The geology of an area north of Gåsbakken, Sør-Trøndelag

By
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Abstract

This paper constitutes a description of the geology of the Lower Ordovician strata outcropping in a 70 sq.km area, north of the village Gåsbakken in Sør-Trøndelag.

A review of the stratigraphy is given. Three phases of deformation are described.

Introduction

The mapping of this area was undertaken in order to correlate the known stratigrahical succession and structure of adjoining areas, which have been mapped by Th. Vogt (1945), Carstens, C. W. (1952) and Chadwick et. al (1964).

A general map and sections are presented showing the geology of the area. Correlation with adjacent areas is demonstrated by a general geological map of the area, and also a structural trend map.

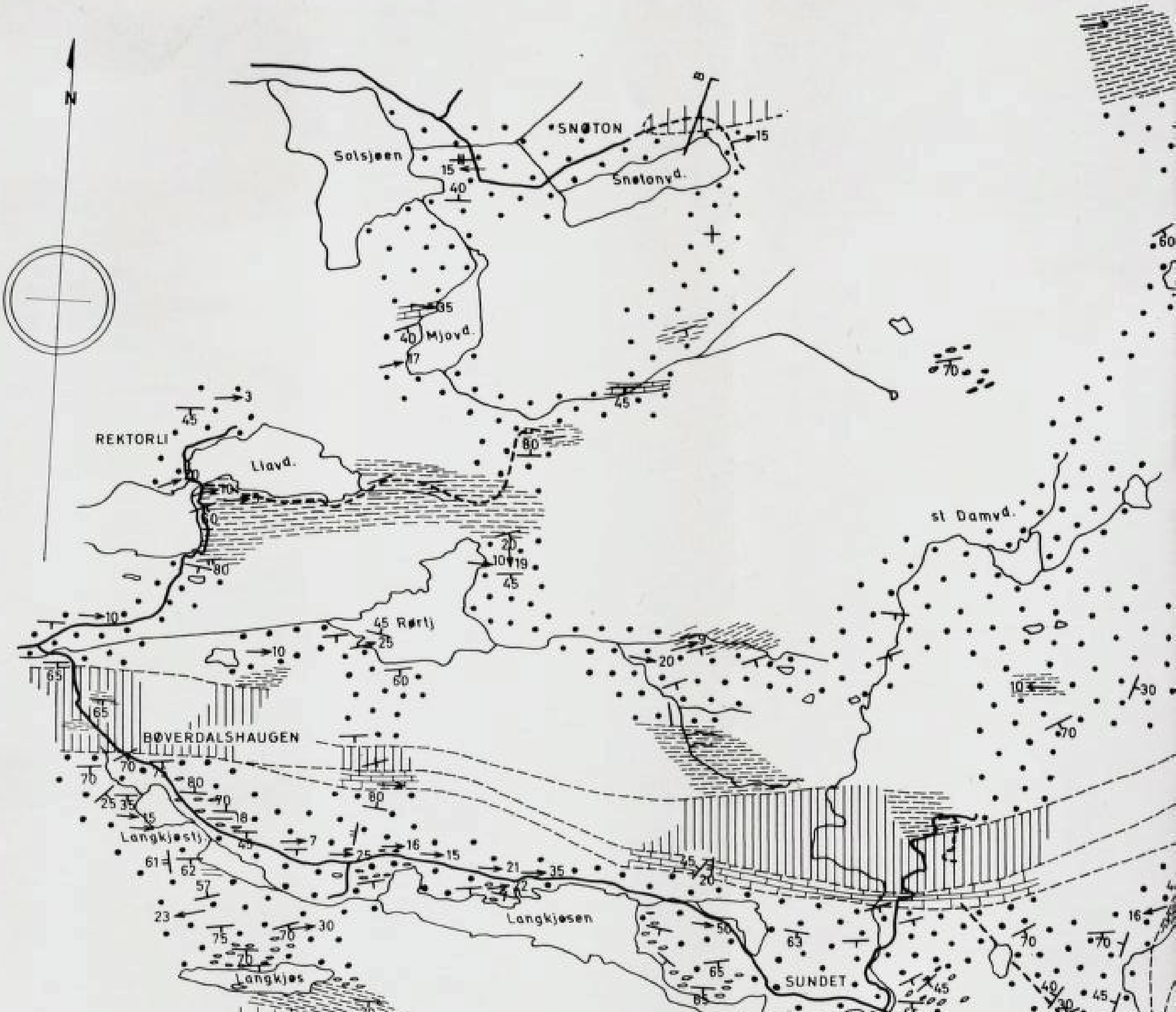
Stratigraphical succession

The sedimentary, volcanic, and intrusive strata outcropping in the locality have been subdivided by Vogt (1945) into the Støren Series (mainly volcanic) of Arenigian age, and the Hovin Series (mainly sedimentary) of Llanvirnian and Llandeilian ages.

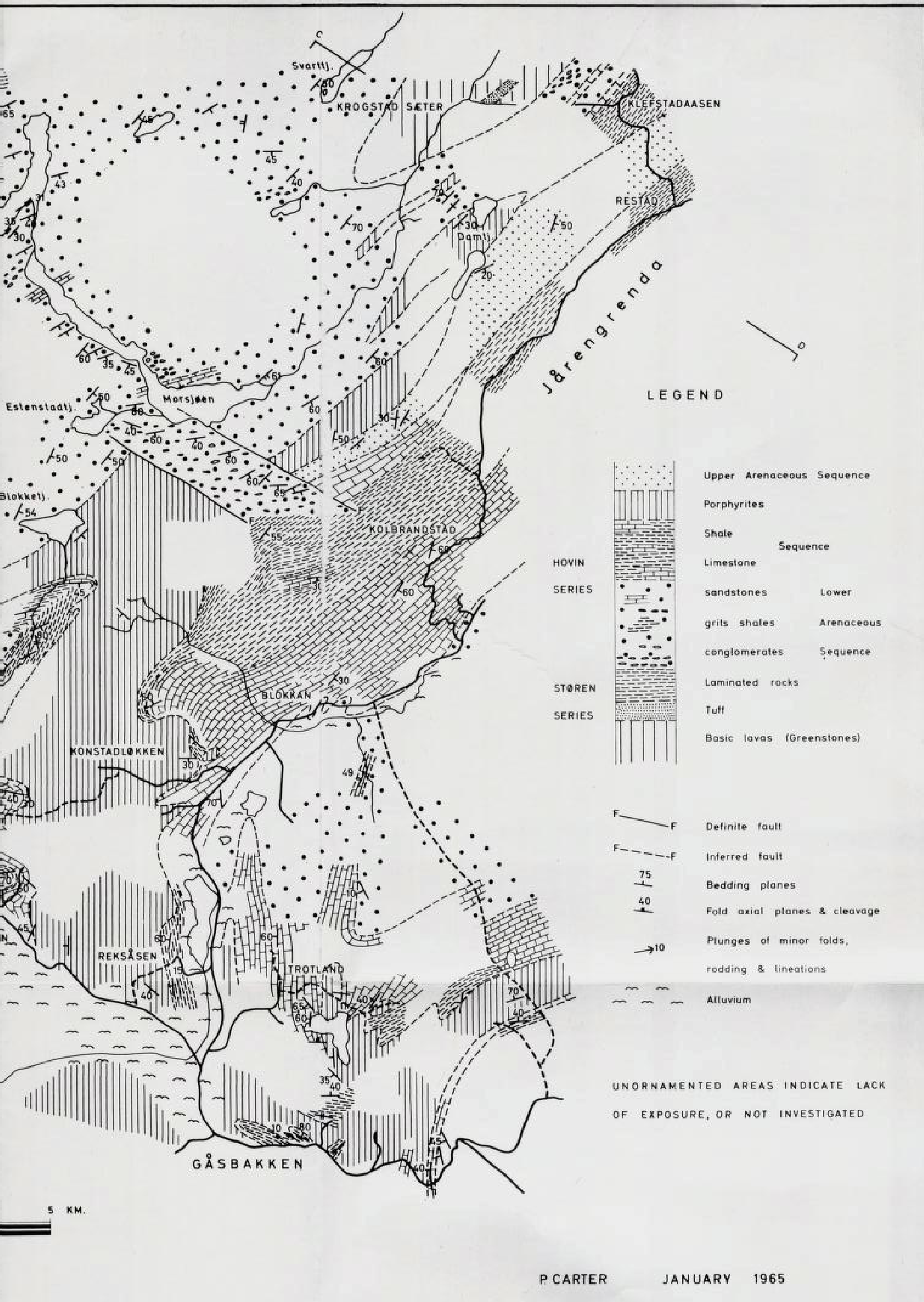
Table 1 shows the local succession in detail.

Carstens, C. W. (1951) showed the Støren Series (which he called the "Bymark Group") to be underlain by the Røros Group, which consists in the main of metamorphosed argillaceous sedimentary rocks.

With reference to Table 1, Blake (1962), from the evidence of graptolites found in the Bogo Shales of the Fjeldheim Beds (of Lower Hovin Series), has shown this horizon to be equivalent to the Phyllographtus Densus Zone (3b) of Middle Arenigian age. This suggests that the age boundaries suggested by Vogt must be revised.



GEOLOGICAL MAP OF AN AREA NORTH OF GÅSBAKKEN



Svarttj.
KROGSTAD SÆTER
KLEFSTADAASEN
RESTAD
Damtj.
Jårengrenda
Morsjøen
Estenstadtj.
Blokketj.
KOLBRANDSTAD
BLOKKAN
KONSTADLØKKEN
REKSÅSEN
TROTLAND
GÅSBAKKEN
5 KM.
LEGEND
Upper Arenaceous Sequence
Porphyrites
Shale
Limestone
Sequence
HOVIN SERIES
sandstones
grits shales
conglomerates
Lower Arenaceous Sequence
STØREN SERIES
Laminated rocks
Tuff
Basic lavas (Greenstones)
Definite fault
Inferred fault
Bedding planes
Fold axial planes & cleavage
Plunges of minor folds, rodding & lineations
Alluvium
UNORNAMENTED AREAS INDICATE LACK OF EXPOSURE, OR NOT INVESTIGATED
P CARTER JANUARY 1965

Table 1 (after Th. Vogt, 1945).

Llandeilian	Lower Hovin Series	Break
		5. Hølonda Andesite
		4. Hølonda Limestone (fossiliferous)
Llanvirnian		3. Hølonda Shale
		2. Gaustadbakk Breccia & Almås Mudstone
		1. Venna Conglomerate
Arenigian (Skiddavian)		Break
	Støren Series	3. Upper Støren Greenstone & Houe Slate
		2. Jåren Beds
		1. Lower Støren Greenstone

The succession established by the present author is given in Table 2, with those established by Vogt (1945) and Chadwick et.al (1964).

Table 2

Present author	Vogt (1945)	Chadwick et.al (1964)
HOVIN SERIES Upper Arenaceous Sequence (sandstones and grits)	HOVIN SERIES	HOVIN SERIES Nyplassen Beds (shales and sandstone)
Porphyrites (intrusive and/or extrusive)	Hølonda Andesites	Intrusive Porphyrites
Shale and limestone Sequence	Limestone Shale	Fjeldheim Beds Shales Limestones Sandstones
Lower Arenaceous Sequence Limestones and sand-stones grits	Gaustad Breccia and Almås Mudstone	
Conglomerates	Venna Conglo-merate	Fjeldheim Conglomerate
BREAK	BREAK	BREAK
TUFFS STØREN SERIES LAVAS (undifferentiated lavas)	STØREN SERIES	STØREN GROUP (sedimentaries, vol-canics, pyroclastics)

A detailed description of the succession tabulated by the present author is given below.

The Støren Series

In the area the Støren Series strata consist of basic lavas, overlain by tuffaceous deposits.

Basic Lavas

The basic lavas include both massive (flow) and pillow lavas, indicating underwater deposition, at least in part. The characteristic sagging or "U"ing of younger semi-molten pillows into those that have already been deposited and solidified, gives good younging data. Secondary alteration of the lavas has resulted in the widespread occurrences of epidote.

Structureless quartz with ferrous impurities - locally known as jasper - occurs in many of the interstices between the pillows. This indicates a silica-rich sea, due to the underwater effusion of silica during the formation of the lavas.

Tuffs

The tuffs show two main varieties. A very distinctive tuff bed immediately overlies the basic lavas. It contains large idiomorphic crystals of feldspar and quartz in a fine-grained matrix predominantly of white mica. The concentration of idiomorphic crystals in the tuff varies from almost totally constituting the deposit, to being sparsely scattered in the fine-grained matrix. The mica matrix is probably the result of secondary alteration after fine-grained feldspars. Secondary alteration has also produced chlorite around the edges of the idiomorphic crystals, and in the fissures.

A very fine-grained tuff bed is occasionally found overlying the distinctive tuff band, and below the Lower Hovin Conglomerate. Its original composition and texture has been greatly changed by secondary alteration.

The Støren Series is overlain by a conglomerate of Lower Hovin age which consists of fragments of Støren lavas and angular fragments of jasper at the base. More rounded cobbles and pebbles occur as the perpendicular distance from the Støren Series strata increases. The deposition of the thick conglomerate layer indicates uplift of the Støren volcanic rocks accompanied by rapid erosion, producing widespread pebble beaches. The Hovin Series strata do not, however, overlie the Støren Series with a very marked degree of angular uncomformity.

The Hovin Series

The Hovin Series is represented in the area mapped by four main sequences of strata which for convenience may be termed the Lower Arenaceous Sequence, the Limestone and Shale Sequence, the Porphyrites, and the Upper Arenaceous Sequence. These names are strictly for local use in the area under consideration and are not being put forward as alternatives for the many names that have already been given for the rocks of Lower Hovin age, outcropping in adjacent areas.

Lower Arenaceous Sequence

This sequence is made up of conglomerates, which occur mainly at the base, grits, sandstones and tuffaceous material, with very local developments of limestone and shale. The sequence thins from circa 600 m by Langkjøsen to circa 300 m in the Jårengrenda.

The conglomerates rarely have a framework of pebbles in contact with each other. More usually pebbles are scattered in greater or lesser quantities in an unsorted matrix. Poor sorting is general in this lowest sequence and in any one outcrop grain size can vary from cobbles to grits or shales. Overall it can be said that the beds become coarser downwards. The pebbles are usually of jasper (in the local sense of the word - amorphus quartz, stained red), and green probably volcanic rocks ascribed by Chadwick et.al. to the Støren "Greenstone" lavas.

The jasper ranges up to blocks almost a metre in diameter in the conglomerate exposed in road cuttings along the north edge of Svorksjøen, and is often less rounded than the well rounded rock pebbles.

The beds sometimes show good sedimentary structures. An outcrop on the southern shore of Morsjøen shows a sharply defined layer of pebbles lying on fine sandstones but grading upwards gradually through grits with scattered pebbles into sandstones over a vertical distance of 2 m. What appear to be turbidite units 30 cm thick with grit bases and shaly upper parts occur in the valley north of Sjømoen and examples of load casting occur nearby. False bedding is shown in an outcrop on the hill just west of Sundet. All these structures provide good younging data for analysing the structure of the area.

Limestones and Shale Sequence

It is convenient to consider together the limestones and shales which lie above the Lower Arenaceous Sequence, since their outcrops suggest them to be local developments within the same general horizon. The sequence varies in thickness from over 300 m. in the Jårengrenda to nil in the far west

Limestones develop locally at or near the top and bottom of the sequence and are fairly continuous along the strike. They can be white, grey or black, are always recrystallized, and are coarse- or fine-grained depending on the amount of recrystallization that has taken place. It is therefore usually difficult to ascertain their original form of deposition, although recognisable reef-breccias sometimes occur, for instance in outcrops between Konstadløkken and Blokkan. The limestones also often contain "ruckled bands" of arenaceous material which are usually about 1-3 mm thick. The bands are sedimentary features and the ruckling illustrates well the plastic deformations of the limestones during folding.

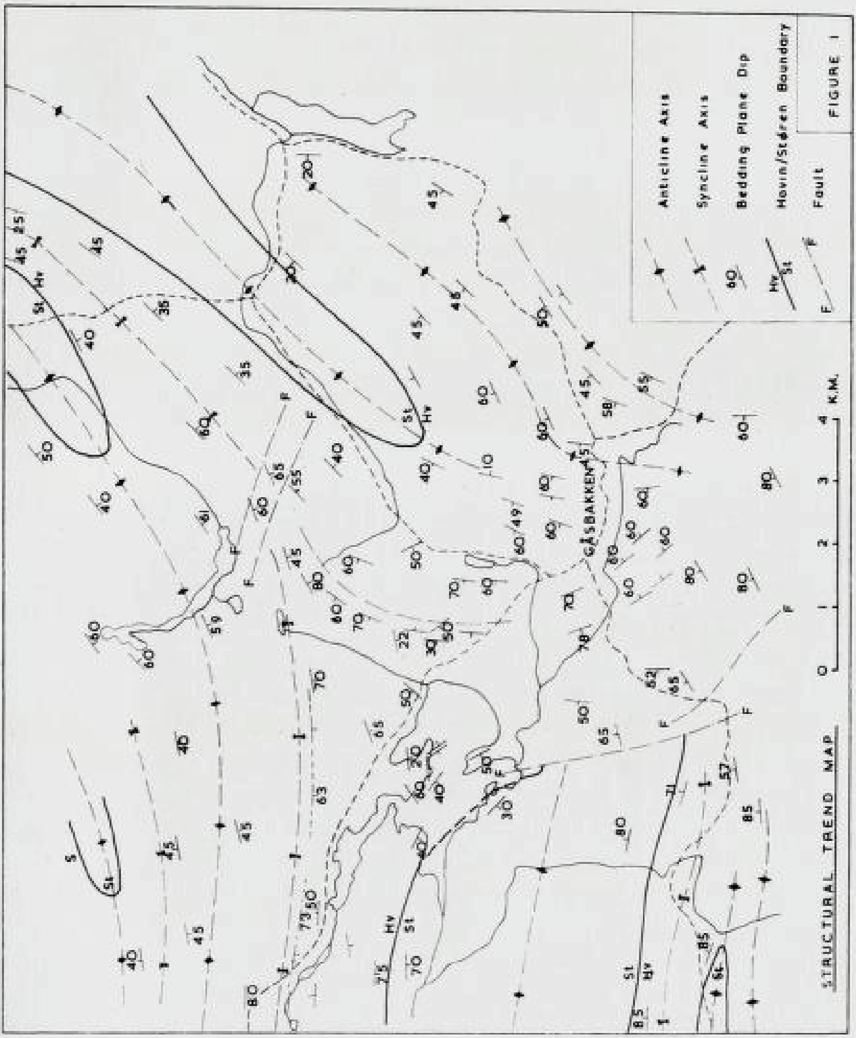
The shales are predominantly grey though sometimes green. Inclusions or flecks of an iron mineral, identified by Vogt (1945) as pyrrhotite, often occur. Occasional sandy bands indicate the bedding, and the shales also sometimes contain lime nodules.

The Porphyrites

It is convenient to deal with the Porphyrites here, as they occur structurally above the Limestone and Shale Sequence, and below the Upper Arenaceous Sequence. The Porphyrite sheet varies from a maximum of circa 300 m around Konstadløkken to nil near Klefstad.

The two pioneer workers in this area, Th. Vogt (1945 and Carstens C. W. (1951), clearly disagreed as to the stratigraphical relationships of the porphyrites. The latter regarded them as intrusive and probably discordant in most cases, whilst the former author regarded them as lavas normally interbedded in the Hovin Group. Vogt even subdivided the porphyrites stratigraphically into Almaas and Berg types, but he acknowledged a discordant intrusive relationship for a minority of the outcrops. Chadwick et.al. considered them to be mainly concordant intrusions.

The present author noted that the Porphyrite sheets do not show any of the typical features normally associated with lava flows such as "blocky" or "ropy" flow surface features, or any evidence of separate flows. However, a prominent Pyroclastic layer is frequently found directly underlying the Porphyrite. This does suggest a possible volcanic origin. Some fragments of the country rock could however, be excepted to be found at the base of a concordant intrusion due to fracturing of the country rock during intrusion. Evidence of strong heating of the country rock in the immediate vicinity of the Porphyrite is given by metamorphosis of the limestone adjacent to the Porphyrite into marble. Porphyrite dykes were found in three outcrops, intruded into the



Støren Series strata and the Lower Hovin conglomerates. These were presumably feeders for the overlying Porhyrite sheets. The author found the field evidence for the precise origin of the Porphyrites to be inconclusive.

Upper Arenaceous Sequence

This sequence forms the youngest strata found in the area. It follows a continuous outcrop from Restad extending south-west along the strike until it is cut off by the major fault south of Morsjøen. The beds are equivalent to the "Restadgrøtås sandstones" of Vogts "Jåren Beds". A green-white weathering surface is displayed by these beds which are better sorted than the beds of the Lower Arenaceous Sequence, they consist of fine-grained grits, sandstones and some shaly bands The sequence is about 150 m thick with the top not seen.

Structural geology

The structural outline plan (Fig. 1) indicates the main directions of the folding in the area. The structure has been determined by three phases of deformation, which took place during the Caledonian orogeny. Chadwick et.al. (1964) have called these the F_1, F_2 and conjugate folding phases respectively.

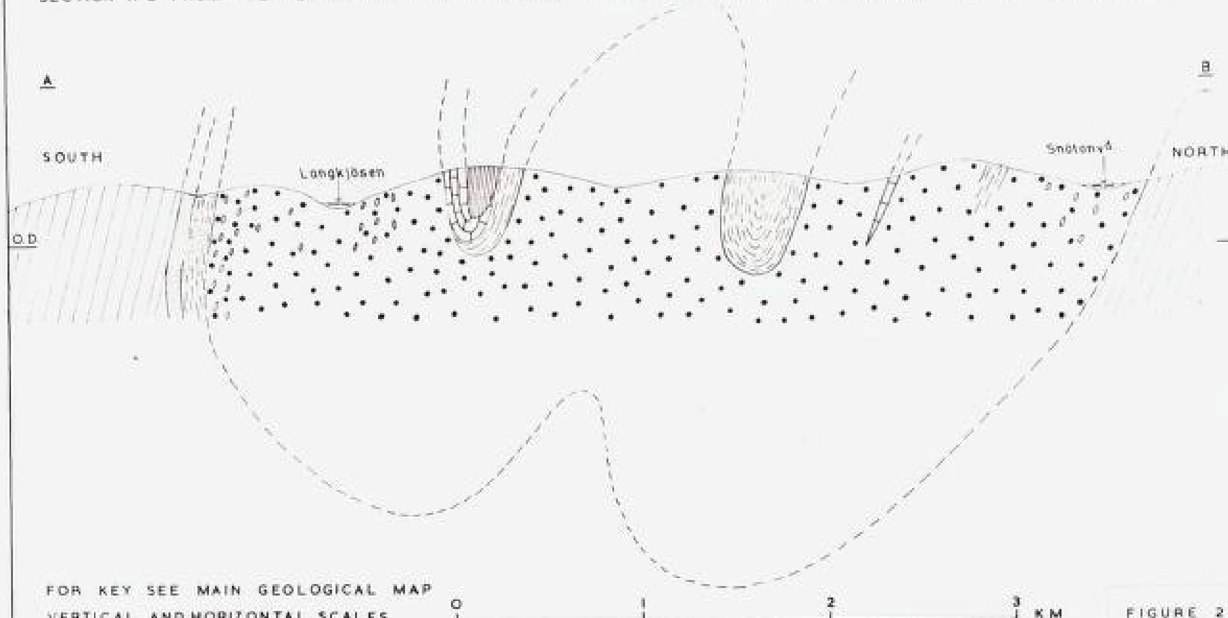
The F_1 phase has produced most of the major folding occurring in Sør-Trøndelag. The strike of the F_1 folding follows a south-westerly direction from the Trondheim area, swinging round more to the west in the area mapped by the author. The F_2 folding phase constituted a second major deformation producing minor conjugate folding. Some minor faulting has occurred. The overall structure of the area constitutes a major F_1 syncline upon which has superimposed the effects of the F_2 folding.

First or F_1 Phase of Folding

The major F_1 syncline strikes south-westerly parallel to the Jårengrenda in the eastern part of the area, swinging round into a westerly strike to the north of Svorksjøen. Hovin Series sediments, with a core of porphyrites and Upper Arenaceous Sequence rocks, have been downfolded by the syncline into Støren Series volcanic rocks, which form the synclinal limbs (Fig. 2). Thus the southern limb of the syncline brings Støren Series rocks to the surface south of Svorksjøen, and south-east of the Jårengrenda. The strata outcropping on the southern limb are overturned between 0° and 20° from the vertical. Evidence for the overturning is given by sedimentary structures in the Hovin Series strata and "V"ing of the pillows in the Støren volcanics. On the northern limb of the syncline, Støren Series volcanics outcrop near Snoton Lake in the extreme north-west of the area, and at Konstad Sæter in the extreme north-east.

The major F_1 folding was accompanied by minor folding, rodding structures parallel to the minor fold axes, shear planes and tension cracks. These structures are best developed in the Hovin Series strata to the north and west of Svorksjøen. The direction of minor fold axes and rodding is east to west, following the strike of the major folding. The majority plunge towards the east, at angles of between 5° and 35° from the horizontal. The tension cracks,

SECTION A-B FROM THE WESTERN ARM OF SVORKSJÖEN IN THE SOUTH-WEST TO SNÖTONV^d IN THE NORTH-WEST



FOR KEY SEE MAIN GEOLOGICAL MAP

VERTICAL AND HORIZONTAL SCALES

FIGURE 2

generally quartz filled, occupy planes perpendicular to the fold axes. The poles to the tension cracks therefore plunge parallel to the minor fold axes. Shear planes are found, parallel to the minor fold axial planes.

Second or F_2 Phase of Folding

The major F_2 folding has been shown by Chadwick et.al. (1964) to be superimposed on the F_1 folding, from the evidence of minor fold interference patterns. A north-westerly striking syncline has been produced with its axis running through the village of Gåsbakken. The core of the syncline is occupied by the Porphyrites, and the limbs by the Lower Arenaceous Sequence strata of Hovin age, and by rocks of the Støren Series. This fold phase appears to be responsible for the arcuate strike of the F_1 syncline and could be responsible for the generally easterly plunge of the F_1 minor fold features in the west of the area. Minor folding and associated structures along F_2 axes confirm the general direction of this phase of folding as shown by the bedding plane strike. The folding due to superimposition of F_2 folding on F_1 structure is complex, but difficult to interpret in detail, due to the poor rock exposure.

Third or Conjugate Phase

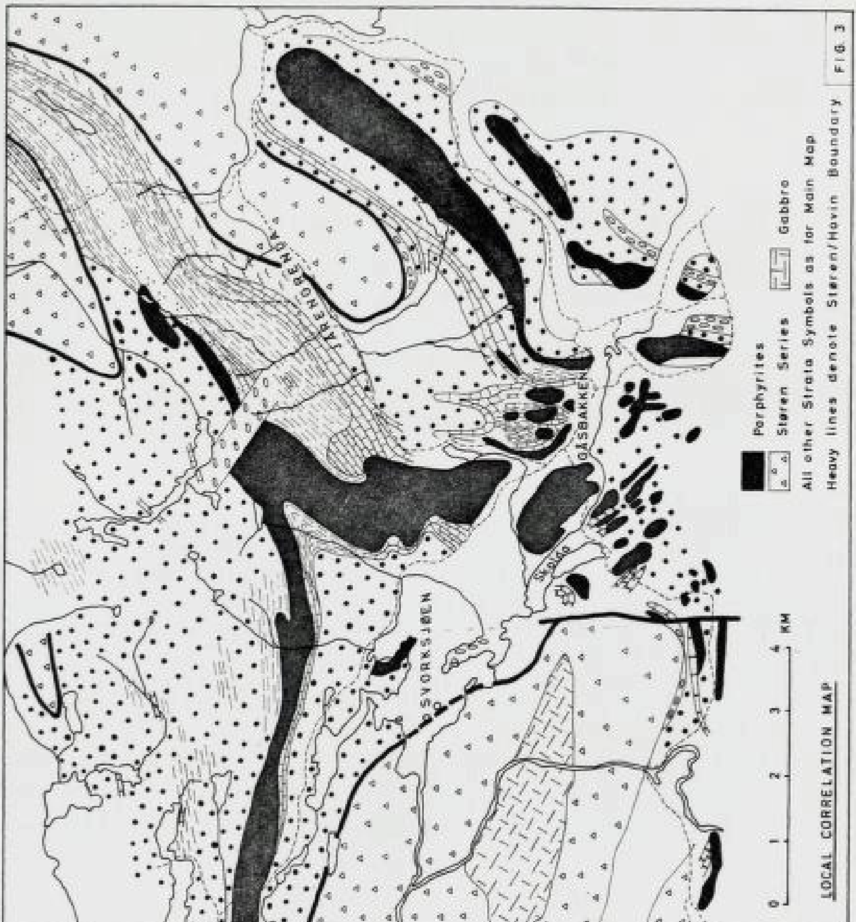
The third phase of deformation did not affect the major structures of the area. Compressive stresses in the rock produced conjugate folding on a minor scale. This has refolded the minor structures produced by previous fold phases.

Faults

Faulting has occurred in this area only on a minor scale. Since the faults transsect F_1 structures, but have not been affected by the F_2 deformation, they are contemporaneous with, or younger than the latter.

Two parallel faults striking north-west occur immediately south of Morsjøen in the east-central part of the area. A fault block of (probably) Lower Hovin conglomerate has been uplifted into the porphyrite and Upper Arenaceous Sequence core of the syncline. Due to the differential erosion, fault scarps occur leaving the conglomerate block upstanding.

On the Ramsberget Peninsula which juts out into Svorksjøen, a fault striking nearly east-west, has brought the porphyrites down against Lower Hovin conglomerates. A prominent fault scarp has resulted from differential erosion, with the porphyrites forming the scarp-face.



Local correlation

The stratigraphy and structure of the area correlates well with those established for adjacent areas by Th. Vogt (1945), Carstens C. W. (1951 and 1952) and Chadwick et.al. (1964). The probable correlation of the strata in the area mapped by the present author, with the strata outcropping in the adjacent areas, is shown in table 2. The geological sketch-map (Fig. 3) indicates the continuity of the strata along the strike into the surrounding areas. The structural trend map (Fig. 1) shows the continuity of the structures. Points of disagreement with previous authors are as follows:

Vogt (1945) believed the Hovin Series strata, downfolded by the F_1 syncline

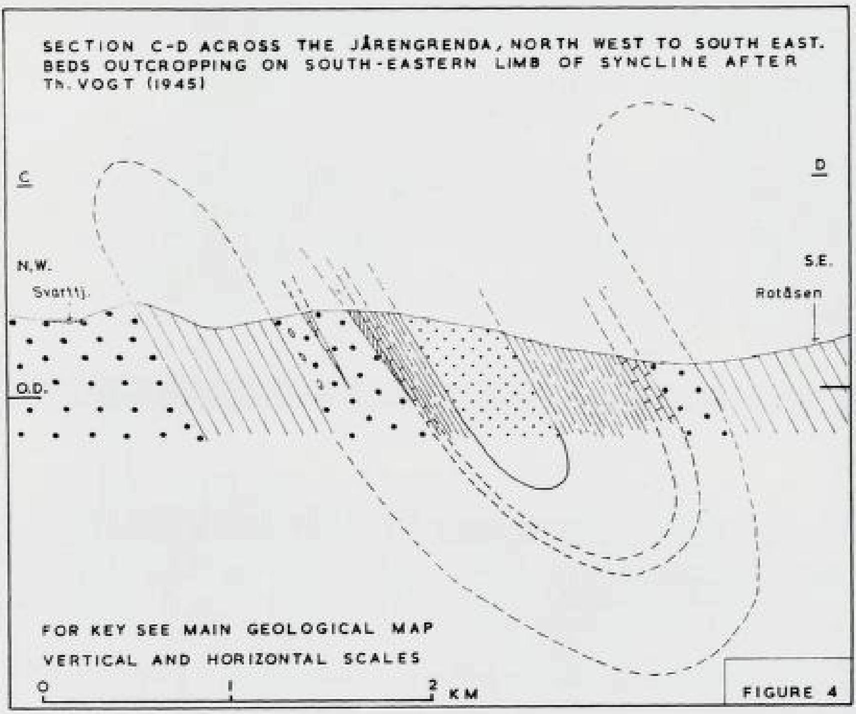


FIGURE 4

in the Jårengrenda, to be a sedimentary series of Støren age. He gave the name "Jåren Beds" to this series, and named the Støren volcanic rocks brought to the surface on the north-western and south-eastern limbs of the syncline, the "Lower Greenstones" and "Upper Greenstones" respectively. Carstens (1951) opposed this interpretation claiming the "Jåren Beds" to be of Hovin age. This sedimentary series has in fact been shown by the present author to comprise synclinally folded strata of Lower Hovin age. A section across the syncline is given in Fig. 4.

Carstens C. W. (1952) believed Støren Series and Røros Group strata to outcrop to the north of Bøverdalshaugen in the extreme west of the area. The strata at this point however belong to the Lower Hovin Series. The outcrop mapped by Carstens as Støren "Greenstone" is in fact porphyrite of Lower Hovin age.

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