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The geology of the Nyplassen area

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79

THE GEOLOGY OF THE NYPLASSEN AREA

J.W. Rowling. Imperial College

1962.

THE GEOLOGY OF THE NYPLASSEN AREA

C O N T E N T S

I N T R O D U C T I O N

The area mapped during the summer of 1961 lies 12 km. E.S.E. of Løkken, a mining town in a valley draining into Trondheimsfjord. Løkken is 51 km. S.W. of Trondheim in the central part of Norway. Just south of the centre of the area mapped is the settlement of Nyplassen, and the region covered by the accompanying maps is called the Nyplassen Area.

The purpose of the mapping was to work out the detailed structure and stratigraphy of the Hovin Series, a predominantly sedimentary group of rocks bounded to the south by the Støren Series.

On the eastern edge the River Trivja forms the boundary between the Nyplassen Area and the Svartvatnet Area mapped by D.H.Blake in 1960. The northern boundary is Voldmovatnet and Kalvhagevatnet Lakes; the areas to the north-west and to the north were mapped by B.Chadwick in the summers of 1960 and 1961 respectively. Also in the summer of 1961, A.E.Beswick mapped the area to the north-east between the Nyplassen Area and the Hølonda-Horg Area mapped by T.Vogt (Norsk geologisk Tidsskrift 25, 1945, pp. 449-527). Thus this summer's programme was to link the mapping of Chadwick and Blake of 1960 in the west to that of T. Vogt of 1945 in the east. Eight weeks were spent in the field, during which approximately 12½ square kilometres were mapped.

In the field the mapping was carried out on a scale of 1:15,000 approximately. No official maps of this scale exist for this area, and so a map was drawn from a mosaic of air photographs of this scale very kindly provided by the Orkla Grube Mining Company of Løkken. The resulting map was somewhat inaccurate because of distortion within the air photographs, the lack of strict ground control, and also because two separate sets of flight lines were used, at an angle to each

/other

Fig 1.

Nyplassen

Stören Series in the background. Arenaceous Series in the middle distance. Nyplassen itself is seen beyond the slag heaps in the foreground. The stone monolith in the centre marks the site of the original church. The River Trivja runs between the slag heaps.

other with insufficient overlap. The position of True North on the map was not constant due to these errors. The grid marked on the topographical map is the 1000 metre universal transverse mercator grid, zone 32, international spheroid. The contours on the topographical map have been adapted freely from the 1:50,000 series, Orkland Sheet, number 1521 II, and should, therefore, not be taken as being very accurate. The magnetic variation in the area is not known very accurately, so that all the dip and strike readings are measured and plotted with respect to Magnetic North only. The mapping in the field was done on tracing-paper overlays on each air photograph, so that the positions of each outcrop are recorded in the correct positions on the relative photograph overlay.

I should like to thank the Orkla Grube Mining Company for the considerable help and hospitality given to us. Mr. Per Sandvick helped and encouraged us in every possible way during our stay in Norway. Prof. T. Strand of Oslo gave us much helpful advice and spent two informative days in the field with us. Mr Sagvold, the geologist at the Løkken mine, gave us much practical help. Mr. and Mrs. B. Chadwick, Mr. A.E.Beswick and myself stayed in a cabin belonging to Mr. Næve of Løkken. The cabin is situated on the northern side of Bjønlivatnet on the farm of his brother, Mr. O. Næve. We also met Mr. and Mrs. Ingvaldsen, Mr. C. Smith and Mr. Thams, whom we thank for their kind hospitality.

In the northern part of the area there are no farms, and a few derelict sheep pens and shepherd huts are the only signs of civilization, except around the shores of Kalvhagevatnet, where recently a few cabins have been built as weekend retreats. There are some farms along the road at Nyplassen, and also near the greenstone boundary in the south where there are a few springs. Hay is the chief crop of these farms, whilst timber is the main natural resource of the area. Many of the farms are now deserted.

/In

Fig 2.

Hutte.

Fig 3.

Hutte overlooking Bjønlivatnet.

In the seventeenth century Nyplassen was a thriving community, as the ore from the workings around Høidal was brought there to be smelted. This was because this is the nearest place with suitably large water supply. Now all that remains are a few quiet farms, the slag heaps from the smelting plant, and a stone monolith raised on the site of the church that once stood there.

The weather whilst in the field was not very good - being the wettest summer in the region for thirty years. There were several beautiful days of hot sunshine but these tended to be separated by several days of either continuous rain or intermittent drizzle. Though our clothes could be dried overnight and mapping was therefore not held up because of wet clothing, the tracing-paper overlays to the air photographs became damp very easily and nearly impossible to use at times.

Flies and mosquitoes were a nuisance during July and part of August, though they were reduced considerably in numbers as the days and nights became cooler. Several adders were seen, but they were very wary and snaked rapidly away. An elk, several deer and a fox were seen at a distance, whilst hares, squirrels, pheasant and numerous other birds were seen at close range.

The relief within the area varies from approximately 320 metres above sea level around Voldmovatnet, to 540 metres on Baklihaug in the north-east corner of the area. The general topography suggests a "grooved peneplain", with broken south-east to north-west ridges rising up to 100 metres above the lowland troughs. The troughs form the sites of the various lakes of the area, including Voldmovatnet, Lomtj, Kalvhagevatnet, Stor Damtj, Jutultj and Langvatnet (only the last two being completely in the area - the first four occur on the boundaries). The drainage appears to be either to the north-west probably controlled by glaciation, or to the north cutting across the east-west strike of the rocks. Many small streams

/are

are flowing in the directions of the faults and this, therefore, includes those flowing to the north-east. The River Trivja flows across the southern part of the area in a north-west direction until it reaches the west boundary of the area where it changes course to a northerly direction. On reaching the northern boundary of the area the river meanders across a marsh often flooded. It then flows into the south-west corner of Voldmovatnet, and out of the north-west corner. The levels of Voldmovatnet and Kalvhagevatnet have been raised artificially by three metres by the construction of a weir at the north-west outlet of the lakes. There are plans to flood the area by a further three metres.

The hills are thickly forested except on the highest ground, as on Nonsaasen, Stenaasen and on the Greenstone hills to the south; whilst most of the lowest ground, other than that occupied by lakes, is covered by marshes and peat logs. Because of the vegetation cover the percentage outcrop is generally as low as one per cent, the outcrops that do exist usually being very small. However, a sufficient number of outcrops occur in the area to enable one to get a general picture of the geology, even if the relations of the different rock types are often obscured. On wooded hillsides fallen trees often provide many good exposures under their roots, and near-vertical slopes are often only moss-covered. Outcrops can be found on the tops of most of the hills, and the numerous streams and rivers sometimes provide good exposures.

Fig 4.

View across marshes at the outlet of Voldmovatnet looking SE. From Lille Buan.
The River Tirja enters on the right & flows into Voldmovatnet, thence out on the left. Centre and right middle distance—
Banded Tuffaceous Shales & Sandstones intruded by porphyrite. High ridges in the centre and left background consist of Massive
Conglomerate & Agglomeratic Grit Series. Extreme left Baklihaug (Porphyrite) and beyond this are hills mapped by
A.E. Beswick in 1964. Background centre and right are hills of Greenstones of the Støren Series.

SYNOPSIS OF GEOLOGY

The rocks of this region were extensively yet weakly regionally metamorphosed during the Caledonian Orogeny, They escaped the high-grade metamorphism that affected all the surrounding rocks. The stratigraphy is complicated by the fact that many of the rock types occuring in the area are lateral equivalents; also faulting and poor exposure contribute to the problems.

Most of the rocks of the area appear to be part of the down-faulted inverted limb of a syncline, which has been extensively faulted. These faults have complicated the structure. There is also evidence of a second more minor-phase of folding.

The oldest rocks exposed in the area belong to the Støren Series. This series consists of greenstones-submarine spilitic lavas - and agglomerates with associated tuffaceous sediments now metamorphosed to phyllites. A 'gabbroic' rock was seen occuring in this succession. C.W.Carstens in 1922 correlated this Series with the Arenigian pillow lavas and radiolarian cherts of Britain.

The Hovin Series is younger than the Støren Series, and T. Vogt considers the part of the Hovin Series present to the north-east in the Hølonda Horg District is of Llanvirnian age. Graptolites found by D.H.Blake in 1960 are of Middle Skiddavian age. Since the shales that these graptolites occur in are near the middle of the Svartvatnet Area succession of D.H.Blake, it follows that the lower part of the Hovin Series must be older than this. This would suggest that the Støren Series are in fact older than was previous ly postulated.

The rocks found in the Hovin Series include various shales, sandstones, grits, conglomerates, limestones, tuffs and

/agglomerates

agglomerates. Most of the succession except the upper part is remarkably tuffaceous and this shows there must have been quite considerable contemporary volcanic activity. Traces of fossils were seen in the limestones, but were very indeterminable. The Hovin Series also includes the intrusive porphyrites. None of the sedimentary groups could be satisfactorily correlated with T. Vogt's stratigraphy in the Hølonda-Horg District. Some of the divisions could be correlated with those of D.H.Blake of 1960.

During Pleistocene times the area was covered in ice - the main effect of this was to erode the topography to its present profile. There are deposits of boulder clays and gravels, though these are often difficult to distinguish from more recent alluvial deposits.

Fig 5.

Locality 276 600m. W. of Svahyllan.
View S.W. from outcrop of Basal Conglomerate. In the foreground sediments of the Arenaceous Series lie in a trough. In the middle distance is the fault scarp of the Stören Series, and beyond this are hills of Hovin sediments. On the left in the background are hills of Greenstone.

THE STØREN SERIES

Kjerulf first introduced the term "Støren Series" in 1875 and subsequent authors have used this name to describe this series. Most authors agree that these rocks can be correlated with the British Lower Ordovician pillow lavas and radiolarian cherts; C.W. Carstens in 1922 correlated them with the Ballantrae Volcanics of the Southern Uplands of Scotland of Arenig age. The Støren Series consists principally of volcanic rocks, with associated pyroclastics. T. Vogt classifies them as typical spilites. No idea of the thickness of this series in the Nyplassen Area could be obtained as the southern boundary was not reached. C. W. Carstens in his Geologisk kart over Løkken-Feltet, 1952, indicates that this southern boundary occurs some 400 metres south of the southern boundary of the area mapped.

In the Nyplassen Area the Støren Series form the southern most outcrops examined. The contact with the Hovin Series seems to be a fault for most if not all of its length. High steep cliffs occur in places along this boundary forming a fault-scarp (Fig.5).

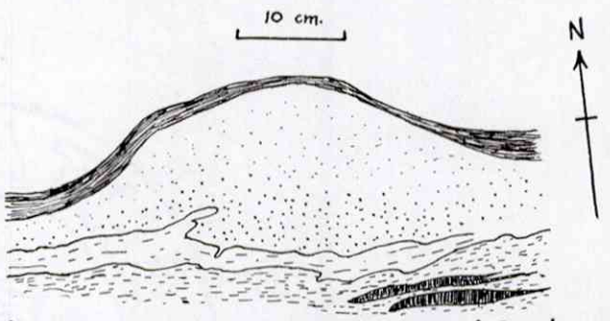
The principal rocks of this series are the basaltic spilitic lavas, often in the form of pillows probably indicating submarine eruption. These pillows were difficult to distinguish clearly in the field; their presence was often noted but their way up could not easily be determined. Some of the best exposed occur 800 metres E.N.E. of Snurli sæter (Figs. 8 & 7), but these are considerably squashed and deformed. At several localities they appear to young to the north showing that they are the right way up. They vary considerably in size; the average is about 0·4 metres and very few appear to be larger than 1·0 metres in diameter. The fact that the pillows are indented into each other suggests that they were plastic during

/formation

Fig 6.

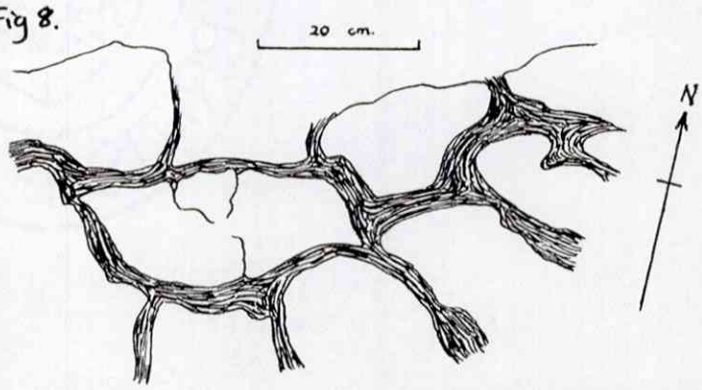
Near Locality 285 550 m. N.W. of Hullet sæter.
Typical exposures of greenstone showing glaciated outline.

Fig. 7.



Locality 173 800 m. E.N.E. of Snurli sæter.
Pillow lavas in the Støren Series, showing vesicular nature of the interior. These appear to decrease in size upwards indicating that the pillows are right way up.

Fig 8.



Locality 174 800 m E.N.E. of Snurli sæter.
Pillows in lavas in the Støren Series. It is very difficult to see which way up these lavas are. The chlorite margin is clear at this locality.

formation. The outer margin is often excessively chloritized. The interior is usually comparatively fresh, with or without vesicles, and containing abundant calcite, and also epidote, albite, chlorite, and sphene: hornblende may or may not be present. Pyrite cubes up to 2 mm. across occur in some lavas. Brian Chadwick has examined the Greenstones in detail and obtained results similar to those of T. Vogt in the Hølonda-Horg district.

Greenstone breccias and agglomerates are quite abundant in this area. One of the best and most typical exposures occurs 600 metres N.W. of Hullet sæter (Figs. 9 & 10). It consists of more or less irregular fragments of tuffaceous material and jasper in a vesicular matrix exhibiting flow-banding round some of the fragments. In places the breccias are interbedded with greenish shale bands. At some localities the agglomerates appear to become finer-grained southwards passing vertically (stratigraphically) from fragments up to 15-20 cm. in size to a dark-green fine-grained phyllite over a distance of 50 metres. Since the banding was dipping to the north, this was taken to indicate that these beds are inverted and young to the south.

In some places especially near the northern boundary the greenstones are massive dark bottle-green fine-grained rocks. Mottled pale and dark, green and grey-green greenstones are abundant also. The greenstones of all types are very irregularly veined and jointed.

Many authors record jasper beds in the Støren Series but none were seen in the Nyplassen Area. T. Vogt describes these as thin, for instance 0·5 - 1·0 metres, and the scattered outcrops may account for their apparent absence.

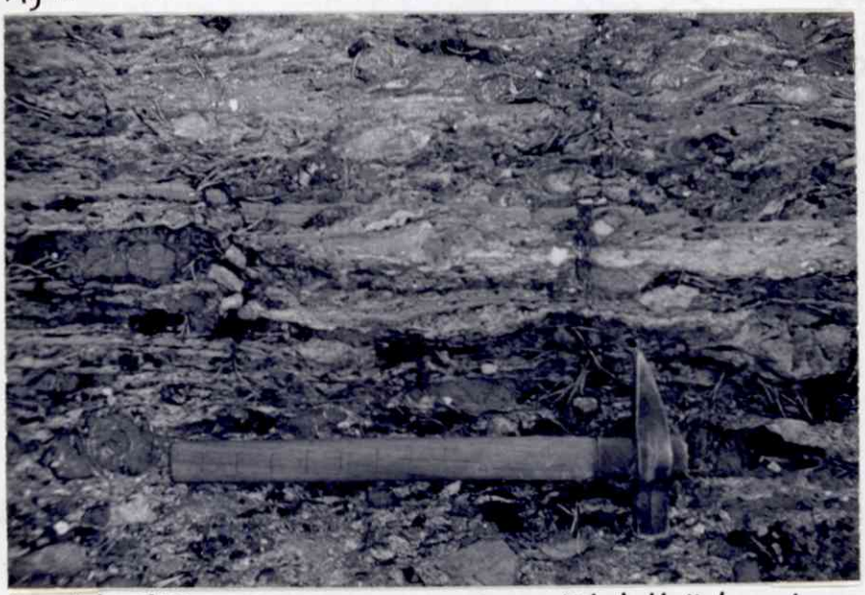
At the side of the road about 200 metres N.N.E. of Hullet sæter occurs an outcrop of a dark green coarse-grained gabbroic rock. The gabbro shows considerable signs of alteration and is

./very

Fig 9.

Locality 283. 600 m. N.W. of Hullet sæter
Agglomerate in the Støren Series. Flow banding can be seen around irregular fragments of tuffaceous matter.

Fig 10.



Locality 283 600 m. NW of Hullet sæter.
Agglomerate in the Støren series — close up of Fig 9.
The vesicular nature of the matrix can be seen — also flow banding round the fragments. The darker fragments are mainly jasper which appears brecciated due to veining by epidote.

Fig 11.

Locality 294 500 m. NE. of Snurli saeter.
Støren Series: vesicular pillow lavas (bottom right & top left), and agglomerate (centre) with flow-banding round the fragments. The agglomerates appear to dip 80/030 and the pillow lavas also appear to be the right way up.

very irregularly jointed and veined. In thin section it is seen to be considerably saussuritized. It consists of felspar 'ghosts' well shaped and up to 1 cm. in length, also ferromagnesian minerals. None of the crystals show any preferred orientation. T.Vogt suggests that this rock-type is merely a higher metamorphic facies, rather than intrusion into the Støren Series. No contacts were seen with the more usual greenstone and it was not, therefore, possible to come to any conclusions.

Fig 12.

View from tree midway between localities 171 & 172 is from the Greenstone looking N. 800 m. NE. of Smurli saeter.
The foreground consists of Arenaceous Series. Ridges in the right middle distance are Nousaasen (Massive Congl.) and Baklihaug (Porphyrite). Malberget in the centre background is Greenstones of the Stören Series mapped by B. Chadwick in 1961. Buan is the farm seen in the left middle distance. Nyplassen is behind the ridges in the centre middle distance.

THE HOVIN SERIES

The Hovin Series consists of principally sedimentary rocks with a few intrusions of igneous material. They provide a distinct contrast to the Støren Series, which are essentially igneous, in that, although most of the rocks contain volcanic material to a greater or lesser extent, they are definitely sedimentary.

The Hovin Series must be younger than the Støren Series as pebbles of greenstone and jasper were identified in some of the Hovin sediments. Also the Støren Series appear to have suffered a greater degree of metamorphism, although the greenstones are likely to be more susceptible to weathering by the nature of their mineralogy. In the Hølonda-Horg District T.Vogt correlates the Hovin Series with the Llanvirnian to Ashgillian. Those sediments exposed in the Hølonda District he maintains are of Llanvirnian to Middle Llandeilian Age. However, in 1960, D.H. Blake found several localities in the Svartvatnet of black pyritiferous shales containing graptolites suggesting a Middle Skiddavian age - Phyllograptus densus zone.

The average dip is between 50° and 70° northwards, striking between 090° and 110° magnetic. This is the same as the Svartvatnet Area to the West. No idea of the true thickness could be obtained due to the faulting in the area.

The relationships of the different rock-types suggests considerable lateral variation due to facies change, but despite this it is not considered necessary to sub-divide the area, but the following group or divisions will be described. The stratigraphy will then be discussed in a later section :-

1. ? Basal Conglomerate.
2. Tuffaceous Banded Shales and Sandstones.
3. Purple Agglomeratic Series.
4. Massive Conglomerate and Agglomeratic Grits Series.
5. Grey Shales.
6. Arenaceous Series.

/ contd. ....

1. Basal Conglomerate:

This is a somewhat dubious division based on a small series of exposures of an inlier 500 metres west-north-west of Svahyllan. These exposures consist of a large semi-overgrown 'roche moutonée' on the summit of a ridge. This ridge has a very steep wooded slope on the southern side down to a small stream, whereas on the northern side there is a hollow between the 'roche moutonée' and a ridge of sandstones and grits of the Arenaceous Series. Unfortunately no contacts can be seen with any other rocks, though outcrops of shales and sandstones of the Arenaceous Series occur very close to the Conglomerate at the western end of the outcrop. There are no exposures towards Svahyllan to the east-south-east. On the southern face of the 'roche moutonée' slickensides were seen indicating a faulted contact to the south. It is impossible to come to any conclusions about the northern boundary.

The rock consists mainly of fragments of grey-green grits or sandstones, jasper, and metamorphosed limestone. The rock weathers very easily along the bedding (Fig.13), and, although it has a generally purple appearance, beds vary from a distinctly reddish-purple to a purplish-grey in colour. The sandstone fragments are somewhat rounded whilst the jaspers and more especially the limestone boulders are often very irregular. A general impression gained is that boulders of different degrees of rounding tended to be segregated into certain beds. Boulders of the metamorphosed limestone up to 15 cm. in size were seen. There are also ~~a few more~~ pebbles of material very similar to the Støren greenstones.

There are several reasons why this inlier has been separated from the other conglomerate and called the Basal Conglomerate. Firstly, from the above description it can be seen that this conglomerate is unlike any others in this area. It occurs about 600 metres from the Støren Greenstones, i.e. the Series below

/the

Fig 13.

Locality 276 500 m WNW of Svahyllan
General view of outcrop of conglomerate showing 'roche moutonée' outline and weathering along bedding.

Fig 14.

Locality 276 500 m WNW of Svahyllan.
Close up of outcrop of conglomerate showing limestone in the upper left corner, dark fragments of jasper, and many grey-green pebbles of grits and sandstone.

the Hovin Series, and it is quite feasible that this may be a thrust or faulted remnant of the basal conglomerate. It corresponds very closely to the description given by T.Vogt of the Venna Conglomerate, which he says is the basal conglomerate of the Hovin Series in the Hølonda Area.

2. Tuffaceous Banded Shales and Sandstones:

This division should be regarded as a typical rock-type occuring in several other sedimentary divisions. Thus sediments of this type occur in the Purple Agglomeratic Series and the Arenaceous Series, as well as forming a separate and distinct division in their own rights. The main outcrops occupy the northern part of the Nyplassen Area, generally forming an area of low relief broken by ridges of intruded porphyrite. The thickness is difficult to estimate because of both the porphyrite intrusions and the presence of faults. The horizontal distance across the exposure perpendicular to the strike is 800 metres approximately of which about 40% is porphyrite. There is a narrow belt about 50 metres wide occuring about 300 metres east of the southern tip of Langvatnet. There are also several outcrops to the north of the summit of Stenaasen.

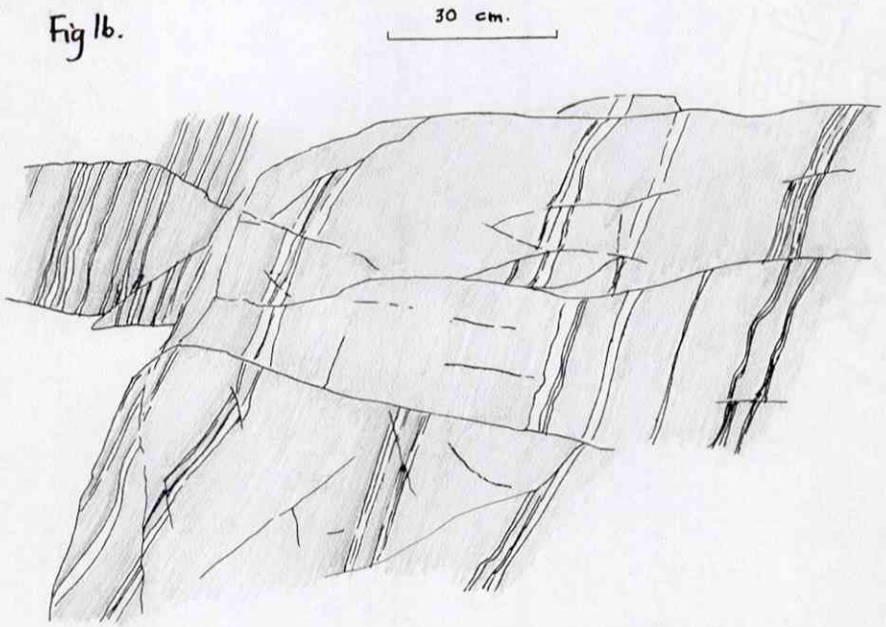
The beds are characteristically either off-white or pale grey, green or grey-green. The banding is usually parallel though it often may be slightly wrinkled and cut by minor faults roughly perpendicular to the bedding. These faults often have a throw of no more than 10 - 15 cm, sometimes very much less (Fig.16). The bands vary considerably in thickness from sandstone bands from 0·5 to 5·0 cm thick to shale bands or partings which may be only 0·1 cm. thick, but also are sometimes much thicker. Close examination of the bands of sandstone reveals that they are often graded, usually younging to the south. Since the beds are dipping to the north then they must be inverted. These beds often show macro- and micro-slump structures. On the slopes

/above

Fig 15.

Locality 239 300m. W. of summit of Stenaasen.
Banded shales and sandstones of the Arenaceous Series which are tightly isoclinally folded. The fold limb in the top half of the photograph dips 80/055° and is inverted.

Fig 16.



Locality 255 400 m. WNW. of summit of Stenaasen.
Tuffaceous Banded Shales and Sandstones cut by many minor faults with a throw of no more than 10–15 cm.

above Kalvhagevatnet about 400 metres north of the summit of Nonsaasen the sandstone bands show structures which can only have formed by slumping (Fig.17). There is a bed about 1·5 metres thick occuring on a south-facing slope about 650 metres west of Svahyllan which is intensely contorted (Fig.18). Since the beds above and below are apparently not affected and dip uniformly to the north it is assumed that this is a bed that slumped some time soon after deposition.

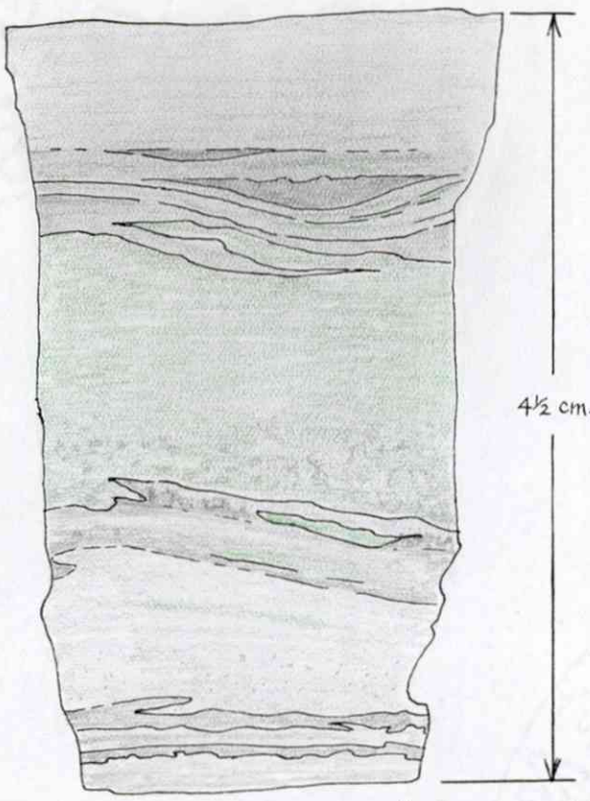
Thin sections of the sandstones and shales show a high percentage of felspar, with some quartz and some composite quartz grains (i.e. quartzite fragments). The fact that these rocks contain such a high percentage of felspar and appear nearly white on the weathered surfaces is very suggestive of a tuffaceous origin for these sediments. The grains are often poorly sorted and rarely show any rounding. Calcite is abundant in the matrix and also as veins: it would appear to be of secondary origin. Pyrite was seen in the shales at one or two localities.

A good exposure of about 30 metres horizontal thickness occurs at the south-east end of a low mound about 700 metres north of the north outlet of Liangvatnet (Fig.19). Here the banded shales and sandstones are graded but there are some homogeneous beds of sandstone. Cleavage and bedding do not coincide and in the graded beds the cleavage is seen to be sigmoidal: becoming more parallel to the bedding as the sediment becomes finer. This is a very useful method for telling the way up of the beds, and in this case shows that they are inverted.

In the south-western corner of Voldmovatnet is a small outcrop of blue grey limestone surrounded by marshes. This limestone is very much veined by calcite apparently roughly parallel to the bedding. There are several remains of fossils, which may be Nautiloid cross-sections. It seems very likely that this limestone, of which about 4 metres thickness are exposed, could be correlated to a similar bed of limestone

/occuring

Fig 17.

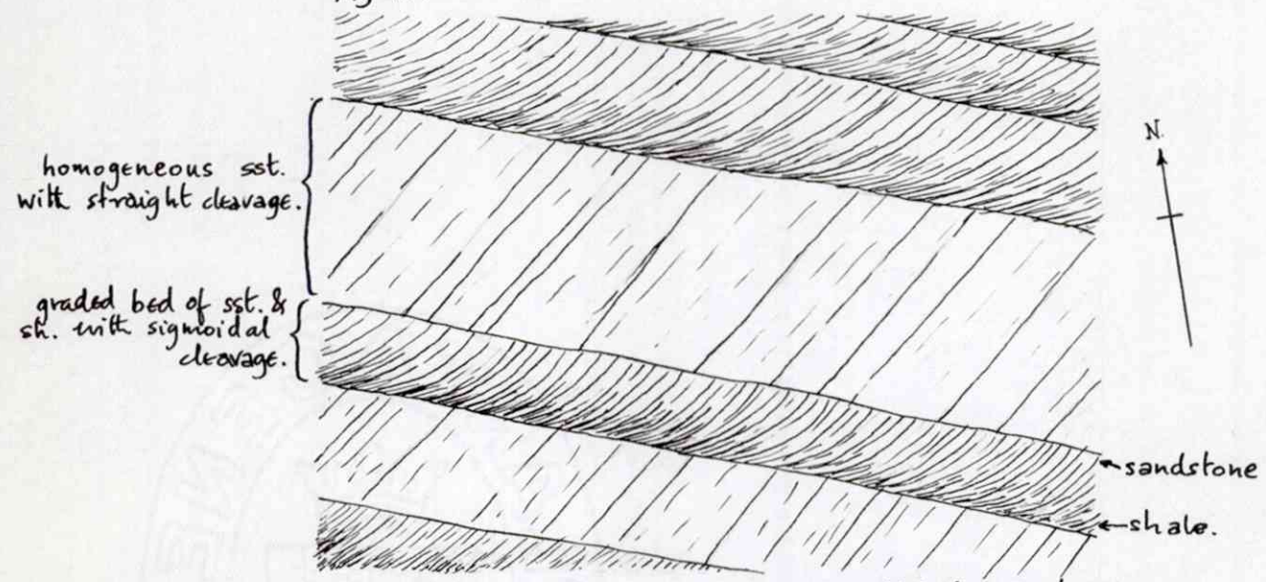


Locality 14 400 m. N. of summit of Nonsaasen.
Hand specimen of Tuffaceous Banded Shales and Sandstones showing slump structures. Grading indicates bedding is inverted.
Dip 30/065°.

Fig 18.

Locality 180. 650 m W. of Svahyllan.
Slumped (?) bedding in sandstones and shales of the Arenaceous Series. Grading indicates bedding inverted.

Fig 19.



Locality 35 700 m N. of N. outlet of Langvatnet.
Graded shales and sandstones showing sigmoidal cleavage in the graded bands. Cleavage becomes more parallel to the bedding as the grain size decreases. This therefore can be used to indicate that the beds are in this case inverted.

Fig 20.

Locality 158. Road side 200 m. NE of Svalvyllan.
Extensively nicked banded sandstones and shales in the Arenaceous Series.

occuring on the northern side of Voldmovatnet mapped by B. Chadwick.

3. Purple Agglomeratic Series:

This series occurs in three main areas; firstly, in the north-east along the northern flanks of Nonsaasen and round to Jutultj ; secondly, in the north-west in an area to the north-west of Langvatnet; and lastly, in the west in a belt north of Fjølhaugen and Grutsaeteren.

The rock types present in this series include thick reddish-purple bands of shales, sandstones and grits, together with tuffs and agglomerates, and occasional limestone bands. The fragments in these sediments include Støren greenstones, jasper, limestone, tuffaceous rocks, grits and sandstones. Interbedded with these often occur rocks very similar to the Tuffaceous Banded Sandstones and Shales Series.

Stratigraphically this Series occurs both above and below the Massive Conglomerate Series and appears to grade into it. The junction is taken where 50 per cent of the rock consists of typical massive conglomerate - this is often difficult to do where the exposure is poor, and so the boundaries marked on the accompanying geological map may not be in the correct position.

In the north-east the Series appears to be below the Massive Conglomerate and is much faulted resulting in variation of dip and thickness. The Series is best exposed between Nonsaasen and Baklihaug in a series of exposures about 200 to 300 metres north of Jutultj in the valley draining from the lake. When examined on comparatively fresh surfaces under fallen trees' roots the agglomerate was seen to consist of jasper up to 40 cm. in size, fine-grained agglomeratic grits, and limestones, with occasional greenstone fragments. These are in an orange-purple sandstone matrix, which contains grains

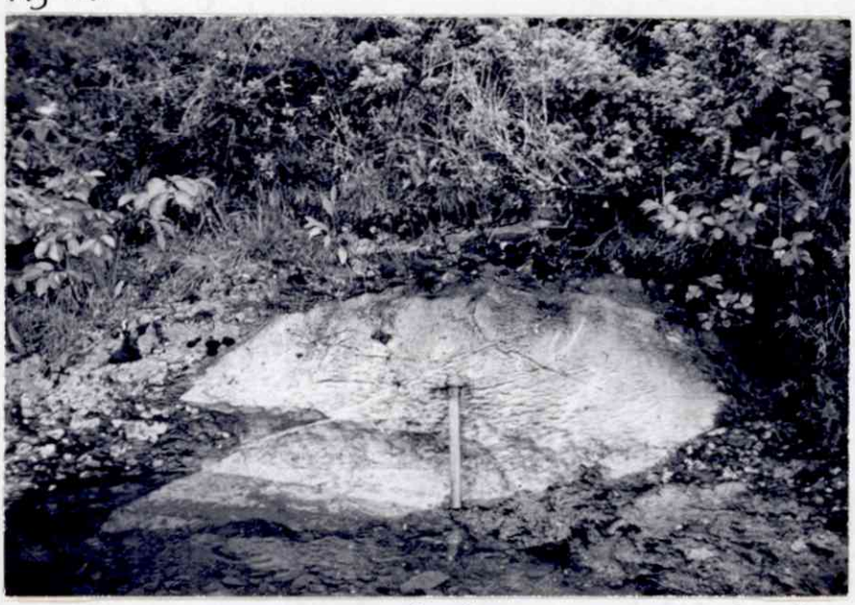
/of

of quartz and quartzite with occasional felspars, mainly albite. Intercalated with this are beds of green and purple sandstones, and also very dark blue-grey shales. These are finely banded and graded, younging to the south, indicating that they are inverted. In places the bedding is much disturbed and the beds take on a mottled appearance: this is presumably of tectonic origin. There are places where the coarser bands have been irregularly eroded and the sandstones appear to infill hollows (Fig.22), though once again this may be of tectonic origin. Some of the bands at a locality 60 metres north-west of Jutultj appear to have slump structures in them, though this is rather doubtful. The agglomerates show no sign of bedding and the fragments are angular or sub-angular. Interbedded with these beds is a bed of pale-grey limestone showing signs of contemporaneous brecciation and cementation. The ground along the valley to the west of Baklihaug in places is pitted with swallow holes; in fact the stream marked on the map flows underground for about 200 metres.

Further west on the north slopes of Nonsaasen the matrix of the agglomerates appears to be more crimson-purple than the bright orange-purple to the east. Fragments of jasper up to 30 cm. in size, and greenstone are quite common, also pale greenish-grey limestone, and tuffs. Vesicular calcitic tuffs are often interbedded and many of the associated limestone beds underwent contemporaneous brecciation and now take the form of a limestone breccia in a tuffaceous shaley matrix. Occasionally pebbles of other material appear to be mixed in with this limestone breccia. The limestones in this part of the area are recrystallized, pale grey, and show no signs of fossils.

The main exposure in the second part of the area is a fault scarp running north-east to south-west near a small lake

Fig 21.



Locality 125 N. Bank of R. Trivja 300m W. of Gnutsaeteren.
Large boulder of limestone in Purple Agglomerate.

Fig 22

Locality 312 400m. N. of Jutultj
Interbedded purple agglomerate and green and purple graded sandstones. Fragments of jasper can be seen in the agglomerate

650 metres north west of the north outlet of Langvatnet. This scarp is about 300 metres long and shows a good section of this series: the bottom appears to be faulted against intruded porphyrite, whilst the top is not seen. There is a small gully running westwards into the hill about halfway along the cliff and it seems that this is a fault which would account for the apparently much greater thickness of this series at this point. The agglomerates here are very sheared, and pebbles are definitely elongated. Most of them appear to have a length to thickness ratio of 2 : 1, but the limestone pebbles are very variable and ratios up to 5:1 were recorded. The fragments include grits, limestone, jasper, and some possible greenstone. Some of the limestone boulders are up to 1 metre in length. There are also a few intermittent limestone bands. An outcrop of this series occurs on the north facing slope running westwards from the stream draining from Langvatnet. Here boulders of limestone up to 0.8 metres in size occur. There is quite a thick bed of limestone with swallow holes along this slope. This limestone shows much evidence for contemporaneous brecciation (Fig.24) and interbedded with this are bands of tuff and agglomerate. Calcite and pyrite are prominent in the latter. The junction of the limestone with the agglomerates is very irregular which would support the theory that the limestones were brecciated.

In the third area this series occurs above the Massive Conglomerate, and limestones are much more prominent. The series is intercalated with the Massive Conglomerate at the junction: limestone bands appear to be mixed with agglomeratic grit beds; also calcareous banded blue-grey shales with purple agglomerate bands containing limestone fragments occur interbedded with grits typical of the Massive Conglomerate Series. In the south facing slope 300 metres north-east of Grutsæteren the succession appears to be: Massive Conglomerate; shales;

/coarse

Fig 23.

Locality 213. 350 m. NE. of Grutsaeteren.
Typical erosion channels on the surface of an outcrop of a limestone band in the Purple Agglomeratic Series.

Fig 24.

Locality 222. 350 m. NW. of N. outlet of Langvatnet.
Limestone breccia. Fragments of porphyrite seen above the head of the hammer.

coarse agglomeratic grit; grey crystalline limestone; purple agglomerate with limestone boulders; limestone breccia associated with tuff bands.

Just north of Fjølhaugen is a belt of limestone about 30 metres wide running from the band in the River Trivja to the end of the porphyrite ridge north of Grutsæteren. It appears to be intruded by a mass of porphyrite immediately east of Fjølhaugen. The limestone is pale-grey in colour and has a crystalline texture. Fossil remains were found that have tentatively been identified as a coral. To the north and south this limestone passes into limestone breccia with grit bands.

In the north bank of the River Trivja 300 metres west of Grutsæteren occur exposures of a purple agglomerate containing immense boulders of limestone. Many of these are 1·0 metres in length, and boulders 2·0 metres and 6·0 metres long were seen. These cannot have moved a very great distance, and I suggest that they also were the result of contemporaneous brecciation (Fig. 21).

The above descriptions compare very closely to those given by T.Vogt of Gaustadbakk Breccia in the Hølonda-Horg District, though its stratigraphical position in the Nyplassen Area does not correspond. However, as both areas are considerably faulted and folded it seems very likely on lithological grounds that this series can in fact be correlated with the Gaustadbakk Breccia.

4. Massive Conglomerate:

This conglomerate is highly tuffaceous and very similar to that mapped by D.H.Blake in 1960 in the Svartvatnet to the west. Many outcrops of this conglomerate occur in the Nyplassen Area north of the River Trivja extending from the western to the eastern boundary, forming an area of high ground of considerable extent. The horizontal thickness perpendicular to the strike is

/greatest

greatest between Nonsaasen and a point some 400 metres east of the southern tip of Langvatnet. Here approximately 1200 metres of conglomerate outcrop dipping on average 70° and striking 120° magnetic. Correcting for dip this gives a true thickness of just over 1100 metres. However, there is one major fault and probably several minor faults between these two points and this cannot be the true thickness. Even allowing for thickness variations due to facies change and a rapid thinning of the conglomerate, near the River Trivja in the west, it has a maximum horizontal thickness of 600 metres.

The conglomerate is very variable in texture and is normally poorly sorted. On Nonsaasen at several localities boulders up to 30 cm. in diameter occur, and at one or two localities up to 80 cm. (Fig.26). Elsewhere it may be quite fine-grained, with fragments less than 2 mm. in diameter. Generally the largest boulders occur in the west; in the east the largest boulders are up to 10-15 cm. in diameter. The matrix appears fairly uniform from east to west, and is very irregular and tuffaceous or agglomeratic. The matrix and the boulders show all degrees of rounding though not very many were sharply angular; also the larger the boulders the greater is the degree of rounding.

The cobbles in this conglomerate consist mainly of igneous material: often tuffaceous and richly felspathic. When an exposure under tree roots (i.e. recently exposed and clear of lichen) is examined the whole outcrop is various shades of pale green with a large percentage of white felspar grains. The lighter colour of the cobbles, as seen in the accompanying photographs (Figs.26,27&28), indicates that they are probably richer in felspar. Occasionally small (8 cm. average diameter) fragments of greenstone, jasper and pale quartzite occur. At one or two localities cobbles of a rock very similar to the Porphyrite were seen. It was estimated at a locality 500 metres east of the

/southern

Fig 25.

Fig 26.

Fig 27.

Localities of Massive Conglomerate on Nonsaasen.
Fig 25 : View of summit from the south.
Fig 26 : Locality 54. Large boulders in foreground 0.8 metres diameter.
Fig 27 : Locality 400 m. S. of summit of Nonsaasen : showing white felspathic nature of both fragments & matrix.

southern end of Langvatnet that 60-70% of the cobbles were tuffs or agglomeratic material.

There are also impersistent bands that are best described as agglomeratic grits. These consist of the same sort of material as the matrix of the conglomerate. In thin section the grains are seen to consist of irregular felspar and amphibole crystals (Fig 30). The felspars are mainly albite showing albite twinning and comprise up to 50% of the rock; they are very variable in shape and size, and have angular or subangular borders. Sub-angular zircon and leucoxene were also seen. Some grains in the grit consist of a single large crystal whilst others are an agglomerate of fine-grained felspathic material. The ground-mass is also felspathic. The finer-grained grit bands often show grading or just banding, as 50 metres north of the outlet of Langvatnet, showing that the conglomerates dip steeply north or north-east. The gritty matrix of the coarser conglomerates is also often banded, giving a similar bedding-plane orientation. At a locality about 40 metres south-west of the summit of Nonsaasen a structure was seen in a narrow band in the conglomerate which seemed to be due to slumping of bedding (Fig.29).

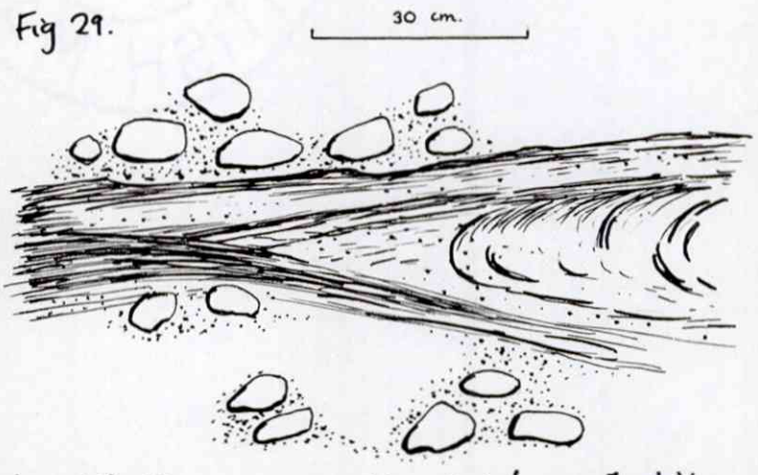
Interbedded with the massive tuffaceous conglomerate and agglomeratic grits are several beds of limestone, calcareous shales, tuffaceous lavas and tuffs. At a locality 300 metres north of Grutsæteren bands of fine tuff of very limited extent and about 1 cm. in thickness occur (Fig.31). At this locality also about 20 metres horizontal thickness of pale-grey brecciated limestone are exposed, with a fairly sharp boundary with the conglomerate. Approximately 600 metres north-north-west of Grutsæteren occurs about 6 metres horizontal thickness of limestone interbedded with the conglomerate. About 400 metres west of Nonsaasen outcrops can be seen of typical massive conglomerate with cobbles up to 30 cm. in size. To the north

/of

Fig 28.

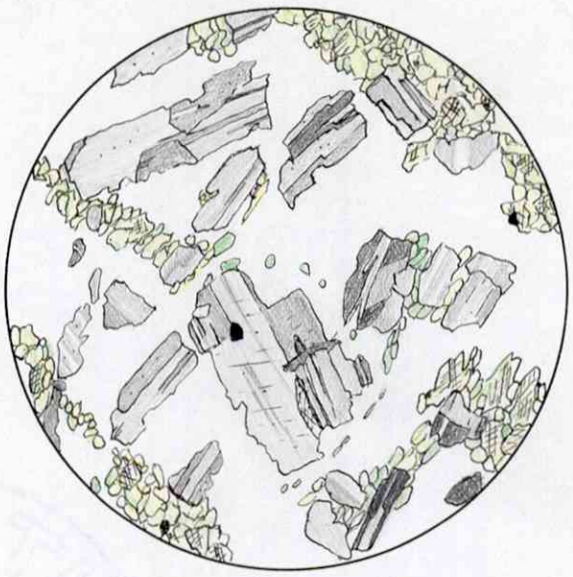
Near Locality 63. 60 m. SW. of summit of Nonsaasen.
showing sub-angular outlines of fragments in the Massive Conglomerate.

Fig 29.



Locality 63. 40 m. SW of summit of Nonsaasen.
Small slump structure in a grit band in the Massive Conglomerate.

Fig 30.



Locality 117. 800 m. NE. of N. outlet of Langvatnet.
Thin section of a tuff band from an agglomeratic grit: irregular plagioclase (mainly albite), pale greenish yellow amphibole; the groundmass (not drawn) consists of felspar, pyroxene and amphibole.

Fig 31.

Locality 227. 300 m. N. of Gnutsaeteren.
Impersistent fine tuff bands interbedded with Massive Conglomerate.

of this is a steep north-facing slope some 15 metres high, at the top of which is an outcrop of a pale-grey limestone conglomerate. Just below this agglomeratic grits interbedded with conglomeratic bands occur. The rest of the slope is covered with vegetation except for a few scattered exposures in the last few metres of the slope of grey crystalline limestone, and a limestone conglomerate consisting of irregular fragments of limestone set in a purple tuffaceous matrix. Interbedded with these are fairly coarse bands of grit and band of conglomerate with rounded cobbles up to 8 cm. in length. This is now in what I have called the Purple Agglomeratic Series and it can be seen that the boundary between the two is perfectly arbitrary, being taken as where 50% of the different bands show purple colouration.

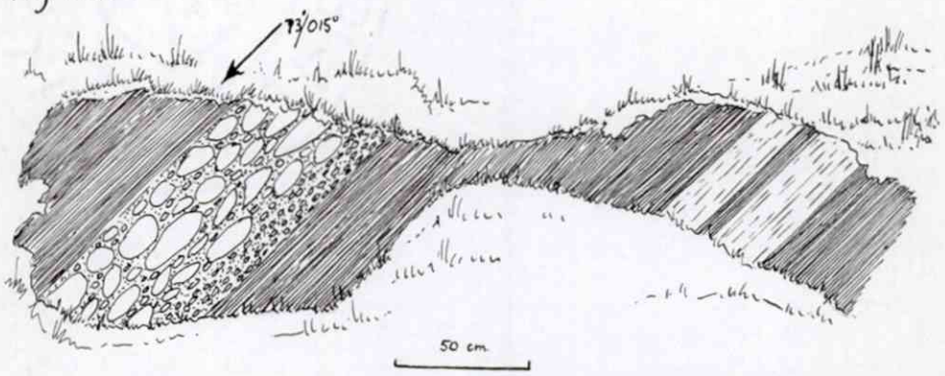
The cobbles in the conglomerate are often oval in shape; whether this is due to original shape or to subsequent tectonic elongation is not very clear. The photographs show jointing and cleavage of the conglomerate and I would tend to favour tectonic elongation as the cause of their shape. The ratio of length to width varies considerably: 5:1 seems to be the maximum with 3:1 as an average ratio.

5. Grey Shales:

These shales occur in a narrow belt running east to west in two main areas: near Fjølhaugen: and to the east of Grutsæteren. The outcrop is approximately 150 metres wide but nowhere is this whole thickness exposed continuously. Around Fjølhaugen the grey shales occur south of the crystalline limestone exposed there. They are blue-grey fissile shales with many green-brown spots after pyrrhotite. At the main bend of the River Trivja to the west of Fjølhaugen, there also occurs a band of limestone agglomerate about 0·5 metres thick. As can be seen from the sketch (Fig.32) this grades into a grit layer and this may be an indication that the beds are inverted. About 30 metres east of this is an exposure of shales with a 5 cm. thick

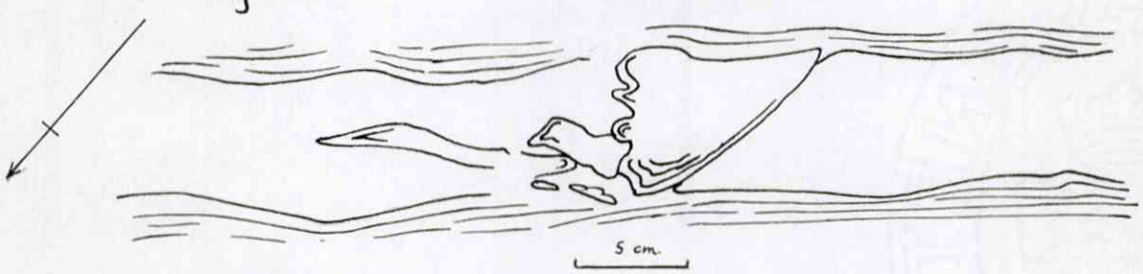
/band

Fig 32.



Locality 207. 200 m. W.S.W. of Fjølhaugen.
Blue-grey fissile shales with an 0.5 m. thick bed of limestone conglomerate and an 0.1 m. thick bed of grit. The shales contain small green specks. Some sandstone bands occur in the shales.

Fig 33.



Locality 208 200 m. W.S.W. of Fjølhaugen.
Sandstone band 5.0 cm thick occurring in grey shales. The sandstone band shows possible slump structures which show that the beds are inverted. Dip 40°/320°.

band of sandstone showing possible slump structures indicating again that the beds may be inverted (Fig.33).

The outcrops to the east start about 400 metres east of Grutsaeteren and extend a further 900 metres eastwards. They consist of banded and graded grey and blue-black fissile shales with green spots. In the middle of these shales occurs a small cliff of banded shales interbedded with a grey limestone breccia and tuffaceous material.

6. Arenaceous Series:

This series of sediments occupies the greater part of the southern half of the Nyplassen Area. It in fact covers about four square kilometres which is approximately a third of the total area mapped.

I have named it the Arenaceous Series because, although it consists of coarse grits, sandstones, shales and limestones, it differs from the other sediments in this area in its predominatly non-tuffaceous nature. It forms a very varied topography from the high steep-sided ridges in the east to the lower more undulating country in the west. The exposure is very poor in this lower western region, whereas it is comparatively good in the east. The road running beside the River Trivja shows some good fresh sections of these rocks.

The series appears to be for the most part a fairly uniform set of alternating grits, sandstones and shales. The colour varies from grey to grey-green, though the majority of the rocks are varying shades of grey. Occasionally, usually associated with thin bands of limestone breccia, blue-black or faintly purplish shales occur. Green or brown specks after pyrrhotite are common, and pyrite was found at one or two localities. The sandstones and shales are often fairly calcareous. The cleavage may be parallel to the bedding though very often it is not (Fig.40).

/North

Fig 34.

Locality 242 at the top of cliff 500 m. NW. of Stenaasen Farm.
Ridge of massive shales, sandstones and grits in the Arenaceous Series.

Fig 35.

Locality 242. 500 m. NW. of Stenaasen Farm.
Massive shales, sandstones and grits in the Arenaceous Series.

Fig 36.

View from Locality 87. 750m. ESE. of Engesletter.
Rapids in the River Tvirfd showing exposures of shales, sandstones and grits in the Arenaceous Series.

Fig 37. N.

Locality 157. Road side 200 m. NE of Svalvy Han.
Green graded grits in the Arenaceous Series. Dip 70/360°.
They young to the North & are therefore the right way up.

North of Stenaasen sediments more typical of the Tuffaceous Banded Sandstones and Shale Series occur (Fig. 38, 39 & 40). These are tightly folded with a good cleavage, and with many small faults displacing the bands. Quartz veins are very common in these rocks (Fig. 48). At a locality in the north bank of the River Trivja just east of Engesletter quartz veins were seen that had either formed along folded bedding planes or had themselves been folded after formation (Fig. 49). Lineations are also quite often seen in the shales.

The grit beds vary in thickness from about 2·0 metres to 10-15 cm. The grains average about 1 cm. in the coarsest grits and these grade into sandstones. Some of the finer grits grade from 0·3 cm. to a fine paper shale. This grading indicates that most of the beds are inverted. There are a few localities where this is not so and the beds are the right way up.

The sandstones are usually fairly flaggy. In some localities cementation appears to be irregular as weathered surfaces show a somewhat blocky appearance, though close examination shows that they are uniform sandstones.

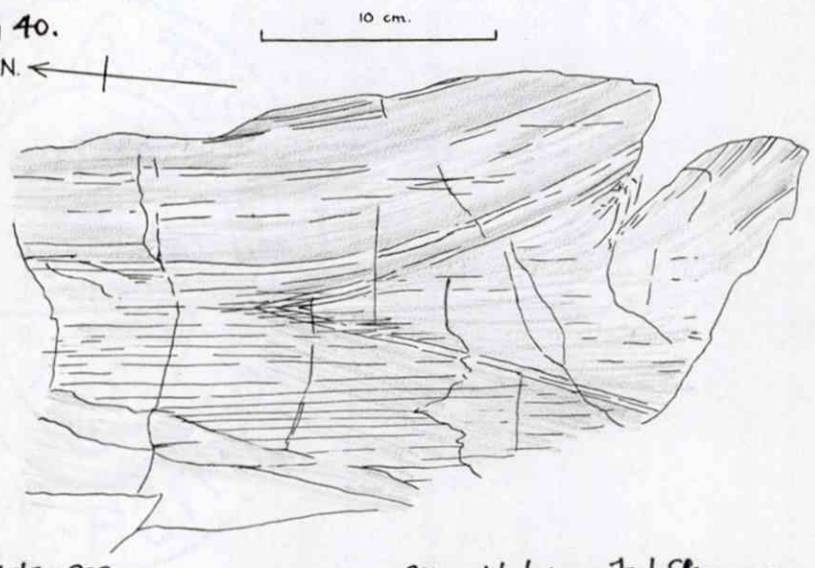
The shales can be slatey, fine paper shales, or sometimes massive or flaggy. No signs of any fossils were seen.

At several horizons throughout this series lenses of limestone and limestone breccia occur. These are never very thick: in the section by the rapids in the R. Trivja 750 metres east-south-east of Engesletter a 1 metre thick bed occurs with boulders up to 20 cm. in length. There are three separate breccia bands around Re sæter with fragments up to 5 cm. in length.

Fig 38.

Fig 39.

Fig 40.



Locality 239. 300 m. W of summit of Stenaasen.

Fig 38 : general view of part of the exposure showing sharply folded banded shales and sandstones.
Fig 39 : close-up of the fold in the foreground of Fig 38.
Fig 40 : sketch of the fold in the right middle distance of Fig 38.

INTRUSIVE IGNEOUS ROCKS

Igneous rocks are intruded into the Hovin Series of this area in the form of a number of dyke- and sill-like intrusions. They appear to be all of one rock type though there are slight variations of grain-size. All the intrusions are porphyritic and probably correspond with the Hølonda Porphyrites described by T. Vogt from the Hølonda-Horg District.

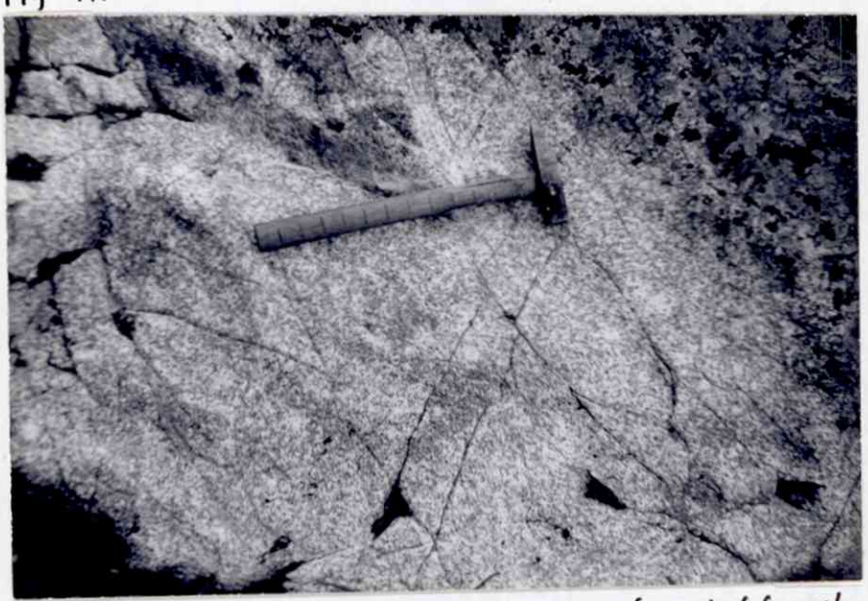
The phenocrysts are up to 1 cm. in length and consist of felspar and pyroxene in a dark green or brown ground mass. On weathered surfaces the phenocrysts stand out as white laths on a dark background (Fig.41). The phenocrysts are very abundant and usually form 40 to 50 per cent of the total rock. Only extremely rarely do they show any preferred orientation. Often xenoliths occur in these porphyrites (Figs.42&43) and are usually dark grey shaley material. They are often baked but have quite sharp margins usually. Some localities show coarse and fine phenocrysts in bands but these do not appear to be consistent.

In thin section they are seen to be very much altered. The tabular phenocrysts of felspar are completely altered, though albite twin lamellae can be seen as 'ghosts'. The pyroxene phenocrysts, probably augite, are much less common. They show alteration around the rims to an amphibole and chlorite. The centres are quite fresh and often show twin lamellae. The groundmass is extremely fine grained and consists of very small laths of albite, with epidote, sericite, and chlorite. Leucoxene crystals after ilmenite were also seen. Before alteration the rock was probably an intermediate rock of andesitic composition. From the above description it follows that this porphyrite corresponds to the 'Berg-type' described by T. Vogt from the Hølonda-Horg District.

In the past there has been much controversy as to whether

/these

Fig 41.

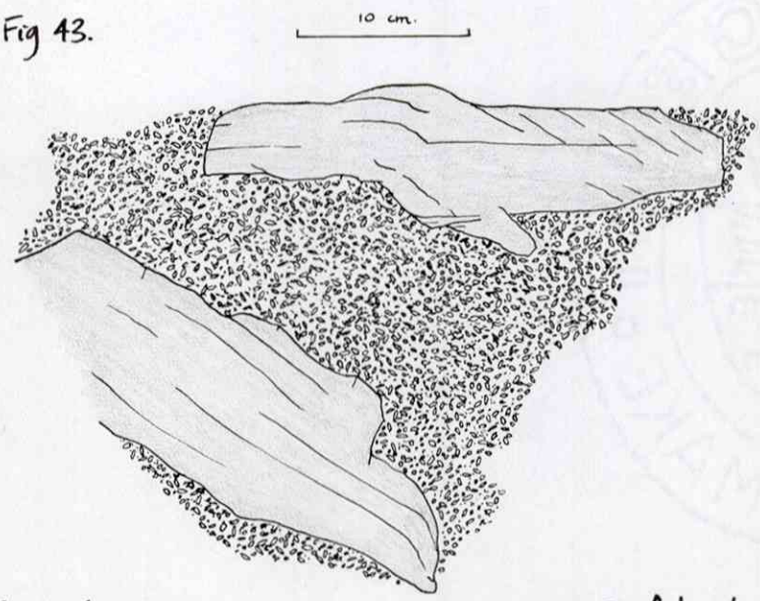


Locality 72. 400 m. W.S.W. of S. end of Langvatnet.
Exposure of porphyrite showing abundant felspar phenocrysts randomly oriented.

Fig 42.

Locality 143 700 m. NW. of N. outlet of Langvatnet.
Xenoliths of metamorphosed sandstone in an exposure of porphyrite.

Fig 43.

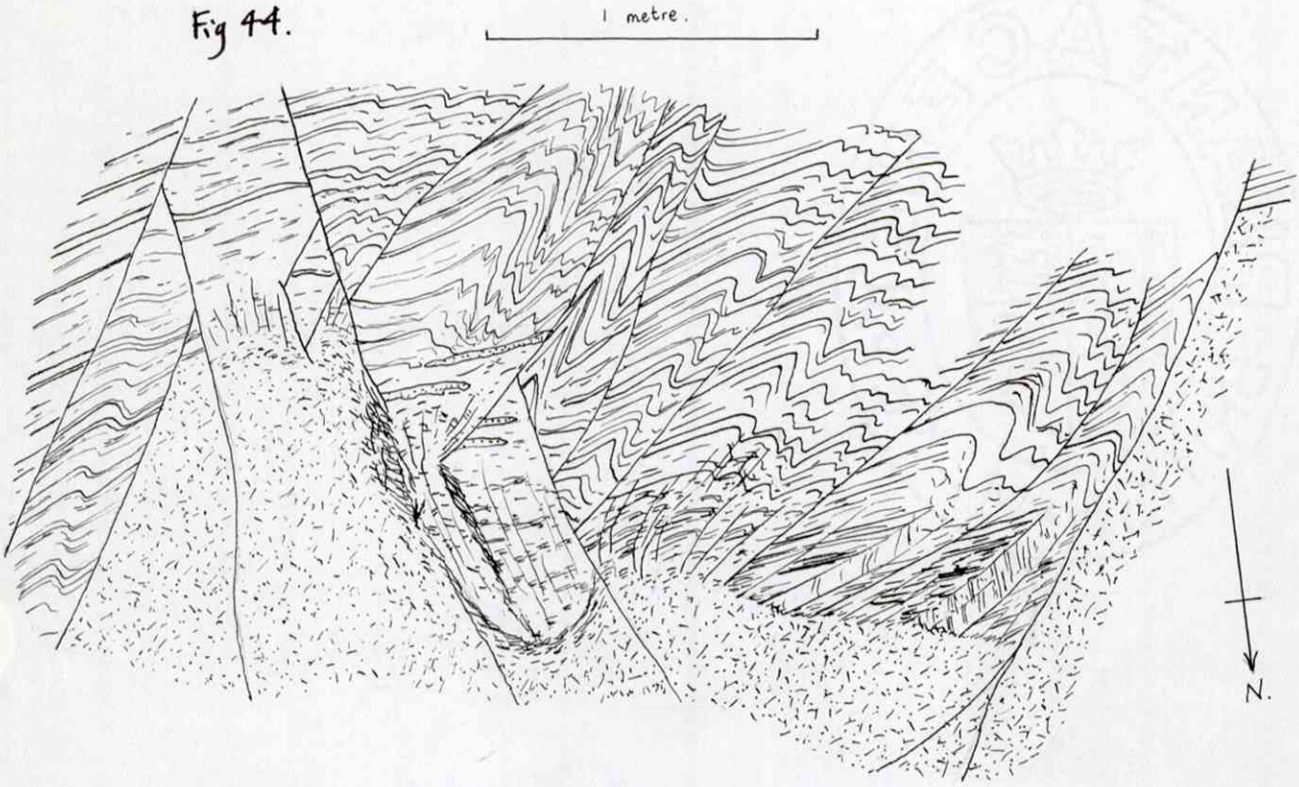


Locality 51. 200 m. S. of Lomtj.
Dark xenoliths of shale in porphyrite.

these porphyrites are intrusive or extrusive. In the Nyplassen Area there are several exposures of the contact between porphyrite and sedimentary rock where it can definitely be proved that they are of intrusive character. This is best demonstrated in the north-west where they are in contact with the Banded Sandstones and Shales. Here the contacts are usually very irregular, cutting across the bedding at angles up to 60 to the strike of the country rock. The line of the contact itself is much faulted (Fig.44), xenoliths of the country rock occur, and stringers of porphyrite are intruded into the sediments. Quartz veins are often common along the contact cutting both the porphyrite and the country rock. The shales are baked for a few centimetres from the contacts, though usually no more than 10 cm. distance. The porphyrites are occasionally chilled to a more glassy rock at the margin for about 0·5 cm. The shales are often distorted near the contact, and faulted contacts with slickensides were not uncommon (Fig.47). In some intrusions top and bottom contacts were seen, and both had the same appearance. Near Fjølhaugen a porphyrite can be seen on the map intruded into the pale grey crystalline limestone.

One of the puzzling features of this region is the stratigraphical distribution of the porphyrite intrusions. As can be seen from the map, they do not appear to intrude actually into the Massive Conglomerate or the Arenaceous Series, or in fact into the older Støren Series. Since they are definitely younger than the latter, and probably younger than the former two, then would seem to suggest extrusion at certain stratigraphic levels. This is I think outweighed by the large amount of evidence of an intrusive nature of the porphyrite.

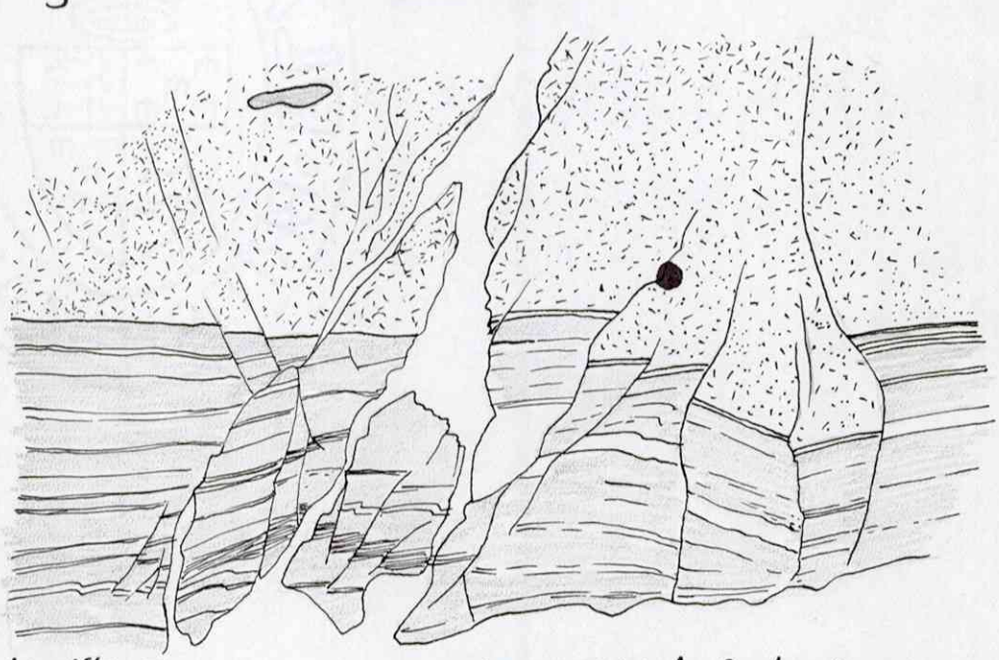
Fig 44.



Locality 27. 500 m. SE. of S. end of Lomtj.

Junction of porphyrite & Tuffaceous Banded Shales and Sandstone Series. Dip of undisturbed shales a few metres further south is 85°/025°. Grading in the sandstone bands indicates that the beds are inverted. Note small stringers of porphyrite intruded into the shales. This, together with the faulted nature of the contact & baking of the shales, shows that the porphyrite is intrusive.

Fig 45.



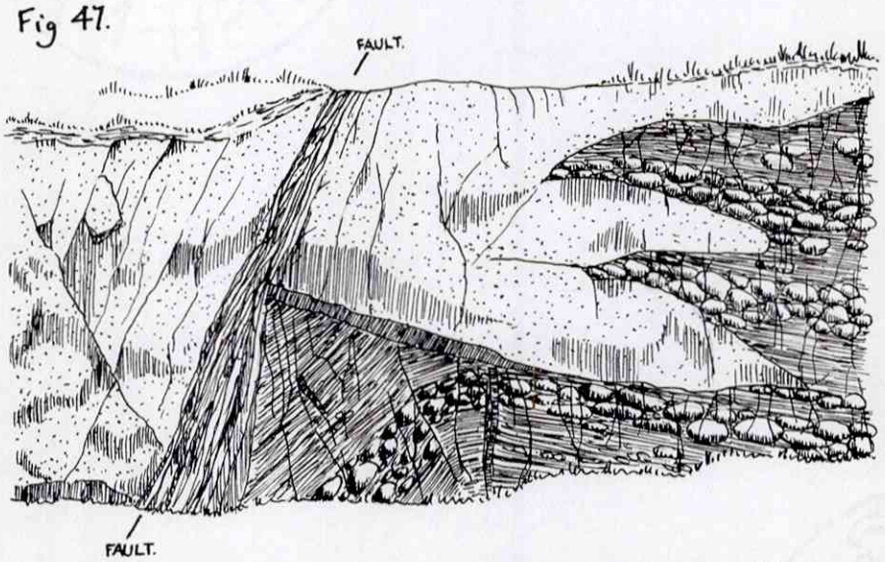
Locality 216. 300 m. WNW of Gruts~~a~~eteren.

Junction of porphyrite & banded shales and sandstones of the Arenaceous Series. Grading in the sandstones indicates that the shales are inverted. A few xenoliths of shale could be seen at this locality. The shales were metamorphosed only for about 25 cm. from the contact.

Fig 46.

Locality 217. 50 m. NW. of Grutsæteren. Junction of porphyrite and shales. The contact itself is obscured. The porphyrite is in the top half of the photograph. The shales at the bottom have glacial striae trending 310°.

Fig 47.



Locality 113. 650 m. NE. of N. outlet of Langvatnet. Junction of porphyrite and Purple Agglomerate Series. The porphyrite cuts across the bedding in places and is intruded as stringers along the bedding elsewhere. Part of the contact is faulted. The agglomerate and shales are considerably fractured and distorted. Jasper and limestone fragments were seen in the agglomerates. Height of the cliff is approximately 12 metres.

G L A C I A T I O N

The whole of this region shows features typical of the glaciation of the Pleistocene Age.

Erosional features include striae, roches moutonées, crag and tail, and hanging valleys. There are eleven scattered localities where glacial striae were seen (e.g. Fig 46). They vary from 320° to 345° and the average direction is to 340° . At two localities traces of previous ice-movements were seen in striations trending 030° and 045° which were superimposed by the more usual 340° striations. Thus there were two directions of ice-flow at these localities: though not necessarily over the whole area. The direction of the ice-flow is also given by presence of many roches moutonées and mounds showing crag and tail features. An average example consists of a ridge trending north-west to south-east with a well exposed cliff or steep slope at the south-east end. The south-west and north-east sides are often poorly exposed, though a few exposures may occur along the top of the ridge. The north-west end is usually completely overgrown by forest but occasionally erratics and plucked blocks are to be seen. Thus the ice-flow would appear to be from the south-east. The general direction of the topography also follows this direction, for example Langvatnet; the main valley of the River Trivja; and the valley to the south of Nonsaasen. This last valley has been excavated to quite some extent, as on its north side are a series of hanging valleys about 60 metres above the valley floor.

Erratics also confirm the general flow of ice from the south-east, as there are many blocks of Trondheimite, a rock-type that does not occur in this area but only several kilometres to the south. Erratics are found in great abundance and consist mainly of rock-types found in the area. Near the top of the slope 350 metres north-east of Grutsæteren there is a perched block of

/massive

massive grit on a limestone pedestal. Boulder clay occurs at several localities especially in the main valley of the River Trivja.

Since glacial times the ice-scoured basins have become filled with peat and alluvium, and the rivers and streams have eroded their courses quite considerably.

STRUCTURE OF THE AREA

The Nyplassen Area is bounded to the south by the Greenstone Fault, the Hovin Series being down-faulted to the north. The vertical displacement of this fault must be several hundred metres. The contact was not visible in the field, but the following evidence justifies its position on the map: the greenstones close to the contact lose their original characteristics and are massive, brecciated and veined bottle-green rocks, with many slickensided surfaces; the Greenstone cuts across the strike of the Hovin Series.

There appears to have been two phases of folding in this area: the first, which was the more important of the two, folded the Hovin Series into a large syncline of which only the northern inverted limb is present; and the second caused bedding and cleavage to be rucked slightly.

In the Banded Sandstones and Shales, the Purple Agglomerate, and the Massive Conglomerate, the bedding is generally dipping northwards between 45° and 85°, striking between 080°and 170°. The more extreme values are probably due to the intrusion of the porphyrites, and the average dip is about 65°, striking 110°. Graded bedding indicates that the beds are younging to the south and are probably therefore the inverted limb of a large fold. Faulting is very evident in these rocks.

The Arenaceous Series south of the River Trivja and on the southern slopes of Stenaasen dips very uniformly northwards between 50° and 80°, and striking between 090° and 125°. The average beds dip 70°, and strike 100°. Generally graded bedding indicates that these beds are inverted but there are some localities where in fact the beds young to the north and are, therefore, the right way up. These are interpreted as being on the limbs of fairly small folds. The bedding in some zones is very irregular, and

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in the area to the north of Stenaasen the banded shales and sandstones are seen to isoclinally folded with a well developed axial plane cleavage. Generally the cleavage in the southern half of the area is not parallel to the bedding, whereas more often than not it is in the northern half. This together with the evidence of the minor folds would seem to suggest that the southern part is near the core of the syncline whereas the northern part is the inverted limb.

Faults obscure much of the structure in this area as blocks of the Hovin Series were rotated in all directions. A very good example of this occurs around Nonsaasen. Here a series of imbricate faults, especially noticeable on air photographs, have rotated blocks of the Hovins in a clockwise direction, suggesting that the northern part moved eastwards and the southern part westwards. The Purple Agglomeratic Series provides a good marker horizon and the structure can be seen quite easily.

There are some very long faults cutting across the strike, and several running parallel to it. Unfortunately most of the latter are very difficult to determine and there must be many more than those indicated on the map. It is important that they should not be disregarded, especially when working out the stratigraphy of the Hovin Series. D.H.Blake, in 1960, suggested that a major fault follows the Svartvatnet depression which if continued into this area would pass just north of Nyplassen. In this area there is no evidence for a fault, except that it would approximately coincide with the boundary between the Grey Shales and the Arenaceous Series, and also if continued still further it could join with the fault marked running south-west from Stor Damtj. However, as there is no field evidence it is difficult to accept the presence of this fault.

Many faults are not visible to any extent in the field and their presence can only be detected by the displacement of beds. Very often faults are not apparent due to lack of exposure and

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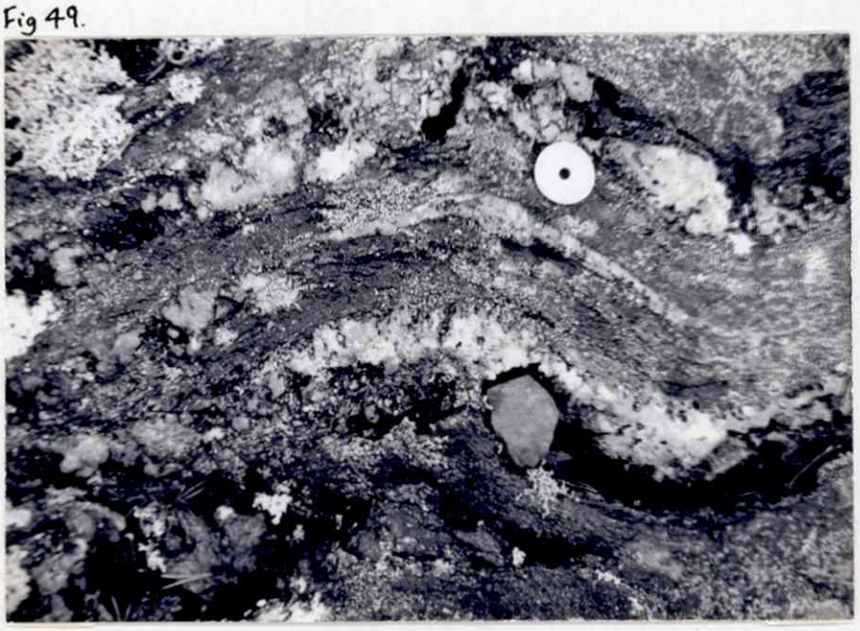
Fig 48

Locality 123 In N. bank of R. Trivja E. of Engesletter.
Quartz veins cutting massive sandstones of the Arenaceous Series. The major veins dip 25/260°.

Fig 49.



Locality 123. In N. bank of R. Trivja E. of Engesletter.
Quartz veins that have been folded. Folds plunge 58°/035°.

if their movement is not more than a few metres often are passed unnoticed.

The second phase of folding is seen in the rucking of the previous folding cleavage (Fig 20). This is especially obvious in the sandstones and shales of the Arenaceous Series. Quartz veins occuring in these in the north bank of the River Trivja just east of Engesletter are folded (Fig.49.).

STRATIGRAPHICAL CORRELATION

WITHIN THE NYPLASSEN AREA:

As has been already mentioned one of the great difficulties in the Nyplassen Area is in deciding the relationships of the rock types in the Hovin Series. This is mainly due to lack of exposures, the presence of faults and probable changes of facies. The absence of any identifiable fossils means that correlation is on a lithological basis. The successions in the extreme west and in the east are are follows :-

East through Fjølhaugen	West through Nonsaasen
6. Arenaceous Series - - - - -	Arenaceous Series
5. Grey Shales	Banded Shales and Sandstones
Limestone	
Agglomeratic Grit	
Purple Agglomerate	
4. Massive Conglomerate - - - -	Massive Conglomerate
3. Purple Agglomerate - - - -	Purple Agglomerate
2. Banded Shales & Sandstones - -	Banded Shales & Sandstones
Limestone	
1.	? Basal Conglomerate

The Arenaceous Series appears easy to correlate from east to west though in the north-east corner of its outcrop it appears to have changed to banded shales and sandstones. This may be due to facies change.

The Massive Conglomerate is the only other division that can be followed continuously from the eastern boundary to the west.

The Purple Agglomeratic Series is a distinctive enough division to be used as a marker horizon.

WITH THE SVARTVATNET AREA:

The Massive Conglomerate and the Arenaceous Series can be definitely correlated with rocks of this area to the west. Most of the succession south of the Massive Conglomerate can be

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satisfactorily correlated with the area between the Rauaaa and Trivja Rivers. North of the Massive Conglomerate correlation with rocks of this area was not so easy at all.

Outside the Nyplassen Area:

It is not easy to correlate any rock-types in this area with any outside areas.

The Støren Series form a fairly distinctive set of rocks and can be traced throughout the Trondheim Region.

None of the sediments of the Hovin Series appear to fit into T. Vogt's stratigraphical column from the Hølonda-Horg District. Even the Purple Agglomeratic Series, which was tentatively identified with the Gaustadbakk Breccia, does not appear in the same relative stratigraphical position. The belt of limestone near Fjølhaugen could correspond to the Hølonda Limestone though this seems unlikely. The Arenaceous Series is probably part of the Hølonda Sandstones and Shales.

BRIEF SUMMARY OF THE GEOLOGICAL HISTORY OF THE AREA

The oldest rocks exposed in the area belong to the Støren Series. They consist of spilitic pillow lavas, with agglomerates, tuffs and jasper, suggesting a submarine formation.

As the basal conglomerate of the Hovin Series contains many fragments of greenstone and jasper, the region must have been uplifted and subjected to sub-aerial erosion. The rest of the Hovin Series are generally typical eugeosynclinal deposits. The banded shales and sandstones suggest deep water conditions with repeated turbidity currents. T. Vogt in 1945 suggested that the Gaustadbakk Breccia is a continental deposit because of its colour, and assumes a regression of the sea and land masses appearing above the surface. He further suggests that "the reddish beds may be attributed to the sedimentation of red-soils from a land with a semi-arid climate, indicating a hot and dry season each year". This does not seem to be the case in this area as the Purple Agglomerate Series contains much limestone breccia suggesting marine deposition. The Massive Conglomerate shows that rather rapid deposition followed probably in fairly shallow waters on a sinking sea floor. The Arenaceous Series with the beds of graded grit represent a return to deeper waters with turbidity currents.

Following the deposition and consolidation of the Hovin sediments the next event was probably the intrusion of the porphyrites. During the Caledonian Orogeny, the rocks of the area were subjected to folding in two or possibly more phases. The faulting in the area is probably later than this, though it is not possible to say how much later.

During the Pleistocene Age the area was covered in ice

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and the movement of this was largely responsible for the present topography.

REFERENCES

Carstens, C.W.	1952	Geologisk Kart over Løkken-Feltet.
Holtedahl, O.	1960	Geology of Norway, N.G.U. 208.
Kiaer, J.	1932	The Hovin Group in the Trondheim Area. With palaeontological contributions by O.A.Høeg, A. Hadding, F.R.C. Reed, A.F.Foerste, T.Strand, L.Strømer and the author. Vid.Akad.Skr. No.4.
Vogt, Th.	1945	The Geology of part of the Hølonda-Horg district, N.G.T., 25, p.449.