

INTERNATIONAL GEOLOGICAL CONGRESS
XXI SESSION NORDEN 1960

**DEVELOPMENT OF GNEISSES
AND GRANITES IN SOUTHERN SWEDEN**

GUIDE TO EXCURSIONS NOS A 28 AND C 23

By

SVEN GAVELIN AND PER H. LUNDEGÅRDH



The Swedish geological guide-books

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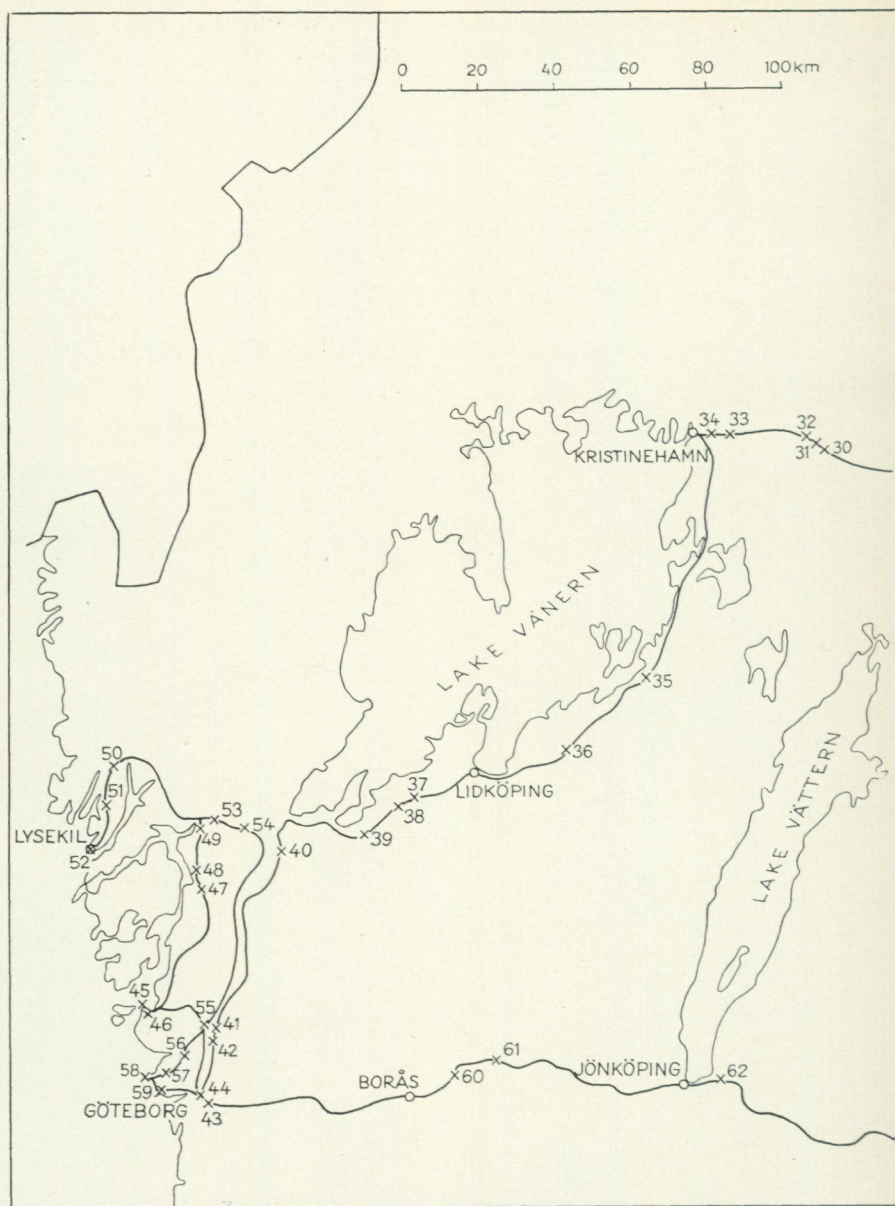
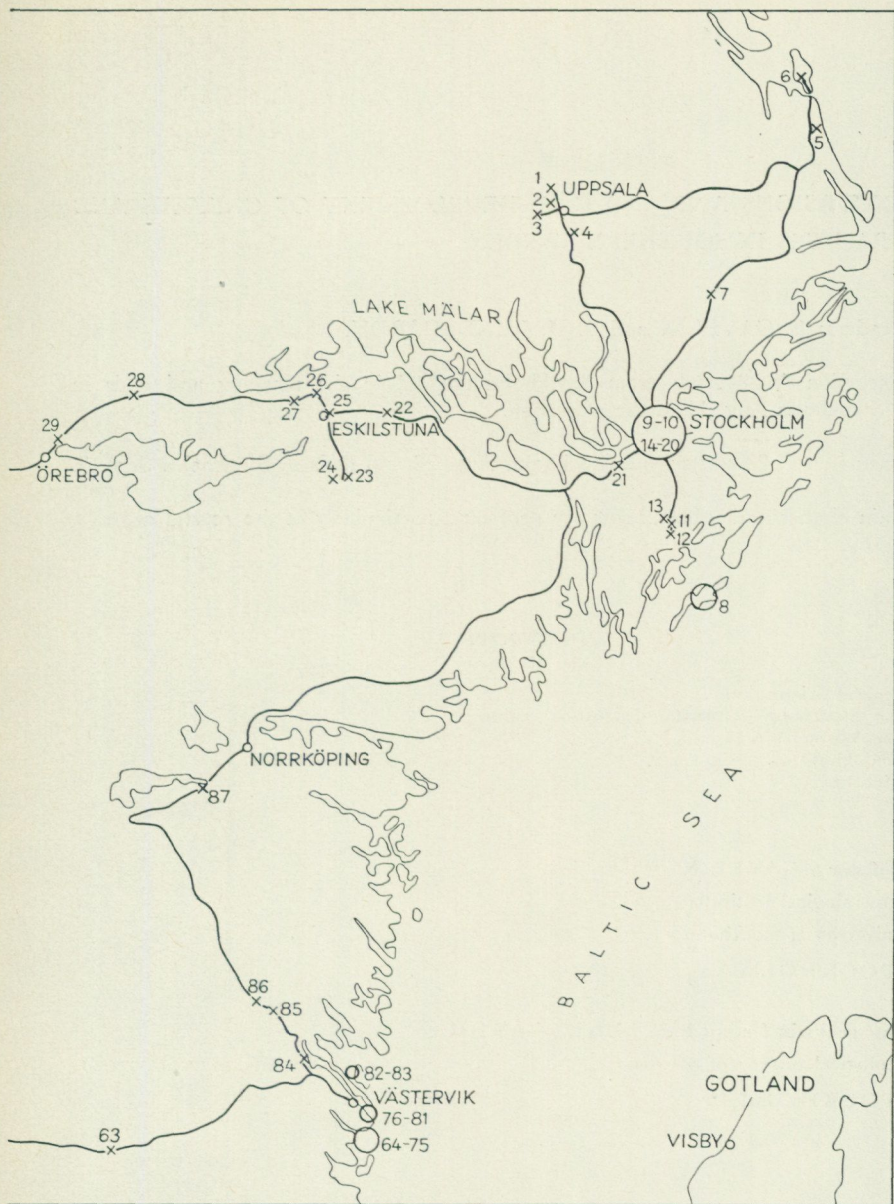


Fig. 1. Excursion route and positions of the localities to be visited. The localities of the Stockholm and Västervik areas are presented in greater detail in Figs. 4 and 12 respectively.



After the preparation of this map, two localities have been inserted in the region between Lidköping and Lysekil, viz. No 37 a 5 km E. N. E. of No 37 and No 40 b 5 km S. S. W. of No 40.

EXCURSIONS A 28 AND C 23: DEVELOPMENT OF GNEISSES AND GRANITES IN SOUTHERN SWEDEN

Leaders: S. GAVELIN and P. H. LUNDEGÅRDH.

Excursion A 28 starts from Stockholm Aug. 2 in the morning and ends in Stockholm Aug. 14 in the afternoon.

Excursion C 23 starts from Stockholm Aug. 26 and ends in Stockholm Sept. 7.

Rain clothes and rubber boots are necessary, particularly in the coastal areas.

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Key map of the Swedish excursions will be found inside of back cover.

General Orientation

By

PER H. LUNDEGÅRDH

The aim of excursions A 28 and C 23 (Fig. 1) will be a demonstration of various supracrustal rocks of the Archean of Southern Sweden and of their alteration products, viz. gneisses, migmatites, and granites. The oldest supracrustal rocks belong to an Old Archean cycle known as the Svecofennian (in Sweden also called the Svionian), the evolution of which seems to have proceeded along the following lines:

	Late Sveco- fennian	Repeated tectonic activity and migmatization	Development of porphyroblasts and/or veins in older rocks. Acid granites, aplite, pegmatite
		Development of joints	Dikes of metabasites and porphyries. Plutonic peridotite and anorthosite, ultrabasic gabbro
	Middle Sveco- fennian	Decreasing orogeny	Acid, intermediate, and porphyritic granites ¹
		Strong tectonic activity,	Basic granite = granodiorite Tonalite Diorite, metabasites ² Gabbro Lherzolite, ultra-mafic gabbro
Old Svecofennian	Målar series ³	strong volcanism	Sedimentary gneisses (most frequently veined), schists, graywackes, intermediate and basic volcanics, porphyritic intrusions, quartzite
	Leptite-hälleflint series ⁴	Increasing tectonic activity	Reddish and red gneisses (frequently veined), leptites, hälleflints, porphyrites, quartzite, limestone, iron ore

¹ In part supracrustal rocks granitized *in situ*

² Mainly metamorphic supracrustal rocks

³ In Finland known as the Bothnian

⁴ In Finland known as the Svionian

The Svecofennian supracrustal rocks and their derivatives (gneisses, mostly veined, and granites) will be demonstrated in the Stockholm—Målar region in its wide sense which includes the central, eastern, and southern parts of the Uppland county, the Stockholm district, and the Södermanland county. We

shall here get acquainted with old volcanics — in the first instance acid ones — and sediments — especially schists and graywackes. We shall also study various gneisses, viz. red and gray, mostly veined and in part banded. Finally, attention will be paid to granites, both basic to acid primorogenic (synkinematic) ones (Middle Svecofennian) and acid serorogenic (late-kinematic) ones (Late Svecofennian). The former have long been known in Sweden as *urgraniter* and comprise both tonalite and granodiorite as well as real granites. The latter comprise the palingenic Stockholm granite and associated rocks including regenerated primorogenic granites, aplites, and pegmatites. Most of the serorogenic rocks have developed by strong alteration (granitization, palingenesis) of Svecofennian volcanics (acid) and sediments.

A more detailed description of the Svecofennian rocks of the Stockholm—Mälars region with special reference to the excursion route will be found in the article below (p. 7 ff) and in P. H. Lundegårdh (1956 and 1960). As suggestions for further reading the following articles should be mentioned; namely 1. referring to the Stockholm area: N. Sundius (1947), B. Loberg (1959), and S.

Late Gothian	Repeated tectonic activity and migmatization	Development of microcline porphyroblasts in older rocks, acid granite (fine-grained), pegmatite
	Decreasing orogeny	Microcline granites (Kroppefjell granite, part of the red Småland granites, etc.) Intermediate granites Porphyritic granites and granodiorites (Askim granite, Filipstad granite, etc.)
	Strong orogeny	Basic granites = granodiorites and tonalites (Åmål granite, gray Småland granite, etc.) Diorite Gabbro Plutonic ultra-basites
	Increasing orogeny	Sedimentary rocks (mainly quartzites) and volcanics (Åmål series, Småland porphyries, Västervik and Vestaná series, etc.)
Early Gothian	Migmatization	Development of veined gneiss, pegmatites
	Strong orogeny	Granites Plutonic basites and ultra-basites
	Increasing orogeny	Sedimentary rocks (mainly graywackes) and volcanics (Stora Le—Marstrand series, Blekinge coastal gneiss, etc.)

Gavelin (1960); 2. referring to areas N. of Stockholm: Th. Lundqvist (1959); 3. referring to the Utö area: P. J. Holmquist (1910), N. Pilava-Podgurski (1956), and Gavelin (1960).

The Middle Archean evolution is known in Sweden as the Gothian. Rocks belonging to this era will be visited in regions situated south and west of the Stockholm—Mälars region. The Gothian evolution very approximately runs according to the above scheme.

The Early Gothian sedimentary rocks of the Stora Le—Marstrand series will be studied at various localities in the Göteborg (Gothenburg)—Lysekil region in Southwestern Sweden, the Late Gothian sedimentary rocks southwest of Lake Vänern and to the north of Göteborg (Åmål series), in the same region, as well as in the Västervik region, Southeastern Sweden. Late Gothian granites will be met with in various parts of Southern Sweden. Special attention will be paid to primorogenic tonalites (Åmål granite, gray Småland granite), as well as to primorogenic granites and granodiorites with microcline porphyroblasts (Askim and Filipstad granites).

A detailed description of the Västervik area, by S. Gavelin, is given below (p. 11 ff). See also T. Du Rietz (1949) and Gavelin (1960). As regards the Göteborg (Gothenburg) region, the reader is referred to P. H. Lundegårdh (1953 and 1958).

The Gothian supracrustal rocks and granitization products *in situ* border on older gneisses, frequently banded, and gneiss-granites of unknown age (the pre-Gothian "iron gneiss" complexes of Southwestern Sweden) or, in part of Southeastern Sweden, probably belonging to the Svecofennian. The pre-Gothian rocks of Southwestern Sweden will be demonstrated at numerous localities northeast, east, and eastsoutheast of Göteborg (Gothenburg).

The youngest Archean rocks of Sweden are the Dalslandian sediments (mainly quartzites and slates or schists) occurring west of Lake Vänern, as well as the Dalslandian granite and pegmatites. The Dalslandian palingenic granite known as Bohus granite will be shown in the neighbourhood of Lysekil, to the north of Göteborg (Gothenburg). This granite mostly seems to originate from rocks belonging to the Stora Le—Marstrand series and underlying pre-Gothian rocks.

The Stockholm—Uppsala—Eskilstuna Region

By

S. GAVELIN AND P. H. LUNDEGÅRDH

As was mentioned in the "General Orientation" the Stockholm area forms part of the so-called Svecofennian belt which occupies large portions of southern Central Sweden and continues eastwards into the southwestern parts of Finland. From the table, page 5, it is seen that two divisions of supracrustal rocks have been identified:

1. The leptite-hällefliint series, characterized by volcanics of metarhyolitic composition, abundant iron ores, and limestones.
2. The Mälars series, largely composed of normal sediments and volcanics, mainly of dacitic or andesitic compositions. Iron ores are practically absent. Poor sorting, scarcity of pure quartzites and limestones give the sedimentary sequence the characteristics of a graywacke suite.

A geological map of the Stockholm—Uppsala area shows that to the north of Stockholm, the primorogenic granites have a wide extension and that supracrustal rocks form fairly narrow strips. South of Stockholm and in the vicinity of the capital wide areas are dominated by veined gneisses which are most probably derived from the graywacke sediments and to a certain extent from Old or Middle Svecofennian intrusives. The most typical development of the leptite-hällefliint series with iron ores is found in the inner parts of southern Central Sweden some 150—200 km W. and N.W. of Stockholm but narrow strips of these rocks extend also to the east, the southernmost area containing identifiable metarhyolitic leptite occurring immediately to the north of Uppsala, about 70 km N. of Stockholm. (See Lundegårdh, 1956.) In addition, there also exists a belt of rocks with still identifiable primary structures belonging to the leptite series in the archipelago E. and S.E. of Stockholm. The island of Utö is situated in this zone, and there beds of fine-grained leptites consisting of quartz, feldspar and subordinate biotite, chlorite and muscovite alternate with beds of limestone. Due to metamorphism some of the calcareous beds have been transformed to skarn rocks. This series contains quartz-banded iron ores — the most low-metamorphic forms appearing as beautifully banded ore with alternating layers of jasper and hematite. Progressive metamorphism has frequently transformed the jasper bands into gray quartz with a subordinate amount of magnetite. In such cases the ore bands mainly consist of magnetite. When calcareous beds were present, skarn bands were formed (diopside, hornblende, actinolite, epidote being the most common minerals).

The leptite zone in the Stockholm archipelago is sometimes bordered by comparatively low-metamorphic sediments of the graywacke series, where primary sedimentary structures are still visible. Alternations between light (originally arenaceous) and dark (originally argillaceous) beds are common features. In these rocks cross-bedding and graded bedding can sometimes be observed (Figs. 2 and 3). Beds or lenses of intraformational conglomerate also occur. The degree of metamorphism can be characterized by the appearance of such minerals as andalusite, cordierite and/or almandite in the micaceous beds.

Among the primorogenic intrusive rocks medium-grained tonalitic or granodioritic varieties are dominating, whereas potassic granites are less abundant. Diorites and gabbros are also met with, and particularly the tonalites and granodiorites frequently contain large amounts of metabasite inclusions ("dark spots"), which show that basites older than the tonalites have existed. On the other hand the primorogenic granites are also penetrated by metabasite dikes, which in some areas may represent a characteristic and important feature in the bedrock. All the rocks mentioned have been penetrated by the serorogenic granites (Stockholm granites), which may also be characterized as late- or postkinematic. The serorogenic granites are mostly gray and fine-grained, but

coarse porphyritic forms may sometimes occur. Generally they contain both plagioclase (oligoclase or albite) and microcline; more pure potassic as well as more sodic types are also met with, however. These granites are always associated with pegmatites and seem to be closely related to the development of the veined gneisses. Most of the pegmatites have a simple composition — quartz, microcline, plagioclase and micas being their chief constituents. In a few cases lithium minerals (Utö) or rare earth minerals (Ytterby) have been encountered.

The gneisses to the south of Stockholm are generally rich in almandite, cordierite, and often sillimanite. North of Stockholm these minerals seem to be less abundant and the gneisses have a conspicuous veined structure with alternating *schlieren* of pegmatitic veins (metatekt) and the remaining gneiss material (paleosome). A separation between paleosome and metatekt is far less marked in the southern gneiss areas. In the gneisses remnants of primorogenic granites, metabasites (Fig. 5), and quartzitic beds can sometimes be identified, but frequently thermal and kinetic metamorphism have obliterated primary structural and textural features to such an extent that no definite statement can be made as to the exact nature of the original rock.

Transitions between gneissic supracrustal rocks with preserved primary structures and serorogenic granitic rocks indicate that such granites at some places may have been formed through granitization *in situ*. On the other hand, the most typical serorogenic granites and pegmatites clearly brecciate the gneisses, and the veins and dikes of granite frequently cut the S-planes of the older rocks. Wide areas to the north of Stockholm have the character of a giant intrusion breccia, the latest granite and pegmatite dikes being definitely post-kinematic. Gneiss blocks of varying dimensions are sometimes found to have been dislocated and rotated by the emplacement of the granite.

The Svecofennian orogenesis is believed to have occurred in several stages. The oldest folding is closely connected with the emplacement of the primorogenic granites, which during this phase frequently received a certain schistosity. This oldest set of folds was cut by the post-granite metabasite dikes which in turn were intensely deformed during a later phase of deformation when also the old S-planes in the primorogenic granites were plastically deformed. In the opinion of the present author¹ this later phase of folding is intimately connected with pegmatitization and the formation of veined gneisses and ends with emplacement of the serorogenic granites (Stockholm granites).

A geological map of the Stockholm area shows that the gneisses S. and E. of Stockholm form several big arcs (Fig. 4). The linear structures and fold axes of these arcs invariably pitch towards the east when observed in the crests of the arcs, whereas the directions in the limbs are more irregular, though frequently almost vertical. Since primorogenic granites and post-granite metabasites are overtaken by the "arc-folding" it seems plausible to the present author¹ that the development of these arcs — at least in the main — is closely associated with the pegmatitization and granitization.

The surroundings of Stockholm offer many examples of the relationships between gneiss formation and emplacement of granites on one hand and kinetic metamorphism on the other. As was mentioned above, the areas to the

¹ S. Gavelin.

north of Stockholm are characterized by granites and pegmatites brecciating the gneisses. Frequently the homogeneous granites are found to cut one or several generations of pegmatite — the oldest dikes then generally being overtaken to some extent by the movements, whereas the latest dikes are clearly postkinematic. When moving southwards in the Stockholm area proper it is found that also granite dikes have been included in the last stages of folding and no definitely postkinematic dikes occur. The frequency of pegmatite and granite dikes is also found to decrease from the north towards the south, and in the more homogeneous gneisses south of Stockholm discordant granite or pegmatite dikes are very rare or absent. At present these facts cannot be given any satisfactory explanation since more regional observations are still too scanty and a more comprehensive discussion of the problem cannot be presented briefly.

In the Eskilstuna region, rocks similar to those described above can be distinguished. The volcanics of the leptite-hälleflint series have been strongly changed during the Svecofennian orogenesis, however. For the most part they display reddish gray to red, more or less granitic gneisses, frequently with veins of dissolved and recrystallized acid silicate minerals — potassic feldspar and quartz essentially. Layers and lenses of metabasite are common (Fig. 6). Part of the layers may be interpreted as dikes. Most of the lenses are boudins.

The leptite gneisses also contain layers of limestone and dolomite. These have been boudined and have recrystallized so that part of them are now rather coarse-grained. Skarn minerals are common (spinel, serpentine, *etc.*)

The Mälars series comprises quartzites (arkosic quartzites and subgraywackes, cp. Pettijohn 1957), graywackes (Fig. 2), slates, and basic volcanics. Graywackes and slates predominate. During the Svecofennian orogenesis, they have been altered to gray mica gneiss, garnet gneiss, and garnet-cordierite-sillimanite gneiss. These gneisses are most frequently rich in conformable veins of dissolved and recrystallized feldspar and quartz containing spots of the mafic minerals of the rocks (Fig. 7). The garnet-cordierite-sillimanite gneiss mostly contains some graphite and frequently pyrite, too. It seems to derive its origin from clay slates exclusively, and is concentrated in the southernmost part of the Eskilstuna region.

During the primorogenic (synkinematic) phase of the Svecofennian evolution, the supracrustal rocks were subjected to strong isoclinal folding along low-dipping east—west axes. The folding ended in thrusts along the limbs of the folds. Simultaneously a number of varieties of primorogenic granite developed, at first tonalite and finally common granites rich in microcline. Much of the primorogenic granite has to be interpreted as Svecofennian supracrustal rocks granitized *in situ*, and the rest of the primorogenic granite seems to display homogenized and mobilized, Old Svecofennian rocks.

The serogenic (late-kinematic) phase of the Svecofennian evolution was characterized by tension and migmatization. The migmatizing agents entered the opening *S*-planes of the country rocks and dissolved part of these, thus giving rise to pegmatite veins — red or reddish in the leptite gneisses, grayish or white in the slate and graywacke gneisses. Part of the country rocks (chiefly the supracrustal ones) were subjected to very strong solution, became mobile and were then intruded as granites and pegmatites. Another part of the country

rocks (chiefly red leptite and red-gray primorogenic granodiorite or granite) became reomorphosed, or regenerated (weak primorogenic structures in the groundmass, cp. Fig. 8, and a lot of serorogenic, roughly idiomorphic microcline porphyroblasts).

The excursions during the first two days (N. of Stockholm and on Utö) are intended to demonstrate the best preserved Svecofennian rocks in the areas to be visited (leptites and graywacke sediments, primorogenic granites and post-granite metabasite dikes). The main purpose will be to give a general idea of the composition and pattern of the kind of bedrock, which was overtaken by the last phase of the Svecofennian metamorphism and which gave rise to the development of veined gneisses and serorogenic granites. During the third day various gneisses derived from the graywacke sediments will be studied, and in addition the relations between these gneisses and serorogenic granites and pegmatites. Similar gneisses will also be met with during the fourth day, but during this part of the excursion we will study gneisses derived from a bedrock where leptites, primorogenic granites, and metabasites were the essential rocks.

The Västervik Area

By

S. GAVELIN

The eastern part of Southern Sweden is dominated by Gothian late- or postkinematic granites. In these are found belts and strips of Gothian supracrustal rocks — both volcanics and sediments. The granites clearly penetrate the supracrustal rocks for the most part but sometimes transitions from volcanics and sediments to granitic rocks are encountered. The surroundings of Västervik on the western coast of the Baltic Sea provide very good examples of the mutual relations between sediments, gneisses and Late-Gothian granites.

The sediments of the Västervik area consist largely of pure quartzites, but feldspathic forms are also met with, particularly in the higher portions of the sedimentary column. Argillaceous sediments occur but are generally intimately mixed up with feldspathic arenites and therefore seem to represent members of a graywacke suite in the sense of Pettijohn (1957). On the other hand, much of the feldspathic quartzite may be characterized as normal arkose. Since metamorphism is a clearly selective process and in the first instance affects the argillaceous portions of the rock sequence, it could be surmised that such sediments originally were much more abundant in the primary basins of sedimentation. Limestones are practically lacking.

Quartzites and arkoses are generally devoid of visible bedding. Sometimes, especially when small amounts of coloured minerals are present, the pure quartzites disclose fine bedding, frequently cross-bedding (Fig. 14). By following up cross-bedding continuously in certain sections it has been possible to show that the thickness of the lower homogeneous quartzite exceeds 1,800 m.

It has not yet been possible to fix the base of the sediments due to the fact

that metamorphism, granitization and granite intrusions have obliterated the primary structures.

The argillites, graywackes and arkoses seem to form an upper division in the sedimentary column but true quartzites are also frequently found among these rocks, though of limited vertical and lateral extension. Sand fillings in mud cracks in argillaceous beds intercalating with arenite beds (Fig. 13) disclose these very sediments to have been formed in a littoral zone. Other primary sedimentary structures observed are graded bedding and ripple marks.

The great thickness of the lower quartzites and the composition of the argillaceous sediments show that sedimentation occurred in a basin characterized by subsidence — probably a geosyncline.

Great masses of basic eruptive rocks occur together with the sediments. Due to metamorphism they now appear as amphibolites. Most of them probably represent intrusives, metagabbros or metadiorites and metadolerites, but it is possible that some of the amphibolites represent originally effusive rocks. Metadacitic and metaandesitic rocks have been observed at one or two localities in the coastal area examined but acid volcanics of the types, which are common in the western inland areas, are absent in the Västervik area proper.

A fairly gentle early phase of folding created a series of anticlines and synclines, oriented N.W.—S.E. in the northern parts of the area, E.—W. or even E.S.E.—W.S.W. in the south. A later phase of tectonism, closely connected with regional thermal and metasomatic metamorphism (formation of gneisses and granitization), was characterized by intense shearing. As a consequence of divergencies with regard to competence in the various sedimentary rocks the deformation was in many respects selective and a very complicated structural pattern was frequently formed, especially in the southern parts of the area. Low-competent rocks (argillites) reacted by flow, high-competent rocks (quartzites, amphibolites) became ruptured (Fig. 15) and broken blocks were frequently rotated. The quartzites behaved more plastically than the amphibolites and penetrated by mechanical force ruptured basic rocks.

Regional metamorphism has a somewhat irregular areal distribution. In the best preserved rocks primary sedimentary structures are still visible. The argillaceous rocks even in areas characterized by comparatively weak metamorphism sometimes contain such minerals as andalusite, cordierite and sillimanite. By more intense metamorphism, particularly if connected with shear, veined gneisses were formed (Fig. 16). Transitions from sediments with interpretable sedimentary structures to granitic rocks with more or less abundant remnants of quartzite and amphibolite can frequently be observed. A peculiar type of metamorphism is the "spotted gneiss", i.e. feldspathic arenites with spots consisting of biotite, sillimanite, and andalusite, surrounded by rims of microcline and some quartz.

The more homogeneous granites are decidedly potassic and both gneiss-formation and granitization seem to be connected with a potash metasomatism. Some granitic rocks seem to have been formed by a granitization more or less *in situ*, but there are also granites with definitely intrusive appearance. The latest granite dikes are clearly postkinematic. In the opinion of the present author the various granites of the area represent various stages of mobilization.

The formation of veined gneisses and granitization are definitely selective

processes, the argillaceous rocks — sometimes with intercalations of feldspathic arenites — being most readily attacked. In part this is very probably due to their tendency to react by flow on mechanical deformation. The chemical composition may also be an essential factor. Pure quartzites are resistant and frequently remain rather intact even in very strongly granitized masses. They are then intensely recrystallized and have thus become very coarse. Sometimes an invasion of microcline in the primarily pure quartzites can be observed. Amphibolites behave approximately in the same manner as quartzites in this respect.

The objects of the excursions in the Västervik area, 10th, 11th, 12th day, can be summarized under the following headings:

1. The primary sediments and their structures.
Localities Nos 64—68.
2. Tectonics, patterns of various kinds of deformation in rocks devoid of granitic or pegmatitic material.
 - a) Gentle folding: Locality No 71.
 - b) Selective deformation of bedded arenite-argillite rocks: Locality No 68.
 - c) Relations between pure quartzite and metabasite dikes: Locality No 77.
3. Structural pattern of deformation connected with granitization and formation of veined gneisses.
 - a) Relations between amphibolites and pure quartzites: Localities Nos 72—74.
 - b) Relation between shearing, thermal and metasomatic metamorphism of bedded sediments: Localities Nos 74, 76.
4. Gradual transformation of sediments into veined gneisses and granites.
 - a) Feldspathization of pure quartzites: Locality No 76.
 - b) Transition from bedded sediments into veined gneiss and granite: Localities Nos 69, 70, 74—77, 80.
5. Formation of spotted gneiss: Localities Nos 78, 79, 82.

Field Guide

(Number of localities, see Fig. 1)

Day 1.

Svecofennian rocks. Leader: P. H. LUNDEGÅRDH.

Route:

By bus Stockholm—Uppsala—BJÖRKBY—Ulva—Broby—Gränby—GRÖNDAL—Gränby—Österby—LÄBY—Uppsala—LILLA DJURGÅRDEN—Almunge—Edsbro—Elmsta—NOTHAMN—Grisslehamn—RIDDARSKÄRET—Grisslehamn—Elmsta—Edsbro—Rimbo—HALL—Angarn—Stockholm.

FIRST STOP:

Björkby.

Loc. No 1.

Tuff breccia (Old Svecofennian quartz-porphry).



Photo: Th. LUNDQVIST.

Fig. 2. Metamorphic graywacke composed of alternating argillaceous and arenaceous layers. Graded bedding is still discernible. Utö, southeastern shore.

- SECOND STOP: Gröndal.
 Loc. No 2. Old Svecofennian volcanic conglomerate.
- THIRD STOP: W. of Läby church (Västerby).
 Loc. No 3. Middle Svecofennian red granite (Vänge granite) with remnants of leptite and granodiorite.
- FOURTH STOP: Lilla Djurgården.
 Loc. No 4. Old Svecofennian sedimentary gneiss with dislocated layers of metabasite in secondary granite showing flowage. Strong plastic deformation of the supracrustal rocks.
- FIFTH STOP: Nothamn.
 Loc. No 5. Red potassic leptite (Old Svecofennian acid volcanic) with dislocated layers of limestone and dikes of metabasite, as well as late intrusions of red pegmatite.
- SIXTH STOP: Riddarskäret.
 Loc. No 6. Middle Svecofennian tonalite with remnant sheets as well as dikes of metabasites. (See Th. Lundqvist 1959.)
- SEVENTH STOP: Hall (5.3 km E. of Kårsta church).
 Loc. No 7. Old Svecofennian gneiss composed of dislocated, in part mobilized and granitized acid layers as well as intermediate

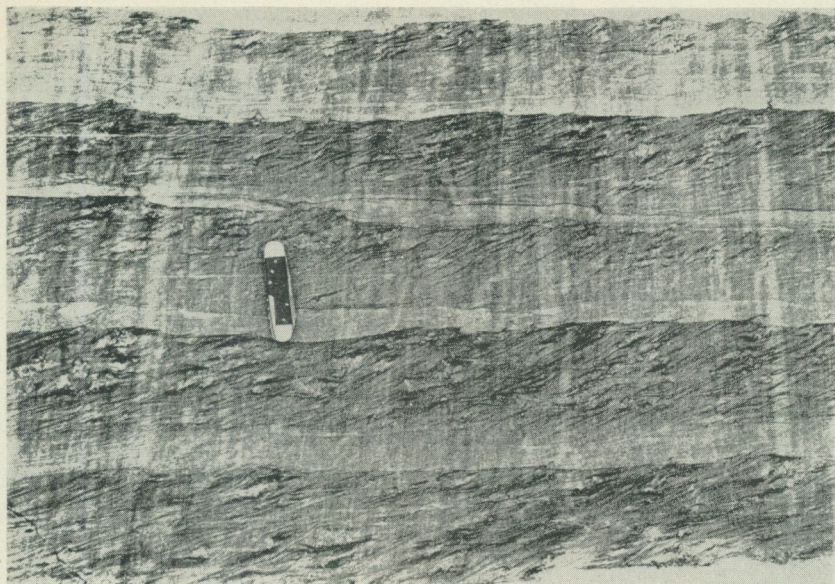


Photo: Th. LUNDQVIST.

Fig. 3. Bedded graywacke (cp. Fig. 2) with transversal schistosity in the argillaceous beds. Utö, southeastern shore.

and basic layers. Porphyritic middle Svecofennian (primorogenic), coarse, red gray to pale gray granite, in part showing late (serorogenic) flowage, has intruded into the gneiss before its partial granitization, which occurred in late Svecofennian (viz. serorogenic) time.

Day 2.

Svecofennian rocks. Leader: S. GAVELIN.

Route:

By bus from Stockholm to Årsta havsbad. By motorboat from Årsta havsbad to UTÖ and back. Return to Stockholm by bus from Årsta havsbad.

Loc. No 8.

During a walk from the landing stage to the southeastern shore of the island successive beds of steeply dipping supracrustal rocks are crossed. At first beds of fairly massive leptites alternating with beds of limestone are met with. A certain bedding in the leptites can sometimes be observed. In the central part of the island open pits from the old mines give a general idea of the structural development of the quartz-banded iron ores. The ores form layers which have been strongly involved in drag-folding with almost vertical fold axes. Various types of ore with quartz and skarn bands can be studied in a stone wall and in lumps from recent

underground prospecting work. At this lastmentioned locality most of the ore consists of hematite layers alternating with bands of red jasper.

S.E. of the ore zone follow limestones with needles of tremolite indicating an initial skarn formation. Further to the southeast bedded leptites with abundant narrow beds of skarn and afterwards a thick bed of porphyritic leptonite with phenocrysts of quartz and feldspar are traversed.

On the shore graywackes and conglomerates appear. The graywackes show alternation between light and dark beds, representing originally arenaceous and argillaceous layers. In the arenaceous beds crossbedding and graded bedding are sometimes visible (Fig. 2).

In the bedded sediments folds of varying dimensions are often seen. Intense shearing has caused a marked schistosity in the originally argillaceous beds, which is orientated approximately parallel to the axial plane of the main fold of Utö rocks — thus frequently being discordant to the bedding of the rock sequence (Fig. 3). The micaceous beds often contain spots of andalusite and/or cordierite. Almandite, too, is sometimes present. Quartz veins are common and sometimes appear as ptygmatic veins.

Return to the landing stage and walk to the southwestern point of the small island Persholmen, where sediments corresponding to those described above occur. These represent the northeastern limb of the main Utö fold. Walk towards the northwest for demonstration of transitions from sediments into veined gneisses. The arenaceous beds seem to have been more resistant and appear as xenoliths in the more completely sheared and gneissic argillaceous beds. Red pegmatite occurs as large semiconcordant dikes in the gneiss.

Finally there will be an opportunity to study rock fragments from the Utö lithium pegmatite in a small lump of pegmatite specimens adjacent to the landing stage.

Day 3.

Svecofennian gneisses and serogonic granites. Leader: S. GAVELIN.

Route:

By bus Stockholm—HAMMARBY—JOHANNESHÖV—VÄSTERHANINGE—MÄLARHÖJDEN and back to Stockholm—LIDINGÖ—FRESCATI—SUNDBYBERG—Stockholm.

FIRST STOP:

Hammarby hills, Lidköpingsvägen.

Loc. No 9.

Gneisses with relict sedimentary features; alternating light and dark beds, the pattern similar to that of the sediments on the southeastern shore of Utö. Feldspathization preferably in the dark beds with gradations from isolated microcline porphyroblasts in dark shists to augen-gneisses with a granitic

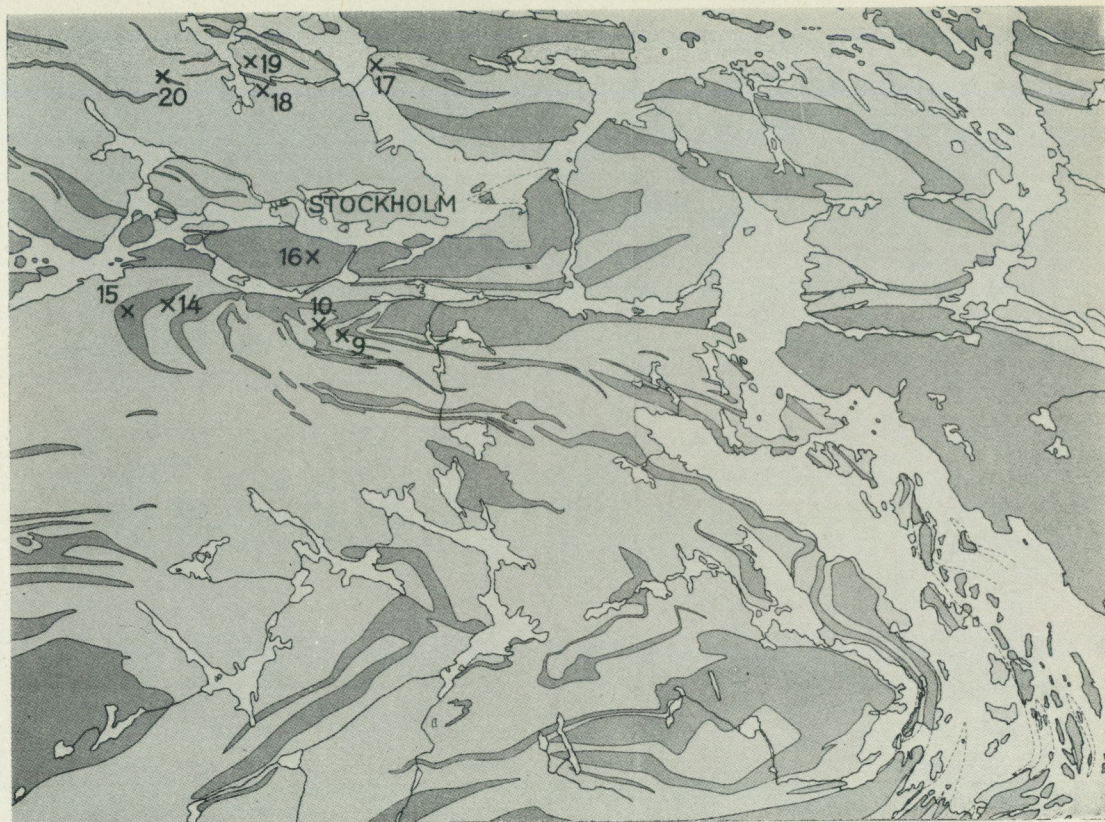


Fig. 4. Structural development of the gneiss areas around and to the south of Stockholm. The figures mark the localities to be visited. After Sundius (1947).



Photo: J. LUNDQVIST.

Fig. 5. Veined gneiss with inclusions of amphibolite. Flow structures are visible in the gneiss. The metabasite fragments are surrounded by biotite-rich reaction zones. Johanneshov.

appearance. Microcline porphyroblasts frequently surrounded by plagioclase rims. Irregular veinlets of fine-grained gray granite (Stockholm granite).

SECOND STOP:

Loc. No 10.

Johanneshov.

"Agmatites". Coarse gneiss, rich in almandite, with abundant inclusions of amphibolite and of originally arenaceous sediments. Flow folding in the gneiss mass is indicated by the pattern of the S-planes and sometimes by the arrangement of the metabasite or metaquartzite inclusions (Fig. 5.).

THIRD STOP:

Loc. No 11.

800 m S. of Västerhaninge church.

Coarse, fairly homogeneous veined gneiss rich in almandite and cordierite. Linear structure pitching moderately towards the east.

FOURTH STOP:

Loc. No 12.

2 km S. of Västerhaninge church.

Light gneisses, in part with primary bedding still visible. Transitions into gray pegmatites, sometimes with a granitic appearance. Almandite is a characteristic constituent in most of these rocks. Portions of the pegmatitic or granitic masses have been mobilized and may sometimes cut across the S-planes of darker gneiss.



Photo: P. H. LUNDEGÅRDH.

Fig. 6. Banded leptite gneiss. The black, basic sheets may be interpreted as dikes (originally sills), 3 km S.S.E. of Årila church, Södermanland.

- FIFTH STOP:** 700 m N.W. of Västerhaninge church.
 Loc. No 13. Light, late-kinematic granite (Stockholm granite), rich in almandite. In part identical with the granitic portions at locality 12.
- SIXTH STOP:** Mälarhöjden, Svandammsplan.
 Loc. No 14. In part agmatitic veined gneisses with inclusions of metabasite. Synkinematic veins of fine-grained, gray granite (the Stockholm granite type). Late- or postkinematic pegmatite.
- SEVENTH STOP:** Mälarhöjden, Sparbanksvägen—Bäckvägen.
 Loc. No 15. Biotite-rich gneisses with several pegmatite generations. The older ones are plastically folded during the later stages of flow folding in the gneiss, the younger ones follow a system of fractures cutting the folds.
- EIGHTH STOP:** Renstiernagatan.
 Loc. No 16. Veined gneisses cut by gray granite (Stockholm granite). At this locality megascopically visible S-planes have de-

veloped as a result of compressional stress. Spotted granite is also seen.

- NINTH STOP:** Lidingsön, S.W. of Torsviksvägen.
Loc. No 17. Spotted Stockholm granite with inclusions of gneiss.
- TENTH STOP:** Veterinärhögskolan.
Loc. No 18. Veined gneiss brecciated by various generations of pegmatite and Stockholm granite. Small gneiss xenoliths sometimes rotated.
- ELEVENTH STOP:** Vetenskapsakademien.
Loc.No 19. Veined gneisses, sometimes containing graphite and sulfides, cut by Stockholm granite, which in turn is penetrated by several generations of pegmatite.
- TWELFTH STOP:** Sundbyberg, Hagagatan. Stockholm granite containing big blocks of gneiss which have been rotated by the emplacement of the granite.
Loc. No 20.
- Day 4.** Svecofennian rocks. Leader: P. H. LUNDEGÅRDH.
- Route:** By bus Stockholm—FITTJABACKEN—Södertälje—Strängnäs—BARVA—Ärla—SLYTAN—Mortorp—ERSÄNG—Slytan—ESKILSTUNA—TORSHÄLLA—GRÖNDAL—Kungsör—Arboga—FELLINGSBRO—Rinkaby—VENA—Örebro.
- FIRST STOP:** Fittjabacken (at high-way No 1).
Loc. No 21. Garnetiferous old Svecofennian sedimentary veined gneiss with cordierite and with sillimanite beautifully elongated along the B-axes.
- SECOND STOP:** 2 km N.W. of Barva church (at high-way No 6).
Loc. No 22. Middle Svecofennian gray granodiorite to tonalite with basic xenoliths, plastic deformation and palingenic red veins.
- THIRD STOP:** S. of Slytan, 3 km S. of Ärla church.
Loc. No 23. Old Svecofennian banded gneiss composed of red leptite gneiss and granite gneiss, metabasite, and other rocks (Fig. 6).
- FOURTH STOP:** Ersäng.
Loc. No 24. Garnetiferous sedimentary veined gneiss (old Svecofennian, compare Fig. 7) with sillimanite and aggregates of dark bluish cordierite.
- FIFTH STOP:** 600 m S. of Årby, in the northern suburbs of Eskilstuna.
Loc. No 25. Secondary late Svecofennian granite with schlieren of pre-existent supracrustal rocks. (Compare Fig. 8.)

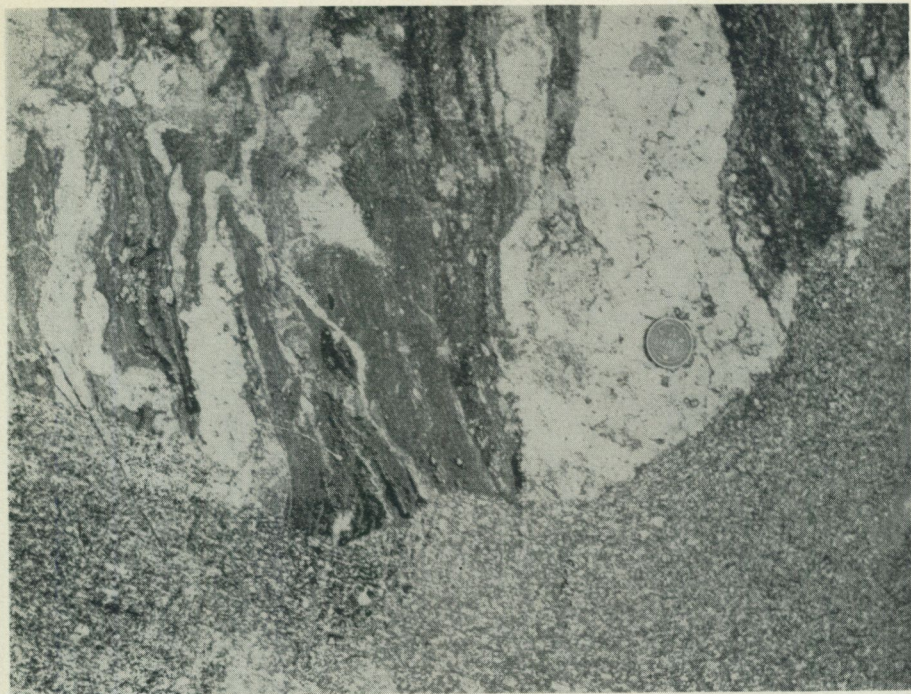


Photo: P. H. LUNDEGÅRDH.

Fig. 7. Veined graywacke gneiss intruded by gray serorogenic granite (Stockholm granite). 2.5 km W.N.W. of Hammarby church, Södermanland.

- SIXTH STOP:** Torshälla.
 Loc. No 26. Strongly deformed, middle Svecofennian granite penetrated by mobilized acid rocks belonging to the leptite-hällefliint series.
- SEVENTH STOP:** Gröndal.
 Loc. No 27. Middle Svecofennian acid granite, and some old Svecofennian acid leptite gneiss, showing strong regeneration and thus frequently grading into late Svecofennian (serorogenic) granite (with rectangular microcline porphyroblasts).
- EIGHTH STOP:** 2 km E.S.E. of Fellingsbro railway station.
 Loc. No 28. Late Svecofennian granite with large rectangular microcline porphyroblasts (Fellingsbro granite) and supracrustal xenoliths.
- NINTH STOP:** Road-junction near Vena, 5 km N.E. of the centre of Örebro (on high-way No 6).
 Loc. No 29. Late Svecofennian granite with large microcline porphyroblasts (Örebro granite). Acid palingenic intrusions.

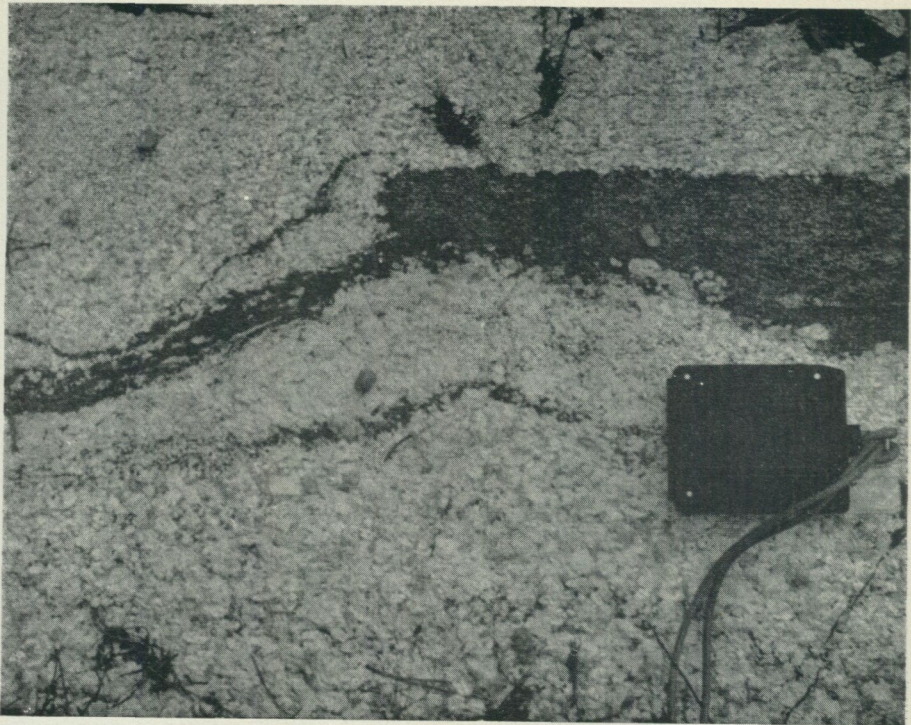


Photo: P. H. LUNDEGÅRDH.

Fig. 8. Serorogenic granite with granitization remnants (basic layers originating from pre-existent banded leptite gneiss). 5.5 km S.S.W. of Kjula church, Södermanland.

- Day 5. Gothian and pre-Gothian rocks. Leader: P. H. LUNDEGÅRDH.
- Route: By bus Örebro—Adolfsberg—Leken—VILLINGSBERG—VÅTSJÖTORP—Karlskoga—EMTEFALLA—DUGGEBO—Kristinehamn—BERGA—Mariestad—HOLMESTAD—Lidköping.
- FIRST STOP: 1 km E.S.E. of Villingsberg (on high-way No 9).
 Loc. No 30. Porphyritic red gray Gothian granodiorite (Filipstad granite) with remnants of tonalite and supracrustal rocks, and with acid palingenic dikes, in part spotted granite.
- SECOND STOP: Villingsberg (on high-way No 9).
 Loc. No 31. Dark gray Gothian tonalite grading to porphyritic granodiorite (development of microcline porphyroblasts along the S-planes). Xenoliths of calcareous arenite and calcilitite altered to lumps of diopside, andradite and epidote.
- THIRD STOP: 1 km N.N.W. of Våtsjötorp (on high-way No 9).
 Loc. No 32. Porphyritic, red gray and gray Gothian granodiorite (Filip-

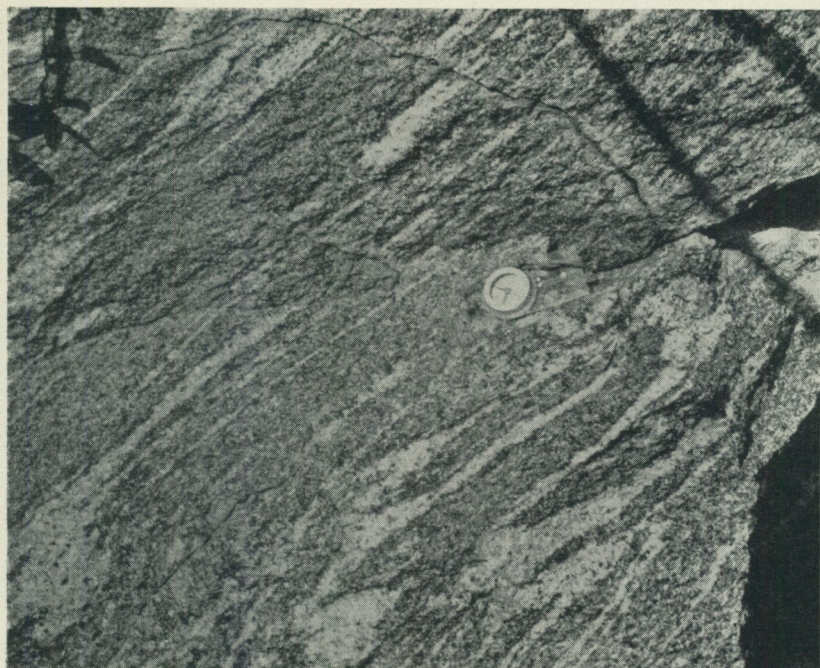


Photo: P. H. LUNDEGÅRDH.

Fig. 9. Pre-Gothian granite gneiss with syenitic schlieren. The rock contains both hornblende and a little garnet. About 5 km N.E. of Backa church, N.N.E. of Göteborg (Gothenburg).

stad granite) with xenoliths and dislocated palingenic granite dikes.

- FOURTH STOP: Emtefalla, S. of Lake Emten (on high-way No 9).
 Loc. No 33. Tectonized schistose Gothian rocks: hyperite with inclusions of red gneiss and surrounded by porphyritic granodiorite.
- FIFTH STOP: Near Duggebo (on high-way No 9).
 Loc. No 34. Strongly schistose, porphyritic Gothian granodiorite to granite (Filipstad granite, cp. above).
- SIXTH STOP: 1 km E. of Berga church (at high-way No 6).
 Loc. No 35. Veined red acid pre-Gothian granite gneiss with flowage and in part showing strong, mechanical weathering.
- SEVENTH STOP: 1.3 km N.N.W. of Holmestad church (at high-way No 6).
 Loc. No 36. Gray and red pre-Gothian banded gneiss and red-gray to gray granodiorite to tonalite with pegmatitic veins. To the west of Götene, Mount Kinnekulle can be seen on the right hand. Mt Kinnekulle displays a complete series of Cambrian and

Ordovician rocks covered with a dolerite bed, which has protected the underlying sedimentary rocks against weathering.

- Day 6.** Pre-Gothian rocks. Leader: P. H. LUNDEGÅRDH.
- Route:** By bus Lidköping—GILLSTAD—LAVAD—SÄRESTAD—GRÄSTORP—TROLLHÄTTAN—L:a Edet—BOHUS—SURTE—Göteborg (Gothenburg)—KALLEBÄCKSBACKEN—ALMEDAL—Göteborg.
- FIRST STOP:** 2.3 km E.N.E. of Gillstad church.
Loc. No 37 a. Gray schistose pre-Gothian tonalite with mylonite zones, strong lineation, and mostly conformable pegmatite veins and schlieren.
- SECOND STOP:** 1.2 km S.S.E. of Orrevalla, near Lavad church.
Loc. No 37. Gneissic pre-Gothian tonalite with late microcline porphyroblasts.
- THIRD STOP:** 900 m E. of Särestad church.
Loc. No 38. Garnetiferous pre-Gothian tonalite with conformable metabasite remnants.
- FOURTH STOP:** 200 m W.N.W. of Grästorp church.
Loc. No 39. Gneissic pre-Gothian augen-granite with zones of mylonite containing late microcline porphyroblasts.
Between Grästorp and Trollhättan Mt Hunne built up of Palaeozoic plateau dolerite is seen to the right.
- FIFTH STOP:** Eastern part of Trollhättan.
Loc. No 40. Strongly gneissic pre-Gothian augen-granite grading into veined gneiss-granite (red veins = ancient augen).
- SIXTH STOP:** Krusetorpet 5 km S.S.W. of Trollhättan (on high-way No 7).
Loc. No 40 b. Beautiful pre-Gothian banded gneiss with distortions owing to local mobilizations of the acid layers.
- SEVENTH STOP:** Bohus (on high-way No 7).
Loc. No 41. Pre-Gothian gneiss-granite or granite gneiss, with beautiful S-planes (thrust and fault planes) moderately dipping towards W.N.W.
- EIGHTH STOP:** Surte (at high-way No 7).
Loc. No 42. The place of the big land-slide in 1953, when part of the village as well as the railway and highway slid towards the river Göta.
- NINTH STOP:** Kallebäcksbacken, in the S.E. environs of Göteborg (at high-way No 5).
Loc. No 43. Pre-Gothian veined gneiss-granite, or granite gneiss, with sparse dikes of late pegmatite. The veins consist of syenite (Fig. 9).
- TENTH STOP:** Near Almedal railway station, in southern Göteborg.
Loc. No 44. Pre-Gothian veined granite-gneiss (pegmatite veins).

Day 7. Gothian, pre-Gothian and Dalslandian rocks. Leader: P. H. LUNDEGÅRDH.

Route: Göteborg—Kungälv—TJUVKILSHUVUD—TJUVKIL—
Sölberga—GRINNERÖD—LJUNGSKILE—GUSTAVS-
BERG—Uddevalla—Munkedal—HALLINDEN—
QUARRY 3 km E. of RIXÖ—LYSEKIL.

FIRST STOP: Tjuvkilshuvud.
Loc. No 45. Early Gothian mica-schist with sparse, conformable veins of reddish palingenic granite and an intrusion of gabbro.

SECOND STOP: Tjuvkil.
Loc. No 46. Early Gothian mica-schists showing weak migmatization.

THIRD STOP: 500 m W. of Grinneröd church (on high-way No 2).
Loc. No 47. Gneissic Gothian tonalite (Åmål granite) with numerous gneiss sheets in part assimilated and following the S-planes which have in part been subjected to plastic deformation combined with the formation of pegmatite veins.

FOURTH STOP: Northern end of Ljungskile (on high-way No 2).
Loc. No 48. Metamorphic schistose early Gothian supracrustal gneiss with layers of granite and pegmatite.

FIFTH STOP: Gustavsberg near Uddevalla (on high-way No 2).
Loc. No 49. Gray red porphyritic Gothian granite.

SIXTH STOP: Near Hallinden railway station.
Loc. No 50. Sedimentary early Gothian veined gneiss, regenerated porphyritic granite, and late Dalslandian, palingenic granite (Bohus granite) with granitization remnants.

SEVENTH STOP: Quarry at the roadway 3 km E. of Rixö.
Loc. No 51. Large quarry in common Bohus granite with regular jointing.

EIGHTH STOP: Stångehuvud, at the southwestern end of Lysekil.
Loc. No 52. Bohus granite of variable grain size (two varieties), in part with diffuse granitization remnants.

Day 8. Gothian rocks. Leader: P. H. LUNDEGÅRDH.

Route: By bus Lysekil—Uddevalla—RAMSERÖD—VÄNE RYR—
Vassända Naglum—Hjärtum—Västerlanda—KUNGÄLV—
SÄVE—BJÖRLANDA—LILLEBYBADET—Torslanda—
SYRHÅLA—Göteborg.

FIRST STOP: Ramseröd in the eastern vicinity of Uddevalla.
Loc. No 53. Red gray Gothian granodiorite to granite with xenoliths of supracrustal origin and local flowage.

SECOND STOP: 1 km W. of Väne Ryr church.
Loc. No 54. Gothian quartzite (Åmål quartzite).



Photo: P. H. LUNDEGÅRDH.

Fig. 10 a. Early Gothian Stora Le—Marstrand series: Interstratified quartzite and mica schist grading to mica gneiss, the later in part plastically deformed. 7 km W. S. W. of Torsby church, N. W. of Göteborg.

THIRD STOP: Kungälv.

Loc. No 55.

One of the oldest towns in Sweden (formerly known as Kongahälla), with Bohus fort from the Middle Ages, when Kungälv belonged to Norway.

Excursion through the fort which stands upon red granitic magnetite-bearing Gothian gneiss grading into secondary granite. Regional investigations have shown that the gneiss originates from arenaceous sediments. (Compare the Åmål quartzite at Väne Ryr, Loc. No 54.)

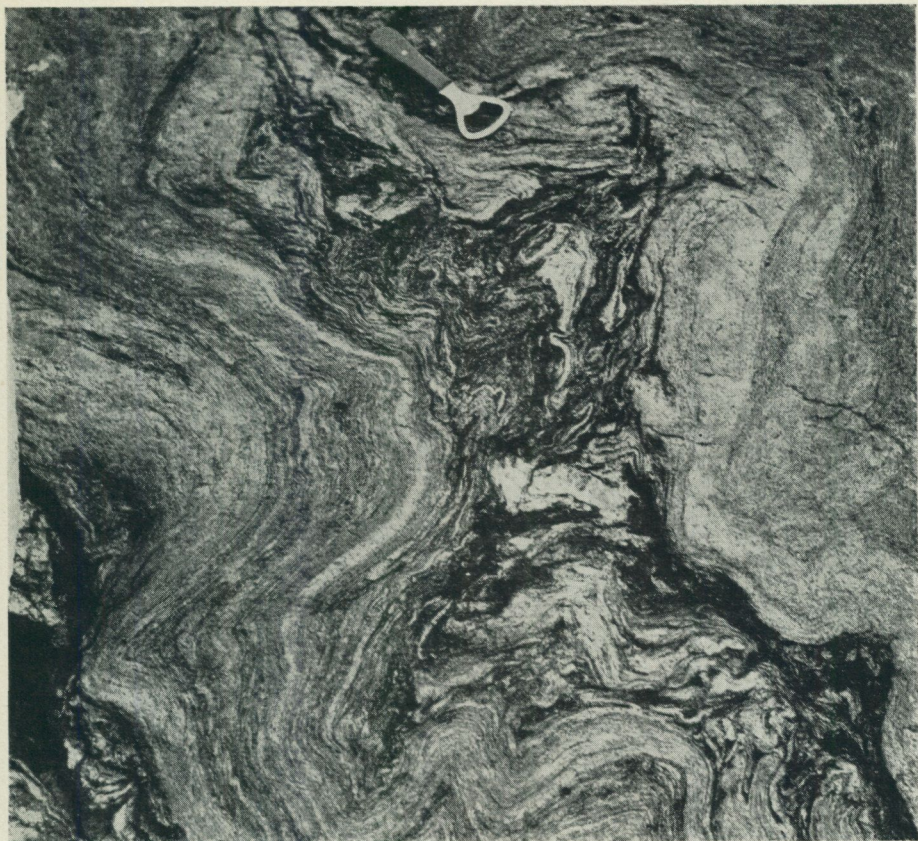


Photo: P. H. LUNDEGÅRDH.

Fig. 10 b. Early Gothian Stora Le—Marstrand series: Metamorphosed graywacke originally composed of arenaceous and lutaceous layers with intercalations (in the centre of the photo) of volcanic tuff. The plastic deformation has been strong. Lillebybadet N.W. of Göteborg.

FOURTH STOP: Säve church.

Loc. No 56. Schistose Gothian augen-granite (Askim granite) with narrow mylonite zones and remnants of red gneiss.

FIFTH STOP: 500 m E. of Björlanda church.

Loc. No 57. Gneissic Gothian tonalite (Åmål granite) with numerous conformable remnants of amphibolitic gneiss as well as conformable bands and schlieren of mobilized acid gneiss, and dikes of fine-grained serogenic granite. (Compare Fig. 11.)



Photo: P. H. LUNDEGÅRDH.

Fig. 11. Gothian tonalite (Åmål granite) with remnants of sedimentary gneiss (cp. Fig. 10). 4 km W.S.W. of Sæve church, N.N.W. of Göteborg.

SIXTH STOP:

Lillebybadet.

Loc. No 58.

Gneissic Gothian tonalite (Åmål granite) as above. Further early Gothian sedimentary gneiss with beautiful plastic deformation, palingenic acid veins, and boudins of metabasite (Fig. 10). Close to the sedimentary gneiss dislocated layers of Gothian quartzite with hornblende porphyroblasts.

SEVENTH STOP:

E. of Syrnhåla, between Torshåla (air port) and Göteborg. Gothian tonalite (Åmål granite) with conformable remnants of basic supracrustal rocks ("dark spots") and acid granite gneiss, as well as narrow dikes of serotogenic granite.

Day 9.

Pre-Gothian and Gothian rocks. Leader: P. H. LUNDEGÅRDH.

Route:

By bus Göteborg—Borås—RÅNGEDALA—FOLKEN—Ulri-
cehamn—Jönköping—Huskvarna—ÅDALSVÄGEN—
Lekeryd—Nässjö—Eksjö—MARIANNELUND—Vimmerby—
Västervik.

FIRST STOP:

In the southeastern end of Rångedala (on highway No 5).

Loc. No 60.

Pre-Gothian acid gneiss with palingenic veins and numerous layers of metabasite.

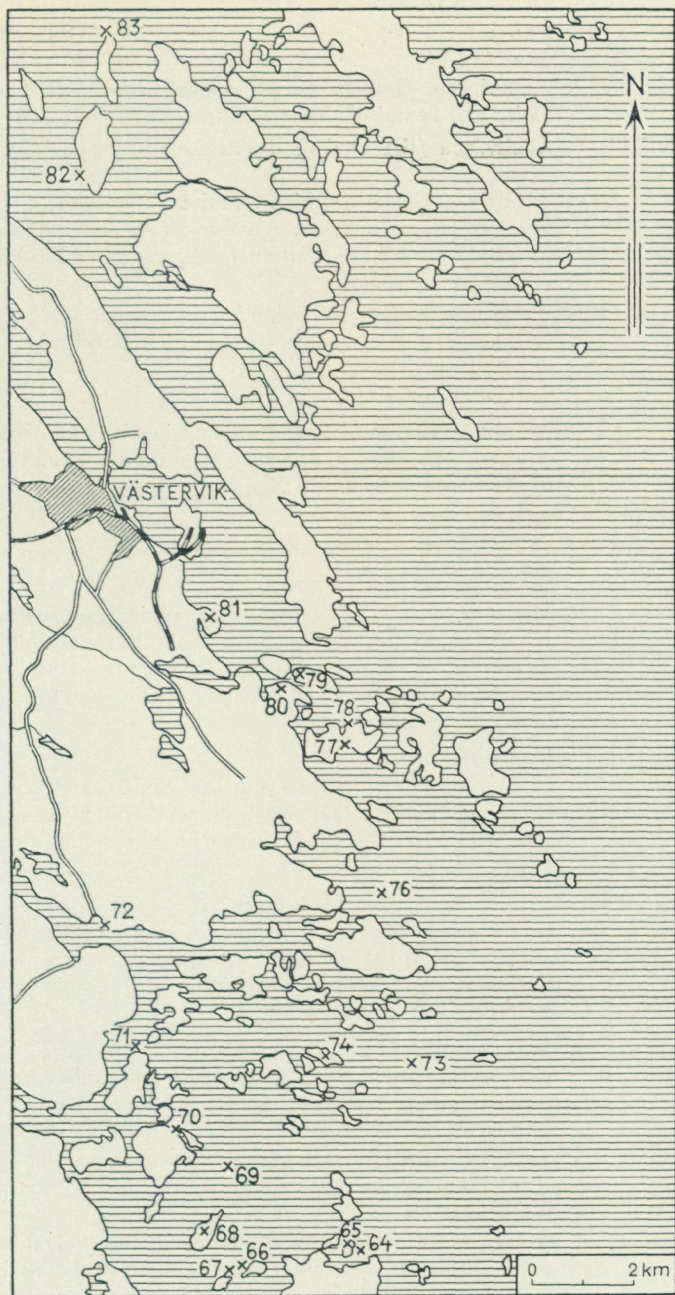


Fig. 12. Positions of the localities to be visited in the Västervik area.

- SECOND STOP: 800 m E.S.E. of the northern end of Lake Folken (at highway No 5).
 Loc. No 61. Granitic pre-Gothian veined gneiss with boudins of metabasite and beautiful thrust planes.
- THIRD STOP: Ådalsvägen (the Ådal road), in the eastern environs of Huskvarna.
 Loc. No 62. Strongly schistose Gothian granite. The schistosity can be followed along a broad north-south zone from the north-eastern part of Lake Vättern in the north to Eastern Scania (Skåne) in the south.
- FOURTH STOP: Western end of Mariannelund.
 Loc. No 63. Gothian syenite with dike of plagioclase-porphyrite.
- Day 10.** Gothian rocks. Leader: S. GAVELIN.
 Route: By bus Västervik to Skaftet. Excursion by motorboat in the southern Västervik archipelago. Return to Västervik by bus from Ytterhult (Fig. 12; Nos 64—72).
- FIRST STOP: Tallsjär.
 Loc. No 64. Upper quartzites with cross-bedding.
- SECOND STOP: Brunnskär.
 Loc. No 65. Metagabbro with xenoliths of quartzite and white aplitic veins. Upper quartzites with cross-bedding and subjected to shearing stress. Amphibolite dike in quartzite. The amphibolite has been ruptured and quartzite, grading to pegmatite, squeezed into the joints.
- THIRD STOP: L. Äppleholmen.
 Loc. No 66. Alternating beds of arenaceous and argillaceous composition. Cross-bedding in arenaceous beds, sand fillings in argillaceous beds. The sand fillings deformed on compaction of the sediment (Fig. 13).
- FOURTH STOP: Tallholmen (N. of Flatholmen).
 Loc. No 67. In the north, the same sediments as at locality 66, in the south, fine-bedded sediments of the normal graywacke suite. Metabasites of varying composition. Red granite brecciating sediments and metabasites.
- FIFTH STOP: Skjortö, S.W.-shore.
 Loc. No 68. Lenticular cross-bedding in coarse, recrystallized quartzite. Bedded sediments of the graywacke suite, sometimes with porphyroblasts of andalusite. Selective deformation, the arenaceous beds being broken and appearing as angular fragments in the argillaceous portions.
- SIXTH STOP: Skjortö hällar.
 Loc. No 69. Mobilized granitic rock with abundant dark xenoliths cutting across primary sedimentary textures. Narrow aplite veins penetrate all these rocks.

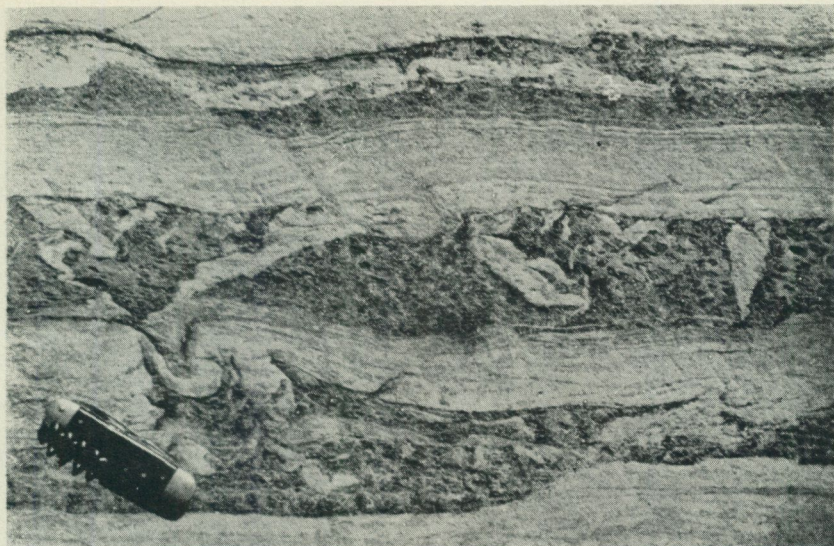


Photo: Th. LUNDQVIST.

Fig. 13. Interbedded arenaceous and argillaceous sedimentary rocks. Small cracks filled with sand are seen in the argillaceous layers. L. Appleholmen.

SEVENTH STOP: Laxholmen (N.E. of Hultö).

Loc. No 70. Transitions from gneisses with visible sedimentary features into homogeneous granite.

EIGHTH STOP: Pipersholmen.

Loc. No 71. Fold structures of a sedimentary sequence consisting primarily of alternating beds of orthoquartzite and graywacke, the argillaceous parts being transformed to veined gneiss. A symmetric anticline can be seen from the sea in a vertical rock surface.

NINTH STOP: S.E. of Ytterhult.

Loc. No 72. Sill of metabasite in orthoquartzite broken by mechanical deformation and displaying mobilization and pegmatization along the cracks.

Day 11.

Gothian rocks. Leader: S. GAVELIN.

Route:

By bus from Västervik to Hornsudd. Excursion by motor-boat from the island Mössan in the south to Spårösund in the north. Return to Västervik by motor-boat (Fig. 12: Nos 73—78).



Photo: P. H. LUNDEGÅRDH.

Fig. 14. Coarse, re-crystallized quartzite with lenticular cross-bedding. Southwestern shore of Skjortö.

- FIRST STOP: Mössan.
Loc. No 73. Metagabbro with xenoliths of quartzite grading into white granitic or pegmatitic veinlets, which penetrate the gabbro.
- SECOND STOP: Walk along the southeastern and northern shores of the Lökholmen island to its western point.
Loc. No 74. Progressive metamorphism of bedded sediments which contain metabasites. On the southern shore the original sedimentary features are still preserved; on the northern shore intense shear has given rise to veined gneisses. Shear and selective mobilization has formed a pattern with small xenoliths of metabasite fairly uniformly distributed throughout the mobilized sedimentary gneiss, which resembles the pattern found in many granites of the Västervik area. At the eastern point of the island a beautiful breccia is seen.

THIRD STOP: Southern shore of Händelöp.
Loc. No 75. Selective granitization in bedded sediments, the argillaceous beds being transformed into porphyritic granitic rocks. To the north, more homogeneous granite.

FOURTH STOP: Bondblekeskäret.
Loc. No 76. Potash metasomatism (feldspathisation) in coarse-grained, recrystallized quartzite. Deformation and mobilization of bedded sediments in the presence of small amounts of granitic matter.

FIFTH STOP: Walk along the shore of Grönö S.W. of Spårösund.
Loc. No 77. From the south northwards increasing granitization of sediments. The process has developed selectively — the pure quartzites being better preserved than the originally argillaceous beds. Metabasite appears as continuous dikes when parallel to the direction of shear, but is broken and “intruded” by mobilized quartzite when occurring discordantly. In veined gneiss metabasite dikes appear as pieces which have drifted apart, thus indicating a tensional stress in the plastic rock mass (Fig. 15).

SIXTH STOP: Spårösund, western shore.
Loc. No 78. Spotted gneisses in various developments.

Day 12. Gothian rocks. Leader: S. GAVELIN.

Route: By motor-boat from Västervik to the archipelago 5 km S.E. of Västervik (localities Nos 79—81). After stop 3 a pleasant canal is passed and Gudinge Bay entered, where two islands are visited. Back to Västervik by motor-boat (Fig. 12: Nos 79—83).

FIRST STOP: Walk along the northern shore of Mjödö.
Loc. No 79. At the eastern point of the island occur spotted gneisses. Towards the west transitions to veined gneisses. Bedded red arenaceous sediments and massive red feldspathic arenites.

SECOND STOP: Walk along the shore of the mainland to the south of Borgö.
Loc. No 80. In the east, feldspathic arenites identical with those at Mjödö. Towards the east increasing metamorphism and granitization. Various patterns of veined gneiss with remnants of bedded sediments (Fig. 15); transitions into granitic rocks. In the east fairly homogeneous granite with continuous beds of coarse pure quartzite.

THIRD STOP: Judön.
Loc. No 81. The same granite as at loc. No 80, with narrow beds of quartzite and veined gneiss. Due to shear and tension these often appear as separate deformed lenses, arranged in strings parallel to the direction of the original bedding and shear.



Photo: BENGT LOBERG.

Fig. 15. Veined gneiss with inclusions of metabasite representing sheared and displaced remnants of originally continuous dikes.

FOURTH STOP: Small islet S.W. of Vidö.

Loc. No 82.

Bedded graywackes with initial and selective formation of spots in some beds. Elongation of spots parallel to tectonic S-planes which are here discordant to the bedding. In the preserved sediments graded bedding can be observed.

FIFTH STOP:

Loc. No 83.

Justerö, northern point.

Bedded sediments penetrated by granite and displaying transitions to gneisses. Discordant metabasite dike with abundant xenoliths of various sediments. The xenoliths are oriented strictly parallel to the tectonic S-planes, which, however, cut across the contacts of the dike.

Day 13.

Gothian and pre-Gothian rocks. Leaders: S. GAVELIN and P. H. LUNDEGÅRDH.

Route:

By bus Västervik—SEGELRUM—Gamleby—Löckerum—BILLSJÖN—DALHEM—Åtvidaberg—Linghem—NORSHOLM—Norrköping—Nyköping—Södertälje—Stockholm.

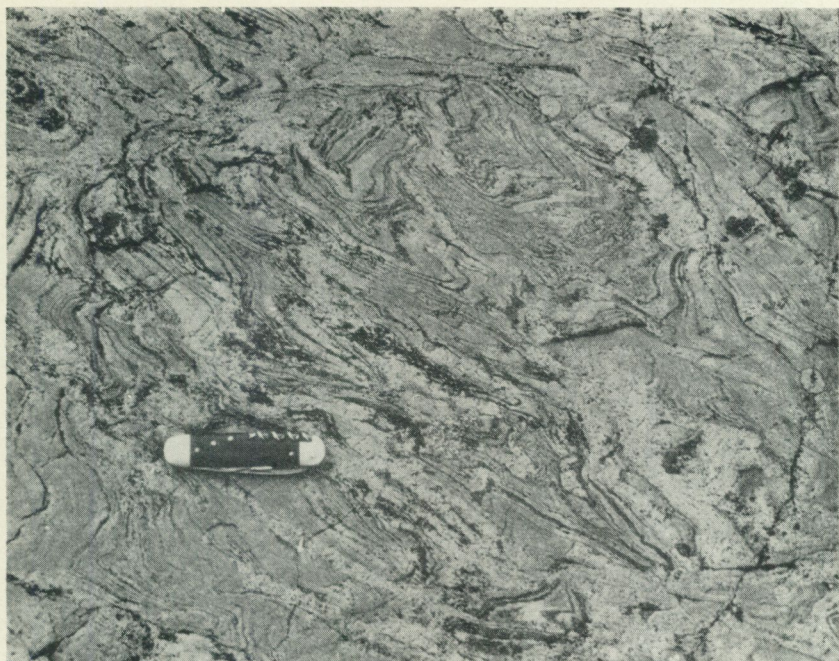


Photo: Th. LUNDQVIST.

Fig. 16. Veined gneiss with remnants of bedded sediments. The mainland to the south of Borgö.

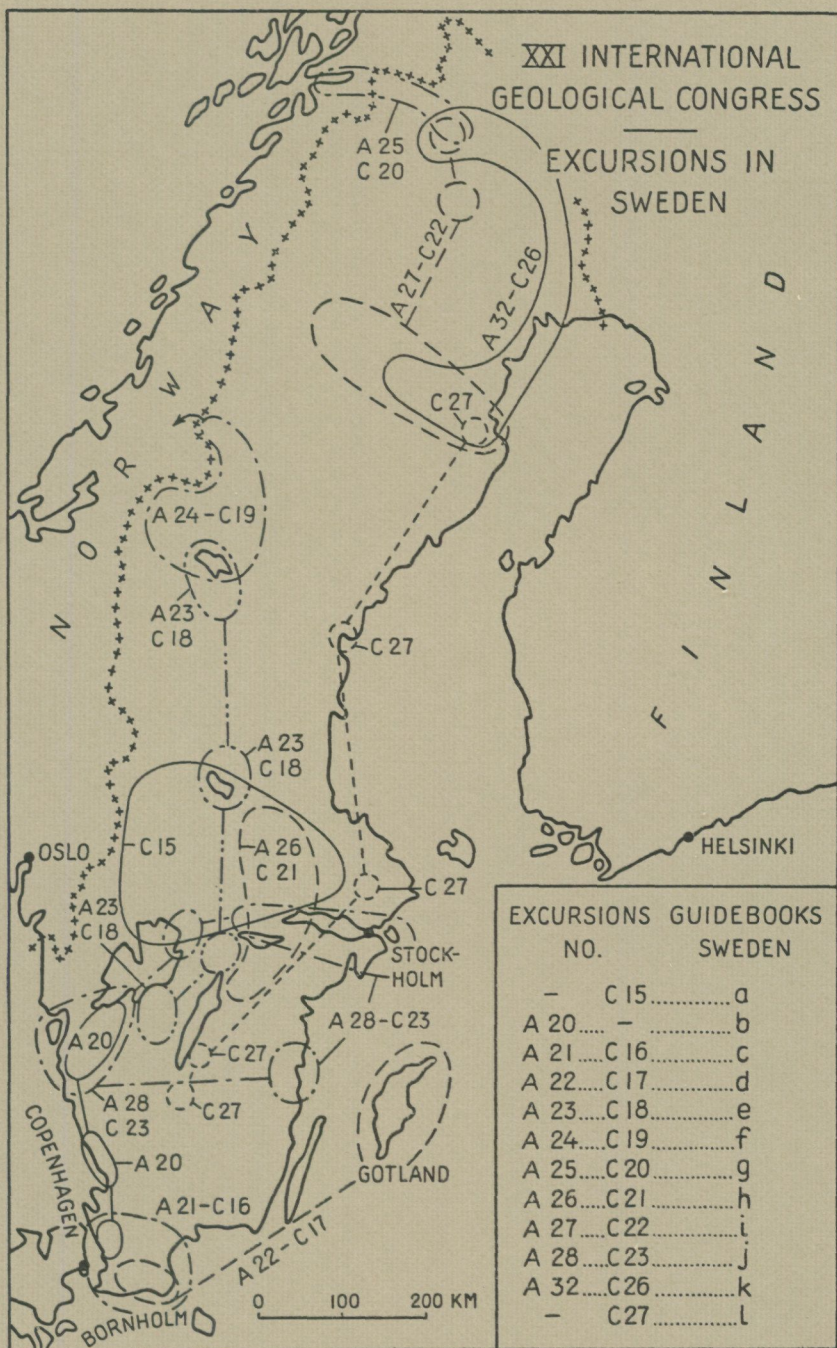
- FIRST STOP:** Near Segelrum (on highway No 4).
Loc. No 84. Västervik sediments with ripple marks. Bedded sediments with andalusite-biotite-microcline spots in certain layers.
- SECOND STOP:** At the road on the northern shore of Lake Billsjön.
Loc. No 85. Tectonized and recrystallized, pre-Gothian (?) red granite with diffuse flowage. Red gray granodiorite with dark remnants of supracrustal rocks. (May be cancelled.)
- THIRD STOP:** 400 m N.N.E. of Dalhem church.
Loc. No 86. Porphyritic red gray Gothian granite (Småland granite) cutting schistose older granite with several post-tectonic microcline porphyroblasts and remnants of supracrustal rocks.
- FOURTH STOP:** Norsholm (on highway No 1, immediately to the west of the Göta channel).
Loc. No 87. Red gray, coarse Gothian augen-granite and dark red gray, secondary granite with microcline porphyroblasts. Intrusions of fine-grained, light-coloured palingenic granite.

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