DE FINLANDE N:o 191

PRE-QUATERNARY ROCKS IN FINLAND

BY

AHTI SIMONEN

WITH 26 FIGURES IN TEXT, ONE TABLE AND ONE MAP

HELSINKI
1960
GOVERNMENT PRESS

Helsinki 1960. Valtioneuvoston kirjapaino

CONTENTS

INTRODUCTION

The rock crust of Finland belongs to the Fennoscandian Shield, whose pre-Cambrian age is controlled by the geological fact that it underlies unmetamorphic Cambrian sediments in its southeastern boundary. The bedrock of Finland represents a deeply denuded section of the pre-Cambrian mobile belts characterized by an abundance of metamorphic and plutonic rocks.

This paper attempts to give a short explanation to the general map of pre-Quaternary rocks in Finland compiled by the present author. The new map is based mainly on the petrographic and lithologic characteristics of rocks, and the pre-Quaternary rocks have been grouped as follows:

— pre-Cambrian metamorphic rocks,
— pre-Cambrian orogenic plutonic rocks,
— unmetamorphic sedimentary rocks,
— anorogenic igneous rocks,
— Paleozoic schists (Caledonian).

The stratigraphic classification used in the earlier maps, compiled by Sederholm (1897, 1911, and 1930), has not been followed in the preparation of the new map. This is due to the fact that our present knowledge of the stratigraphy of the Finnish pre-Cambrian rock crust is not so high as was believed some decades ago. The last views of Sederholm's stratigraphic classification, presented in 1932 in the explanation to the geological map of Fennoscandia, have been critizized and re-interpreted by later investigators and at the present stage of study it is necessary to revise many earlier stratigraphic conclusions. New, important stratigraphic studies of some key areas and radioactive age determinations have given many new suggestions regarding the stratigraphic problems under lively discussion, but it is difficult to apply these new preliminary results to the whole Finnish rock crust. However, some essential points of the pre-Cambrian stratigraphy will be presented (Table I) and for further information the reader is referred to the paper of the present author (Simonen, 1960 a) dealing with the pre-Cambrian stratigraphy of Finland.

Table I. Stratigraphic classification of the pre-Cambrian rocks in Finland

			Age
Cambrian quartz sandstone			500 m.y.
post-Jotnian diabase			diagenesis
unmetamorphic Jotnian sediments in Satakunta and Muhos			1 300 m.y.
anorogenic granites (rapakivi)			1 620 m.y.
orogenic plutonic rocks { late-kinematic (migmatites, granitization) synkinematic (regional metamorphism)			1 750—1 850 m.y.
metamorphic rocks:			
Svecofennidic belt	Karelidic belt		
	Eastern Finland	Northern Finland	
Upper Svecofennian: argillaceous sediments		Kumpu formation: arkoses and conglomerates	
Middle Svecofennian: basic volcanics and intercalated sedimentary rocks	Kalevian: argillaceous sediments	Lapponian: argillaceous sediments basic volcanics quartz sandstones	
Lower Svecofennian: graywacke-slates and quartz-feldspar rocks	Jatulian: marine Jatulian; argillaceous sediments and dolomites Kainuan quartz sandstones Sariolian arkoses and conglomerates		
		Belomorides: orthogneisses paragneisses Tuntsa—Savukoski formation	1 900—2 000 m.y.
Basement unknown	Pre-Karelian basement; orthogneisses and paragneisses		2 600 m.y.

PRE-CAMBRIAN METAMORPHIC ROCKS

The pre-Cambrian metamorphic rock complexes of Finland can be divided into three main units (Fig. 1):

- — granite gneiss and granulite complex in eastern and northern Finland;
- — Svecofennidic schist belt in western and southern Finland characterized by an abundance of mica gneisses;
- — Karelidic schist belt in eastern and northern Finland characterized by an abundance of true quartzites.

The granite gneiss complex represents so far as known the oldest pre-Cambrian in Finland. It forms an old basement for deposition of Karelian sediments and it has acted as a resistance area during the Karelidic folding. This oldest structural element in the Finnish rock crust is called the pre-Karelian basement. The age of the basement in eastern Finland is about 2 500 million years (Kouvo, 1958).

The Svecofennidic schist belt includes both the Svionian and Bothnian formations of Sederholm (1932), and the Karelidic belt includes the Jatulian, Kalevian, Ladogian and Lapponian formations of Sederholm (1932). It was supposed that the Svecofennidic and Karelidic belts belonged to two independent orogenic cycles. Furthermore, it was commonly believed that the highly metamorphic Svecofennidic belt was considerably older than the Karelidic belt. The mutual relationship of the Svecofennidic and Karelidic ranges appears today, however, in a new light now that knowledge of pre-Cambrian sedimentation and tectonics has increased and that the age difference between the two supposed orogenies has not been established by radioactive age determinations.

No valid evidence for a marked unconformity between the Svecofennidic and Karelidic belts has been found in Finland. The grade of metamorphism of the Karelidic schists in eastern Finland increases westward so that the Karelidic phyllites pass gradually without unconformity into migmatitic mica gneisses of the Svecofennidic type. It is possible that the Karelidic and Svecofennidic belts belong to the same orogenic cycle and represent

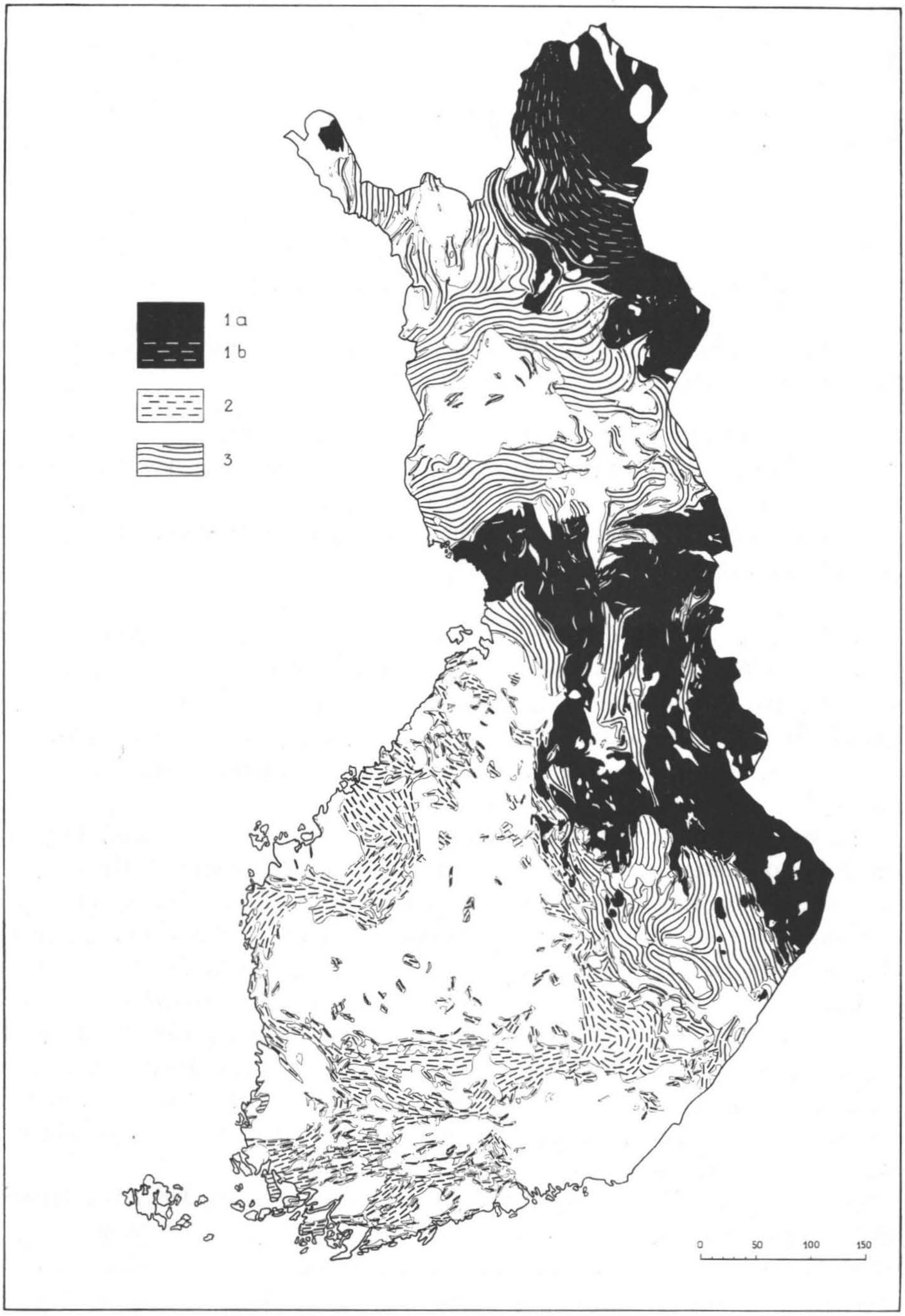

Fig. 1. Main units of the pre-Cambrian metamorphites in Finland. 1 a, pre-Karelian granite gneiss basement; 1 b, granulite arch; 2, Svecofennidic schist belt; 3, Karelidic schist belt.

different stages and different sediment associations of the same cycle of sedimentation (cf. Mikkola, 1953; Metzger, 1959; Simonen, 1960 a). The Karelidic schist belt, with an abundance of true quartzites, represents an evolutionary phase upon a peneplane, consisting of the pre-Karelian granite gneiss basement, and the Svecofennidic schist belt represents thick accumulations of graywackes in geosynclinal troughs.

Radioactive age determinations (Kouvo, 1958; Gerling and Polkanov, 1958) show that the age of the synkinematic plutonism and associated metamorphism in the Svecofennidic and Karelidic belt is of the same age within the limits 1 750—1 850 million years. This supports the conception that the Svecofennidic and Karelidic belts belong to the same Svecofenno-Karelidic orogenic range.

GRANITE GNEISS AND GRANULITE

Silicic granite gneisses occupy large coherent areas in eastern and northern Finland. Furthermore, the granite gneisses occur also in the Karelidic schist belt as domes mantled by Karelidic schists (cf. Fig 1). These gneisses form an ancient basement, the so-called Jatulian continent (Väyrynen, 1954), which acted as a floor for Karelian sediments. Field evidence shows that the basement gneiss is separated from the Karelidic schists by a first-order unconformity, an interval of deep erosion and peneplanation (Eskola, 1949; Väyrynen, 1954; Preston, 1954; Matisto, 1958).

Granite gneiss in eastern Finland. The basement gneiss complex in eastern Finland contains paragneisses penetrated by orthogneisses. The paragneisses consist of amphibolites, mica gneisses, and quartz-feldspar gneisses. They originated from a bedded rock series and Preston (1954) has stated that the grains of zircon in acid paragneisses show rounding and low elongation characteristic of well-worked sedimentary grains. The relics of the supracrustal formations, belonging to the granite gneiss complex of eastern Finland, have been named by Väyrynen (1933) as the Ipatti formation. The orthogneisses of the basement complex are mainly gneissose quartz diorites and granodiorites with a cataclastic texture (Fig. 2). Striped gneisses and migmatites are common.

Some parts of the ancient basement have undergone rejuvenation and remobilization under Karelidic movements. Remobilization of mantled gneiss domes in the Karelidic belt has been pointed out by Eskola (1949) and, according to Härme (1949), the highly migmatic granite gneiss area in northern East Bothnia must have been, at least partly, re-fused. Massive, acid plutonic rocks, occurring in the area of basement gneisses in eastern Finland, belong partly to the pre-Karelian rock crust, because boulders of

Fig. 2. Orthogneiss of the pre-Karelian basement. Pielisjärvi. $^1/_1$ nat. size. Photo: Wilkman.

massive granite have been found in the Karelian basal conglomerates, and partly to the Karelidic plutonic rocks penetrating the pre-Karelian basement.

The old age of the pre-Karelian basement in eastern Finland has been verified also by radioactive age determinations. Kouvo (1958) has given the Pb^{207}—Pb^{206} age of 2 530 m.y. for zircon in the Sotkuma gneiss belonging to the pre-Karelian basement, and the most probable age for the pre-Karelian gneiss at Koli is 2 650 m.y. (an oral communication by Dr. O. Kouvo).

Granite gneiss in northern Finland. The granite gneiss complex in Finnish Lapland also contains both para- and orthogneisses. The paragneisses are characterized by an abundance of highly aluminous mica schists, and mica gneisses containing garnet, staurolite, kyanite, and cordierite (Tuntsa—Savukoski formation of Mikkola, 1941). Furthermore, acid quartz-feldspar gneisses with thin beds of amphibolites are common, especially in the most northern area of the gneisses (Fig. 3).

The orthogneisses are gneissose granodiorites with a cataclastic texture and they penetrate the paragneisses of the area. Massive, acid plutonic rocks, penetrating the gneisses, have been considered by Mikkola (1941) as granites belonging to the Karelidic orogeny, because they also penetrate the Karelidic schists.

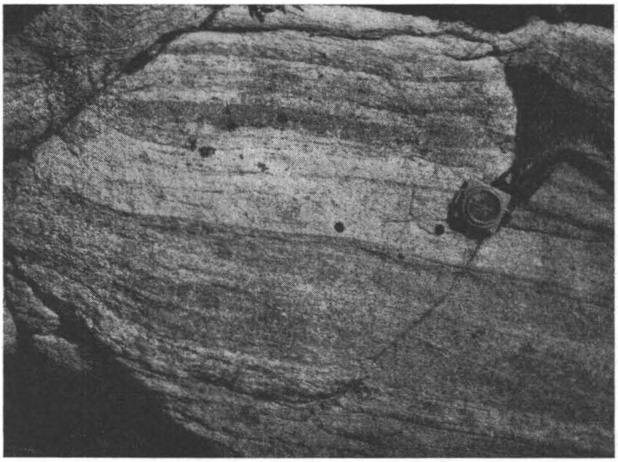

Fig. 3. Banded quartz-feldspar gneiss. Tervavuono, Inari. Photo: Meriläinen.

Considerable parts of the gneiss complex in Finnish Lapland seem to belong to the Belomorides of the Kola peninsula and East Karelia, which are younger (1 900—2 000 million years according to Gerling and Polkanov, 1958) than the basement in eastern Finland. Mention should be made that the Rb^{87}—Sr^{87} age for a quartz dioritic orthogneiss in Inari is 1 900 m.y. (an oral communication by Dr. O. Kouvo).

Granulite. A special part of the gneiss complex of Finnish Lapland is the so-called granulite formation, which had been metamorphosed under higher PT-conditions than the surrounding rock crust. Eskola (1952a) has shown that the granulite formation contains rocks of different origins. Widely distributed acid garnet-bearing quartz-feldspar gneisses (Fig. 4), and sillimanite-, cordierite- and biotite-bearing gneisses have been considered as paragneisses whose primary chemical composition varied from arenaceous to argillaceous. Indistinct banding of different layers and the presence of quartzite and graphite-bearing bands suggest a sedimentary origin. Orthogneisses of the granulite complex are represented by hypersthene gneisses, norites and charnockitic quartz diorites.

The gneisses of the granulite formation pass gradually into the gneisses of the granite gneiss complex, and therefore the granulite may be considered as a product of high metamorphism of the granite gneiss complex. This view has been presented already by Kranck (1936), and is supported by new field work by Meriläinen (1959). Granite gneiss and granulite in Finnish Lapland form a tectonic unit characterized by a wide synclinorium. This

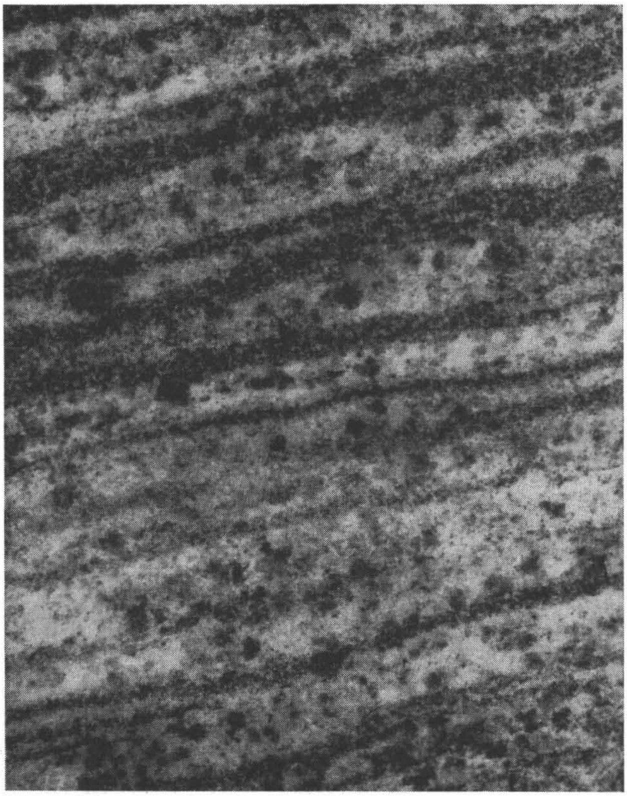

Fig. 4. Garnet-bearing acid granulite with banded structure. Inari. $^1/_1$ nat. size. Photo: Halme.

gneiss complex had been tectonically active during the Karelidic orogeny, judging by the fact that the granulite formation has been overthrusted towards the southwest, making the Karelidic schists follow the tectonics of the granulite arch (cf. Eskola, 1941).

SVECOFENNIDIC BELT

The Svecofennidic schist belt (cf. Fig. 1) trends from East Bothnia into southern Finland, forming a large bend like an interrogation mark. In southeastern Finland the Svecofennidic zone turns to the north and comes into contact with the Karelidic range of eastern Finland. The drawing of a sharp demarcation line between the Svecofennidic and Karelidic belts in this boundary zone is difficult, because no evidence for a marked unconformity has been found.

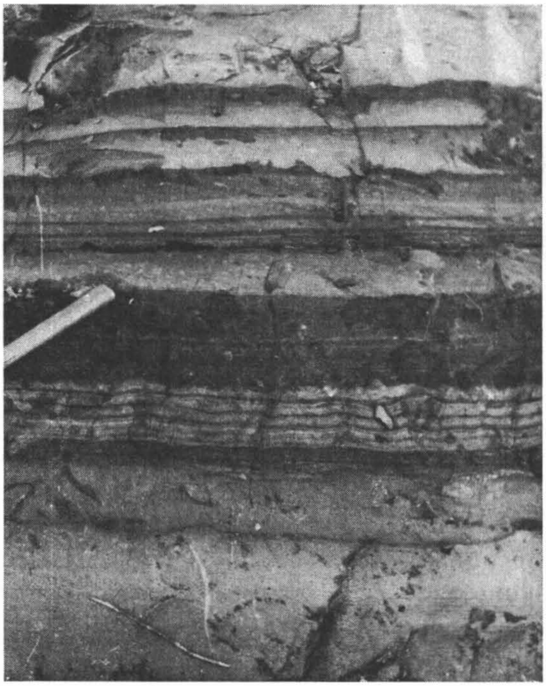

Fig. 5. Graded bedding in graywacke-slate. Ajonokka, the Tampere area. Photo: Pääkkönen.

The general strike of the Svecofennides in Finland is quite variable owing to the bending of the schist zone. Dips of the schistosity and bedding are generally parallel and are vertical or steep. Some areas are characterized by a gently dipping schistosity and bedding. The Svecofennidic schists are strongly folded. The fold axes of the main folding are subhorizontal, while the axial planes are vertical or steep and usually parallel to the bedding planes. Vertical or slightly overturned isoclinal folds are predominant.

The Svecofennidic schists have been primarily argillaceous and arenaceous sediments metamorphosed into phyllites, mica schists, mica gneisses and quartz-feldspar schists. Volcanics, mainly basic lavas and tuffs, metamorphosed into amphibolites are abundantly present in some parts of the Svecofennidic zone.

The widely distributed Svecofennian argillaceous sediments are represented by three different types of micaceous schists, phyllites, mica schists, and mica gneisses.

The phyllites occur only in the best-preserved parts of the Svecofennidic zone. They show graded bedding (Fig. 5) and their petrographic charac-

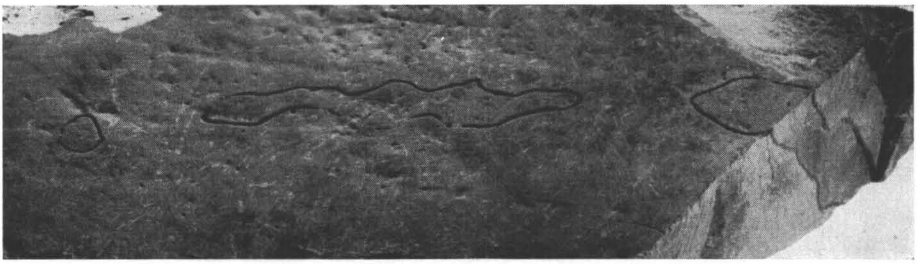

Fig. 6. Corycium in graywacke slate. Tähtinen, Aitolahti. $^1/_3$ nat. size. Photo: Halme.

teristics are similar to the graywacke-slates in geosynclinal deposits of younger age (Simonen and Kouvo, 1951).

The phyllites show an intimate association of the arenaceous and argillaceous materials. The sorting of deposited material has not been complete, and the presence of a remarkable amount of fresh feldspar shows that the chemical weathering of material has been incomplete. It should be mentioned that Sederholm found in the phyllite of the Tampere area cell-shaped, carbonaceous sacs, which he interpreted as Archean fossils and named *Corycium enigmaticum* (Fig. 6).

Fig. 7. Mica schist with andalusite porphyroblasts. Jumesniemi, Hämeenkyrö. $^1/_1$ nat. size. Photo: Halme.

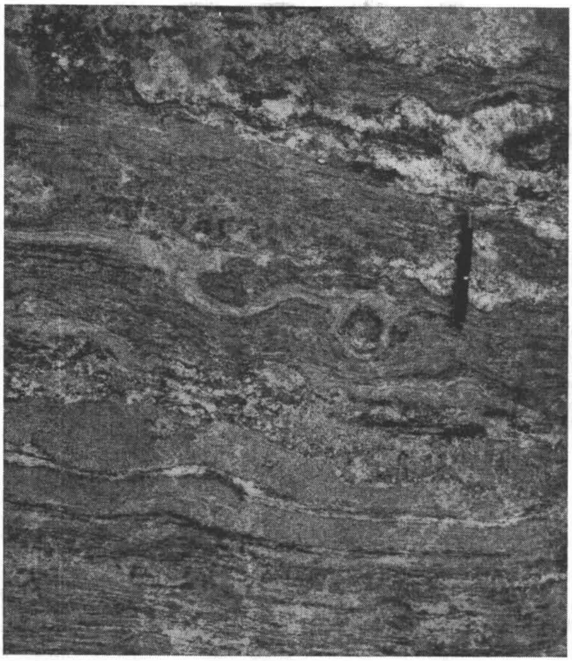

Fig. 8. Migmatitic coarse-grained garnet-cordierite gneiss (kinzigite). Launonen. Photo: Härme.

Rankama (1948) proved, by means of the C^{12}/C^{13} ratios, the organic origin of the *Corycium* carbon. This is the most valid evidence of ancient life during the sedimentation of Svecofennian strata.

The phyllites pass gradually, without a change in chemical composition, into mica schists usually containing porphyroblasts of cordierite and andalusite (Fig. 7). The sporadically observed relic structure of graded bedding in the mica schists shows that the conditions of their deposition were similar to those prevailing during the sedimentation of the phyllites.

Strongly recrystallized mica gneisses, especially coarse-grained garnet- and cordierite-gneisses (kinzigites), are widely distributed in the Svecofennidic schist belt (Fig. 8). They show indistinct banding of arenaceous and argillaceous layers, owing to the primary variations in the sedimentary strata. Furthermore, calcareous concretions and graphite-bearing bands suggest a sedimentary origin (cf. Hietanen, 1943; Parras, 1958). The gradual transition from the mica schists into mica gneisses shows that the mica gneisses represent only a highly metamorphic variety of the Svecofennidic micaceous schists.

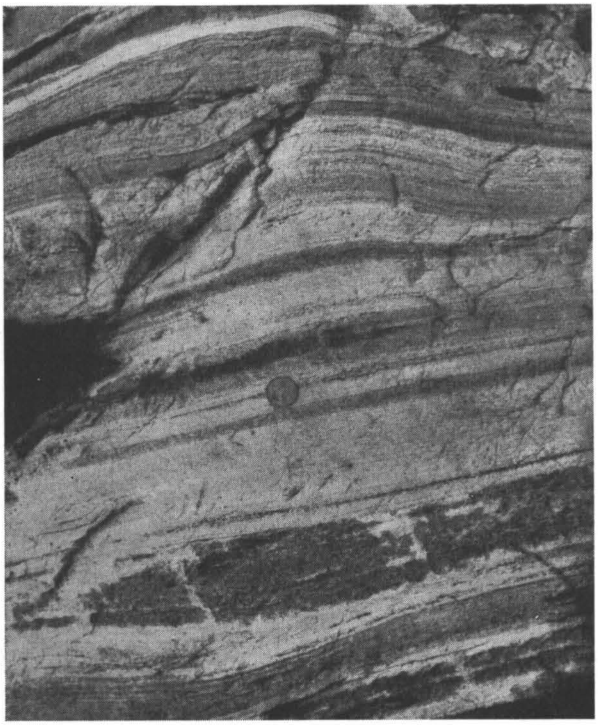

Fig. 9. Stratified quartz-feldspar schist (leptite), Konala, Helsinki. $^1/_5$ nat. size. Photo: Härme.

The chemical composition of the Svecofennidic phyllites, mica schists and mica gneisses varies within the same limits, ranging from that of a shale to that of a sand, but the greatest part of the chemical compositions are intermediate between these extreme limits and show conspicuous similarities to the chemical compositions of the graywackes of orogenic belts. The primary structural and chemical features of the phyllites, mica schists and mica gneisses are similar, suggesting that all these rocks were deposited under similar conditions in the axial portion of the sediments in the Svecofennidic geosyncline. According to this conclusion, the phyllites, mica schists and mica gneisses represent three different metamorphic zones of the geosynclinal graywacke succession.

Quartz-feldspar schists or leptites occur in different parts of the Svecofennidic belt, especially in the Kemiö—Lohja zone. In earlier investigations the leptites were interpreted mainly as acid lavas and pyroclastics, but the purely sedimentary sandstone character of some leptites were pointed out also. New investigations (Tuominen and Mikkola, 1950; Härme, 1960)

Fig. 10. Stratified quartz-feldpar schist with calcareous, diopside-bearing bands. Olkkala, Vihti. Photo: Härme.

have shown, however, that the relative abundance of sedimentary leptites is greater than was supposed earlier. The leptites are usually layered (Fig. 9) and they occur in close association with micaceous sediments and in many cases they contain minute amounts of aluminous silicate minerals (almandine, cordierite, or sillimanite), indicating an excess of alumina. Some silicic leptites contain diopside- and carbonate-bearing bands, indicating the presence of calcareous material (Fig. 10).

Occurrences of calcitic limestone (not marked on the general map) have been met with in the zone of leptites (Härme, 1960). Most of the leptites must be considered as impure arkoses mixed with argillaceous or calcareous material. Some few leptites, however, show chemical as well as textural characteristics of acid rhyolitic lavas and pyroclastics.

Metamorphic basic and intermediate volcanics are characteristic of some parts of the Svecofennidic zone. They are both lava flows and pyroclastics. The volcanic rocks crystallized from the lava flows usually exhibit a blastoporphyritic texture (Fig. 11), but other relic textures, such as fluidal, amygdaloidal, perlite and pillow lava (Fig. 12) texture, likewise indicate a volcanic origin. Pyroclastics are characterized by a banding of

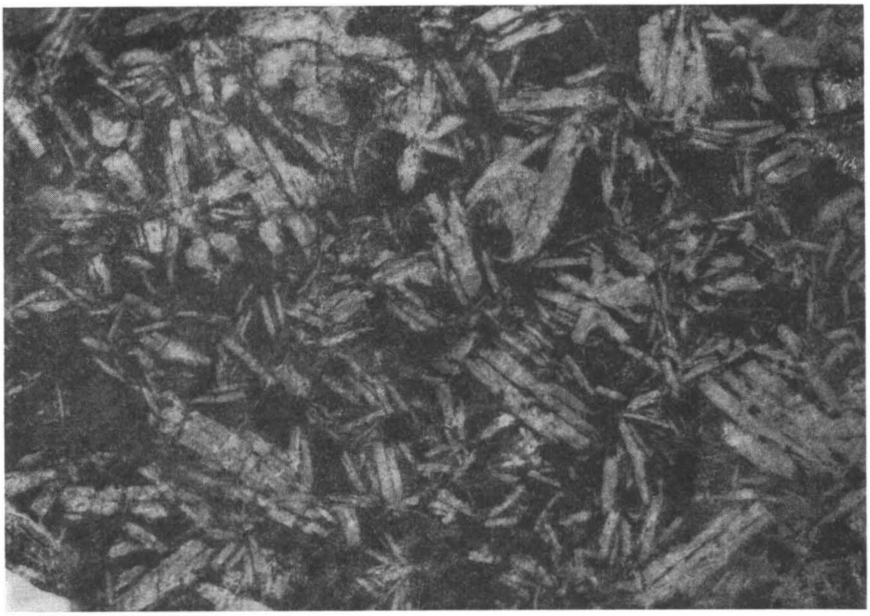

Fig. 11. Plagioclase porphyrite. Ryssholm, Pernaja. $^1/_1$ nat. size. Photo: Halme.

different layers, and beds of agglomerates (Fig. 13) and volcanic conglomerates afford the best evidence of a volcanic origin.

Interpretation of the stratigraphic sequence of the strongly folded Svecofennidic strata has been possible only in some key areas where the relics of sedimentary structures are so well preserved that they allow the sequence of layered rocks to be determined, although the beds have been folded to a vertical position. The most commonly used relic structure for this purpose has been graded bedding, but many other characteristics of sedimentary and volcanic rocks have also been used in the stratigraphic study.

A key area for the explanation of the stratigraphy has been the Tampere schist belt, where the stratigraphic sequence of the strata (Simonen, 1953) is, from the highest to the lowest stratigraphic member, as follows:

	Thickness in metres
basic volcanics	>1 000
conglomerates and associated beds of graywacke-slates and arkoses	700— 800
basic and intermediate volcanics	800—1 500
quartz-feldspar rocks (arkoses, graywackes and pyroclastics)	1 500—2 200
graywacke-slates	>3 000

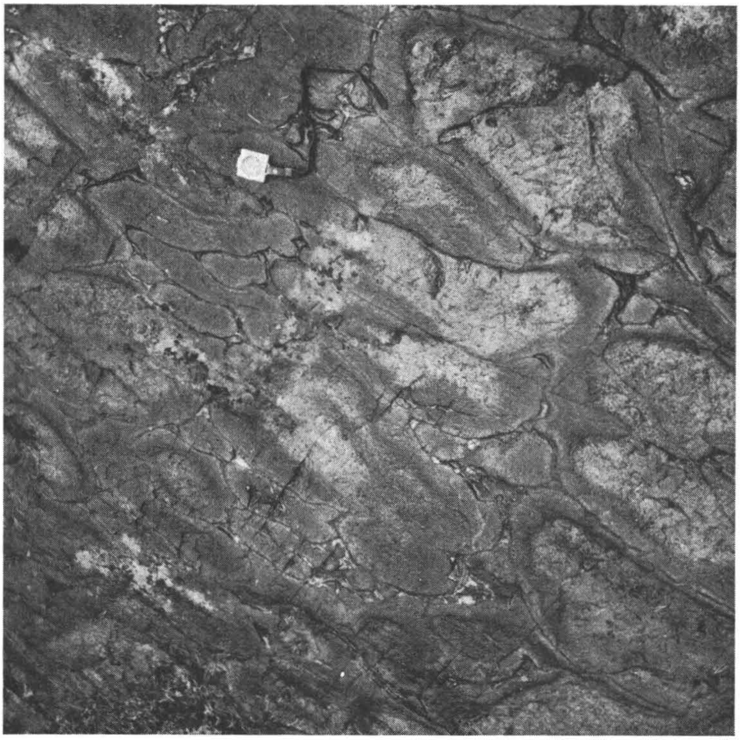

Fig. 12. Metamorphic pillow lava. Hanni, Kannus. Photo: Halme.

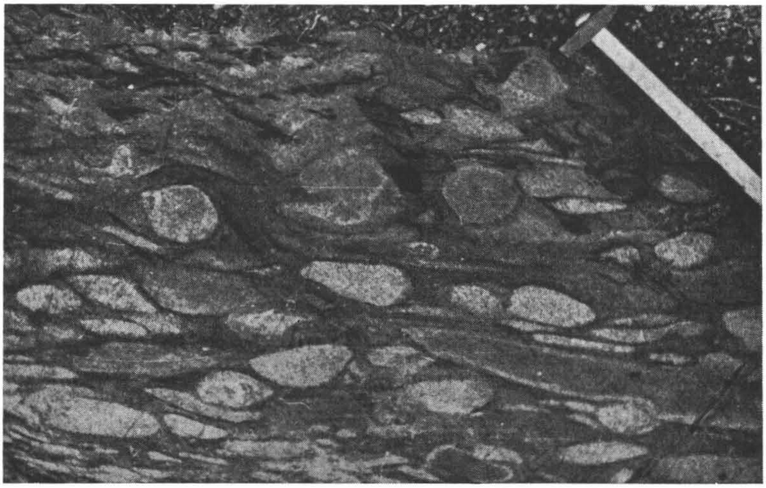

Fig. 13. Metamorphic agglomerate. Ypäjä. Photo: A. Laitakari.

The total thickness of the strata has been at least 8 kilometers. The said sequence shows conspicuous similarities to the graywacke-basalt association of geosynclinal deposits of younger age. No valid evidence of a sedimentation floor or basement for Svecofennian sedimentation has been found.

A stratigraphic succession similar to that of the Tampere area has been found in many parts of the Svecofennidic belt, as has been summarized by Simonen (1953). Recently, new data on Svecofennian stratigraphy presented by many investigators (Härme, 1954, 1960; Neuvonen, 1954; Salli, 1955; Edelman, 1960) have verified the principal ideas on the stratigraphy and sedimentation of the Svecofennian formations. The standard section of the Tampere area is characterized by argillaceous and arenaceous sediments underlying basic volcanics. In some areas, especially in southern Finland, argillaceous sediments have also been found overlying the basic volcanics of the standard section.

In the light of the new stratigraphic studies the Svecofennian strata are divided into Lower, Middle and Upper Svecofennian successions (Simonen, 1960 a). The Lower Svecofennian is represented by graywacke-slates and quartz-feldspar rocks, or leptites, underlying the basic volcanics. The Middle Svecofennian is characterized by basic volcanics with intercalated sedimentary rocks. The Upper Svecofennian is represented by argillaceous sediments overlying the basic volcanics.

Taken as a whole the Svecofennidic metamorphic rocks represent a geosynclinal association (Simonen, 1953). The micaceous schists are products of incomplete weathering and they are similar to the graywackes of orogenic belts. The quartz-feldspar schists or leptites have been interpreted generally as impure arkoses. The abundance of basic volcanics in the graywacke succession is a characteristic feature of geosynclinal deposits and the Svecofennian basic volcanics must be considered as representatives of the initial volcanism in the Svecofennidic geosyncline.

Furthermore, the rarity of true quartzites and limestones is characteristic of the geosynclinal association of the Svecofennides. An intimate association of limestones and calcareous sediments with arenaceous sediments, especially in the leptite belt of southern Finland, indicates, however, conditions prevailing in marginal parts of a geosyncline where the tectonic activity during accumulation had not been so great as in the actively subsiding geosynclinal belt characterized by graywackes.

KARELIDIC BELT

The Karelidic schists trend from southeastern into northern Finland and they form many separate basins (cf. Fig. 1). An alpinotype folding of the Karelidic belt was stressed by Wegmann as early as 1928. The Karelidic

Fig. 14. Ripple marks in the Karelidic quartzite.
Kivalo ridge. $^1/_3$ nat. size. Photo: Halme.

folding in eastern Finland took place against the resistance area of the basement complex and it is characterized by overthrusts along which ophiolitic intrusions have occurred. Väyrynen (1939) distinguished two phases of movements in the Karelidic belt of eastern Finland. The first phase of folding acted from west to east against the pre-Karelian basement and resulted in the formation of gently folded synclinal basins. Later movements were characterized by overthrust nappes pushed from the northwest. A basin-like structure of the Karelidic schist area north of the town of Kemi has been described by Härme (1949). Fold axes in the Karelidic belt are subhorizontal and in eastern Finland well-developed axial culminations and depressions occur in the schist belt trending north-south. The pre-Karelian basement appears in the axial culminations of the Karelidic zone in the districts of Nurmes and Pudasjärvi.

The Karelidic schists were originally true quartz sandstones and argillaceous sediments, metamorphosed into quartzites, phyllites, and mica schists. Metavolcanics, mainly basic lavas and tuffs, have a widespread occurrence in the Karelidic belt of northern Finland. The large occurrence of true quartzites shows that the association of sedimentary rocks in the Karelidic belt is different from that in the Svecofennidic range. Furthermore, carbonate

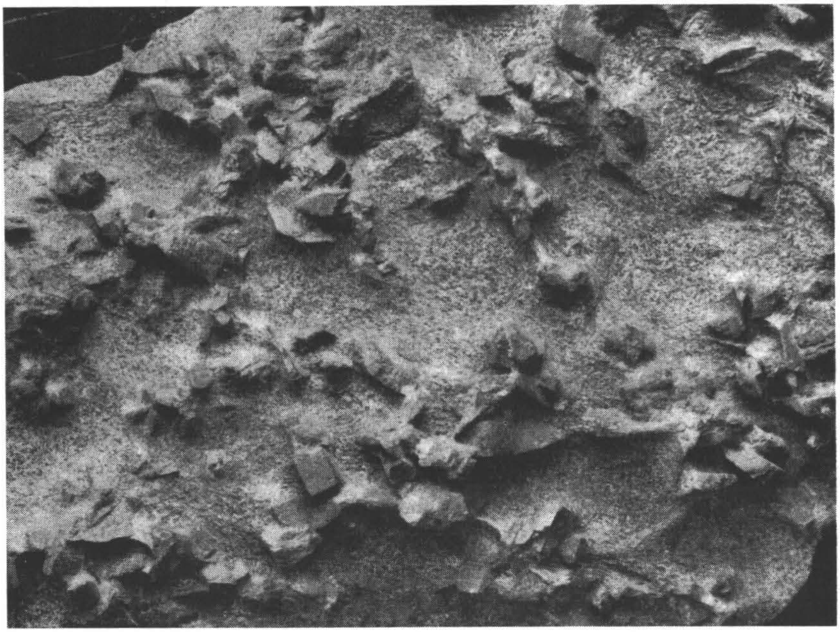

Fig. 15. Staurolite-bearing mica schist. Tohmajärvi. 1/3 nat. size. Photo: Halme.

rocks of the Karelidic belt are mainly dolomitic, whereas those of the Svecofennidic zone are mainly calcitic.

The Karelidic quartzites are almost monomineralic rocks and their grade of metamorphism varies greatly, appearing in glassy, schistose, and clastic varieties. Many well-preserved sedimentary structures, such as ripple marks (Fig. 14), cross bedding, and mud cracks, have been found in low-metamorphic quartzites. Conglomeratic interbeds with well-rounded quartz pebbles are common. Feldspar-bearing, arkosic varieties of the quartzite are rare. Some arkosic varieties of the sandstone have been marked on the general map as quartz-feldspar schists. Sericite is a common accessory mineral and sericite quartzites occur as interbeds in pure quartzites. The cement of the quartzites has been mainly siliceous, but also cements containing calcareous, argillaceous, and bituminous material have been found. The petrographic characteristics and petrology of the quartzites have been described, especially by Hietanen (1938) and Väyrynen (1933, 1939 and 1954).

Phyllites and mica schists of the Karelidic belt are quite similar to those of the Svecofennidic zone. The »flysch» character of the wide phyllite and mica schist area in northern Karelia has been pointed out by Wegmann

Fig. 16. Metamorphic pillow lava. Saarijärvi, Suomussalmi. Photo: Matisto.

(1928). The micaceous schists show graded bedding and stratification. The content of mica varies greatly in different layers and the mica schists contain porphyroblasts of andalusite, cordierite or staurolite (Fig. 15). Feldspar is abundant in portions, poor in mica, indicating that the chemical weathering of material has been incomplete. Carbonaceous, sulphide-bearing black schists, considered as bituminous shales, also occur in the Karelidic belt. Some varieties of carbonaceous schists contain tremolite porphyroblasts, having originally been bituminous marly sediments. Especially in northern Karelia and in western Lapland the Karelidic phyllites and mica schists pass gradually into coarse-grained mica gneisses and veined gneisses.

Metamorphic basic volcanics with a basaltic bulk composition are characteristic of the Karelidic belt in northern Finland. They were originally basalts, tuffs and hypabyssal diabases. The effusive character of metabasalts, metamorphosed into greenstones, appears in porphyritic, amygdaloidal and pillow lava (Fig. 16) textures and structures. Agglomerates are common in pyroclastics. The greenstones are associated with ultrabasic, picritic

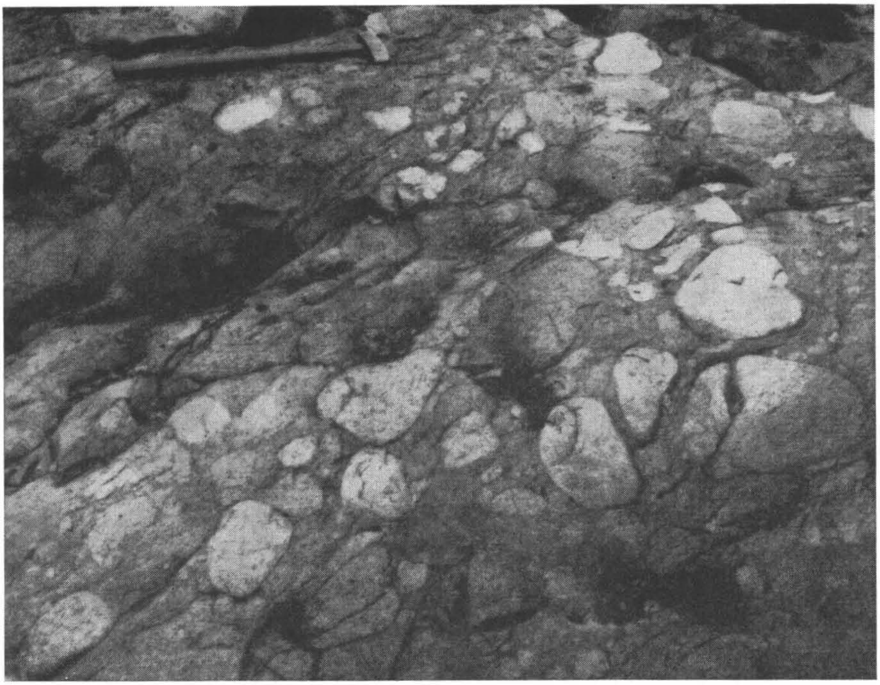

Fig. 17. Basal conglomerate, containing pebbles of granite gneiss. Viesimonjoki, Kiihtelysvaara. Photo: Wilkman.

varieties; and jaspilites, considered as chemical precipitations of volcanic origin, have been found in the greenstones of the Kittilä area. The basic volcanics of the Karelidic belt have been metamorphosed into greenstones, consisting of albite, epidote, and chlorite, but in parts the greenstones pass gradually into amphibolites.

A key area for interpretation of stratigraphy and sedimentation has been the Karelidic belt in eastern Finland, where the Karelidic schists are separated by a marked unconformity from the granite gneiss basement. The initial Karelian sedimentation is represented by basal conglomerates (Fig. 17) and arkosic sandstones lying directly upon the granite gneiss. These sediments have been interpreted as river valley deposits owing to mechanical weathering. This basal formation has been called the Sariolian formation by Eskola (1919), and Väyrynen (1933) has named it the Sariolian facies of the Jatulian formations. The Sariolian deposits do not have a wide extension and occur only sporadically as the basal beds of the Karelian strata.

After the deposition of the Sariolian formations the conditions of sedimentation changed, causing strong chemical weathering. The pure quartzites associated with quartz conglomerates, sericite quartzites, and kaoline deposits rest upon the Sariolian formations or directly upon an ancient peneplain consisting of granite gneiss. This widely distributed quartzite formation has been named by Väyrynen (1933) as the Kainuan facies of the Jatulian formation. The Kainuan formation begins with sericite-bearing quartz conglomerates associated with sericite schists and kaoline deposits. With a decrease in the sericite content, the quartzites pass into pure quartzites of the upper division of the Kainuan formation. The Kainuan quartzite represents a reworked sandstone deposited on a stable platform. The Kainuan quartzite formation is widely distributed in the Karelidic belt and it forms an excellent horizon for use in stratigraphic correlation. The Kainuan quartzites form the lowest member of a transgressive epicontinental succession and, in many places, they underlie dolomites and carbonaceous pelitic schists, which have been called marine Jatulian sediments.

The Jatulian succession of the Karelian strata has been overlain by a thick accumulation of the so-called Kalevian formation, consisting mainly of phyllites and mica schists. According to Väyrynen (1933), the Kalevian phyllites overlie the Jatulian sediments unconformably. Conglomerates containing mainly pebbles of Kainuan quartzite separate the Jatulian formation from the Kalevian phyllites and mica schists. The marked unconformity between the Jatulian and Kalevian successions does not, however, exist in all sections of the Karelian sedimentation area. The Kalevian phyllites are characterized by incomplete chemical weathering and they represent the flysch sediments of the Karelian sedimentation.

The standard section of the Karelian formations in eastern Finland is, according to Väyrynen (1933), as follows:

Kalevian phyllites and mica schists

Jatulian	marine Jatulian; phyllites and dolomites Kainuan quartzite Sariolian arkoses and conglomerates

——— Great unconformity ———

Granite gneiss basement

The supracrustal rocks of northern Karelia do not contain basic volcanics, but evidence of igneous activity during deposition is the presence of uralite diabase sills in the Jatulian formations. The uralite diabases do not penetrate the Kalevian sediments, and therefore it seems plausible that their emplacement indicates a marked change in tectonic activity between a stable platform (Jatulian sedimentation) and a subsiding geosyncline (Kalevian sedimentation).

New important stratigraphic studies in the Karelidic belt have been carried out by Härme (1949) in the Kemi area in northern Finland. The Karelian succession begins with quartzites which underlie greenstones and slates with intercalated dolomites. The quartzites of the Kemi area can be correlated with the Kainuan quartzites of the standard section, the greenstones are probably equivalent to the post-Jatulian uralite diabases in eastern Finland, and the thick accumulation of graded-bedded slates corresponds to the Kalevian type of geosynclinal sedimentation.

The Karelidic schists in Finnish Lapland consist mainly of quartzites, mica schists, and basic volcanics (cf. Mikkola, 1941) and they have usually been named as Lapponian formations. The stratigraphic succession of the Lapponian strata is not known in detail. The Lapponian schists are overlain by coarse-grained, arkosic quartzites and conglomerates, containing pebbles of Lapponian schists. This younger sediment formation is called the Kumpu-Oraniemi formation (Mikkola, 1941), which has been considered as a molasse accumulation of the Karelidic cycle.

Taken as a whole the stratigraphic units of the Karelidic belt represent different stages and types of the Karelidic cycle of sedimentation. The Jatulian transgressive series, characterized by an abundance of true quartzites, is typical of the evolutionary phase upon a stable platform. The Kalevian type of micaceous schists, which are products of incomplete chemical weathering, and associated basic volcanics in northern Finland represent a geosynclinal association. The arkoses and conglomerates of the Kumpu—Oraniemi formation represent the youngest stage of the sedimentation in the Karelidic belt. They are a molasse type of sediments deposited at the end phase of the Karelidic orogenic cycle.

OROGENIC PLUTONIC ROCKS

The oldest plutonic rocks of Finland occur as highly metamorphic orthogneisses in the pre-Karelian basement complex and they have been described earlier (cf. pp. 9—11). An abundance of plutonic rocks, mainly granodiorites and granites, whose emplacement was closely connected with the orogenic movements, is characteristic of the deeply eroded section of the Svecofennidic and Karelidic belts, where the plutonic rocks penetrate the metamorphic schists. General relationships between deformations of schists and intrusions of plutonic rocks were pointed out by Wegmann and Kranck (1931) in the archipelago east of the city of Helsinki and their conclusions have given rise to a magmatectonic classification of the plutonic rocks. Magmatectonic points of view have been discussed by many authors (Wahl, 1936; Saksela, 1936 and 1953; Eskola, 1952 b; Marmo, 1956; Simonen, 1960 b) and the intimate relation that exists between the processes of mountain folding and intrusions of different granite groups has been stressed. In a root zone of the ancient mountain chain there always occur two kinds of silicic plutonic rocks. On the one hand, there are »gneissose granites» with a granodioritic composition which have been intruded at an early stage of the orogenesis and received their present gneissose character during subsequent periods of orogenesis. On the other hand, there are potash-rich granites which are massive with a pegmatitic character and form migmatites. Both these granitoids belong to the period of mountain folding and are thus of orogenic character. These two groups of granitoids are usually named synkinematic and late-kinematic granites.

The synkinematic plutonic rocks are mainly gneissose granodiorites and quartz diorites (Fig. 18) associated with minor bodies of basic differentiates consisting of peridotites, gabbros, and quartz gabbros. They form concordant bodies with surrounding schists. The structures (foliation and lineation) of plutonic bodies coincide very well with those in the wall rock. Gneissose varieties occur especially in the boundary zones of the plutonic bodies.

The late-kinematic plutonic rocks are mainly potash-rich microcline granites without associated basic differentiates. They penetrate the synkinematic plutonic rocks and form migmatites with the schists and synkine-

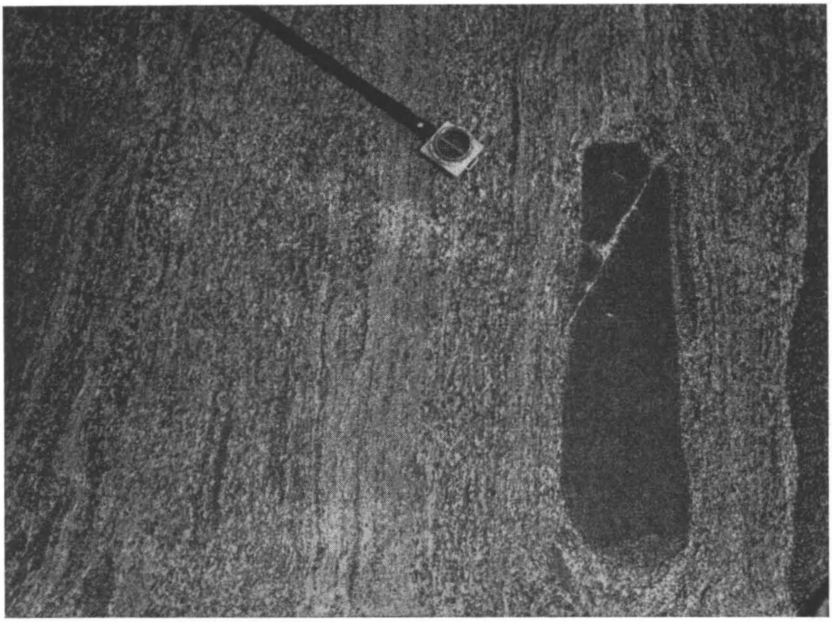

Fig. 18. Gneissose quartz diorite with dark inclusions. Hanko. Photo: Härme.

matic rocks. Furthermore, the process of metasomatic granitization is closely connected with the emplacement of the late-kinematic granites. Many migmatites formed by late-kinematic granites show structures indicating high plasticity (Fig. 19). The migmatitic and granitized masses caused a violent folding in their surroundings owing to a diapiric rise and updoming of the granite masses (cf. Edelman, 1949; Härme, 1954). These movements connected with the emplacement of microcline granite, are late-kinematic in relation to the orogenic movements.

The separation of the synkinematic and late-kinematic types of the orogenic plutonic rocks is relatively easy in coherent schist belts, but a twofold tectonic classification of plutonic rocks may be too categorical; and it is not always possible to carry out everywhere, especially in the wide plutonic rock complex areas outside the schist belts. In wide plutonic areas, where the framework of the schists does not control the shapes of plutonic bodies, there occur many transitional varieties, ranging from gneissose synkinematic types to massive late-kinematic plutonic rocks. As a general rule, however, it must be mentioned that quartz dioritic and granodioritic plutons and associated basic differentiates usually show slightly developed gneissose margins, whereas potash-rich granites are massive.

Fig. 19. Migmatite. Veins of migmatite-forming microcline granite follow the fold structure of banded gneiss. Risholm, Inkoo. Photo: Härme.

Concerning the general map, the orogenic quartz diorites and granodiorites as well as basic plutonic rocks represent synkinematic types, while the orogenic granites are late-kinematic in relation to the orogenic movements of the Svecofennidic or Karelidic belt. The wide areas designated as »acid plutonic rocks in general» mean plutonic rock complexes containing many different types of plutonic rocks, or then these areas contain acid plutonic rocks whose petrographic and tectonic character has not been known in any considerable detail.

Plutonism in the Svecofennidic and Karelidic belts seems to be of the same age, because the radioactive age of the synkinematic plutonism in both belts lies within the limits 1750—1850 million years. (Kouvo, 1958; Gerling and Polkanov, 1958). This result has been proved by many different methods of radioactive age determinations (cf. Kouvo, 1958).

Geological studies have shown that the deformation and metamorphism of the schists took place in close connection with the emplacement of plutonic rocks (cf. Wegmann and Kranck, 1931; Simonen, 1948 b; Edelman, 1949). Thermal conditions favoring regional metamorphism were produced by the emplacement of the plutonic rocks in the root zone of the ancient mountain chain. An abundance of plutonic activity is especially characteristic of the mobile Svecofennidic belt, whereas the plutonic rocks do not comparably penetrate the Karelidic schists overlying the ancient, pre-Karelian stable platform. This explains why the grade of metamorphism of the Svecofennidic belt is higher than that of the Karelidic belt.

PLUTONIC ROCKS OF THE SVECOFENNIDIC BELT

Different petrographic provinces of orogenic plutonic rocks occur in the Svecofennidic belt. The petrographic provinces showing continuous series from basic to acid members, can be classified into granodiorite, trondhjemite, charnockite, and granite provinces, named according to the most acid members. The migmatite-forming microcline granite in southern Finland takes a unique position among the Svecofennidic plutonic rocks, because it is not associated with basic and intermediate plutonic rock types.

The calcic plutonic rocks of the granodiorite, trondhjemite, and charnockite provinces are typical representatives of synkinematic intrusives whose emplacement occurred in the principal Svecofennidic schist belt. The calc-alkalic plutonic rocks of the granite province occur at the rand zones of the coherent Svecofennidic schist belt, or outside of it in Central Finland, and their sharp separation into synkinematic and late-kinematic groups is difficult on account of the many transitional varieties. Planar and linear structures are usual in gabbros, quartz diorites and granodiorites of the granite province; but they are not so well-developed as in the case of the calcic provinces, and the granitic members of the granite province are massive, showing a late-kinematic mode of occurrence. The migmatite-forming microcline granites are late-kinematic plutonic rocks of the Svecofennides and they indicate regional migmatization and granitization in the root zone of the ancient mountain chain.

The mineralogical composition of the Svecofennidic plutonic provinces is presented in Fig. 20. To the separate provinces, excepting the migmatite-forming microcline granites, belong basic, intermediate, and acid plutonic rocks, which form continuous rock series. The most acid end members of the granodiorite, trondhjemite, and charnockite provinces are characterized by a preponderance of plagioclase over potash feldspar and they differ from each other mainly in respect to the different reaction types of mafic minerals.

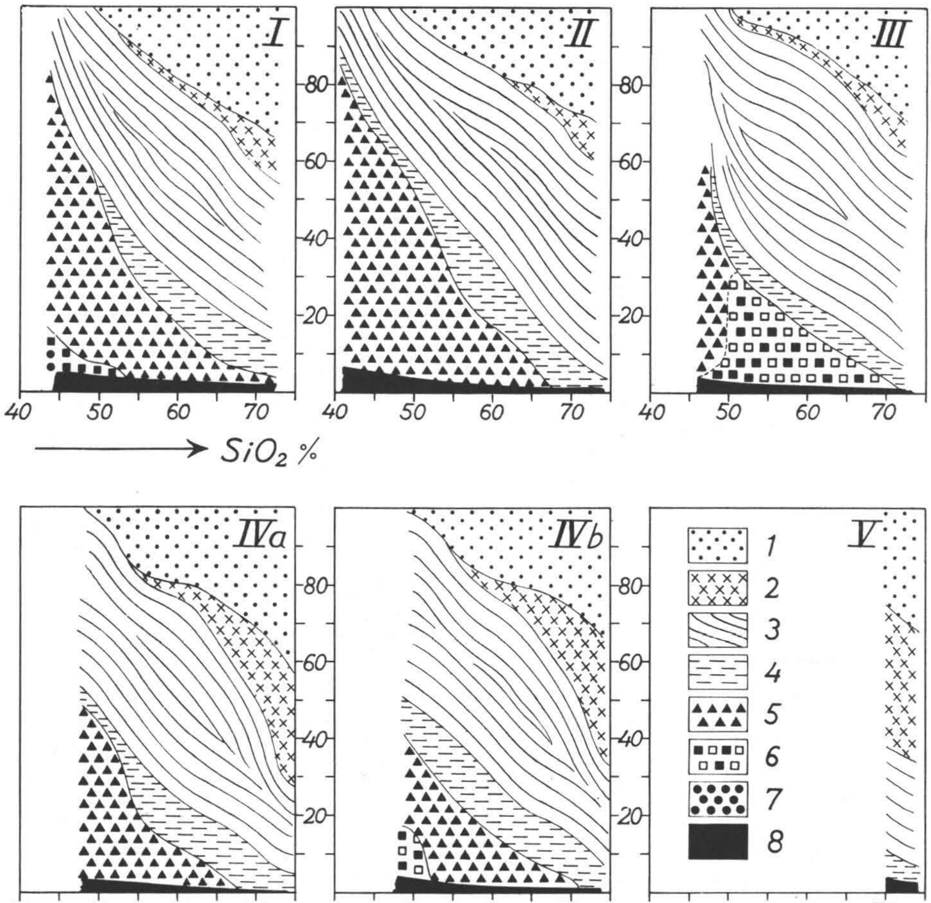

Fig. 20. Mineralogical composition of the Svecofennidic plutonic rock provinces. I, granodiorite province; II, trondhjemite province; III, charnockite province; IV a, granite province of the Tampere area; IV b, granite province in East Bothnia; V, microcline granite. 1, quartz; 2, microcline; 3, plagioclase; 4, biotite; 5, hornblende; 6, pyroxene; 7, olivine; 8, accessories. (Simonen, 1960 b).

A meta-aluminous association (hornblende and biotite) is characteristic of the granodiorite province, a peraluminous reaction type (biotite) of the trondhjemite province and a subaluminous reaction type (pyroxene) of the charnockite province. Differences in the mineralogical composition of the separate provinces are most apparent in acid end members, whereas the basic rocks of different provinces are mineralogically closely related. Real granites (Or $>$ Ab $+$ An) are present only in the granite province and among the migmatite-forming microcline granites.

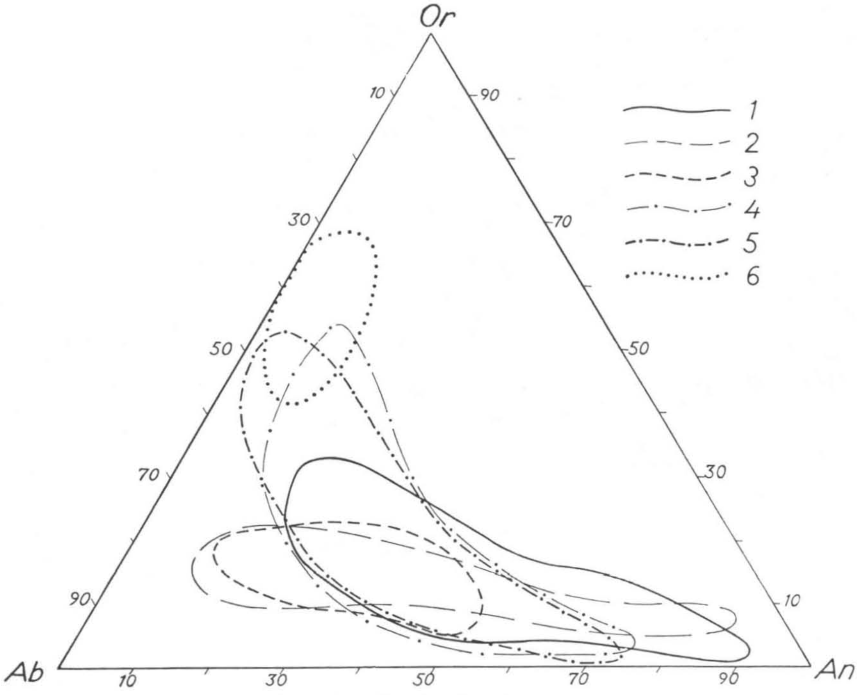

Fig. 21. Normative proportions Or: Ab: An in the Svecofennidic plutonic provinces. Different fields are as follows: 1, granodiorite province; 2, trondhjemite province; 3, charnockite province; 4, granite province in the Tampere area; 5, granite province in East Bothnia; 6, microcline granite. (Simonen, 1960 b).

The chemical characteristics of the plutonic provinces are presented by normative proportions Or: Ab: An (Fig. 21). The fields of the trondhjemite and charnockite provinces have the same position, and they distinctly deviate, especially through a high content of Ab, from the other provinces. The granodiorite, trondhjemite and charnockite provinces do not continue into the granite field as in the case of the plutonic rocks of the granite province. The migmatite-forming microcline granites show higher values of Or than the granites of the granite province.

A magmatic origin of the granodiorite, trondhjemite, charnockite and granite provinces has been suggested by 1) intrusive mode of occurrence, 2) compositional series with a gradual transition from basic to acid members, 3) reaction series of mafic and salic minerals (zoned plagioclase), 4) gradual increase of ratios (FeO): (MgO) and ($Na_2O + K_2O$): (CaO) with an increasing silica content of plutonic rocks, 5) an eutectoid granite composition of the most acid members of the granite province. Assuming a magmatic origin, the chemical differences between different provinces may be interpreted as being due to slight primary chemical differences between the parent magmas (cf. Simonen, 1960 b). Compositional differences between the parent magmas, appearing especially in the contents of lime and alkalies, have been principal factors in causing independent plutonic provinces to evolve. The main factor controlling the paths of evolution of the trondhjemite and charnockite provinces, which are chemically closely related, has been, however, different contents of volatile substances in the parent magma. The trondhjemites have been differentiated from a parent magma rich in water, whereas the charnockites have been crystallized from a magma poor in volatile substances (cf. Hietanen, 1943; Simonen, 1948 a).

The great total bulk of acid plutonic rocks in comparison with that of associated basic rocks suggests that the parent magma has been acid, probably quartz dioritic or granodioritic in composition. Great quantities of acid magma may have formed locally by complete or differential fusion of various rocks in deep levels of the earth's crust. Especially the sial crust of granodioritic bulk composition could produce great masses of acid magmas by anatexis.

The migmatite-forming microcline granites provide much field evidence contradictory to the mode of origin resulting from magmatic crystallization. The relic stratigraphy and relic structures, or »old drawings» (Wegmann, 1935), show that another solid rock, a Svecofennidic schist or synkinematic plutonic rock, formerly occupied the place of the present microcline granite. This makes clear that the process of metasomatic granitization played a great role in their origin. Sometimes metasomatic replacement occurred without any considerable increase of volume, but large granitized masses were updomed diapirically. The granitized masses were mobile and highly mobile granitic material was intruded into a zone of metasomatic granitization. Many metasomatic granites do not correspond to an eutectoid granite composition of residual granite magmas, but they contain more potash than eutectoid granites. This may be the result of postmagmatic potash metasomatism at a hydrothermal stage of the granitizing liquid (cf. Eskola, 1955).

The migmatites in the coastal area of Finland have been described in the classical papers of Sederholm (1923, 1926 and 1934). Many new investigations concerning migmatites and the metasomatic granitization of the Svecofennides have been carried out by various authors (Edelman, 1949; Eskola, 1950, 1952 b, 1956; Härme, 1958, 1959; Seitsaari, 1951;Simonen, 1948 b; Vaasjoki, 1953).

PLUTONIC ROCKS OF THE KARELIDIC BELT

Different petrographic provinces of orogenic plutonic rocks occur also in the Karelidic belt. The earliest phases of the Karelidic plutonism are represented by emplacement of basic and ultrabasic rocks which are not genetically associated with silicic rock types. Different petrographic provinces of the gneissose synkinematic plutonic rocks, grading from basic to acid members, do not show a wide areal distribution, but potash-rich late-kinematic granites without associated basic and intermediate differentiates are abundant in the Karelidic belt.

On the general map the basic plutonic rocks of the Karelidic belt are mainly gabbroidic rocks which do not grade into silicic plutonic rocks. Some of the gabbroidic rocks are metadiabases in texture and their emplacement may be closely related to the basaltic volcanism of the geosynclinal phase. Some of the gabbro bodies (Koitilainen, Kivalo, Syöte) are associated with peridotites, plagioclase-rich ossipitic gabbros, and anorthosites. A gravitative differentation of a wide gabbroidic sill in the Kivalo ridge has been pointed out by Härme (1949). The predominant rock of the sill is ossipitic gabbro, but it grades in the lowest part of the body into serpentine peridotite, and anorthosites occur at the top of the differentiated sill.

The occurrence of basic and ultrabasic ophiolitic intrusions is a characteristic feature of the Karelidic belt. The forms of ophiolitic bodies are small lenses, which occur as discontinuous belts marking zones of strong tectonic movements. They consist of various types of ultrabasics and gabbros or their metamorphic derivates, viz. serpentinites, soapstones, chlorite schists and amphibolites. Small lenses of serpentinites are especially abundant in the Karelidic belt. Originally they were mainly dunites whose serpentinization had been an autometamorphic process (cf. Haapala, 1936). The composition and origin of the soapstones has been studied by Wiik (1953).

The synkinematic plutonic rocks, mainly gneissose acid varieties associated with basic and intermediate differentiates, are represented by different petrographic provinces. Some differentiated types of so-called Hetta granites and the members of the syenite series in the western part of Finnish Lapland described by Mikkola (1941) show characteristics of the synkinematic intrusions. The granodiorites and associated basic differentiates of the so-called Haparanda series (Ödman, Härme, Mikkola, and Simonen, 1949) are the best-known representatives of the synkinematic plutonic rocks of the Karelidic belt. They penetrate the Karelidic schists north of the Gulf of Bothnia (Härme, 1949; Mikkola, 1949), in Enontekiö (Matisto, 1959) and in Suomussalmi (Matisto, 1958). Furthermore, differentiated plutonic rocks of a synkinematic type occur in the transitional boundary zone between the Svecofennidic and Karelidic belts in eastern Finland, where charnockitic pyroxene-bearing silicic rocks are abundant.

The grade of metamorphism of the Karelidic schists increases in the vicinity of the synkinematic intrusives. Therefore, the low-metamorphic Karelidic greenstones and argillaceous sediments grade over into amphibolites and sillimanite gneisses in the western part of Finnish Lapland, where synkinematic plutonic rocks are abundant. Furthermore, the increase of the grade of metamorphism of the Karelidic schist in northern Karelia westwards is due to a contemporaneous increase of the plutonic intrusions.

Late-kinematic granites are abundant in the Karelidic belt and they form many large uniform bodies. These potash-rich granites are mainly massive and coarse-grained with a pegmatitic character. They do not show any relationship with some basic differentiates. These granites are commonly migmatite-forming and wide migmatite aureoles occur around many wide granite bodies.

UNMETAMORPHIC SEDIMENTARY ROCKS

Pre-Cambrian unmetamorphic sedimentary rocks unconformably overlying the metamorphic formations have been found at Satakunta and Muhos. Sederholm (1897) proposed the name »Jotnian formation» for the sedimentary rocks in Satakunta and for all such late pre-Cambrian rocks in Fennoscandia which had not undergone diastrophism in pre-Cambrian times. Only very few sporadic occurrences of Cambrian sediments have been found in Finland.

ARKOSE SANDSTONE OF SATAKUNTA

The Jotnian formation of Satakunta consists of red-colored, stratified arkosic sandstones with thin intercalated beds of red or black shales. It fills a downfaulted block in the metamorphic complex; the thickness of the deposit is, however, unknown. The distribution and the field description of the sandstone are given by Laitakari (1925) and a sedimentary petrographic study has been carried out by Simonen and Kouvo (1955).

The mineralogical and chemical characteristics of the sandstone are typical of the red sandstones of the arkose suite. The ratio of quartz to feldspar varies greatly and the feldspar commonly occupies 20—40 per cent of the total amount of sand particles. The feldspar is predominantly potash feldspar. Some mineralogical characteristics (triclinic symmetry of the potash feldspar particles and presence of garnet and sillimanite as heavy minerals) show that the source of the detrital material was mainly the metamorphic Archean basement complex. The ratio of quartz to feldspar and the textural features, poor roundness and sorting, show that the Jotnian sandstone belongs to the class of immature sands which are products of rapid erosion and deposition controlled by the conditions of steep relief.

The stratification of the sandstone is generally horizontal and many sedimentary structures indicating terrestrial conditions of deposition are present. Current bedding is common and ripple marks (Fig. 22), made by water, are symmetric or asymmetric. Furthermore, mud cracks, clay galls, and rain drop impressions have been found. These sedimentary structures and the red color of the sandstone indicate a terrestrial oxidizing environment

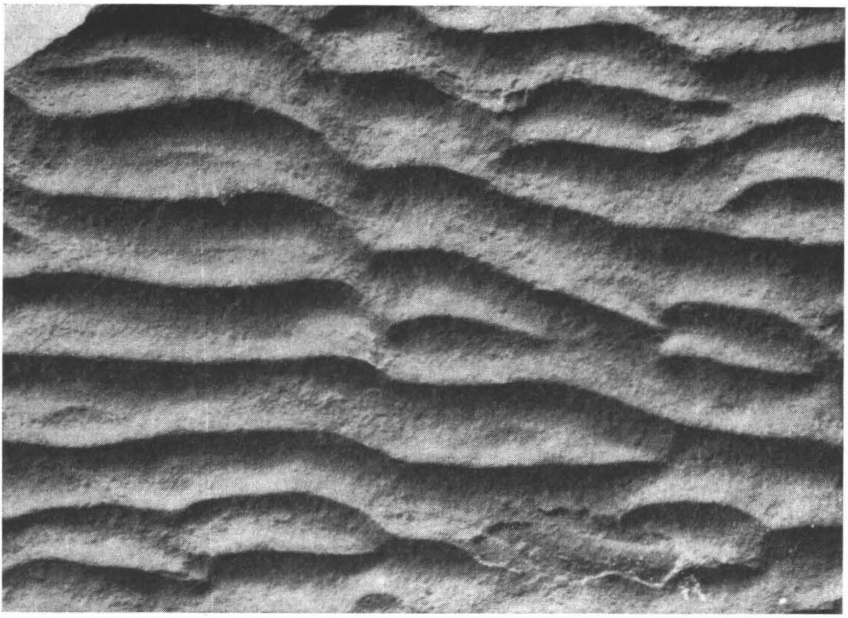

Fig. 22. Ripple marks in the Jotnian sandstone. $^{1}/_{3}$ nat. size. Photo: Halme.

at the place of deposition. All features of the Jotnian sandstone in Satakunta are similar to the arkoses that are characteristic of thick terrestrial piedmont facies in postgeosynclinal basins.

The K^{40}—A^{40} age for the intercalated red shale in the Jotnian sandstone at Harjavalta is 1 300 million years (determined in the Precambrian Laboratory in Leningrad). This may show the age of diagenesis in the sedimentary deposit. The K^{40}—A^{40} age for the intercalated shale in Leistilänjärvi (determined in the same laboratory is only 1 150 m.y.). This specimen is, however, taken from the close vicinity of a post-Jotnian diabase dike and therefore this age probably represents the time of the recrystallization of the shale caused by intrusion of the diabase dike.

SILTSTONE OF MUHOS

Unmetamorphic conglomerates, sandstones, siltstones, and shales occupy a wide area in northern East Bothnia. The so-called Muhos sediments are downfaulted along the northern boundary. The total thickness of the deposit is many hundred meters and may reach about one thousand meters according to an unpublished report on the drill hole made by the Oulujoki Company.

The vertical variations in the stratigraphic column are presented in Fig. 23. The Muhos formation begins with basal conglomerates and coarse-grained arkoses lying unconformably upon the Archean basement complex. The basal conglomerate contains rounded and angular pebbles of granite and schist and its matrix is brown-colored arkose rich in silty material. The conglomerate-arkose association forms an accumulation about 20 meters thick at the base of the Muhos formations and it is overlain by thick deposits of red, brown or greyish green siltstones and shales with thin interbeds of arkosic sandstone. The red and brown siltstones and shales are predominant, forming 80—90 per cent of the total thickness. The predominance of red beds in the Muhos formation indicates an oxidizing condition of terrestrial sedimentation. The association of red shales, siltstones, and sandstones indicates floodplain deposits in the piedmont facies of postgeosynclinal basins (Simonen and Kouvo, 1955).

The correlation of the Muhos sediments with the Jotnian formation in Satakunta is suggested by similar petrographic features and a similar manner of occurrence in downfaulted blocks of the crystalline basement. Two K^{40}—A^{40} ages, 1 280 and 1 310 million years respectively, for the shales of the Muhos formation (determined in the Precambrian Laboratory in Leningrad) suggest that the diagenesis of the Muhos sediments took place at the same time with that of the Jotnian arkose sandstone in Satakunta.

QUARTZ SANDSTONE

Sporadic occurrences of Cambrian quartz sandstone have been found in the coastal area of southwestern Finland and in Central Finland. Cambrian sediments also occur in the westernmost part of Finnish Lapland, along the rand zone of the Caledonidic mountain chain (cf. p. 46).

In the coastal area of southwestern Finland many small deposits of Cambrian quartz sandstone occur as fillings of fault cracks in pre-Cambrian rocks or as fillings of cavities in pre-Cambrian crystalline limestone. The manner of occurrence shows that the ancient sub-Cambrian peneplain on which these sandstones were deposited had been situated slightly above the present surface. The mineralogical and textural features of the quartz sandstones show a maturity produced by intense chemical and mineralogical weathering. Fossil Brachiopods suggesting a Lower Cambrian age have been found in the sandstone dike of Saltvik (Metzger, 1922). These small occurrences of quartz sandstone are not marked on the general map.

The widest occurrence of pure quartz sandstone is in Lauhavuori, South East Bothnia, described by Simonen and Kouvo (1955). This sandstone deposit overlies the pre-Cambrian basement complex and its thickness is only a few dozen meters. Quartz is the main component of the sand particles

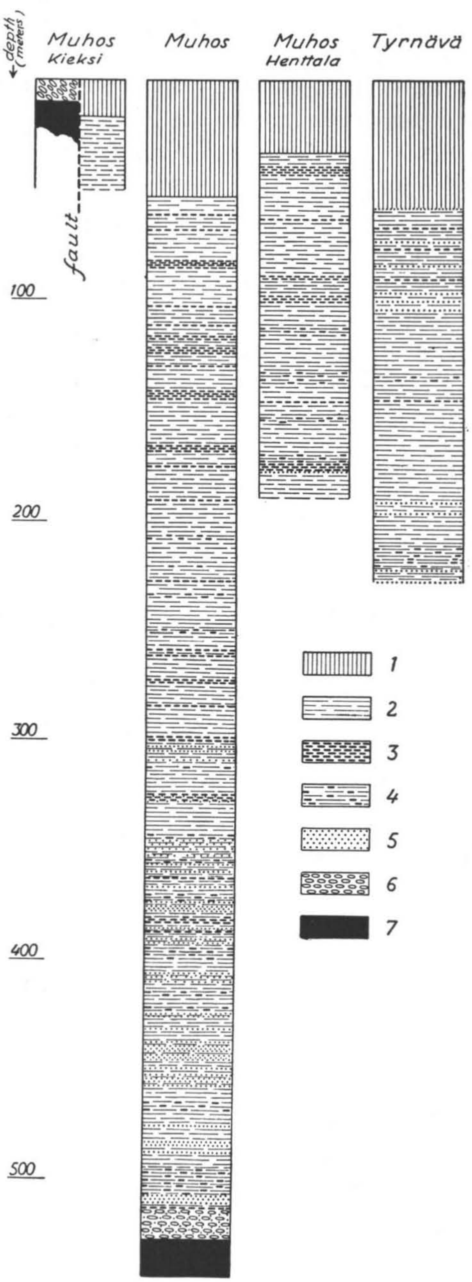

Fig. 23. Vertical sections of the Muhos formation. 1, Pleistocene deposits; 2, red siltstones and shales; 3, grey and green shales; 4, intimate alternation of red and grey shales; 5, sandstone; 6, conglomerate; 7, Archean rocks. (Simonen and Kouvo, 1955).

and the content of strongly kaolinized feldspar is very low. The cement is siliceous. The mineral particles are extremely rounded and the sorting is good. Stratification and cross-bedding are common structural features. Petrographic characteristics similar to the Cambrian quartz sandstones in the coastal area indicate the Cambrian age. Lauhavuori, the highest hill in southern East Bothnia, probably is where the sub-Cambrian peneplain had not been destroyed by later erosion, as in the case of the coastal area, where the sandstone dikes indicate that the ancient peneplain originally was a little above the present surface. Taken as a whole, the sporadic occurrences of quartz sandstone in Finland seem to indicate a Cambrian transgression over a stable peneplained platform.

ANOROGENIC IGNEOUS ROCKS

Igneous rocks, whose emplacement is not related to orogenic movements, are mainly represented by massive granites of pre-Cambrian age. Anorogenic diabase dikes of a different age have been found to cut sharply the pre-Cambrian folded formations, but only the post-Jotnian diabases in Satakunta have been marked on the general map and described in this connection. Only very few and sporadic evidences of igneous activity after pre-Cambrian times have been found in the pre-Cambrian platform of Finland. These are represented on the general map by alkaline rock in Kuusamo and by dacite from Lappajärvi.

ANOROGENIC GRANITES

Many large and discordant plutons of massive granites occur in southern Finland. They cut sharply the ancient folded pre-Cambrian belts and they do not form migmatites with country rocks. These granites are anorogenic in relation to orogenic movements and they represent the youngest pre-Cambrian granites so far known in Finland. The radioactive age of 1 620 million years (Kouvo, 1958) for anorogenic plutonic rocks has been proved by many different methods.

Different petrographic varieties of anorogenic granites occur and many large plutons are composed of many texturally different granite types. So-called rapakivi granites are most common. Coarse-grained, massive granites of Onas, Bodom, Obbnäs, and Åva also belong among anorogenic granites. The best-known occurrence of these granites is the granite body of Åva (Kaitaro, 1953) characterized by ring dike intrusions of granites and monzonites.

Rapakivi granites are coarse-grained porphyritic granites with ovoids of potash feldspar. In a typical rapakivi texture (Fig. 24) the greatest part of the potash feldspar ovoids are surrounded by plagioclase mantles (wiborgite type). In some varieties the plagioclase mantles around potash feldspar ovoids are lacking (pyterlite type). The ratio between mantled and non-mantled ovoids varies greatly and texturally there is a gradual transition

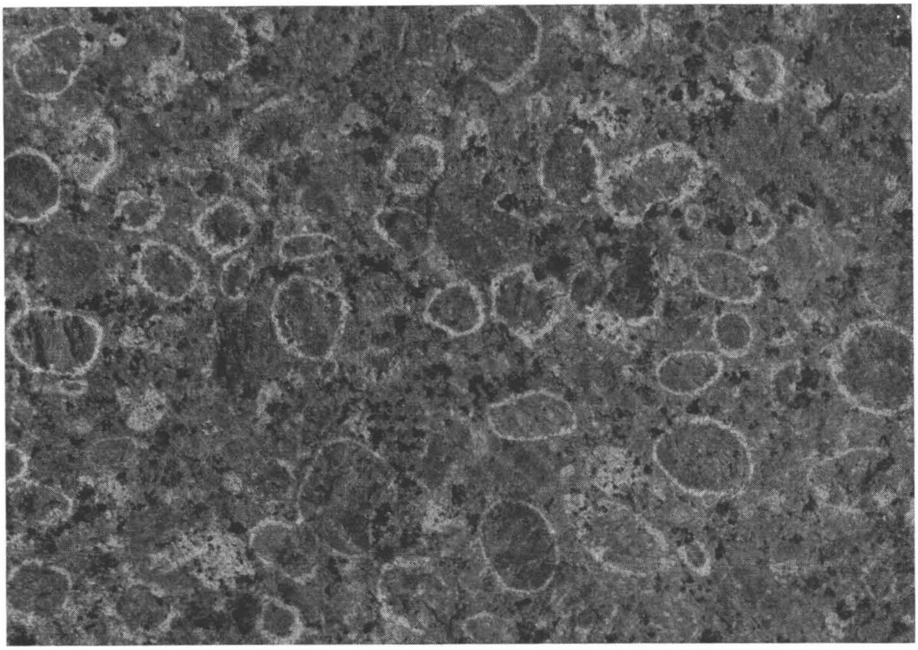

Fig. 24. Rapakivi texture. Potash feldspar ovoids surrounded by plagioclase mantles. Vehkalahti. $^1/_3$ nat. size. Photo: Sederholm.

from wiborgite to pyterlite. Porphyritic granites with angular potash feldspar phenocrysts are also present and a gradual transition from these to pyterlites is observed. Furthermore, even-grained, granite porphyritic, and quartz porphyritic types occur in the rapakivi areas. Pegmatites and aplites are rare, but miarolitic cavities are characteristic.

Main minerals of texturally different varieties of the rapakivi granites are potash feldspar (mainly orthoclase), plagioclase (oligoclase), and quartz. Biotite and hornblende are the most common mafic minerals. Fayalite, hypersthene, and diopside are present in some rare varieties of the rapakivi granites. Fluorite and zircon are characteristic accessory minerals.

A characteristic feature of the rapakivi granites is that quartz occurs in two separate generations. Idiomorphic bipyramidal quartz is a striking characteristic of the rapakivi granites, but the later generation of quartz is xenomorphic. Also other main minerals of the rapakivi granites occur in two generations (cf. Wahl, 1925).

Chemical composition of the rapakivi granites is characterized by high contents of potash and silica, whereas the contents of lime and magnesia

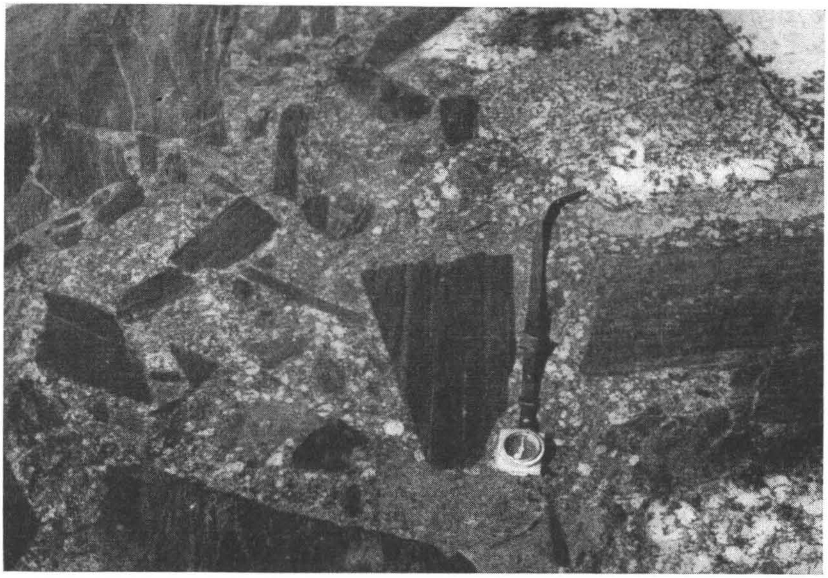

Fig. 25. Intrusive contact of rapakivi. Fragments of wall rock are amphibolite. Lyöttilä, Iitti. Photo: Lehijärvi.

are low. The chemistry of the rapakivi granites is discussed by Sahama (1945), who has done also trace element determinations which show that especially fluorine, zirconium, barium, rubidium and lead have an enrichment in the rapakivi granites.

A magmatic origin of the rapakivi granites has been suggested by Finnish geologists (Wahl 1925; Eskola, 1928; Savolahti 1956). Sharp intrusive contacts (Fig. 25) and gradual transition of effusive types (quartz porphyries and granite porphyries) to coarse-grained rapakivi varieties are the best evidences of magmatic origin. Different explanations to the typical rapakivi texture have been presented by various authors, and discussed in classical papers of Sederholm (1928) and Wahl (1925). Recently Savolahti (1956) has discussed the crystallization of rapakivi and he concludes that »crystallization has started with potash feldspar and quartz while the composition of the residual magma moves toward the granitic minimum and that the younger rock types of the same intrusion are richer in plagioclase and mafic minerals». A residual magma has been originated whose crystallization-produced rock types are richer in plagioclase and mafic minerals than the main part of the intrusion. This inverse crystallization of the rapakivi magma offers an explanation to the typical rapakivi texture characterized by potash feldspar ovoids mantled by plagioclase.

DIABASE

Diabase dikes and sills occur abundantly in the Jotnian area of Satakunta in southwestern Finland. They represent the youngest member of the Jotnian complex (rapakivi granite, arkose sandstone and diabase) and show both vertical and horizontal chilled contacts against country rocks consisting of the Svecofennidic rocks, rapakivi granites, and Jotnian sandstones. Diabases represent hypabyssal eruption channels of basaltic magma intrusions into a stable platform characterized by faulting tectonics.

Labradoritic plagioclase, olivine, and augite are the main minerals of the diabase, commonly called olivine diabase. The chemical composition is basaltic, similar to that of plateau basalts. Texture is ophitic.

Contact phenomena of the diabase, resulting in partial or almost complete melting of country rocks, have been described and discussed thoroughly by Kahma (1951). Partial melting of various silicic country rocks, in the closest vicinity of the diabase contact, has produced an intergranular melt of eutectoid granite composition. This melt has intruded from host rock into the chilled contact zones of the diabase. »Palingenic dikes», consisting mainly of quartz and alkali feldspar, have been formed. An almost complete remelting of a granite lens, situated between two diabase sills in Suontaka has taken place. Reactions between anatectic granite melt and solidified diabase have caused hybridization of original contact zones.

ALKALINE ROCK

Alkaline rocks have been found only in one small area in Iivaara, Kuusamo. This occurrence is probably a satellitic massif of well-known Paleozoic alkaline rocks in Kola peninsula. A new study of the alkaline district in Iivaara was published recently by Lehijärvi (1960).

Central massif of the alkaline district in Iivaara consists of rocks whose main minerals are nefeline and pyroxene in varying mutual ratios (urtite-ijolite-melteigite series). Petrographic types containing considerable cancrinite or titaniferous garnet (iivaarite) have also been encountered.

Intrusion of alkaline magma has caused metasomatic fenitization of pre-Karelian granite gneisses in the closest proximity of the alkaline mass. In a narrow transitional zone between the fenite and the alkaline mass there occur heterogeneous hybrid rocks (juvites, malignites, etc.) which represent a mobile contact zone crystallized from an alkaline magma mixed with partially melted portions of the granodioritic country rocks.

DACITE

The remains of an ancient volcanic neck occurs in Kärnäsaari, Lappajärvi. The rock is an unmetamorphic volcanic explosive breccia with a dacitic bulk composition. It contains an abundance of mineral and rock fragments of surrounding pre-Cambrian granites and gneisses in a volcanic matrix (Saksela, 1949). Amygdaloids of calcite and chalcedon are present. Geological age of the occurrence is uncertain.

Fig. 26. The structure of the Caledonidic range with its rand zone. 1, pre-Cambrian rocks; 2, Cambrian peneplain; 3, Lower Cambrian sediments; 4, overthrust plane; 5, Caledonidic gneisses. Porojärvi, Enontekiö. Photo: Matisto.

PALEOZOIC SCHISTS

A narrow belt of the Caledonidic mountain range with its rand zone occurs in the westernmost part of Finnish Lapland (Fig. 26). A thin succession of Lower—Cambrian basal conglomerates, quartz sandstones and shales occurs on the pre-Cambrian crystalline basement and these autochthonous sediments are overlain by tectonized beds of shale, quartzite and dolomite. The total thickness of the afore mentioned sediments is 150—190 meters (Hausen, 1942). The sedimentary rocks are overlain by allochthonous, silicic schists and gneisses of the Caledonidic range. These gneisses have been overthrust from the northwest. Some phacolite intrusions of gabbroidic rocks have taken place in the Caledonidic gneiss complex (Hausen, 1941).

ACKNOWLEDGEMENTS — To the Finnish Scientific Research Council (Valtion luonnontieteellinen toimikunta) the author is very grateful for the financial aid given him.

Miss Thyra Åberg has drawn the general geological map and Mr. Paul Sjöblom, M. A., has corrected the English of the manuscript. To them the author is greatly indebted.

REFERENCES

Edelman, Nils (1949) Structural history of the eastern part of the Gullkrona basin, SW-Finland. Bull. Comm. géol. Finlande 148.

—»— (1960) The Gullkrona region, SW Finland. Bull. Comm. géol. Finlande 187.

Eskola, Pentti (1919) Huvuddragen av Onega-Kareliens geologi. Meddel. geol. fören. i Helsingfors, 1917—18, p. 13.

—»— (1928) On rapakivi rocks from the bottom of the Gulf of Bothnia. Fennia 50.

—»— (1941) Erkki Mikkola und der heutige Stand der präkambrischen Geologie in Finnland. Geol. Rundschau 32, S. 452.

—»— (1949) The problem of mantled gneiss domes. Quart. J. Geol. Soc. London 104, p. 461.

—»— (1950) Nature of metasomatism in the processes of granitization. Internat. Geol. Congress, Report of the 18th session, Great Britain 1948. Part III. Proc. of section B. Metasomatic processes in metamorphism. p.l.

—»— (1952 a) On the granulites of Lapland. Am. J. Sci. Bowen volume, p. 133.

—»— (1952 b) A discussion of domes and granites and ores. C. R. Soc. géol Finlande 25; Bull. Comm. géol. Finlande 157, p. 125.

—»— (1956) Postmagmatic potash metasomatism of granite. C. R. Soc. géol. Finlande 29; Bull. Comm. géol. Finlande 172, p. 86.

Gerling, E. K. and Polkanov, A. A. (1958) Проблема абсолютного возраста Докемьрия Балтийского Щита. Академия Наук СССР. Геохимия 8.

Haapala, Paavo (1936) On serpentine rocks in northern Karelia. Bull. Comm. géol. Finlande 114.

Hausen, H. (1941) Das Halditjokko—Massiv. Geol. Rundschau 32, S. 508.

—»— (1942) Das Abschnitt Finnlands der kaledonischen Überschiebungszone. Soc. Scient. Fennica. Comm. Phys.—Math. 11.

Hietanen, Anna (1938) On the petrology of Finnish quartzites. Bull. Comm. géol. Finlande 122.

—»— (1943) Über das Grundgebirge des Kalantigebietes im südwestlichen Finnland. Bull. Comm. géol. Finlande 130.

Härme, Maunu (1949) On the stratigraphical and structural geology of the Kemi area, Northern Finland. Bull. Comm. géol. Finlande 147.

—»— (1954) Structure and stratigraphy of the Mustio area, southern Finland. C. R. Soc. géol. Finlande 27; Bull. Comm. géol. Finlande 166, p. 29.

—»— (1958) Examples of the granitization of plutonic rocks. C. R. Soc. géol. Finlande 30; Bull. Comm. géol. Finlande 180, p. 45.

—»— (1959) Examples of the granitization of gneisses. C. R. Soc. géol. Finlande 31; Bull. Comm. géol. Finlande 184, p. 41.

—»— (1960) Suomen geologinen yleiskartta. The general geological map of Finland. Lehti — Sheet — Bl. Turku. Kivilajikartan selitys. Explanation to the map of rocks.

Kahma, Aarno (1951) On contact phenomena of the Satakunta diabase. Bull. Comm. géol. Finlande 152.

KAITARO, SIMO (1953) Geologic structure of the late pre-Cambrian intrusives in the Åva area, Åland islands. Bull. Comm. géol. Finlande 162.

KOUVO, OLAVI (1958) Radioactive age of some Finnish pre-Cambrian minerals. Bull. Comm. géol. Finlande 182.

KRANCK, E. H. (1936) Zur Tektonik der lappländischen Granulite. C. R. Soc. géol. Finlande 9; Bull. Comm. géol. Finlande 115.

LAITAKARI, AARNE (1925) Über das Jotnische Gebiet von Satakunta. Bull. Comm. géol. Finlande 73.

LEHIJÄRVI, MAUNO (1960) The alkaline district of Iivaara, Kuusamo, Finland. Bull. Comm. géol. Finlande 185.

MARMO, VLADI (1956) On the emplacement of granites. Am. J. Sci. 254, p. 479.

MATISTO, ARVO (1958) Suomen geologinen yleiskartta. The general geological map of Finland. Lehti — Sheet D 5. Suomussalmi. Kivilajikartan selitys. With an English summary.

—»— (1959) Suomen geologinen yleiskartta. The general geological map of Finland. Lehti — Sheet B 8. Enontekiö.

MERILÄINEN, KAUKO (1959) Granuliittimuodostumasta Inarissa. Geologi 6, s. 58.

METZGER, ADOLF A. Th. (1922) Beiträge zur Paläontologie des nordbaltischen Silurs im Ålandgebiet. Bull. Comm. geol. Finlande 56.

—»— (1959) Svekofenniden und Kareliden. Acta Acad. Aboensis, Mathem. et Phys. 21.

MIKKOLA, AIMO (1949) On the geology of the area north of the Gulf of Bothnia. Bull. Comm. géol. Finlande 146.

MIKKOLA, ERKKI (1941) Suomen geologinen yleiskartta. The general geological map of Finland. Lehdet — Sheets B 7—C 7—D 7. Muonio—Sodankylä—Tuntsajoki. Kivilajikartan selitys. Explanation to the map of rocks.

MIKKOLA, TOIVO (1953) Peruskalliogeologian näköaloja. Geologi 4, s. 29.

NEUVONEN, K. J. (1954) Stratigraphy of the schists of the Tammela—Kalvola area, southwestern Finland. C. R. Soc. géol. Finlande 27; Bull. Comm. géol. Finlande 166, p. 85.

PARRAS, KAUKO (1958) On the charnockites in the light of a highly metamorphic rock complex in southwestern Finland. Bull. Comm. géol. Finlande 181.

PRESTON, JOHN (1954) The geology of the pre-Cambrian rocks of the Kuopio district. Ann. Acad. Sci. Fennicae, Ser. A, III, 40.

RANKAMA, KALERVO (1948) New evidence of the origin of pre-Cambrian carbon. Bull. Geol. Soc. Am. 59, p. 389.

SAHAMA, Th. G. (1945) On the chemistry of the east Fennoscandian rapakivi granites. C. R. Soc. géol. Finlande 18; Bull. Comm. géol. Finlande 136, p. 15.

SAKSELA, MARTTI (1936) Über die geologische Kartierung und die Einteilung der Granite im finnischen Grundgebirge. C. R. Soc. géol. Finlande 9; Bull. Comm. géol. Finlande 115, S. 275.

—»— (1949) Das pyroklastische Gestein von Lappajärvi und seine Verbreitung als Geschiebe. C. R. Soc. géol. Finlande 22; Bull. Comm. géol. Finlande 144, p. 19.

—»— (1953) Über die tektonische Einteilung det Tiefengesteine. C. R. Soc. géol. Finlande 26; Bull. Comm. géol. Finlande. 159, S. 19.

SALLI, I. (1955) Vieskan—Himangan liuskemuodostuman rakennetta ja stratigrafiaa. Geologi 4, s. 29.

SAVOLAHTI, ANTTI (1956) The Ahvenisto massif in Finland. Bull. Comm. géol. Finlande 174.

SEDERHOLM, J. J. (1897) Über eine archäische Sedimentformation im Südwestlichen Finland und ihre Bedeutung für die Erklärung der Entstehungsweise des Grundgebirges. Bull. Comm. géol. Finlande 6.

SEDERHOLM, J. J. (1911) Les roches préquaternaires de la Finlande. Bull. Comm. géol. Finlande 28.

—»— (1923) On migmatites and associated pre-Cambrian rocks of Southwestern Finland. Part I. The Pellinge region. Bull. Comm. géol. Finlande 58.

—»— (1926) On migmatites and associated pre-Cambrian rocks of Southwestern Finland. Part II. The region around the Barösundsfjärd W. of Helsingfors and neighbouring areas. Bull. Comm. géol. Finlande 77.

—»— (1928) On orbicular granites etc. Bull. Comm. géol. Finlande 83.

—»— (1930) Pre—Quaternary rocks of Finnland. Bull. Comm. géol. Finlande 91.

—»— (1932) On the geology of Fennoscandia. Bull. Comm. géol. Finlande 98.

—»— (1934) On migmatites and associated pre-Cambrian rocks of Southwestern Finland. Part III. The Åland islands. Bull. Comm. géol. Finlande 107.

SEITSAARI, JUHANI (1951) The schist belt northeast of Tampere in Finland. Bull. Comm. géol. Finlande 153.

SIMONEN, AHTI (1948 a) On the petrochemistry of the infracrustal rocks in the Svecofennidic territory of southwestern Finland. Bull. Comm. géol. Finlande 141.

—»— (1948 b) On the petrology of the Aulanko area in southwestern Finland. Bull. Comm. géol. Finlande 143.

—»— (1953) Stratigraphy and sedimentation of the Svecofennidic, early Archean supracrustal rocks in southwestern Finland. Bull. Comm. géol. Finlande 160.

—»— (1960 a) Pre-Cambrian stratigraphy of Finland. XXI Internat. Geol. Congress, Norden 1960. Section 9. Pre-Cambrian stratigraphy and correlation.

—»— (1960 b) Plutonic rocks of the Svecofennides in Finland. Bull. Comm. géol. Finlande 189.

—»— and KOUVO, OLAVI (1951) Archean varved schists north of Tampere in Finland. C. R. Soc. géol. Finlande 24; Bull. Comm. géol. Finlande 154, p. 93.

—»— and KOUVO, OLAVI (1955) Sandstones in Finland. C. R. Soc. géol. Finlande 28; Bull. Comm. géol. Finlande 168, p. 57.

TUOMINEN, HEIKKI V., and MIKKOLA, TOIVO (1950) Metamorphic Mg—Fe enrichment in the Orijärvi region as related to folding. C. R. Soc. géol. Finlande 23; Bull. Comm. géol. Finlande 150, p. 67:

VAASJOKI, OKE (1953) On Migmatites and Ore Mineralizations in the Pernaja District, Southern Finland. Bull. Comm. géol. Finlande 163.

VÄYRYNEN, HEIKKI (1933) Über die Stratigraphie der Karelischen Formationen. C. R. Soc. géol. Finlande 6; Bull. Comm. géol. Finlande 101, S. 54.

—»— (1939) On the geology and tectonics of the Outokumpu ore field and region. Bull. Comm. géol. Finlande 124.

—»— (1954) Suomen kallioperä. Helsinki.

WAHL, WALTER (1925) Die Gesteine des Wiborger Rapakivi-gebietes. Fennia 45.

—»— (1936) The granites of the Finnish part of the Svecofennian Archaean mountain chain. C. R. Soc. géol. Finlande 9; Bull. Comm. géol. Finlande 115, p. 489.

WEGMANN, C. E. (1928) Über die Tektonik der jüngeren Faltung in Ostfinnland. Fennia 50.

WEGMANN, C. E. und KRANCK, E. H. (1931) Beiträge zur Kenntnis der Svecofenniden in Finnland. Bull. Comm. géol. Finlande 89.

—»— (1935) Zur Deutung der Migmatite. Geol. Rundschau 26.

WIIK, H. B. (1953) Composition and origin of soapstone. Bull. Comm. géol. Finlande 165.

ÖDMAN, OLOF H., HÄRME, M., MIKKOLA, A. och SIMONEN, AHTI (1949) Den svensk-finska geologiska exkursionen i Tornedalen sommaren 1948. Geol. Fören. i Stockholm Förhandl., 71, s. 113.

Bulletin de la Commission géologique de Finlande.

*N:o 1.	Ramsay, Wilhelm und Nyholm, E. T. Cancrinitsyenit und einige verwandte Gesteine aus Kuolajärvi. S. 1—12. 4 Fig. 1895	—
*N:o 2.	Sederholm, J. J. Ueber einen metamorphosierten praecambrischen Quarzporphyr von Karvia in der Provinz Åbo. S. 1—16. 12 Fig. 1895	—
N:o 3.	Ramsay, Wilhelm, jemte Bihang 1 af Hackman, Victor och 2 af Sederholm, J. J. Till frågan om det senglaciala hafvets utbredning i Södra Finland. S. 1—44. 1 karta. Résumé en français: La transgression de l'ancienne mer glaciaire sur la Finlande méridionale. 1896	150: —
*N:o 4.	Frosterus, Benj. Ueber einen neuen Kugelgranit von Kangasniemi in Finland. S. 1—38. 11 Fig. 2 Taf. 1896	—
*N:o 5.	Berghell, Hugo. Bidrag till kännedomen om Södra Finlands kvartära nivåförändringar. S. 1—64. 16 fig. 1 plansch. 1 karta. Deutsches Referat: Beiträge zur Kenntniss der quartären Niweauschwankungen Süd-Finlands. 1896	—
*N:o 6.	Sederholm, J. J. Über eine archäische Sedimentformation im südwestlichen Finland und ihre Bedeutung für die Erklärung der Entstehungsweise des Grundgebirges. S. 1—254. 97 Fig. 5 Taf. 2 Karten. 1897	—
*N:o 7.	Ailio, Julius. Über Strandbildungen des Litorinameeres auf der Insel Mantsinsaari. S. 1—43. 8 Fig. 1898	—
*N:o 8.	Andersson, Gunnar. Studier öfver Finlands torfmossar och fossila kvartärflora. S. 1—210. 21 fig. 4 tafl. Deutsches Referat: Studien über die Torfmoore und die fossile Quartärflora Finlands. 1898	—
N:o 9.	Sederholm, J. J. Esquisse hypsométrique de la Finlande. P. 1—17. 1 carte. 1899	150: —
N:o 10.	Sederholm, J. J. Les dépôts quaternaires en Finlande. P. 1—28. 2 fig. carte. 1899	150: —
*N:o 11.	Hackman, Victor. Neue Mitteilungen über das Ijolithmassiv in Kuusamo. S. 1—45. 7 Fig. 1 Taf. 2 Karten. 1899	—
*N:o 12.	Ramsay, Wilhelm und Borgström, L. H. Der Meteorit von Bjurböle bei Borgå. S. 1—28. 20 Fig. 1902	—
*N:o 13.	Frosterus, Benj. Bergbyggnaden i sydöstra Finland. S. 1—168. 18 fig. 8 tafl. 1 karta. Deutsches Referat: Der Gesteinsaufbau des südöstlichen Finland. 1902	—
*N:o 14.	Borgström, Leon. H. Die Meteoriten von Hvittis und Marjalahti. S. 1—80. 8 Taf. 1903	—
N:o 15.	Hackman, Victor. Die chemische Beschaffenheit von Eruptivgesteinen Finlands und der Halbinsel Kola im Lichte des neuen amerikanischen Systemes. S. 1—143. 3 Tab. 1905	150: —
*N:o 16.	Sundell, I. G. On the Cancrinite-Syenite from Kuolajärvi and a Related Dike Rock. P. 1—20. 1 plate. 1905	—
*N:o 17.	Fircks, Curt. On the Occurrence of Gold in Finnish Lapland. P. 1—35. Frontispiece. 15 fig. 1 map. 1906	—
*N:o 18.	Tanner, V. Studier öfver kvartärsystemet i Fennoskandias nordliga delar. I. Till frågan om Ost-Finmarkens glaciation och nivåförändringar. S. 1—165. 23 fig. 6 tafl. Résumé en français: Études sur le système quaternaire dans les parties septentrionales de la Fenno-Scandia. I. Sur la glaciation et les changements de niveau du Finmark oriental. 1906	—
*N:o 19.	Trüstedt, Otto. Die Erzlagerstätten von Pitkäranta am Ladoga-See. S. 1—333. 80 Fig. 19 Taf. 1 Karte. 1907	—
N:o 20.	Tanner, V. Zur geologischen Geschichte des Kilpisjärwi-Sees in Lappland. S. 1—23. 3 Fig. 2 Taf. 1 Karte. 1907	100: —

---

*) Loppuunmyyty.
Out of print.

N:o 21.	Tanner, V. Studier öfver kvartärsystemet i Fennoskandias nordliga delar. II. Nya bidrag till frågan om Finmarkens glaciation och nivåförändringar. S. 1—127. 10 fig. 6 tafl. Résumé en français: Études sur le système quaternaire dans les parties septentrionales de la Fenno-Scandia. II. Nouvelles recherches sur la glaciation et les changements de niveau du Finmark. 1907	250: —
N:o 22.	Borgström, L. H. Granitporphyr von Östersundom. S. 1—20. 3 Fig. 1 Taf. 1907	100: —
*N:o 23.	Sederholm, J. J. Om granit och gneis, deras uppkomst, uppträdande och utbredning inom urberget i Fennoskandia. S. 1—110. 11 fig. 8 tafl. 1 planteckn. 1 karta. English Summary of the Contents: On Granite and Gneiss, their Origin, Relations and Occurrence in the Pre-Cambrian Complex of Fenno-Scandia. 1907	—
*N:o 24.	Sederholm, J. J. Les roches préquaternaires de la Fennoscandia. P. 1—39. 20 fig. 1 carte. 1910	—
N:o 25.	Tanner, V. Über eine Gangformation von fossilienführendem Sandstein auf der Halbinsel Långbergsöda-öjen im Kirchspiel Saltvik, Åland-Inseln. S. 1—13. 5 Fig. 2 Taf. 1911	100: —
*N:o 26.	Mäkinen, Eero. Bestimmung der Alkalien in Silikaten durch Aufschliessen mittelst Chlorkalzium. S. 1—8. 1911	—
N:o 27.	Sederholm, J. J. Esquisse hypsométrique de la Finlande. P. 1—21. 5 fig. 1 carte. 1911	100: —
*N:o 28.	Sederholm, J. J. Les roches préquaternaires de la Finlande. P. 1—27. 1 carte. 1911	—
*N:o 29.	Sederholm, J. J. Les dépôts quaternaires de la Finlande. P. 1—23. 5 fig. 1 carte. 1911	—
*N:o 30.	Sederholm, J. J. Sur la géologie quaternaire et la géomorphologie de la Fennoscandia. P. 1—66. 13 fig. 6 cartes. 1911	—
N:o 31.	Hausen, H. Undersökning af porfyrblock från sydvästra Finlands glaciala aflagringar. S. 1—34. 9 fig. Deutsches Referat. 1912	100: —
N:o 32.	Hausen, H. Studier öfver de sydfinska ledblockens spridning i Ryssland, jämte en öfversikt af is-recessionens förlopp i Ostbaltikum. Preliminärt meddelande med tvenne kartor. S. 1—32. Deutsches Referat. 1912	100: —
N:o 33.	Wilkman, W. W. Kvartära nivåförändringar i östra Finland. S. 1—40.9 fig. Deutsches Referat. 1912	150: —
N:o 34.	Borgström, L. H. Der Meteorit von St. Michel. S. 1—49. 1 Fig. 3 Taf. 1912	150: —
N:o 35.	Mäkinen, Eero. Die Granitpegmatite von Tammela in Finnland und ihre Minerale. S. 1—101. 23 Fig. 1913	150: —
N:o 36.	Eskola, Pentti. On Phenomena of Solution in Finnish Limestones and on Sandstone filling Cavities. P. 1—50. 15 fig. 1913	150: —
N:o 37.	Sederholm, J. J. Weitere Mitteilungen über Bruchspalten mit besonderer Beziehung zur Geomorphologie von Fennoskandia. S. 1—66. 27 Fig. I Taf. 1913	200: —
N:o 38.	Tanner, V. Studier öfver kvartärsystemet i Fennoskandias nordliga delar. III. Om landisens rörelser och afsmältning i finska Lappland och angränsande trakter. S. 1—815. 139 fig. 16 tafl. Résumé en français: Études sur le système quaternaire dans le parties septentrionales de la Fennoscandia. III. Sur la progression et le cours de la récession du glacier continental dans la Laponie finlandaise et les régions environnantes. 1915	750: —
N:o 39.	Hackman, Victor. Der gemischte Gang von Tuutijärvi im nördlichen Finnland. S. 1—41. 9 Fig. 1914	100: —
*N:o 40.	Eskola, Pentti. On the Petrology of the Orijärvi region in Southwestern Finland. P. 1—277. 55 fig. 6 plates. 2 maps. 1914	—
N:o 41.	Borgström, L. H. Die Skapolithlagerstätte von Laurinkari. S. 1—30. 7 Fig. 1913	100: —
N:o 42.	Hackman, Victor. Über Camptonitgänge im mittleren Finnland. S. 1—18. 3 Fig. 1914	100: —

---

*) Loppuunmyyty.
Out of print.

N:o 43.	Wilkman, W. W. Kaleviska bottenbildningar vid Mölönjärvi. S. 1—36. 11 fig. Résumé en français. 1915	100: —
N:o 44.	Eskola, Pentti. Om sambandet mellan kemisk och mineralogisk sammansättning hos Orijärvitraktens metamorfa bergarter. S. 1—145. 5 fig. English Summary of the Contents. 1915	150: —
N:o 45.	Ailio, Julius. Die geographische Entwicklung des Ladogasees in postglazialer Zeit und ihre Beziehung zur steinzeitlichen Besiedelung. S. 1—158. 51 Abbild. 2 Karten. 1915	250: —
N:o 46.	Laitakari, Aarne. Le gisement de calcaire cristallin de Kirmonniemi à Korpo en Finlande. P. 1—39. 14 fig. 1916	100: —
N:o 47.	Mäkinen, Eero. Översikt av de prekambriska bildningarna i mellersta Österbotten i Finland. S. 1—152. 25 fig. 1 karta. English Summary of the Contents. 1916	250: —
*N:o 48.	Sederholm, J. J. On Synantetic Minerals and Related Phenomena (Reaction Rims, Corona Minerals, Kelyphite, Myrmekite, &c.). P. 1—148. 14 fig. in the text and 48 fig. on 8 plates. 1916	—
N:o 49.	Wilkman, W. W. Om en prekalevisk kvartsitformation i norra delen af Kuopio socken. S. 1—18. 7 fig. Résumé en français. 1916	100: —
N:o 50.	Sauramo, Matti. Geochronologische Studien über die spätglaziale Zeit in Südfinnland. S. 1—44. 5 Abbild. 4 Taf. 1918	150: —
N:o 51.	Laitakari, Aarne. Einige Albitepidotgesteine von Südfinnland. S. 1—13. 5 Abbild. 1918	100: —
N:o 52.	Brenner, T. H. Über Theralit und Ijolit von Umptek auf der Halbinsel Kola. S. 1—30. 4 Fig. 1920	100: —
N:o 53.	Hackman, Victor. Einige kritische Bemerkungen zu Iddings' Classifikation der Eruptivgesteine. S. 1—21. 1920	100: —
N:o 54.	Laitakari, Aarne. Über die Petrographie und Mineralogie der Kalksteinlagerstätten von Parainen (Pargas). S. 1—113. 40 Abbild. 3 Taf. 1921	150: —
N:o 55.	Eskola, Pentti. On Volcanic Necks in Lake Jänisjärvi in Eastern Finland. P. 1—13. 1 Fig. 1921	100: —
N:o 56.	Metzger, Adolf A. Th. Beiträge zur Paläontologie des nordbaltischen Silurs im Ålandsgebiet. S. 1—8. 3 Abbild. 1922	100: —
*N:o 57.	Väyrynen, Heikki. Petrologische Untersuchungen der granitodioritischen Gesteine Süd-Ostbothniens. S. 1—78. 20 Fig. 1 Karte. 1923	—
*N:o 58.	Sederholm, J. J. On Migmatites and Associated Pre-Cambrian Rocks of Southwestern Finland. Part I. The Pellinge Region. P. 1—153. 64 fig. 8 plates. 1 map. 1923	—
N:o 59.	Berghell, Hugo und Hackman, Victor. Über den Quartzit von Kallinkangas, seine Wellenfurchen und Trockenrisse. Nach hinterlassenen Aufzeichnungen von Hugo Berghell zusammengestellt und ergänzt von Victor Hackman. S. 1—19. 19 Fig. 1923	100: —
N:o 60.	Sauramo, Matti. Studies on the Quaternary Varve Sediments in Southern Finland. P. 1—164. 22 fig. in the text. 12 fig., 1 map and 2 diagrams on 10 plates. 1923	250: —
N:o 61.	Hackman, Victor. Der Pyroxen-Granodiorit von Kakskerta bei Åbo und seine Modifikation. S. 1—23. 2 Fig. 1 Karte. 1923	100: —
N:o 62.	Wilkman, W. W. Tohmajärvi-konglomeratet och dess förhållande till kaleviska skifferformationen. S. 1—43. 15 fig. 1 karta. Deutsches Referat. 1923	100: —
N:o 63.	Hackman, Victor. Über einen Quarzsyenitporphyr von Saariselkä im finnischen Lappland. S. 1—10. 2 Fig. 1923	100: —
N:o 64.	Metzger, Adolf A. Th. Die jatulischen Bildungen von Suojärvi in Ostfinnland. S. 1—86. 38 Abbild. 1 Taf. 1 Karte. 1924	150: —
N:o 65.	Saxén, Martti. Über die Petrologie des Otravaaragebietes im östlichen Finnland. S. 1—63. 13 Abbild. 5 Fig. auf 1 Taf. 2 Karten. 1923	150: —
N:o 66.	Ramsay, Wilhelm. On Relations between Crustal Movements and Variations of Sea-Level during the Late Quaternary Time, especially in Fennoscandia. P. 1—39. 10 fig. 1924	100: —

---

*) Loppuunmyyty.
Out of print.

N:o 67.	Sauramo, Matti. Tracing of Glacial Boulders and its Application in Prospectin. P. 1—37. 12 fig. 1924	100: —
N:o 68.	Tanner, V. Jordskredet i Jaarila. S. 1—18. 2 fig. 10 bild. Résumé en français. 1924	100: —
N:o 69.	Auer, Väinö. Die postglaziale Geschichte des Vanajavesisees. S. 1—132. 10 Fig. 10 Taf. 11 Beil. 1924	250: —
N:o 70.	Sederholm, J. J. The Average Composition of the Earth's Crust in Finland. P. 1—20. 1925	100: —
N:o 71.	Wilkman, W. W. Om diabasgångar i mellersta Finland. S. 1—35. 8 fig. 1 karta. Deutsches Referat. 1924	100: —
N:o 72.	Hackman, Victor. Das Gebiet der Alkaligesteine von Kuolajärvi in Nordfinnland. S. 1—62. 6 Fig. 1 Taf. 1925	150: —
N:o 73.	Laitakari, Aarne. Über das jotnische Gebiet von Satakunta. S. 1—43. 14 Abbild. 1 Karte. 1925	150: —
N:o 74.	Metzger, Adolf A. Th. Die Kalksteinlagerstätten von Ruskeala in Ostfinnland. S. 1—24. 9 Abbild. 2 Karten. 1925	100: —
N:o 75.	Frosterus, Benj. Ueber die kambrischen Sedimente der karelischen Landenge. S. 1—52. 1 Fig. 1925	150: —
N:o 76.	Hausen, H. Über die präquartäre Geologie des Petsamo-Gebietes am Eismeere. S. 1—100. 13 Fig. 2 Taf. 1926	150: —
N:o 77.	Sederholm, J. J. On Migmatites and Associated Pre-Cambrian Rocks of Southwestern Finland. Part II. The Region around the Barösundsfjärd W. of Helsingfors and Neighbouring Areas. P. 1—143. 57 fig. in the text and 44 fig. on 9 plates. 1 map. 1926	300: —
N:o 78.	Väyrynen, Heikki. Geologische und petrographische Untersuchungen im Kainuugebiete. S. 1—127. 37 Fig. 2 Taf. 2 Karten. 1928	200: —
N:o 79.	Hackman, Victor. Studien über den Gesteinsaufbau der Kittilä-Lappmark. S. 1—105. 23 Fig. 2 Taf. 2 Karten. 1927	200: —
N:o 80.	Sauramo, Matti. Über die spätglazialen Niveauvershiebungen in Nordkarelien, Finnland. S. 1—41. 8 Fig. im Text. 11 Fig., 1 Karte und 1 Profildiagr. auf 7 Taf. 1928	100: —
N:o 81.	Sauramo, Matti und Auer, Väinö. On the Development of Lake Höytiäinen in Carelia and its Ancient Flora. P. 1—42. 20 fig. 4 plates. 1928	100: —
N:o 82.	Lokka, Lauri. Über Wiikit. S. 1—68. 12 Abbild. 1928	150: —
N:o 83.	Sederholm, J. J. On Orbicular Granite, Spotted and Nodular Granites etc. and on the Rapakivi Texture. P. 1—105. 19 fig. in the text and 50 fig. on 16 plates. 1928	250: —
N:o 84.	Sauramo, Matti. Über das Verhältnis der Ose zum höchsten Strand. S. 1—17. 1928	50: —
N:o 85.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, I. P. 1—88. 1 stéréogramme. 1929	200: —
N:o 86.	Sauramo, Matti. The Quaternary Geology of Finland. P. 1—110. 39 fig. in the text and 42 fig. on 25 plates. 1 map. 1929	300: —
N:o 87.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, II. P. 1—175. 48 fig. 8 planches. 1929	350: —
N:o 88.	Tanner, V. Studier över kvartärsystemet i Fennoskandias nordliga delar. IV. Om nivåförändringarna och grunddragen av den geografiska utvecklingen efter istiden i Ishavsfinland samt om homotaxin av Fennoskandias kvartära marina avlagringar. S. 1—589. 84. fig. 4 tavl. 1 karta. Résumé en français: Études sur le système quaternaire dans les parties septentrionales de la Fennoscandie. IV. Sur les changements de niveau et les traits fondamentaux du développement géographique de la Finlande aux confins de l'océan Arctique après l'époque glaciaire et sur l'homotaxie du quarternaire marin en Fennoscandie. 1930	750: —
N:o 89.	Wegman, C. E. und Kranck, E. H. Beiträge zur Kenntnis der Svecofenniden in Finland. I. Übersicht über die Geologie des Felsgrundes im Küstengebiete zwischen Helsingfors und Onas. II. Petrologische Übersicht des Küstengebietes E von Helsingfors. S. 1—107. 4 Fig. 16 Taf. mit 32 Fig. 1 Übersichtskarte. 1931	200: —

N:o 90.	Hausen, H. Geologie des Soanlahti-Gebietes im südlichen Karelien. Ein Beitrag zur Kenntnis der Stratigraphie und tektonischen Verhältnisse der Jatulformation. S. 1—105. 23 Fig. im Text und 12 Fig. auf 4 Taf. 1930	250: —
N:o 91.	Sederholm, J. J. Pre-Quaternary Rocks of Finland. Explanatory Notes to accompany a General Geological Map of Finland. P. 1—47. 40 fig. 1 map. 1930	150: —
N:o 92.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, III. P. 1—140. 29 fig. 3 plances. 1930	250: —
N:o 93.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, IV. P. 1—68. 12 fig. 6 planches. 1931	200: —
N:o 94.	Brenner, Thord. Mineraljordarternas fysikaliska egenskaper. S. 1—159. 22 fig. Deutsches Referat. 1931	350: —
N:o 95.	Sederholm, J. J. On the Sub-Bothnian Unconformity and on Archæan Rocks formed by Secular Weathering. P. 1—81. 62 fig. 1 map. 1931	250: —
N:o 96.	Mikkola, Erkki. On the Physiography and Late-Glacial Deposits in Northern Lapland. P. 1—88. 25 fig. 5 plates. 1932	250: —
N:o 97.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, V. P. 1—77. 15 fig. 1932	200: —
N:o 98.	Sederholm, J. J. On the Geology of Fennoscandia. P. 1—30. 1 map. 1 table. 1932	150: —
N:o 99.	Tanner, V. The Problems of the Eskers. The Esker-like Gravel Ridge of Čahpatoaiv, Lapland. P. 1—13. 2 plates. 1 map. 1932	100: —
N:o 100.	Sederholm, J. J. Über die Bodenkonfiguration des Päijänne-Sees. S.1—23. 3 Fig. 1 karte. 1932	250: —
N:o 101.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, VI. P. 1—118. 17 fig. 5 planches. 1933	250: —
N:o 102.	Wegmann, S. E., Kranck, E. H. et Sederholm, J. J. Compte rendu de la Réunion internationale pour l'étude du Précambrien et des vieilles chaînes de montagnes. P. 1—46. 1933	150: —
N:o 103.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, VII. P. 1—48. 2 fig. 1933	150: —
N:o 104.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, VIII. P. 1—156. 33 fig. 7 planches. 1934	250: —
N:o 105.	Lokka, Lauri. Neuere chemische Analysen von finnischen Gesteinen. S. 1—64. 1934	150: —
N:o 106.	Hackman, Victor. Das Rapakiwirandgebiet der Gegend von Lappeenranta (Willmanstrand). S. 1—82. 15 Fig. 2 Taf. 1 Analysentab. 1 Karte. 1934	200: —
N:o 107.	Sederholm, J. J. † On Migmatites and Associated Pre-Cambrian Rocks of Southwestern Finland. Part III. The Åland Islands. P. 1—68. 43 fig. 2 maps. 1934	200: —
N:o 108.	Laitakari, Aarne. Geologische Bibliographie Finnlands 1555—1933. S. 1—224. 1934	250: —
N:o 109.	Väyrynen, Heikki. Über die Mineralparagenesis der Kieserze in den Gebieten von Outokumpu und Polvijärvi. S. 1—24. 7 Fig. 1 Karte. 1935	100: —
N:o 110.	Saksela, Martti. Über den geologischen Bau Süd-Ostbothniens. S. 1—35. 11 Fig. 1 Titelbild. 1 Taf. 1 Karte. 1935	150: —
N:o 111.	Lokka, Lauri. Über den Chemismus der Minerale (Orthit, Biotit u. a.) eines Feldspatbruches in Kangasala, SW-Finnland. S. 1—39. 2 Abbild. 1 Taf. 1935	150: —
N:o 112.	Hackman, Victor. J. J. Sederholm. Biographic Notes and Bibliography. P. 1—29. With a vignette. 1935	100: —

N:o 113.	Sahama (Sahlstein), Th. G. Die Regelung von Quarz und Glimmer in den Gesteinen der finnisch-lappländischen Granulitformation. S. 1—110. 5 fig. 80 Diagr. 3 Taf. 1936	200: —
N:o 114.	Haapala, Paavo. On Serpentine Rocks in Northern Karelia. P. 1—83. 21 fig. 2 maps. 1936	150: —
N:o 115.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, IX. P. 1—505. 83 fig. 20 planches. 1936	500: —
N:o 116.	Väyrynen, Heikki. Petrologie des Nickelerzfeldes Kaulatunturi —Kammikivitunturi in Petsamo. S. 1—198. 71 Abbild. 36 Tab. 1 Karte. 1938	250: —
N:o 117.	Kilpi, Sampo. Das Sotkamo-Gebiet in spätglazialer Zeit. S. 1—118. 36 Abbild. 3 Beil. 1937	250: —
N:o 118.	Brander, Gunnar. Ein Interglazialfund bei Rouhiala in Südostfinnland. S. 1—76. 7 Fig. im Texte u. 7 Fig. auf 2 Taf. 1937	200: —
N:o 119.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, X. P. 1—170. 30 fig. 4 planches. 1937	250: —
N:o 120.	Hyyppä, Esa. Post-Glacial Changes of Shore-Line in South Finland. P. 1—225. 57 fig. 21 tab. 2 append. 1937	250: —
N:o 121.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XI. P. 1—166. 47 fig. 8 tab. 2 cartes. 1938	250: —
N:o 122.	Hietanen, Anna. On the Petrology of Finnish Quartzites. P. 1—118. 20 fig. 2 plates. 3 maps. 1938	250: —
N:o 123.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XII. P. 1—107. 20 fig. 3 planches. 1938	250: —
N:o 124.	Väyrynen, Heikki. On the Geology and Tectonics of the Outokumpu Ore Field and Region. P. 1—91. 11 fig. 2 maps. 1939	250: —
N:o 125.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XIII. P. 1—119. 45 fig. 1 planche. 1939	150: —
N:o 126.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XIV. P. 1—140. 60 fig. 4 planches. 1941	200: —
N:o 127.	Mölder, Karl. Studien über die Ökologie und Geologie der Bodendiatomeen in der Pojo-Bucht. P. 1—204. 7 Abbild. 1 Karte. 14 Diagr. 14 Tab. 1943	250: —
N:o 128.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XV. P. 1--183. 43 fig. 2 planches. 1943	250: —
N:o 129.	Lokka, Lauri. Beiträge zur Kenntnis des Chemismus der finnischen Minerale Glimmer, Pyroxene, Granate, Epidote u. a. Silikatminerale sowie melnikowitähnliches Produkt und Shungit. S. 1—72. 48 Tab. 1943	200: —
*N:o 130.	Hietanen, Anna. Über das Grundgebirge des Kalantigebietes im südwestlichen Finnland. S. 1—105. 55 Fig. 8 Tafeln. 1 Karte. 1943 ..	—
N:o 131.	Okko, V. Moränenuntersuchungen im westlichen Nordfinnland. S. 1—46. 12 Abb. 4 Tab. 1944	150: —
N:o 132.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XVI. P. 1—196. 41 diagr. 9 tabl. 3 vartes. 3 fig. 1944	250: —
N:o 133.	Rankama, Kalervo. On the Geochemistry of Tantalum. P. 1—78. 1 fig. 8 tables. 1944	200: —
N:o 134.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XVII. P. 1—91. 59 fig. carte. 1944	200: —
N:o 135.	Sahama, Th. G. Spurenelemente der Gesteine im südlichen Finnisch-Lappland. S. 1—86. 12 Fig. 29 Tab. 1945	200: —

---

*) Loppuunmyyty.
Out of print.

N:o 136.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XVIII. P. I—XXXVIII; 1—67. 3 diagr. 11 tabl. 2 cartes. 11 fig. 2 planches. 1945	250: —
N:o 137.	Rankama, Kalervo. On the Geochemical Differentiation in the Earth's Crust. P. 1—39. 18 tables. 1946	150: —
N:o 138.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XIX. P. 1—120. 7 diagr. 13 tabl. 9 fig. 1 planche. 1946	250: —
N:o 139.	Brenner, Th. Om mineraljordarternas hållfasthetsegenskaper. S. 1—77. 11 fig. Summary in English. 1946	150: —
N:o 140.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XX. P. 1—302. 37 tabl. 103 fig. 6 planches. 2 cartes. 1947	400: —
N:o 141.	Simonen, Ahti. On the Petrochemistry of the Infracrustal Rocks in the Svecofennidic Territory of Southwestern Finland. P. 1—18. 7 tabl. 5 fig. 1948	50: —
N:o 142.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XXI. P. 1—129. 45 fig. 1 planche. 4 tabl. 3 cartes. 1948	250: —
N:o 143.	Simonen, Ahti. On the Petrology of the Aulanko Area in Southwestern Finland. P. 1—66. 25 fig. 6 tabl. 1 map. 1948	150: —
N:o 144.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XXII. P. 1—165. 70 fig. 3 plances. 4 cartes. 1949	250: —
N:o 145.	Salmi, Martti. Physical and Chemical Peat Investigations on the Pinomäensuo Bog, SW. Finland. P. 1—31. 12 fig. 1 table. 1949	100: —
N:o 146.	Mikkola, Aimo. On the Geology of the Area North of the Gulf of Bothnia. P. 1—64. 20 fig. 10 tabl. 1 map. 1949	150: —
N:o 147.	Härme, Maunu. On the Stratigraphical and Structural Geology of the Kemi Area, Northern Finland. P. 1—60. 29 fig. 4 tabl. 1 map. 1949	150: —
N:o 148.	Edelman, Nils. Structural History of the Eastern part of the Gullkrona Basin, SW-Finland. P. 1—48. 16 fig. 2 tabl. 8 plates. 1949	150: —
N:o 149.	Lokka, Lauri. Contributions to the Knowledge of the Chemistry of the Radioactive Minerals of Finland. P. 1—76. 7 fig. 33 tabl. 1950	200: —
N:o 150.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XXIII. P. 1—111. 27 fig. 7 planches. 5 tabl. 2 cartes. 1950	300: —
N:o 151.	Lokka, Lauri. Chemical Analyses of Finnish Rocks. P. 1—75. 1950	200: —
N:o 152.	Kahma, Aarno. On Contact Phenomena of the Satakunta Diabase. P. 1—84. 22 fig. 10 tabl. 5 plates. 1951	250: —
N:o 153.	Seitsari, Juhani. The Schist Belt Northeast of Tampere in Finland. P. 1—120. 53 fig. 9 tabl. 2 maps. 1951	400: —
N:o 154.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XXIV. P. 1—241. 95 fig. 3 planches. 24 tabl. 1951	500: —
N:o 155.	Virkkala, K. Glacial Geology of the Suomussalmi Area, East Finland. P. 1—66. 26 fig. 1 plate. 1951	200: —
N:o 156.	Marmo, Vladi — Mikkola, Aimo. On Sulphides of the Sulphide-bearing Schists of Finland. P. 1—44. 7 fig. 4 plates. 1951	150: —
N:o 157.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XXV. P. 1—148. 35 fig. 28 tabl. 1952	450: —
N:o 158.	Neuvonen, K. J. Thermochemical Investigation of the Åkermanite — Gehlenite Series. P. 1—57. 7 fig. 12 tabl. 1952	150: —
N:o 159.	Suomen Geologisen Seuran julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société géologique de Finlande, XXVI.	400: —
N:o 160.	Simonen, Ahti. Stratigraphy and Sedimentation of the Svecofennidic Early Archean Supracrustal Rocks in Southwestern Finland. P. 1—64. 17 fig. 8 tabl. 2 maps. 1953	200: —
N:o 161.	Disler, Jürg. Die Kupferkieslagerstätte von Outokumpu, Finnland. (Ihre Lage, ihre Struktur und ihre Form.) S. 1—114. 39 Fig. 9 Diagr. 4 Taf. 1953	400: —

N:o 162.	Kaitaro, Simo. Geologic Structure of the Late Pre-Cambrian Intrusives in the Åva Area, Åland Islands. P. 1—71. 37 fig. 6 tabl. 1 map. 1953	200: —
N:o 163.	Vaasjoki, Oke. On Migmatites and Ore Mineralizations in the Pernaja District, Southern Finland. P. 1—62. 24 fig. 3 tabl. 1 plate 1 map. 1953	200: —
N:o 164.	Vähätalo, Veikko O. On the Geology of the Outokumpu Ore Deposit in Finland P. 1—99. 9 fig. 13 tabl. 19 plates and 3 maps. 1953	650: —
N:o 165.	Wiik, H. B. Composition and origin of Soapstone. P. 1—57. 11 fig. 6 tabl. 1953	150: —
N:o 166.	Suomen Geologisen Seuran julkaisuja. — Meddelanden från Geologiska Sällskapet i Finland. — Comptes Rendus de la Société géologique de Finlande XXVII. P. 1—106. 16 tabl. 43 fig. 1954	350: —
N:o 167.	Hyyppä, Esa. On the Pleistocene Geology of Southeastern New England. P. 155—225. 33 fig. 1955	200: —
N:o 168.	Suomen Geologisen Seuran julkaisuja. — Meddelanden från Geologiska Sällskapet i Finland. — Comptes Rendus de la Société géologique de Finlande XXVIII. P. 1—141. 63 fig. 34 tabl. 1955	450: —
N:o 169.	Salmi, Martti. Prospecting for Bog-Covered Ore by Means of Peat Investigations. P. 1—34. 6 fig. 8 tabl. 1955	150: —
N:o 170.	Okko, Veikko. Glacial Drift in Iceland, its Origin and Morphology. P. 1—133. 35 fig. and one table in text. 32 fig. in plates I—XVI. 1955	400: —
N:o 171.	Pääkkönen, Veikko. Otanmäki, the Ilmenite-Magnetite Ore Field in Finland. P. 1—71. 41 fig. 19 tabl. 2 plates and 3 maps. 1956	300: —
N:o 172.	Suomen Geologisen Seuran julkaisuja. — Meddelanden från Geologiska Sällskapet i Finland. — Comptes Rendus de la Société géologique de Finlande XXIX. P. 1—100. 24 fig. 30 tabl. 1956	350: —
N:o 173.	Ramdohr, Paul. Die Beziehungen von Fe-Ti-Erzen aus magmatischen Gesteinen. S. 1—19. 2 Diagr. 25 Taf. 1956	400: —
N:o 174.	Savolahti, Antti. The Ahvenisto Massif in Finland. The Age of the Surrounding Gabbro-anorthosite Complex and the Crystallization of Rapakivi. P. 1—96. 22 fig. 11 tabl. and 1 map 1956	350: —
N:o 175.	Salmi, Martti. Peat and Bog Plants as Indicators of Ore Minerals in Vihanti Ore Field in Western Finland. P. 1—22. 6 fig. 1 tabl. 1956	100: —
N:o 176.	Marmo, Vladi. Geology of the Nokia region, Southwest Finland. P. 1—38. 16 figs. 1957	150: —
N:o 177.	Tuominen, Heikki. The Structure of an Archaean Area: Orijärvi, Finland. P. 1—32. 16 figs. 6 plates. 1957	500: —
N:o 178.	Mölder, K., Valovirta, V. und Virkkala, K. Über Spätglazialzeit und frühe Postglazialzeit in Südfinnland. S. 1—49. 9 Abb.	200: —
N:o 179.	Repo, R. Untersuchungen über die Bewegungen des Inlandeises in Nordkarelien. S. 1—178. 114 Abbild. 1 Taf. 1 Karte. 1957	600: —
N:o 180.	Suomen Geologisen Seuran julkaisuja. — Meddelanden från Geologiska Sällskapet i Finland. — Comptes Rendus de la Société géologique de Finlande XXX	400: —
N:o 181.	Parras, Kauko. On the Charnockites in the Light of a Highly Metamorphic Rock Complex in Southwestern Finland. P. 1—137. 24 figs. 13 tables and 1 map. 1958	600:—
N:o 182.	Kouvo, Olavi. Radioactive Age of some Finnish Pre-Cambrian Minerals. P. 1—70. 3 figs. 10 tables. 1958	300: —
N:o 183.	Virkkala, K. Über die spätquartäre Entwicklund in Satakunta, W-Finnland. S. 1—56. Abb. 26. 1959	200: —
N:o 184.	Suomen Geologisen Seuran julkaisuja. — Meddelanden från Geologiska Sällskapet i Finland. — Comtes Rendus de la Société géologique de Finlande XXXI. P. 1—137. 30 figs. 29 tabl. 8 pls. 1959	450: —
N:o 185.	Lehijärvi, Mauno. The Alkaline District of Iivaara, Kuusamo, Finland. P. 1—62. 23 figs. 24 tables and 1 plate. 1960	300:—
N:o 186.	Salmi, Martti. Imatra Stones in the Glacial Glay of Vuolenkoski. P. 1—27. 8 figs. 1 table. 1959	150: —

N:o 187. Edelman, Nils. Gullkrona region, SW Finland. (in print) ....

N:o 188. Suomen Geologisen Seuran Julkaisuja — Meddelanden från Geologiska Sällskapet i Finland — Comptes Rendus de la Société Géologique de Finlande. XXXII. (in print) ....

N:o 189. Simonen, Ahti. Plutonic rocks of the Svecofennides in Finland. (in print) ....

N:o 190. Marmo, Vladi. On the sulphide and sulphidegraphite schists of Finland. (in print) ....

N:o 191. Simonen, Ahti. Pre-Quaternary rocks in Finland. P. 1—49. 26 rigs. 1 table. 1 map. 1960 .... 700: —

SUOMEN KALLIOPERÄ
PRE-QUATERNARY ROCKS OF FINLAND
FINLANDS BERGGRUND