The Geology of the Caledonides of the Reisa Valley Area, Troms-Finnmark, Northern Norway.

by

Finn J. Skjerlie and Tek Hong Tan.

Introduction.

In the summers of 1958 and 1959, Geofysisk Malmleting carried out a survey of the Reisa Valley region, with as its main purpose the investigation of known iron deposits and recently reported lead occurrences in the area. As coherent geological data were lacking, it was also judged necessary to work out a geological map and to study the general petrography and structural geology of the region. During the months of July and August 1959, the authors joined Geofysisk Malmleting's team in Finnmark and took part in the exploration of the Precambrian greenstone area surrounding the Časkias copper deposits. During this period they were given the opportunity to extend the survey of the lower Caledonides east of the county boundary of Troms. Some of the observations reported here were made by cand. mag. Tore Torske, who took part in the survey of the Caledonides in the area under discussion.

The adjoining Birtvarre region and the Precambrian area of western Finnmark were recently mapped by Padget (1955) and Holmsen, Padget, Pehkonen (1957), while the Caledonides in the Finnish territory were studied in detail by Hausen (1942 b). The present area is for the most part geologically unsurveyed, except for the visits by Karl Pettersen (1888) and Thorolf Vogt. The latter made a reconnaissance of the part of the contact zone between the Precambrian and the Caledonides, lying between Torneträsk (Sweden) and the Reisa river. The results were presented in a lecture held for Norsk Geologisk Forening, the summary of which was published in 1918.

The Reisa Valley proper is a U-valley in the northernmost part of the area under consideration, about 4—5 kilometers wide. The mountains on either side of the valley may reach the height of more than

1000 meters above sea level, while the river itself flows at an altitude of 70 meters. The high lying land is a very rugged country with several glaciated valleys crossing the area. Towards the south, the U-valley narrows to 500 meters or less, and becomes more canyon-like. The ground on both sides of the Reisa river rarely exceeds the elevation of more than 700 meters. The upland here is a flat, undulated plain with a comparatively little relief, and is the westerly extension of Finnmarksvidda, the plateau of Finnmark. At Nedrefoss, the last point one can reach by river boat (about 70 km from Reisafjord), the river is 130 meters above sea level. Raisjavrre, the source of the Reisa river, lies at an elevation of 447 meters. The eastern area under present survey, part of the Finnmarksvidda proper, belongs to a different drainage system, and the relief is even less prominent.

The present paper deals only with the results of the general geological reconnaissance of the Reisa Valley region and not with the investigation of the mineral deposits. The area is more than 1500 square kilometers and only a fraction of the period in the field could be spared for geological work which did not appear relevant to the authors' original mission. The present authors thus can present only the broadest outlines of the geology of the Caledonides in the Reisa Valley region, in the realization that additional work in this area would lead to significant improvements on their observations and conclusions.

Aknowledgement.

The present authors had the occasion to discuss their results with Dr. Tore Gjelsvik and state geologist Per Holmsen, who have worked in the southern parts of the area. The authors are deeply indebted to them for the fruitful discussions and for the additional information they gave.

Autochthonous rocks.

THE PRECAMBRIAN BASEMENT

The Caledonides rest on a basement of Precambrian rocks. The publication of the field survey of western Finnmark by Holmsen, Padget, Pehkonen (1957) can be summarized as follows:

Between Raisjavrre and the Finnish border is a large area of granitic rocks, with numerous inclusions of "supracrustal schists". The rocks are generally speaking banded granite gneisses which appear to be the results of granitization. Of the original supracrustals, quartzite and amphibolite are the best preserved. Within the granitic rocks there occur two belts of greenstones and some zones of albite-carbonate rocks. East of Raisjavrre there are two broad belts of greenstones, separated from each other by zones of argillites and sandstones. Časkias mountain is in the western greenstone belt, Čaravarre ridge (south of Čarajavrre) in the sandstone ,and the southern tip of Čarajavrre lies in the eastern greenstone. The greenstone may be fine-grained and banded («sedimentary greenschists»), fine-grained and dense («extrusive greenstone») to medium-grained («intrusive greenstone») where amphiboles and feldspars are macroscopically visible. The contact between the basement and the overlying Paleozoic sediments is found (or, if covered, expected to occur) along Sallejokka at 600 meters above sea level, south of Sieidas at 470 meters, at Bulljovagge at 600 meters, south of Njarggavarre most probably higher than 600 meters, near Nedrefoss at 300 meters, and at the Finnish border at 800 meters above sea level. The highest points in the Precambrian area are Časkias 774 meters, and Čaravarre 891 meters above sea level. The erosional surface under the Cambrian Hyolithus Zone is a slightly undulated plane, which dips towards the NNW with an angle less than 4° in the Reisa Valley. Previous authors (a. o. Holtedahl 1918) noted that the Precambrian in Finnmark was eroded to a flat peneplain. Around Bulljovagge the sub-Cambrian surface rises to over 600 meters, and leads one to conclude that there must have been a low hill during the Cambrian deposition. A similar hill is believed to have existed west of Čarajavrre. The general slope of the sub-Cambrian surface in Troms is on the average 2½° towards the west (Vogt, 1918).

EOCAMBRIAN ROCKS

The occurrence of autochthonous Eocambrian rocks has been reported by Holmsen (1956 and 1957). At a number of localities in western Finnmark he found tillite on the sub-Cambrian surface under the basal conglomerate of the Hyolithus Zone. At Bulljovagge the tillite was found to rest on quartzite and arkosis beds, which Holmsen named sparagmite. The total thickness of the Eocambrian here, he writes, is probably more than 5.5 meters. C. O. Mathiesen, geologist of Kautokeino Kobberfelter, discovered more tillite outcrops west of Bulljovagge (personal communication 1959). Holmsen's and Mathiesen's discoveries are entered on the geological map.

No rocks, recognisable as tillite, were found west of Časkias.

THE HYOLITHUS ZONE

The Hyolithus Zone lies on the Precambrian with an angular unconformity. Whereas the Precambrian rocks near the contact were generally found to have a N-S strike and a very steep dip, the lowermost beds of the Hyolithus Zone overlies mainly granitic rocks in the western part of the area under discussion. Towards the east the Zone overlies mainly the greenstone.

The rocks of the Hyolithus Zone are chiefly conglomerates, sandstone and shales, the latter being the most characteristic feature of the formation. In the incisions and gorges of five tributaries of the Reisa river, practically the whole sequence could be studied from the base to the top. The sixth stream, Avasjokka, flowing in the canyon of Ave Vagge, has apparently already been visited by Vogt (1918). There is a frequent alternation of the different rock types, and these can be grouped together into five members listed below and in fig. 1. The generalization, however, need not to be applicable outside this small area.

Conglomeratic series. The thickness is less than 5 meters, sometimes only 1 meter. The actual conglomerate is found in the 5 river exposures mentioned above. The components are usually vein quartz and to a lesser extent granitic rocks. The size of the pebbles usually varies from 5 to 10 cm, but smaller and larger fragments occur. At Nedrefoss the conglomerate is not present but the series is represented by a coarse, badly sorted arkosic sandstone, the grain size varying from 0.1 mm to over 2 mm, though larger pebbles were found.

Weak mineralization have taken place in the conglomeratic series, but due to the very limited extent they did not appear to be of economic importance. Near Nedrefoss, galena was found occurring with the cementation quartz of the arkosic beds. In a stream south of Avasjokka the matrix of the conglomerate contains masses of pyrite. The sulfide impregnations in the basal conglomerate near Čarajavrre were previously noted by Holmsen (1956).

Lower shale and sandstone series. This is a series of alternating beds of sandstone and shale. The thickness of the individual beds are mostly

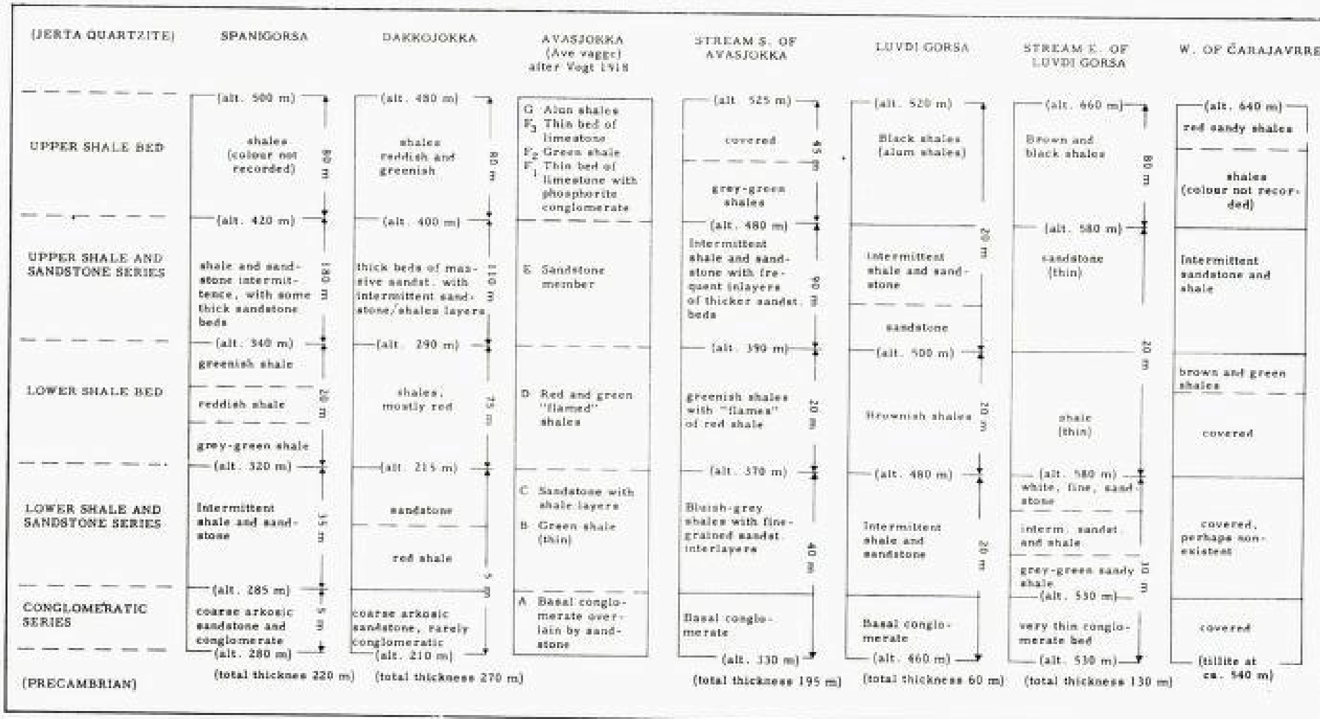


Fig. 1. Schematic sections of the Hyolithus Zone around the Reisa river.
Skjematiske snitt av Hyolithussonen ved Reisaelven.

between 5 cm and 5 meters. The thinner sandstone layers were found to have irregular thickness; they were seen to pinch and swell and even wedge out, reappearing either at the same or at a different level. Both the thin and thick sandstone beds are as a rule cross-bedded.

Trails and prints of worms and probably of other animals are abundant in the sandstone layers, especially where these alternate intensively with the shale. Shrinkage cracks may occur, though less frequently, in argillaceous layers in the sandstone. Ripple marks were occasionally found, and a sandstone bed was seen to display slump-structures.

Lower homogenous shale bed. The shale is usually sandy, but the sandstone is practically absent. A few sandstone layers still occur, but they are not always noticeable as here they are very fine-grained and have the same colour as the surrounding shales. The colour of the shales can be dark red, chocolate brown or greyish green. The shales have a regular diagonal jointing, and irregular conchoidal cleavage.

Upper shale and sandstone series. This series shows little difference with the lower shale and sandstone. The main difference is its greater thickness, and the presence of thicker sandstone beds. In one of the sandstone layers of this series one may find rounded pebbles of black slate.

Upper homogeneous shale bed. This is also similar to the lower shale. Only the thickness here is greater. The upper shale is overlain by fine-grained quartzite, one of the types of rock found in the Jerta Nappe.

This general subdivision also fits with Vogt's description of the section in Ave Vagge, as can be seen on the figure 1. Towards the east, however, the lower shale and the sandstone series seem to be absent, as Holmsen describes the succession there as: 1) Basal Conglomerate, 2) Lower shale, 3) Sandstone beds, 4) Upper shale.

Folding is very often seen in the lower and upper shale and sandstone series. The folds themselves are generally not more than 100 meters wide. More than one independent set of folds were observed lying over each other. The folds are generally asymmetric and the axial plane dips mostly in the westerly direction but occasionally it dips to the east. Smallscale overthrusting can also be noted.

No folding was observed in the conglomeratic series. The layers of the lowermost series were regarded as having generally remained rigid. The present difference in the strike directions of these bottom beds is believed to be chiefly due to the slight undulations of the sub-Cambrian surface and the resulting initial dip of the first overlying sediments. Some overthrusting has, however ,also taken place here, as in the valley of Dakkojokka one can see a slab of Precambrian mica schist lying between the lower sandstone and shale series.

The schematized sections in fig. 1 shows how different are the observations taken from the two sandstone and shale series at the outcrops. The present deformed state (folding, thrusting and possibly locally squeezing out of some beds caused by the great Caledonian overthrust above), coupled with the difficulty of making accurate and continuous recordings of the rocks when they are so deformed, are undoubtedly some of the reasons. Nevertheless, primary differences are considered to have existed before the deformation took place. We therefore hesitate to carry out a parallelization of the beds over a great distance.

Allochthonous rocks.

THE JERTA NAPPE

Overlying the Hyolithus zone is an overthrust formation of quartzites, the thickness is estimated to be about 500 meters. The quartzite is generally a fine-grained rock, the colour light grey or dark bluish grey. Often it resembles chert. A close study might lead to a distinction of several types. Clastic characters are generally macroscopically invisible, but near the base some banding may be seen, and occasionally a vague granularity.

In the quartzite one very frequently finds thin layers of grey-green to brown shales, very much like some of the shale types in the underlying Hyolithus Zone. These layers can be as thin as a few centimeters, but thicker beds of some meters are present. A thick bed of black shales with pyrite impregnations was found by Per Holmsen south of Jorbbesjavrre (Personal communication).

Other rocks belonging to this formation are dolomite and conglomerates. The dolomite was found north of Reikojvarre forming a low anticline. The layer wedges out towards the east. Thin layers of conglomerates were recorded, also with a very limited extension.

One of the most interesting rocks of this unit is a tillite ,occurring 5 km NNE of Sieidas ridge. An outcrop is found not very far from the junction of Gironjokka and Rapesjokka, and nearby lies a belt of large boulders of this rock, most likely worked up by frost action through the overburden from the bedrock underneath (fig. 2 and 3). The

Fig. 2. Dolomite tillite of the Jerta Nappe, Gironjokka.
Dolomitt-tillitt, Gironjokka.

components of the conglomerate are mostly dolomite and the usual size ranges between 5 cm and 30 cm. The dolomite is light grey, and has a yellow weathering colour. Other components are greenstone and quartzite. The matrix is dark brownish grey with no apparent sorting in grain size, the smaller particles (mostly quartz) are badly rounded, while the larger (mainly dolomite) fragments are quite angular. The coarse conglomerate is not stratified but a number of the frost-shot blocks were seen to have strata of finer material (fig. 4), with some of the layers displaying distinct grading of the fragments from coarse to fine, presumably from bottom to top. These stratified and occasionally "graded" beds might be regarded as fluvioglacial deposits.

A similar tillite was found in the stream incision of Jorbbesjokka. This was found by Per Holmsen to be lying between two beds of chocolate-brown shales of Eiocambrian age. A thrust-plane was seen between the Eocambrian shales and the underlying beds of the Hyolithus Zone (Holmsen, personal communication 1960).

The name Jerta Formation is proposed as a stratigraphic term. Jerta

Fig. 3. Dolomite tillite of the Jerta Nappe, Gironjokka.
Dolomitt-tillitt, Gironjokka.

Fig. 4. Stratified conglomerate, Gironjokka.
Lagdelt konglomerat, Gironjokka.

is the name of a mountain (830 m) serving as an important landmark for the Lapps and hunters traversing the region. All the quartzites were named Jerta Quartzite in the field, though it is recognized that there are several distinct types. The formation can also be regarded as a tectonic unit, and for this the name Jerta Nappe is suggested.

THE REISA VALLY NAPPE

The Reisa Valley Nappe comprises rocks of Eocambrian and Cambro-Silurian age. The overthrust has caused an extensive mylonitization along the lower boundary. Higher up a number of minor thrusts have occurred.

Padget (1955) has given a very detailed description of the geology of the adjoining Birtavarre region and divides the Caledonides as follows.

Birtavarre Series	a. Non granitized schists. b. Granitized schists.
Sparagmitic Schists. (Hyolithus zone)	

This succession was obtained in the Skibotndal, where, as already observed by Hausen, (1942 b), the blue quartz series (Jerta Quartzite) is absent. The granitized schists are made up of quartz schists, quartz-mica schists, mica schists, epidote schists and amphibolites. The granitization, Padget writes, "is represented by feldspathic and quartzofeldspathic material in greater or lesser amounts. It occurs in a variety of ways, as augen, as more indefinite schlieren, as coarse-grained pegmatitic bodies with both parallel and discordant relationships to the layering of the rocks".

In the Reisa Valley area the Sparagmitic Schists are overlain by the Upper Birtavarre Series ("non granitized schists") and not, as was expected, by the Lower Birtavarre Series ("granitized schists"). Beds answering to the description of the latter were not encountered. In the north, pelitic schists may occur in somewhat larger quantities between the Sparagmitic Schists, but this fact is not considered significant enough to regard the rocks here as a separate unit, as the majority of the rocks are still recognizable as Sparagmitic Schists.

Sparagmitic Schists. The Sparagmitic Schists thus begins with a thick zone of mylonite. The rocks are very fine-grained and often banded. As

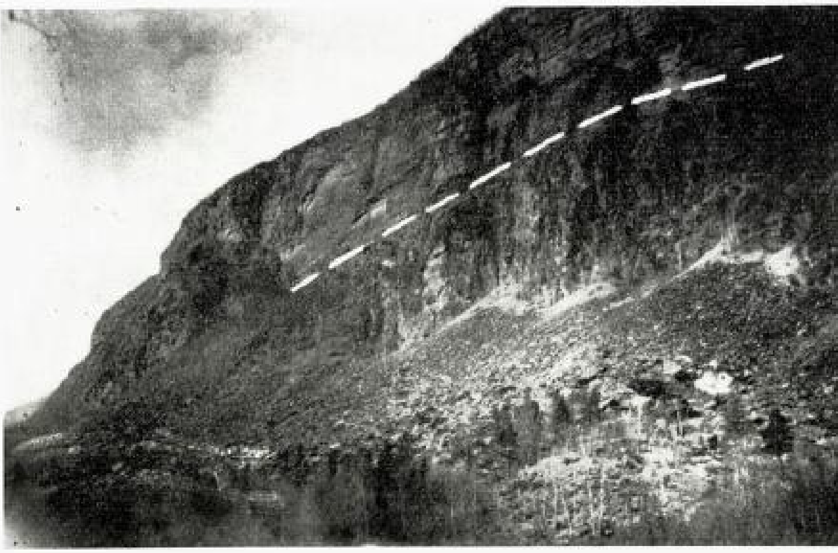


Fig. 5. Contact between the Jerta Nappe (below) and the Reisa Valley Nappe (above), north of Nedrefoss.

Grense mellom Jertadekket (under) og Reisadalsdekket (over), nord for Nedrefoss.

Hausen (1942 b) already observed in the corresponding zone in Finnish territory, there is a frequent, very regular, vertical jointing in two, and sometimes three directions. Rivers are inclined to make deep incisions in this rock and small and large canyons are often formed. Extensive outcrops of these mylonitic schists are to be found in the river bed 4 km north of Reikojavrre, in the valley of Vuobmedokka, in and along Mollisgoppejokka and along the Reisa river. Above the eastern bank of the latter there is a continuous exposure for many kilometers of this rock, dipping very slightly to the north. Just north of Nedrefoss one can see very clearly the contact between the Sparagmitic Schists and the underlying Jerta Nappe (fig. 5).

The Sparagmitic Schists have as a rule a greyish colour and a pronounced parallel texture. It is fine- to medium-grained. The schists show as a rule granoblastic structures, but clastic structures appear locally. The chief minerals are quartz and feldspar. The quartz content is 30—60 %, and the mineral is always recrystallized. Of the feldspar there are both albite (<10 % An) and potash feldspar. The potash feldspar is microcline or microperthite with spindles of albite. At some places, especially along the lower part of Punta river, there occurs microcline microperthite as "augen" up to ½ cm in diameter. Its shape seems to indicate a sedimentary origin, but it is also possible that it is formed by metamorphism. The feldspar content is usually 30—40 %. Biotite and muscovite appear as a rule together in all thin sections, often as parallel intergrowths, the biotite occasionally showing chloritization (to pennine with abnormal blue interference colours). Epidote is a usual mineral, and appears often as layers together with the mica. Now and then the epidote displays a myrmekite-like structure with inclusions of quartz. Garnet occurs as small idiomorphic grains in some of the rocks, occasionally also showing incipient chloritization.

Ore minerals occur in small quantities, as a rule ilmenite, and generally partly altered to leucoxene. Other accessory minerals are zoisite, sphene, orthite-epidote, pyrite, rutile, apatite and zircon.

Outcrops of conglomerates were not found, but just south of the upper part of Caucasjokka there occur numerous angular blocks of a quartz conglomerate. A relatively short glacial transportation was assumed.

Greenschists and other rocks. The greenschists are generally formed as fine- to medium-grained schists of greyish green to dark green colour. The chief constituents are albite, chlorite, actinolite, epidote and calcite. Quartz and biotite may also occur. Accessory minerals are sphene, hematite, ilmenite, pyrite, apatite, rutile and zircon. The rocks may otherwise be developed as epidote-amphibolites, sometimes with garnets, perhaps due to the uneven metamorphism in the area. It is probable that the greenschists were originally volcanic tuffs.

As one sees on the geological map, there often occur smaller and larger zones of mica schists within the greenschists. Thin layers of graphite schists, quartzite and limestone also occur, and we believe these to be original changes in the sedimentation. The mica schists are mostly formed as dark grey to silver grey garnet-biotite schists. The garnets are usually between 0.2 and 2.0 cm in diameter. The schists contain quartz and small quantities of albite. As a rule the garnets and biotite are partly chloritized. Muscovite and graphite are seen in all thin sections. Accessory minerals are iron ore, zoisite, apatite, zircon, rutile and tourmaline.

These rocks have been folded in the Sparagmitic Schists. Not infrequently one finds shreds of sparagmite, torn loose and wedged in the greenschists. The boundaries between the greenschists and the Sparagmitic Schists are always tectonized and the crush-zones usually have a thickness of 1—5 meters. These are very often mineralized with magnetite and/or hematite. None of these deposits are of any economic importance.

Instrusive rocks. Instrusive rocks, mostly developed as amphibolites, are found scattered over the whole area within the Sparagmitic Schists. They usually occur as small lense-shaped bodies of 10—15 meters length, but there appear also larger massives. The largest occur north of Somashjärvi, and in the area near Caucasjokka. The instrusive rocks are always conformable with the schistosity of the schists. As a rule they have a marked parallel texture suggesting that the rocks were intruded before the last movements have ended. Plagioclase varies from albite to andesine, depending on the grades of saussuritization. Occasionally it also displays weak sericitization. Green and blue-green hornblende is the dominating dark mineral. In some cases this can be partly altered into brown biotite. North of Somashjärvi there occasionally occur small quantities of augite showing partial alteration to hornblende. Garnet was only found north of Caucasjokka. Accessory constituents are muscovite, sphene, zoisite, rutile, apatite, quartz, and iron ore.

In the massives north of Somashjärvi some of the rocks are hornblendites with ca. 90 % hornblende. In some other parts of these massives the rocks contain so much feldspar that it would be more appropriate to call them hornblende gneisses.

A lens of dunite was found about one kilometer north of Somashjärvi. Owing to the scarcity of exposures its exact size and shape is not known, but the body is estimated to be at least 500 meters in diameter. It rests on a thin layer of amphibolite. The contacts of this basic body with the surrounding Sparagmitic Schists are not exposed. The colour of the dunite is greenish black. The weathered rock is brown to dirty yellow.

In thin sections the dunite appeared to be made up almost exclusively of olivine showing incipient alteration to serpentine. The only other constituent is magnetite occuring in small quantites, and is probably formed during the alteration of the olivine. The magnetite is mainly concentrated along microscopical zones of shearing. Larger veins of magnetite, up to one cm thick, were observed at the outcrops and the mineral may also occur as round nodules of about ¾ cm diameter. It was seen in the field that in the larger shearing zones the dunite may be completely serpentinized.

The dunite answers closely to the description of Hausen's "Olivinstein" (1942 a), occurring in the basic complex of the Reisduoddar Haldde (Halditjokko).

Granitized rocks. Evidence of granitization was found in some localities in the Sparagmitic Schists, especially near Reisduoddar Haldde and north of Caucasjokka. The process must have taken place at a relatively late stage of the orogenesis, as also some of the instrusive rocks have been subjected to granitization. In the areas near Reisduoddar Haldde granitic gneisses were formed. Enclosed in the granitic gneisses are relics of Sparagmitic Schists. At some other localities there are schlieren and veins of rocks resembling pegmatite, and it is possible that here too an addition of material has taken place.

As mentioned earlier, the "augen" of potash feldspar, which are to be found at several places in the Sparagmitic Schists, are not regarded as evidence of granitization.

In the thin sections of the rocks inside the granitized areas it is clearly evident that potash feldspar (microcline) has replaced plagioclase. The replacement has led to the formation of myrmekite, and very often one finds unaltered relics of plagioclase enclosed in microcline. The granitization of the intrusive amphibolites has also caused the hornblende to be altered to brown biotite.

Structure.

It is generally accepted that the Precambrian basement and the Hyolithus Zone are autochthonous rocks while the overlying series are allochthonous. It is, however, also earlier observed that thrust planes are present and small scale overthrusting can occasionally be seen within the Zone. Hausen (1942 b), although calling the Hyolithus Zone "autochthones Kambrium", remarks that the upper parts of Zone are really par-autochthonous.

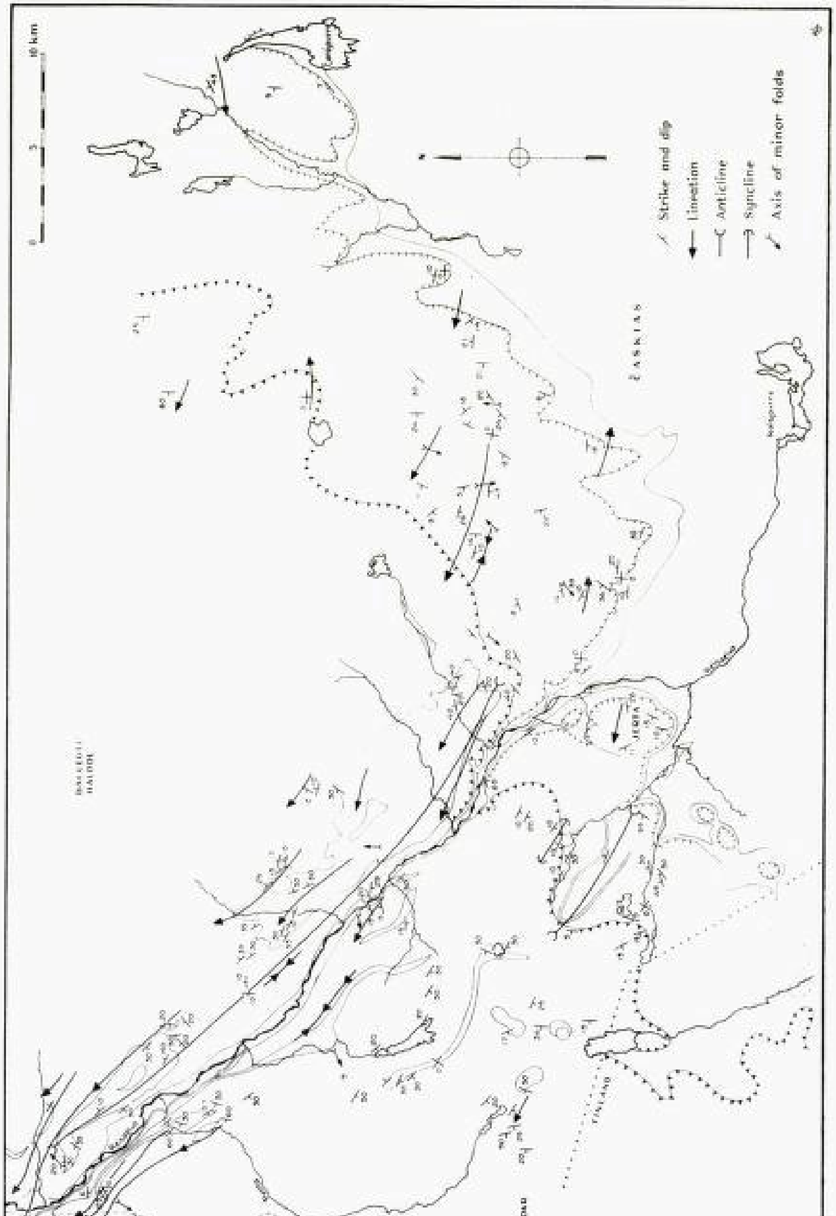
Whereas the beds of the Hyolithus Zone do not seem to be appreciably disturbed near Čarajavrre, intensive disharmonic folding occurs in the west. This could be observed very clearly around the Reisa river. The axes of folding lie mainly around NW-SE. Near Čarajavrre the few small folds seem to be orientated mainly W-E.

The overlying quartzite formation, which in turn is overlain by the Reisa Valley Nappe, is already recognized by Hausen (1942 b). He calls this "Blauquartz-Tonschiefer-Dolomitfolge". We prefer to use a less cumbersome term and propose the name "Jerta Formation". The age was tentatively suggested by Hausen to be "Untersilurisch" (Ordovician), and the series was considered to be par-authochthonous. The presence of the tillite at the base of the formation, however, forces one to conclude that the Jerta Formation is Eocambrian, and that the rocks are thrust over the Hyolithus Zone. Along the Finnish border the boundaries of the Jerta Nappe become difficult to place, due to the poverty of outcrops and perhaps more complicated structures. One gets the impression here that one or more crush zones have appeared. The presentation of the boundaries on the geological map is not altogether certain, but it is considered to be the most reasonable interpretation based on the data hitherto gathered. The geology on the Finnish territory is derived from Hausen's (1942 b) paper. The Precambrian-Caledonian boundary, however, had to be moved southwards as quartzite outcrops were found on Vartoaivi, and shale outcrops further south. The quartzite is somewhat different, but the rock is considered to belong to the Jerta Nappe.

As mentioned earlier the Reisa Valley Nappe strats with a thick mylonitic zone. This major thrust zone was already recognized by Hausen (1942 b), referred to as "mylonitische Hartschiefer", and by Padget (1955). The thrusting is directed towards the SE. Within the Reisa Valley Nappe there have occurred a number of subordinate thrusts. Padget (1955) has recognized the Cappis Thrust in the Birtavarre Series. Thrusting has also taken place along the boundary between the Birtavarre Series and the Sparagmitic Schists, clearly indicated by mylonitization. It is furthermore considered most likely that the sedimentary greenschists and mica schists are younger than Eocambrian and are folded into the Sparagmitic Schists during the orogeny.

Padget (1955) proposes to adopt provisionally the term "Seve" for this overthrust complex, which lies directly on the Hyolithus Zone near Kilpisjärvi, but he also states that "much more work in intermediate ground is obviously necessary before true identity of the tectonic units can be established". Even though much can be said in favour of the parallelization with the Seve Nappe in northern Sweden, we prefer to adopt a local name, the Reisa Valley Nappe, until such parallelization is proven in the field.

The various structural observations are entered on the structural map (fig. 6). The lineation in the rocks is visible as a typical stretching or as a parallel orientation of prismatic minerals. The majority of the


0
5
10 km
Strike and dip
Lineation
Anticline
Syncline
Axis of minor folds

linear structures go NW-SE or WNW-ESE. A study of the dragfolds in the area indicates that the movement must have taken place towards ESE or SE. The orientation of the linear structures thus corresponds with the direction of the overthrust. This is in accordance with the prevailing opinion of the Scandinavian geologists (Kvale 1953).

Padget (1955) has shown a somewhat more southerly direction of transport (SSE) for the Birtavarre region. Within the Reisa Valley area one sees that the lineation has a tendency to bend from ESE-WNW near the Hyolithus Zone to SE-NW near the Birtavarre region. Within the Birtavarre region this swings to SSE-NNW, but according to his structural map it appears that the SE-NW direction becomes again prominent farther west (towards Lyngen and Kåfjord). Observations on the Kviteberg, near Lyngen (Reitan and Geul 1960) also indicate pressure from the NW. There must, however, have occurred a compression perpendicular to the direction of movement, probably during the last phases of orogeny. This compression is indicated by large, weak folds with their axes parallel to the direction of movement. It appears that the Reisa Valley is formed on the southwestern limb of a large anticline, "the Reisa Valley anticline". The plunge is to the NW. Another anticline occurs NE of Reikojavrre, also with a plunge to the NW. Within the Birtavarre region this compression has likewise caused folding parallel with the direction of movement. Padget (1955) has indicated the "Kåfjorddalen syncline", where the plunge is about 15°—20° to the NNW. Only the most important folds are mentioned here, but there occur several more large scale folds parallel with the direction of movement over comparatively large areas, which can only be explained by a compression at right angles to this movement.

Concluding remarks.

It may be summarized that the geology of the area under review is made up of the Precambrian basement, the overlying autochthonous (and par-autochthonous) Hyolithus Zone, and the overthrust Jerta Nappe and Reisa Valley Nappe.

← Fig. 6. Structural map.
Strukturkart.

The age of the Hyolithus Zone was determined to be lower Cambrian, but the alum shale at the top was assumed to be middle or upper Cambrian (Holtedahl 1953, p. 244). The basal tillite and underlying autochthonous sparagmite are obviously Eocambrian. Although the Hyolithus Zone is well-known and its lithology and paleontology locally fairly well described, little seems to have been done to study this formation from a sedimentological viewpoint. We can at present contribute little to the previous observations except the recording of the successive strata as was done by earlier investigators, but this is only one of the steps in the stratigraphical studies of any formation. As mentioned earlier, we prefer to refrain from correlating the individual beds of the Zone over a wide area. One reason for this is that the tectonic disturbances (thrusts) in the locations where the complete sections are exposed, necessitates a more careful and critical study than has hitherto been made. The other reason is the preliminary interpretation that the greater part of the Zone (i.e. sandstone and shale series) is characterized by shallow water and rapid deposition, making it uncertain that the individual beds, even the thicker ones, have a great lateral extension.

The Jerta Nappe starts with a tillite, so that the age of the lower part is determined as Eocambrian, and this obliges us to accept that the unit is an overthrust, older formation. Metamorphism is generally very low — the shales are not always easily distinguishable from the underlying rocks. The quartzite, which is usually very fine-grained, shows at the base and at the top brecciation, but may elsewhere display vague clastic structures. A considerable part of the quartzite shows no clastic structures at all, and resembles chert or flint. The whole formation is believed to be Eocambrian, as its sequence bears some resemblance to the Eocambrian Sandstone Series of East Finnmark. The quartzite and shale alternation seems to be similar to the sandstone and shale sequence of the Porsanger Sandstone (Holtedahl 1918) or Older Sandstone Series (Føyn 1937). On account of the tillite at the base, however, the Jerta Nappe is more likely to be correlated with the Younger, Tillite-bearing Sandstone Series of the Tana district. The Jerta Nappe thins out in Finnish territory east of Kilpisjärvi, and it is not known how far it extends eastwards.

The Reisa Valley Nappe begins at its base with a thick mylonitic zone which can be observed at several localities. The division, valid for these rocks in the Birtavarre region, was not found to apply in the

Reisa Valley, as the Lower Birtavarre Series ("granitized schists") do not occur here. The Birtavarre Series in the present area starts with the Guolas Limestone and Lower Brown Schists, both belonging to the lowermost beds of the Upper Birtavarre Series ("non-granitized schists"), and lying directly on the Sparagmitic Schists. Padget's remark (1955, p. 45) that the "granitized schists" extend to localities near Bilto, in Punta valley and near Sappen, could not be confirmed by our observations. The variance in our respective findings is probably due to the acceptance of different criteria. During our survey, a boundary between two rock units is chosen at places where there is a marked change in the lithological sequence; the higher metamporhism and the possible occurrence of more pelitic schists are not regarded as significant as the presence of the bulk of the rocks which are recognized as metamorphosed sparagmites. Neither is the appearance of granitization phenomena considered to be decisive enough to regard the rocks in these parts as a separate stratigraphic unit. The "granitized rocks" as presented on the geological map of this paper have therefore no stratigraphic significance.

The greenschists, which are believed to be of volcanic origin, are assumed to be younger (Cambro-silurian) than the surrounding Sparagmitic Schists. The boundaries with the Sparagmite Schists are always tectonized and it is concluded that the greenschists were brought into their present positions during the orogeny.

The low metamorphism in the Jerta Nappe leads us to assume that the transport of the nappe is relatively short. The Reisa Valley Nappe on the other hand is assumed to have been thrust from a greater distance away.

Sammendrag.

Reisadalområdets geologi.

Somrene 1958 og 1959 utførte Geofysisk Malmleting malmundersøkelser i Reisadalen og tilstøtende områder. Da kjennskapet til berggrunnen var meget mangelfullt var det nødvendig å kartlegge et større område geologisk. Det geologiske kartet omfatter kaledonidene i Reisadalsområdet begrenset i vest til Birtavarrefeltet (Padget 1955) og er mer enn 1500 km² stort. I denne avhandling er bare resultatene av den geologiske kartlegging behandlet, ikke av de utførte malmundersøkelser. Forfatterne kan for det meste bare gi hovedtrekkene av Reisadalsområdets geologi, men mener det har en viss betydning at deres resultater blir kjent.

Den geologiske bygning innen Reisadalsområdet er i hovedtrekkene at Hyolithussonen ligger med en tydelig diskordans autoktont (og par-autoktont) på de prekambriske bergarter. Over Hyolithussonen opptrer det to dekker. Det undre dekket — Jertadekket — består sannsynligvis i sin helhet av eokambriske bergarter, mens det øvre dekket — Reisadalsdekket — omfatter bergarter både av eokambrisk og kambro-silursk alder.

Homsen (1955 og 1956) har påvist at eokambrisk tillitt ligger mellom prekambrium og den underkambriske Hyolithussonen på flere lokaliteter øst for Časkias. På grunnlag av en del undersøkte profiler i Reisadalen har forfatterne forsøkt å foreta en grov stratigrafisk inndeling av Hyolithussonen. Ovenfra og ned finner en følgende avdelinger:

5. Øvre leirskifer.
4. Øvre leirskifer- og sandsteinserie
3. Undre leirskifer
2. Undre leirskifer- og sandsteinserie
1. Basalkonglomerat

Hyolithussonen varierer meget i mektighet fra et profil til et annet. Dette skyldes delvis tektoniske forstyrrelser, men en må også anta at det har vært primære fasies-variasjoner før deformasjonen satte inn.

Over Hyolithussonen ligger Jertadekket med en tydelig tektonisk grense. Den dominerende bergart er en finkornet blåaktig kvartsitt som ofte kan minne om chert. Som lag i kvartsitten opptrer det leirskifer og konglomerat, i et par tilfeller også dolomitt. Hausen (1942 b) kaller formasjonen «Blauquarz-Tonschiefer-Dolomitfolge», og mener at den er ordovicisk (untersilurisch) og ligger par-autoktont i forhold til Hyolithussonen. Imidlertid tyder funn av dolomitt-tillitt i undre del av Jertaformasjonen på at den er av eokambrisk alder og må oppfattes som et overskjøvet dekke. Den lave metamorfosen av bergartene innen Jertadekket tyder etter forfatternes mening på at skyvningen har vært relativt kort.

Over Jertadekket ligger Reisadalsdekket som i den nedre del er sterkt mylonittisert i stor mektighet. I Reisadalsdekket inngår bergarter både av eokambrisk og kambro-silursk alder. Underst ligger sparagmittiske skifre med innfoldete flak av kambro-silurske grønnskifre og glimmerskifre. Øverst ligger Birtavarreseriens bergarter, vesentlig amfibolitter. Lokalt kan bergartene vise granittisering. Padget (1955) inndeler kaledonidene i Birtavarreområdet på følgende måte:

Birtavarreserien	a. ikke granittisert
	b. granittisert
Sparagmittiske skifre	

Innen Reisadalsområdet opptrer ikke de granittiserte bergarter tilhørende Birtavarreserien, og på det geologiske kartet har forfatterne trukket grensen for Birtavarreserien ved (a), «de ikke ganittiserte bergarter».

Under den kaledonske orogenese ble dekkene skjøvet mot SØ-ØSØ, og av strukturkartet (fig. 6) fremgår det at linjestrukturene innen området er parallell med denne retning. Retningen for materialtransporten eller overskyvningene faller altså sammen med linjestrukturenes retning. Dette er overensstemmende med det herskende syn blant skandinaviske geologer. Padget (1955) har påvist en noe mer sydlig transportretning i Birtavarrefeltet (SSØ). Innen Reisadalsområdet kan en av strukturkartet se at linjestrukturene har en tendens til å bøye av fra ØSØ-VNV nær Hyolithussonen, til SØ-NV nær Birtavarrefeltet. Innen Birtavarrefeltet bøyes så linjestrukturene ytterligere av til SSØ-NNV, men av Padgets kart fremgår det at retningen SØ-NV igjen blir den dominerende lenger vest (mot Lyngen og Kåfjord).

Imidlertid må det, sannsynligvis i en sen fase av orogenesen, ha inntruffet en kompresjon loddrett på retningen for overskyvningene. Denne kompresjon viser seg ved store, relativt flate foldninger med akser parallell bevegelsesretningen. Således er Reisadalen skåret ned i den sydvestlige sjenkel av en stor antiklinal, «Reisadalsantiklinalen». Disse store folders akser stuper mot nordvest med relativt flatt fall.

References.

Føyn, Sven. 1937. The eo-cambrian series of the Tana district, Northern Norway. Norsk Geologisk Tidsskrift, Bind 17, pp. 65—164.

Hausen, H., 1942 a. Das Halditjokkomassiv. Acta Academiae Aboensis. Math. et Physica 13 (14).

— 1942 b. Der Abschnitt Finnlands der kaledonischen Ueberschiebungzone. Soc. Scient. Fennica, Comm. Physico — Math., 11 (9).

Holmsen, P., 1956. Hyolithus-sonens basale lag i Vest-Finnmark. Norges Geologiske Undersøkelse Nr. 195, pp. 65—72.

— 1957. De eoambriske lag under hyolithussonen mellom Carajavrre og Caskias, Vestfinnmark. Norges Geologiske Undersøkelse Nr. 200, pp. 47—50.

Holmsen, P., Padget, P. and Pehkonen, E., 1957. The Precambrian Geology of Vest-Finnmark, Northern Norway. Norges Geologiske Undersøkelse Nr. 201.

Holtedahl, O., 1918. Bidrag til Finnmarkens Geologi. Norges Geologiske Undersøkelse Nr. 84.

— 1953. Norges Geologi. Norges Geologiske Undersøkelse Nr. 164.

Kvale, A., 1953. Linear Structures and their Relation to Movement in the Caledonides of Scandinavia and Scotland. Quart. Journ. Geol. Soc. London. 109, 1, pp. 51—73.

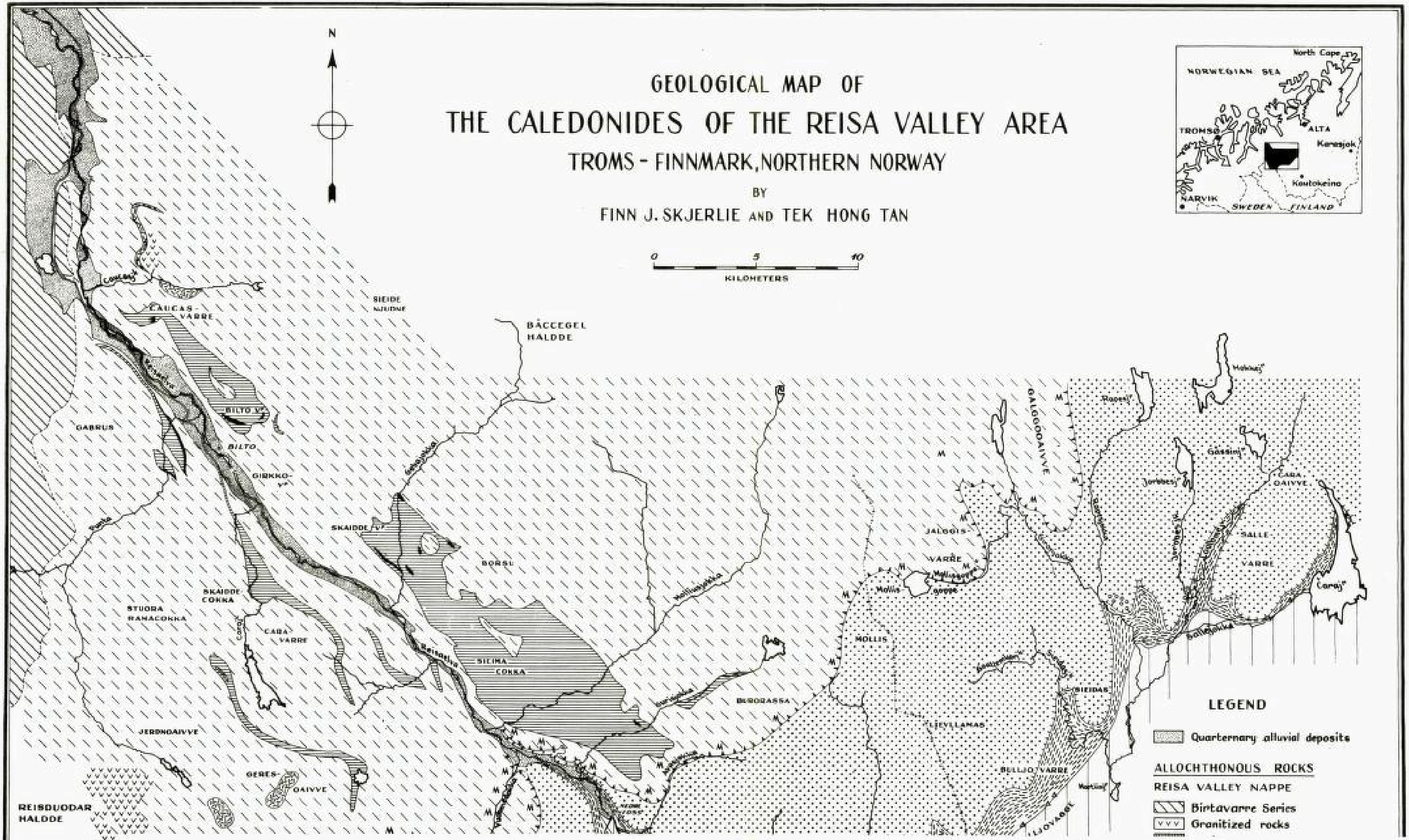
Padget, P., 1955. The Geology of the Caledonides of the Birtavarre Region, Troms, Northern Norway. Norges Geologiske Undersøkelse Nr. 192.

Pettersen, K. 1887. Den nord-norske fjeldbygning I. Tromsø Museums Årshefter X.

— 1888. Den nord-norske fjeldbygning II. Tromsø Museums Årshefter XI.

Reitan, P. and Geul, J. J. G., 1959. On the formation of a carbonate-bearing ultrabasic rock at Kviteberg, Lyngen, Northern Norway. Norges Geologiske Undersøkelse Nr. 205, pp. 111—127.

Vogt, Th., 1918. Geologiske studier langs den østlige del av fjellkjeden i Tromsø amt. Norsk Geologisk Tidsskrift Bind IV, pp. 260—266.



N
GEOLOGICAL MAP OF
THE CALEDONIDES OF THE REISA VALLEY AREA
TROMS - FINNMARK, NORTHERN NORWAY
BY
FINN J. SKJERLIE AND TEK HONG TAN
0 5 10
KILOMETERS
North Cape
NORWEGIAN SEA
TROMSØ
ALTA
Karasjok
Kautokeino
NARVIK
SWEDEN
FINLAND
LAUCAS-VARRE
BÅCCEGEL HALDDE
GABRUS
BILTO
GIRKKO-Vr
SKAIDDE Vr
BORSU
SKAIDDE COKKA
STUORA RANACOKKA
CABA VARRE
Reisaelva
SICIMA COKKA
BURORASSA
JERDNOAIVVE
GERES-OAIVVE
REISDUODAR HALDDE
GALGGOAIVVE
JALGOIS-VARRE
Mollis
MOLLIS
LJEVLLAMAS
BELLJO VARRE
SIEIDAS
CABA OAIVVE
SALLE VARRE
LEGEND
Quarternary alluvial deposits
ALLOCHTHONOUS ROCKS
REISA VALLEY NAPPE
Birtavarre Series
Granitized rocks