Geology of the Altenes Area, Alta–Kvænangen Window, North Norway

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Precambrian supracrustal and intrusive rocks of the Raipas Group of supposed Karelian age are unconformably overlain by Vendian to ?Lower Cambrian sedimentary rocks, which have in turn been overridden by allochthonous rocks of the Kalak Nappe Complex. The Raipas rocks are divided into 3 formations; the lithologies of these units and of the autochthonous cover sequence are described. The structural history of the area includes a Precambrian, post-Karelian to pre-Vendian, deformation episode as well as Caledonian events. It is shown that in the north-western part of the window, the Raipas 'basement' together with its autochthonous cover has been affected by high-angle, SE-directed thrusting and imbrication during the Caledonian orogeny.

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Introduction

The Altenes peninsula is situated on the northern side of Altafjord, Finnmark (Fig. 1), and covers an area of about 130 km^2. Most of the ground lies between 200 and 400 m a.s.l. The degree of outcrop is excellent, except in the easternmost part, but exposures of good quality are mostly confined to the coast.

The area was mapped in 1972–73 for ore prospecting purposes as part of the North Norway project of the Geological Survey of Norway (NGU) on a scale of 1:21,500 (Fareth 1975), in connection with a geochemical survey (Krog & Fareth 1975). Some of the regional implications of this mapping and of investigations in a neighbouring area were discussed by Roberts & Fareth (1974). Additional data from Altenes were collected by the author on a short visit in 1977. Previous accounts of the geology are confined to brief remarks by Holtedahl (1918, p. 105–108), and rock sample descriptions and a fragmentary map by M. G. Legg (1961, unpublished data in NGU's files).

A 400^g compass was used in the present investigation; for dip values, 100^g = vertical.

Geological setting

This description concerns the north-eastern part of the Alta–Kvænangen window of Precambrian and overlying autochthonous rocks of Vendian – ?Lower Cambrian age in the Altenes area (Fig. 1). The major part of the area is underlain by low-grade sedimentary and volcanic rocks which are correlated with the Raipas Group rocks in Alta, of supposed Karelian age (Barth & Reitan 1963). Similar rocks are found in the Komagfjord window to the north-east (Reitan

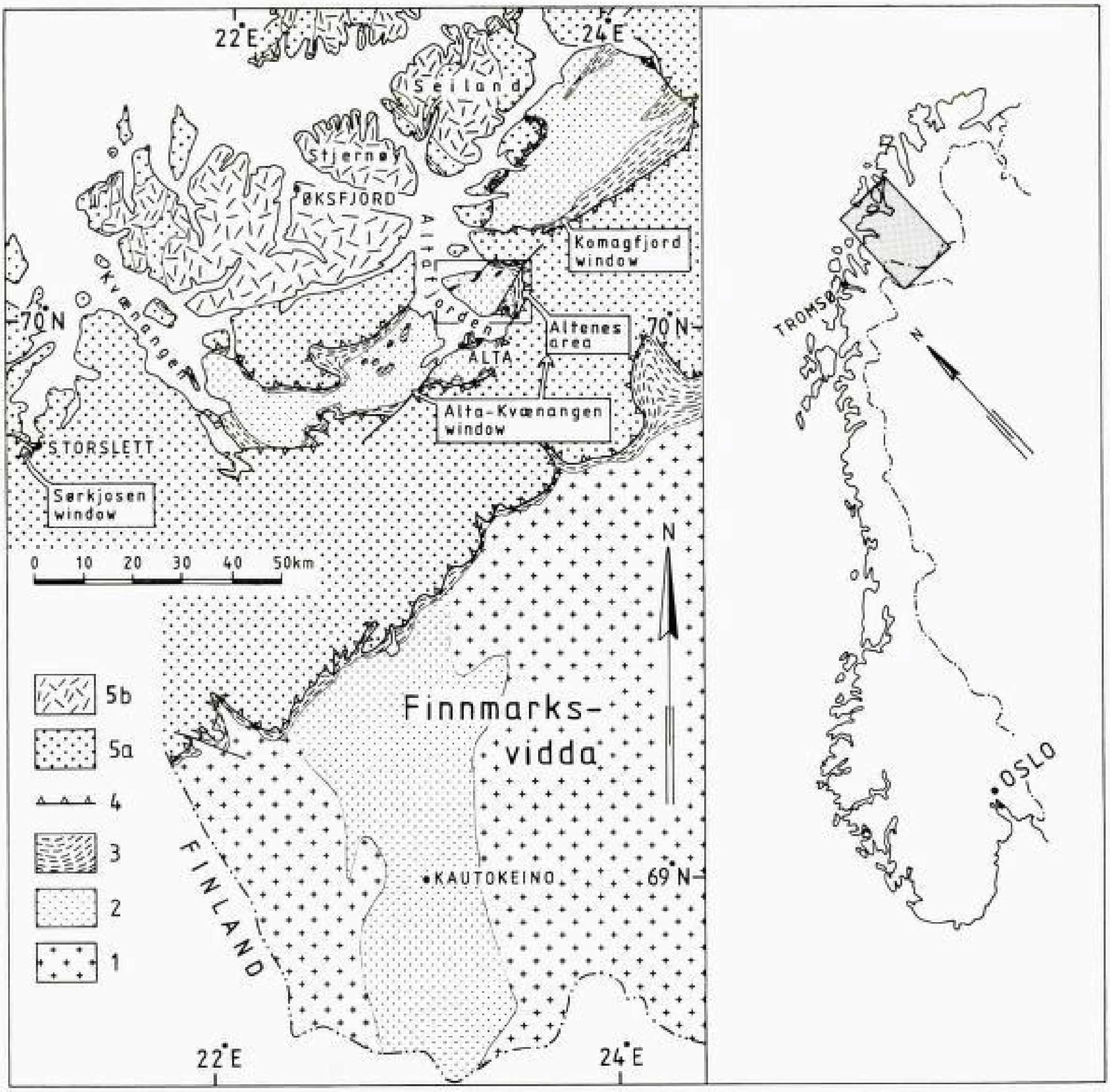

Fig. 1. Regional geology and location map. (1) Precambrian basement rocks older than Raipas Group; (2) Raipas Group and probable correlatives; (3) Autochthonous/parautochthonous Late Precambrian–Cambrian rocks (Dividal Group, Bossekop Formation, Borras Formation and probable correlatives); (4) Thrust plane; (5a) Kalak Nappe Complex (= Reisa Nappe Complex), locally including Tierta and Gaissa Nappes at base: mainly supracrustal rocks; (5b) Kalak Nappe Complex: igneous rocks of the Seiland petrographic province. Based on Skålvoll (1972), Bjørlykke & Fareth (1973), Roberts (1973), Fareth & Lindahl (1974), Roberts & Fareth (1974), Jansen (1976), Zwaan (1976) and T. Torske (pers. comm. 1977).

1963), the small Sørkjosen window to the south-west (Zwaan 1976), and in a N–S trending belt on Finnmarksvidda. On Finnmarksvidda, the Raipas rocks are bordered by other, presumably older, Precambrian rocks. The Precambrian rocks in the windows and on Finnmarksvidda are overlain unconformably by

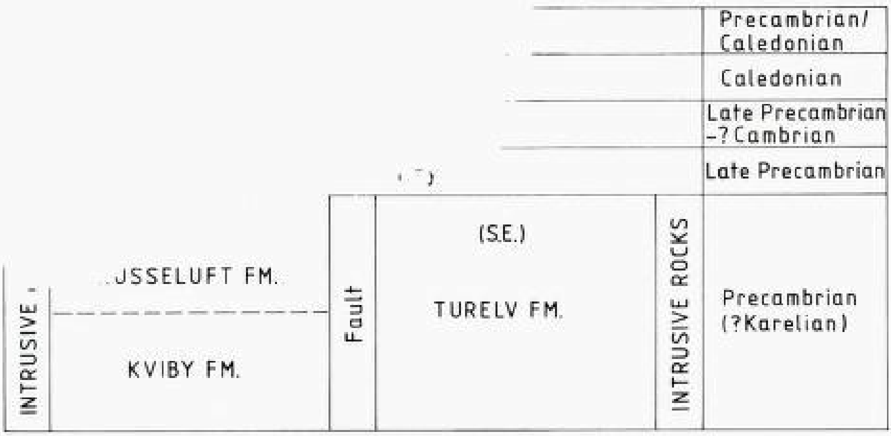

Fig. 2. Schematic representation of the principal tectono-stratigraphical elements in the Altenes area.

weakly metamorphosed sedimentary rocks including tillite, ranging in age from latest Precambrian (Vendian, in some areas possibly older) to Cambrian (Roberts & Fareth 1974). The uppermost tectono–stratigraphic unit is the Kalak Nappe Complex, equivalent to the Reisa Nappe Complex west of Kvænangen. These complexes are composed of plutonic and metamorphic rocks of Precambrian to Lower Paleozoic age (Roberts 1974, Zwaan 1976).

Tectono-stratigraphy

The tectono–stratigraphical relationships between the rock units are shown in Fig. 2.

The Precambrian rocks below the unconformity can in broad terms be correlated with the Raipas rocks at Alta. The latter have been variously named Raipas System (Dahll 1868), *Avdeling* (Division), Formation, Group, Series and Suite. The present author feels that the usage of Holtedahl & Dons (1960), Zwaan et al. (1973) and Gautier (1977) is preferable, and will extend their Raipas Group to include the equivalent rocks in the Altenes area.

A major fault trending SW–NE from Russeluft to Leirbotnvatnet splits the Raipas Group into two outcrop areas (Plate 1). On the north-western side of the fault two formations are recognised, the names of which are informal: the *Kviby formation* composed of basic volcanics, and the *Russeluft formation* composed of epiclastic sediments. The boundary between the two formations is tectonised, but in one coastal exposure (described in a later section) there is evidence suggesting a depositional relationship between them. The Kviby and Russeluft formations can be correlated with parts of Gautier's (1977) Lower and Upper Raipas sub-groups, respectively.

The Raipas rocks on the south-eastern side of the fault are more poorly exposed and have more complicated structures than those on the north-western side. Lithologies corresponding with those of both Lower and Upper Raipas

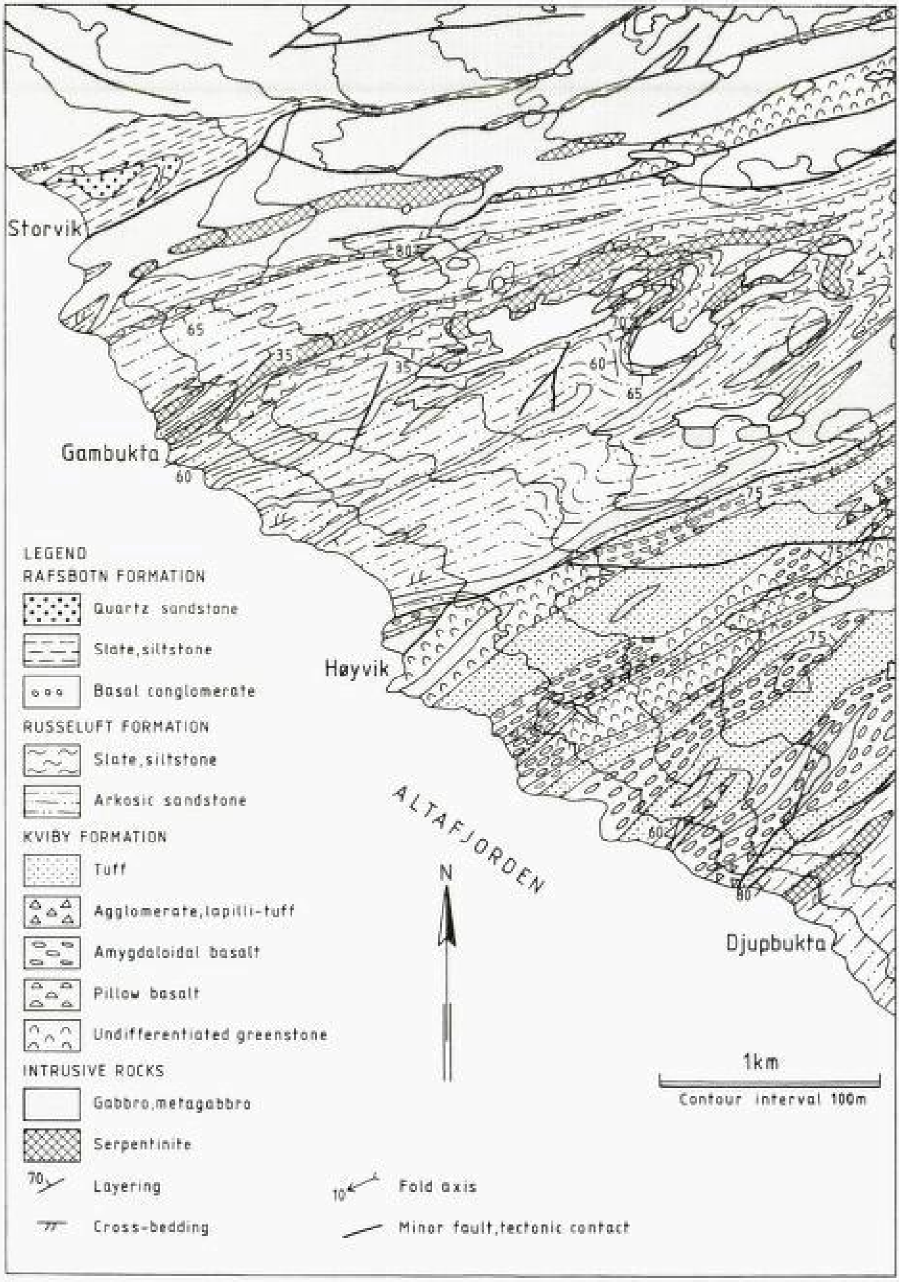

Fig. 3. Detailed geological map of the area around Høyvik (see Plate 1 for location).

have been found, but it has not been possible to map them separately. The informal term *Turelv formation* is used to denote all the Raipas rocks in this part of the area.

Due to marked changes in lithology and structures across the Russeluft-Leirbotnvatnet fault, it is assumed that the fault has a Precambrian origin, as

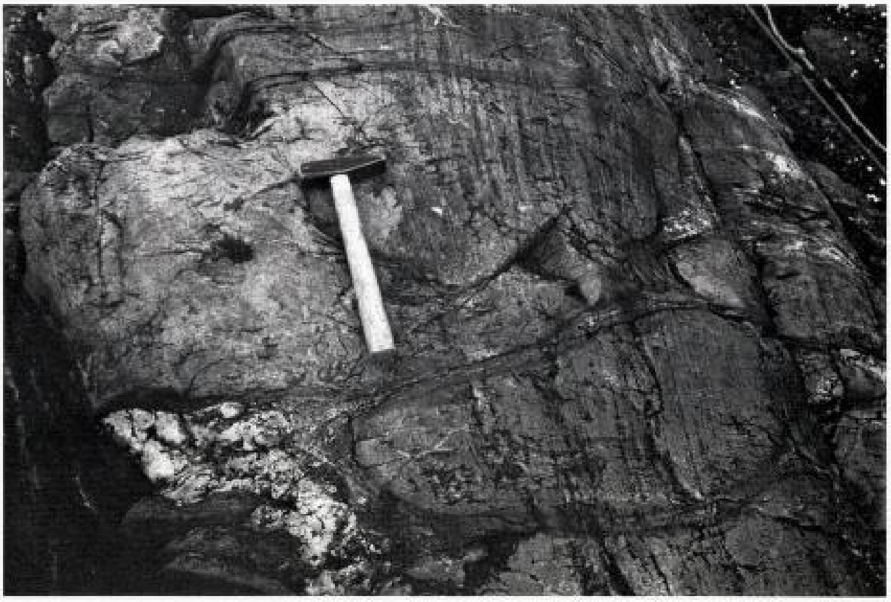

Fig. 4. Pillow lava, Høyvik. Note fine-grained marginal zone. Length of hammer handle 30 cm.

illustrated in Fig. 2, but definite proof for this is lacking. It has also been active in Caledonian time, deforming both the Rafsbotn formation autochthon and the Kalak Nappe Complex.

Description of rock units

KVIBY FORMATION

The Kviby formation is composed of low-grade metamorphic, extrusive volcanic rocks. From their mineralogy and field appearance the rocks have been classified as basaltic, although no analyses of bulk chemistry were made for this investigation. The formation crops out in three belts which are considered to represent approximately equivalent stratigraphies which have been tectonically separated. The thickness of the south-eastern belt, not accounting for possible repetition of layers, varies from about 600 m in the north-east to about 1500 m in the south-west, including a 100 – 200 m thickness of intrusive bodies in most sections. The other belts are thinner, and the rocks are generally more deformed there than in the south-eastern belt. The distribution of the rock-types varies in different areas. In the north-east part of the south-eastern belt pyroclastic rocks predominate, whereas lavas constitute a substantial portion of the coastal section in the south-west (Fig. 3).

Pillow basalt occurs at several levels. The most extensive layer, which is about 50 m thick, has been traced for about 3 km along the contact against gabbro east of Langvatnet. The width of the pillows is generally 0.3–1.0 m. In the most favourable localities, primary features such as fine-grained marginal zones (Fig. 4) and amygdules are fairly well preserved. In general, the pillow structure is rather obscure due to tectonic deformation. It has not been found suitable for geopetal determination.

Amygdaloidal basalt without pillow structure has a fine-grained, dark green matrix, and amygdules filled with quartz. The amygdules are ovoid or irregular, their size is 2–30 mm and they compose 5–30% of the rock.

Agglomerate, lapilli-tuff and tuff grade into each other. The coarser pyroclasts are predominantly greenstone, seldom diabase or gabbro. Maximum size observed is about 30 cm, but usually the pyroclasts are less than 10 cm in length (Fig. 5). The proportion of lapilli and blocks to tuff material varies greatly. Tuffs with only scattered lapilli are widespread.

To a large extent, especially in the mountains, poor exposures and tectonic deformation preclude the observation of primary structure in the Kviby formation, and the rocks have been mapped as undifferentiated *greenstone*.

The mineralogy of the volcanics is of low-grade metamorphic origin. The matrix of the rocks is composed of albite + amphibole + epidote ± chlorite ± biotite ± leucoxene. The amphibole is in most cases colourless to light green tremolite/actinolite. Megacrysts in the pyroclastic rocks include plagioclase, epidote, olive-green amphibole and quartz.

RUSSELUFT FORMATION

The Russeluft formation is composed of medium- to thick-bedded sandstone of chiefly arkosic composition, with subordinate slate, siltstone and conglomerate. Like the Kviby formation, outcrops are located in three separate belts, the easternmost of which is the most extensive, its thickness being around 3500 m. Tectonic repetition of layers may, however, have occurred in this belt. Cross-bedding structures, which are widespread throughout the formation, invariably show younging directions towards the south-east.

Arkosic sandstone. The sandstone is light grey, frecuently with a reddish tinge. Somewhat darker varieties with a shade of green also occur. Quartz, plagioclase and microcline, in descending order of abundance, are the major minerals. The amount of phyllosilicates is small. Occasional samples are rich in quartz and grade into quartz sandstone. The rocks have an undeformed appearance in many localities, but microscopic examination usually reveals some micro-brecciation. Quartz as a rule shows undulatory extinction. Average grain size is commonly about 0.5–1.0 mm. Bed thickness is between 0.1–1.0 m. Depositional structures include ripple marks, graded bedding and cross-bedding. Soft-sediment deformation of foresets in cross-bedded units can be seen in some localitites (Fig. 6). Cross-bedding has been used to determine way-up in all the outcrop areas of the Russeluft formation. Examples of graded bedding are few and show fining upwards. In a few zones scattered pebbles of quartz and coarse-grained gneiss are found in the sandstone. The pebbles are rounded and about 2–6 cm across.

Conglomerate (not shown on the map) occurs between Kvibyvatnet and Bannasgamvatnet. The most extensive zone is about 1 km long and up to 30 m thick. It consists of rounded to subangular, sometimes flattened, clasts of quartz

Fig. 5. Agglomerate with large clast of amygdaloidal basalt, Tømmerholmen. (Note miniature crag-and-tail caused by glacial erosion). Length of pencil 14 cm.

Fig. 6. Cross-bedded sandstone with foresets deformed prior to consolidation, 150 m southeast of Gambukta.

and feldspar. Average grain size is 0.5–1.0 cm. Quartz pebbles may be up to about 5 cm across. The rock grades into arkosic sandstone.

Slate, siltstone. Fine-grained sediments occur sparingly throughout the Russeluft formation. The most extensive zone is found in the central belt (Fig. 3) and attains a thickness of about 100 m. The rocks have a greyish colour and are composed of alternating layers of clayey and silty material varying in thickness from about 0.2–10.0 cm. They are frequently somewhat calcareous. Cleavage cutting layering is developed to a varying degree.

Contact metamorphic features are noted near intrusives, the sedimentary rocks taking on a hornfelsic appearance. Slates and siltstones are commonly partly assimilated by intrusive gabbros, particularly in the area between Kviby and Langvatnet. Growth of epidote and tremolite/actinolite in the sedimentary rocks is also noted as a contact metamorphic feature.

Dolomitic breccia (not shown on the map) is found in a small area 1.5 km north-west of Russeluft. It is composed of dolomitic and quartzo-feldspathic fragments in a dolomitic matrix. The outcrop area measures about 50 m × 400 m. Layering is not seen. The contacts with the surrounding arkoses have not been observed, and the origin of the breccia is unknown.

TURELV FORMATION

The term 'Turelv formation' is used for convenience for what might more correctly be termed 'undifferentiated rocks of the Raipas Group south-east of the Russeluft–Leirbotnvatnet fault'. This rock unit consists of both volcanic and sedimentary rocks, which may be stratigraphical equivalents of parts of the Kviby and Russeluft formations, respectively. The outcrops are separated into an eastern and a western belt by the large gabbroic body east of Turelva. The northernmost part of the western belt is included in Fig. 7. The stratigraphical thickness of the Turelv formation has not been determined.

Greenstone is fine-grained, massive or laminated. No recognisable primary volcanic structures have been observed. In many cases, it is difficult to distinguish between lavas and intrusives in the field. The main minerals of the greenstones are albite, light green amphibole and epidote. Chlorite, ore minerals, leucoxene and calcite occur in varying amounts. Some greenstone samples display relics of an ophitic or subophitic texture.

Dolomite. Massive and laminated dolomite grade into each other and occur most extensively in the hillside west of Grareinelva. In the massive dolomite, breccias resembling karst fillings occur. Minor chert bands up to 1 cm thick have been observed in the dolomite.

Phyllite. Dark-coloured pelitic rocks occur in zones up to 50 m thick. The rocks are distinguished from the slates in the Russeluft formation by having a phyllitic lustre, probably due to a slightly higher degree of metamorphism. The phyllosilicates in two samples were sericite and chlorite.

Quartz sandstone occurs in contact with dolomite, in zones up to 100 m thick. It is medium-grained, has a reddish colour and contains occasional zones of quartz conglomerate up to 10 m thick.

Arkosic sandstone has its main occurrence on the eastern side of the large gabbroic body east of Turelva, where a maximum apparent thickness of 700 m is exposed. The rocks are less well preserved than the arkoses of the Russeluft formation, and primary structures have not been found. Contact metamorphic effects such as hornfels, growth of epidote and tremolite/actinolite, and partial assimilation by gabbro, are seen in many localities.

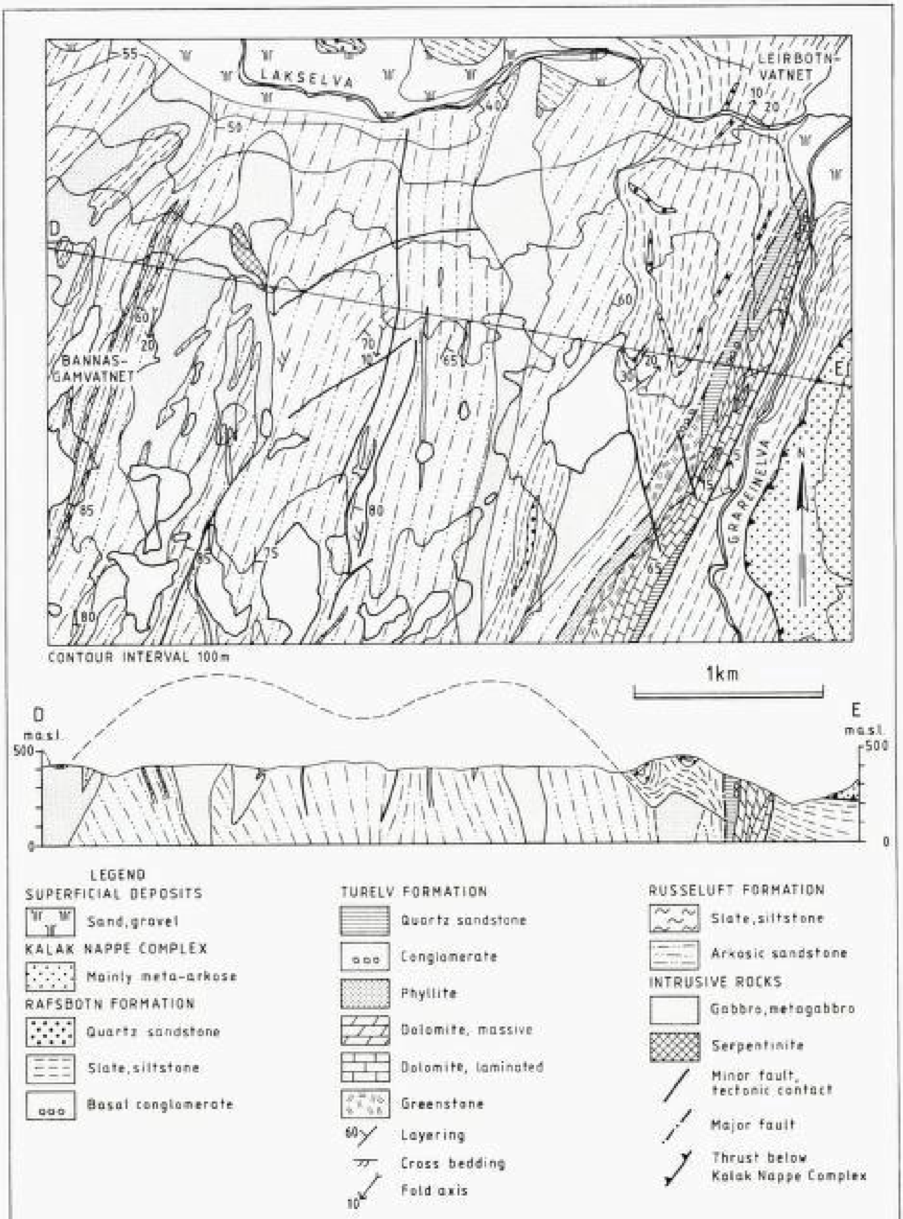

Fig. 7. Detailed geological map and profile of the Bannasgamvatnet–Leirbotnvatnet area. (See Plate 1 for location).

INTRUSIVE ROCKS

Bodies of intrusive, dominantly gabbroic rocks, constitute about a quarter of the exposed area of Precambrian rocks in the Altenes window. They are usually lenticular sheets or sub-concordant dykes and vary in dimension from the metre scale up to 12 km in length and several hundred metres thick. Individual bodies have nowhere been observed to cross formational boundaries.

Fig. 8. Columnar jointing in diabase, Tømmerholmen.

Gabbro, metagabbro, diabase. The rocks are mostly medium-grained, with a sub-ophitic texture. Saussuritisation and uralitisation have taken place to a varying degree. A small portion of the samples have unaltered pyroxene and plagioclase. A particularly fresh specimen from a locality 400 m north-west of Trollvatnet has orthopyroxene and clinopyroxene together with slightly zoned basic andesine. A diabase dyke cutting the layering in pyroclastic rocks on Tømmerholmen displays well-preserved columnar jointing (Fig. 8).

Serpentinite. Ultramafic rocks have intruded the sedimentary sequence of the Russeluft formation. They occur as lenses with longest dimension up to 1.5 km, mainly in the fine-grained sedimentary rocks west of Langvatnet. Other ultramafic bodies are contained in gabbroic rocks. Most samples of ultramafic rocks have a mineralogy dominated by serpentine and chlorite. Relict textures suggest that the rocks were originally composed of olivine and poikilitic pyroxene. A sample from the ultramafic body north-east of Bannasgamvatnet contains about 3% plagioclase.

Tonalite (not shown on the map). A swarm of dykes, each dyke between 200–800 m long, up to 20 m thick and oriented approximately NW-SE, occurs in a restricted area in the north-eastern part of Altenesfjellet. The rocks have a porphyritic texture with euhedral crystals of quartz and zoned plagioclase set in a fine-grained quartzo-feldspathic matrix; compositionally they correspond to tonalite. The dykes cut through the bodies of metagabbro.

RAFSBOTN FORMATION

This formation is composed of low-grade sedimentary rocks, mainly slate and siltstone. The sediments were deposited unconformably on a substrate of

Fig. 9. Basal conglomerate, Rafsbotn Formation, Djupvik. Person standing on underlying gabbro. Dark fragments in conglomerate are gabbro; light fragments are quartz and quartzo-feldspathic rock. The contact between conglomerate and gabbro is approximately vertical.

deformed and eroded Raipas Group supracrustals and intrusives, and are autochthonous with respect to this substrate. The formation occurs in two different settings (see chapter 'Structural history'): —

1. The areas along the edges of the window in the north and east (Kviby – Leirbotnvatnet, Leirbotvatnet – Rafsbotn, Rafsbotn – Turelva) and two small outliers north of Bannasgamvatnet. Here the basal contact has gentle to moderate dips (Plate 1, profile segment B–C), except where disturbed by the Russeluft–Leirbotnvatnet fault. There is no evidence to indicate that the rocks of the Rafsbotn formation in these areas were deposited outside the present area.
2. Narrow zones in the north-western part of the Altenes area, between Storvik and Djupvik. The basal unconformable contact is vertical or steeply inclined in an inverted position (Plate 1, profile between A and Langvatnet). These occurrences of the Rafsbotn formation have been tectonically transported, together with their substrate, from a position probably not very far to the north-west.

The stratigraphical thickness of the Rafsbotn formation is estimated to be between 50 and 100 m.

Tillite is considered to represent the lowermost stratigraphical unit. It is confined to a single locality, described by Roberts & Fareth (1974), where it rests on Raipas rocks. Its maximum exposed thickness, according to observations made in 1977, is 4 m.

Conglomerate is found as a discontinuous layer along the basal contact of the Rafsbotn formation in localities where the tillite is absent. It is chiefly a quartz conglomerate, up to 1 m thick, with well-rounded pebbles which are 1–3 cm in size. The zones between Storvik and Djupvik, which rest on gabbro, have at their base a generally less well-sorted conglomerate with less well-rounded pebbles. Maximum exposed thickness is about 2 m. Many subangular blocks are found, frequently more than 10 cm in size. A large percentage of the clasts, in several localities more than 50%, is composed of gabbro (Fig. 9).

Slate, siltstone. These rocks, which in many localities are interbanded, constitute the dominant lithology of the Rafsbotn formation. The rocks may be laminated on a mm to cm scale, but homogeneous pelites also occur. The coloration is grey, green or red. A mottled red-green alternation is particularly characteristic. Slaty cleavage is prominent in most localities. Trace fossils have been found in siltstone at Mosenes (Roberts & Fareth 1974).

Quartz sandstone is medium-grained, grey or red and occurs in horizons which range in thickness from a few decimetres to several metres. These seem to be most frequent in the lower part of the formation. Layers of *conglomerate* with quartz and quartzite pebbles about 1 cm in size are found at a few localities. The layers are up to 1 m thick.

KALAK NAPPE COMPLEX

The Rafsbotn formation is overthrust by rocks of the Skillefjord Nappe of the Kalak Nappe Complex (Roberts 1974). The nappe rocks directly bordering the Altenes area are dominantly grey to greenish grey, flaggy meta-arkoses with subordinate mica schist. They contain pegmatite lenses, and isoclinal folds are common. No further account of these rocks will be presented here.

REGIONAL METAMORPHISM

From the mineralogy of greenstones and pelitic rocks it can be concluded that the degree of regional metamorphism in both the Raipas Group and the Rafsbotn formation is about the same and does not exceed low greenschist facies. There may be a slight difference between the Turelv formation and the other formations, as the pelitic rocks of the former have a phyllitic appearance, in contrast to the slates of the Russeluft and Rafsbotn formations. However, more refined investigations are necessary to determine whether this is significant. Whether the metamorphic mineral assemblages of the Raipas Group rocks date from Precambrian or Caledonian metamorphic events, or both, is not known.

Structural history

The Altenes area can be divided into three subareas which show different structural histories (*a–b–c*, Fig. 10). The diving line between subareas *a* and *b* is the Russeluft–Leirbotnvatnet fault; that between *b* and *c* is less precisely defined. It has been drawn at the north-western boundary of the south-eastern belt of the Kviby formation, but it could be somewhat further north-west.

In subareas *a* and *b* the sediments of the Rafsbotn formation overlie their

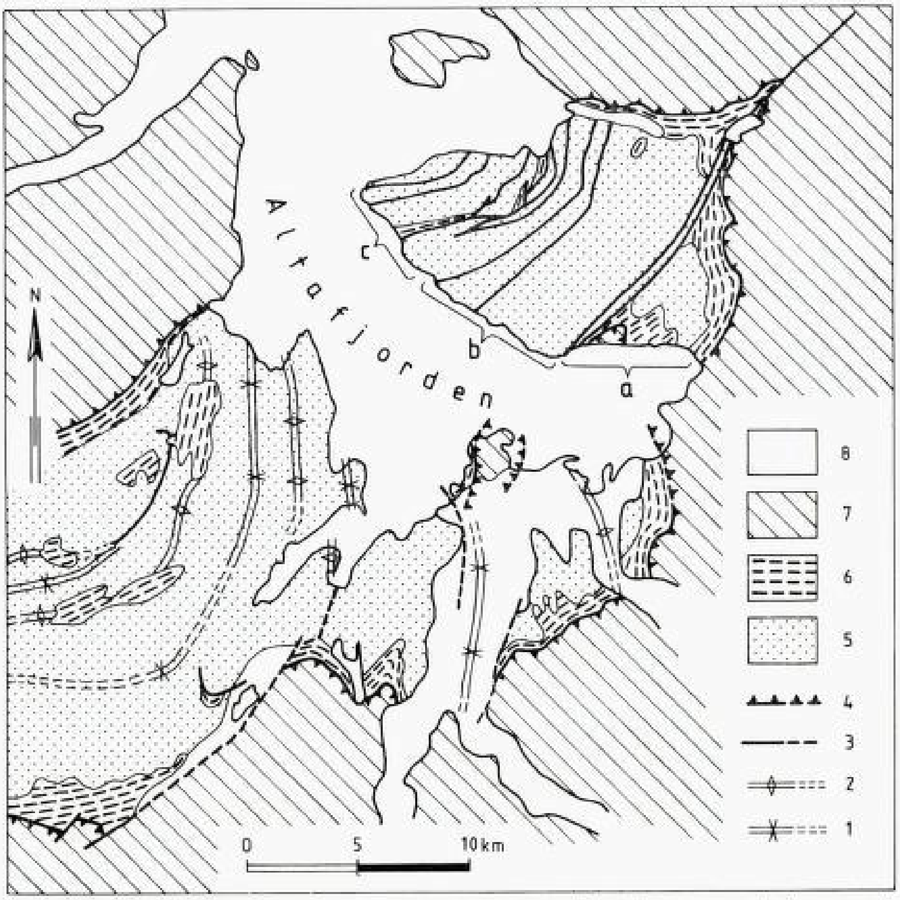

Fig. 10. Simplified map showing structural subdivision of the Altenes area (subareas *a*, *b* and c), and main structural features of the Altafjord region. (1) Syncline, dashed where inferred; (2) Anticline; (3) Fault, tectonic contact; (4) Thrust plane below Kalak Nappe Complex; (5) Raipas Group; (6) Bossekop, Borras and Rafsbotn Formations; (7) Kalak Nappe Complex; (8) Superficial deposits. Data from the southern side of the fjord modified from Gautier (1977).

substrate in a normal position, whereas in subarea *c* they occur in vertical or steeply inclined, overturned zones, sandwiched between slices of the substrate upon which they were deposited.

The layered rocks of the Raipas Group in general have steep, often vertical dips. In subarea *a*, large-scale folding is probably the main factor controlling the present distribution of the Raipas rocks. Open to tight folds with NE-SW to N-S trending axes and steep axial planes, and with amplitudes ranging from 0.1 m to 50 m have been observed, but poor outcrop has prevented mapping of individual large-scale folds.

In subareas *b* and *c*, mesoscopic folds in the Raipas rocks are rare and restricted to zones with extensive outcrops of slate, and to local areas in the vicinity of minor faults. The largest folds are found in slate-siltstone lithologies 1–2 km west of Langvatnet, where tight folds with steeply dipping axes have

Fig. 11. Contact between Russeluft and Kviby Formations, northern side of Djupbukta. East is towards the right. Tuff (Kviby Formation) immediately to the left of the person, who is standing on sandstone (Russeluft Formation). Thin bed of sandstone (light-coloured) in tuff is present in the left part of the picture.

amplitudes up to 500 m. No major isoclinal folds exist in the rocks belonging to the Russeluft formation in these two subareas. This is proved by the widespread cross-bedding structures, constantly showing younging direction towards the south-east.

Cleavage is poorly developed in the Raipas rocks. The sandstones and the bulk of the volcanic rocks are more or less massive. Cleavage transecting layering has been noted in slate and tuff. The scattered observations yield younging directions which correspond with those decuded from sedimentary structures.

In order to understand the major structure of subarea *b,* it is important to determine the nature of the contact between the Russeluft and Kviby formations. This is sharp wherever exposed. As might be expected in a tectonically disturbed area, the contact between the competent sandstones and the relatively less competent effusives shows signs of movement, the effusives being in general sheared and shattered immediately adjacent to the contact. The contact has accordingly been drawn as 'tectonic' on the geological map. However, observations at the coastal exposure of the contact on the northern side of Djupbukta between Høyvik and Russeluft suggest that the contact may have a depositional origin (Fig. 11). Here, the inverted basal lithology of the Russeluft formation, dipping 90° to the north-west, is an arkosic sandstone, below which is a tuff belonging to the Kviby formation. Within this tuff, 3 and 5 m away from the contact, are found two beds of arkosic sandstone, each half a metre thick. This kind of contact could tentatively be interpreted as a transitional one, the two sandstone beds being forerunners of the Russeluft formation and representing temporary cessation of a waning volcanic activity. If this interpretation is correct, the Raipas rocks in subarea *b* can be envisaged to constitute the north-western limb of a syncline whose south-eastern limb has been cut out by tectonic movements.

When discussing the major structures of the Raipas rocks in subareas *a* and *b*, we are mainly – although not exclusively – dealing with the effects of events that took place before the deposition of the Rafsbotn formation. In subarea *c*, the mode of occurrence of the Rafsbotn formation shows that in this north-western area, Caledonian events have played a major part. Here, slices of the Raipas substrate, partly with zones of the Rafsbotn formation sandwiched between them, have been piled upon one another in some kind of imbrication structure. This implies that the rocks in this subarea are not autochthonous. Probably their source area was not very far to the north-west. The generally NW-dipping tectonic contacts in subarea *c* are interpreted as minor, high-angle thrusts.

The structures described above differ from those on the opposite side of Altafjord. Here, Gautier (1977) has mapped a number of major synclines and anticlines, whereas complete folds on this scale are absent from subareas *b* and *c* in Altenes.

In both the Altenes area and the rest of the Alta–Kvænangen Precambrian window, the Raipas rocks display a varying strike trend. This may be due to some extent either to two separate phases or to a primary non-cylindricity of Precambrian folding. However, in the Altenes area, the curving trend of the thrusted zones involving Rafsbotn formation rocks in subarea *c*, which is reflected in a less conspicuous strike change in subarea *b* from NNE-SSW in the north to NE-SW in the south, could indicate that part of the deformation of the Raipas rocks is Caledonian, not only in subarea *c* but also in *b*.

Reitan (1963) found thrusts in the north-western part of the Komagfjord window which are similar in attitude to those described from Altenes. The structural position of his Kvalsund formation is similar to that of the Rafsbotn formation in subarea *c*, although no basal conglomerate has been described from the Kvalsund formation.

Folding is widespread in the Rafsbotn formation. The scale varies from about 1 cm to 100 m, the largest folds being found in thick quartzite intercalations. The folds vary in style from open to tight, curvilinear to chevron, and symmetrical to inequant. Also, directions of fold axes and axial planes show great variability. In large parts of the area the pelitic rocks have a steep to vertical cleavage trending NE-SW to N-S, which is axial planar to small-scale folding. The spacing between cleavage planes is in the interval 0.5 cm–2 cm. The observations in the outcrop areas of the Rafsbotn formation are not sufficient to provide a detailed structural history for this formation. The thrust plane beneath the Kalak Nappe Complex truncates folds in the Rafsbotn formation, proving that the folds pre-date this thrusting (D. Roberts, pers. comm.).

The following sequence of events is envisaged to have led to the present disposition of the rock formations in the Altenes area:

Precambrian: Deposition of Kviby, Russeluft and Turelv formations. Folding, intrusion, faulting, including the Russeluft–Leirbotnvatnet fault.

Vendian – ?Lower Cambrian: Deposition of Rafsbotn formation on a peneplaned surface.

Caledonian I: Folding of Rafsbotn formation rocks. Approximately SE-directed compression in Raipas basement, causing high-angle thrusting/imbrication in subarea *c*. In this subarea the Rafsbotn formation took part in the thrust movements. Compression possibly also caused some deformation of the Raipas rocks in subarea *b*. Younger folding in the cover rocks; this includes folds which deform the thrust plane beneath the Kalak Nappe Complex.

Caledonian II: Re-activation of Russeluft–Leirbotnvatnet fault, the block on south-eastern side sinking at least 300 m near Russeluft, displacement decreasing towards Leirbotnvatnet. The fault dies out north-eastwards in the Kalak Nappe Complex, outside the map area.

The Altenes area is thus not just a simple 'window' where erosion has exposed a basement. The Raipas rocks have taken part in the structural development of the area not only in Precambrian time but also after they had acquired their cover of younger sediments.

Finally, it should be noted that Torske (1978) has proposed an aulacogen-rift model for the Raipas rocks in the Alta–Kvænangen window and their correlatives on Finnmarksvidda. The studies which are now in progress in both areas will probably throw new light upon this part of the Baltic shield margin to which the Altenes area belongs.

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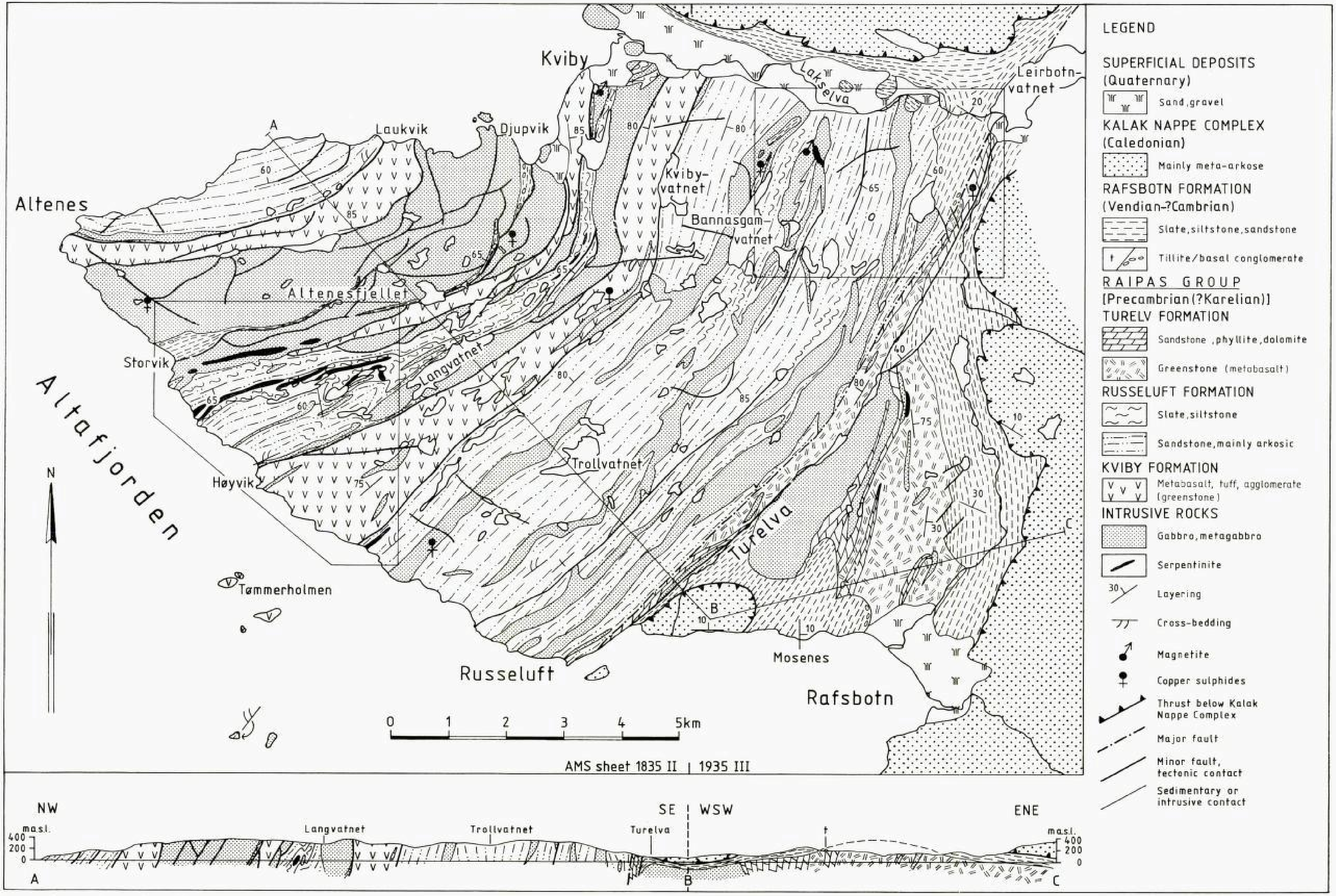

Plate 1. Geological map of the Altenes area.