The Surna, Rinna and Orkla Nappes of the Surnadal-Orkdal district, southwestern Trondheim Region.

SIGBJØRN KOLLUNG

Kollung, S. 1990: The Surna, Rinna and Orkla Nappes of the Surnadal-Orkdal district, southwestern Trondheim Region. *Nor. geol. unders. Bull. 418,* 9–17.

In the district between Surnadal and Orkdal within the 'Gula', the rock sequence between the Late Precambrian metasandstones of the Tingvoll Nappe and assumed Lower Ordovician metavolcanites of the Støren Nappe, three major nappes have been distinguished. These tectonic units are here termed the Surna Nappe, the Rinna Nappe and the Orkla Nappe and are correlated with the Essandsjø (Seve), Øyfjell (Köli) and Gula Nappes, respectively. Metapelites represent the most widely distributed lithology, with basic metavolcanites occurring in the Surna and Orkla Nappes. Metamorphic grade generally decreases upwards; amphibolite facies in the Surna Nappe, garnet grade in the Rinna Nappe, and garnet to biotite grade in the Orkla Nappe. The lithologies of the Orkla Nappe are divided into two formations; the Hoston Formation below, composed mainly of greenschists and phyllites and the overlying Svorkmo Formation which consists mainly of phyllites.

S. Kollung, Hertug Skules gt. 10, 0652 Oslo 6

Introduction

In the district between Surnadal and Orkdal, in the western part of the Trondheim Region (Fig.1, Plate 1), a sequence of metapelites and basic metavolcanites, the socalled 'Gula', has been studied. The rocks are situated between Late Precambrian metasandstones (sparagmites) of the Tingvoll Nappe and Lower Ordovician metavolcanites of the Støren Nappe. Studies from the Surnadal synform, in the western part of the district, have recently been presented by Kollung (1984) and Rickard (1985). From Surnadal, the rock sequence on the northern side of the synform has been followed over Øvre Rindal to Orkdal, with the Hoston-Svorkmo area given special attention in the present study. This rock sequence, referred to as the 'western schists', has been subdivided tectonostratigraphically, and its regional correlation is discussed. The lower part consists of amphibolite-facies rocks, i.e. mica schists, gneisses and amphibolites, while the upper parts are greenschist-facies lithologies, i.e. chlorite-mica schist, phyllites and greenschists.

Diverging opinions have been presented regarding the tectonostratigraphy of the Orkdal area; some are shown in Table 1. Törnebohm (1896) divided the western schists into 3 units. The lowest unit is the Åre schist, interpreted as crystalline 'sparagmite', forming the Seve Nappe, with its type locality at Åreskutan, in Jämtland, Sweden. However, only the lowermost part of the Åre schist, a pale quartz-mica schist, is of 'sparagmitic' character. The remainder of Törnebohm's Åre schist, including hornblende schist and brown mica gneiss, corresponds to the amphibolite-facies rocks. The higher units are the Røros and the Brek schists, which correspond with schists in the eastern part of th Trondheim Region, and in the westernmost portion of the central Gula Group, respectively. Carstens (1920, 1951) simplified this scheme drastically, in placing the western schists in one large unit, the Røros Group, which he correlated with the Gula Group schist. Carstens recognised the difference between the lower, brown, mica schists and the upper, grey-green schists, but believed that the contact between them was of transitional character. Rutter et al. (1967) considered the phyllitic rocks in the upper part of the western schists to belong to the Hovin Group, the metasediments occurring above the Støren volcanites. From studies in

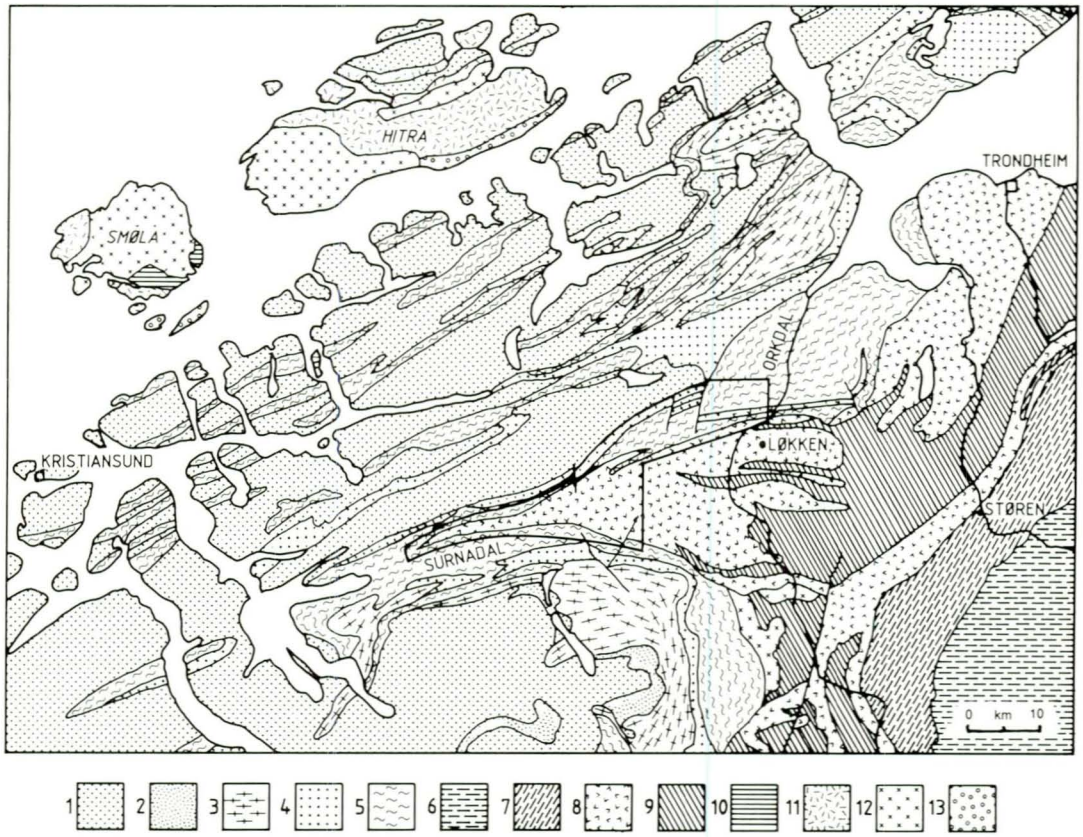


Fig. 1.
Geological setting of the Surnadal - Orkdal district.
1—2. Autochthon. Rocks of mainly Precambrian age. 1. Basement. Gneisses and granite. 2. Cover. Metasandstone and quartzite. 3-10. Allochthon. Rocks of Precambrian to Silurian age overthrust during the Caledonian orogeny. 3. Osen-Røa Nappe and equivalent nappes. Granitic to tonalitic gneiss; in the south including metasandstone and quartzite. 4. Tingvoll, Leksdal Nappe. Augen gneiss (below), metasandstone. 5. Surna, Blåhø Nappe. Mica schist and amphibolite. In SE, including Köli and Gula Nappes, with phyllite and greenschist. 6—7. Gula Nappe. 6. Singsås Formation. Calc-silicate schist and gneiss, with quartzite and amphibolite. 7. Undal Formation. Phyllite. 8—9. Støren Nappe. 8. Støren Group. Greenstone and amphibolite. 9. Lower Hovin, Upper Hovin and Horg Groups. Phyllite, greywacke, conglomerate, limestone, rhyolite, greenstone. 10. Metabasalt, Smøla. 11—12. Caledonian intrusive rocks. 11. Diorite and gabbro. 12. Granite, granodiorite and quartz diorite. 13. Fosen Group. Rocks of Devonian age. Sandstone and conglomerate. Compiled from Ramberg (1973), Wolff (1976), Sigmond et al. (1984), Askvik & Rokoengen (1985) and Gee et al. (1985), with revisions based on the mapping of the present author.

eastern parts of the Trondheim Region, Wolff (1967) opposed Carstens' view of correlating the Røros and the Gula schists, and the western schists were renamed the Gula Group. Chaloupsky (1977) included both mica schists and phyllites in this unit; he also considered basic volcanites occurring in both types of schists to represent infolded parts of the Støren Group. In a regional study, Gee (1978), following Törnebohm (1896), extended the Seve Nappe into southwestern parts of the Trondheim Region; however, he included the entire sequence of western schists in the Seve. Prestvik (1983) recognised a thrust contact between mica schists and phyllites. He correlated the mica schists with the Gula Group of the central part of the Trondheim Region

Table 1. Tectonostratigraphy of the Hoston-Svorkmo area compared with earlier interpretations from neighbouring areas.

Törnebohm 1896		Carstens 1920, 1951		Prestvik 1983	Present paper		
Støren Group		Støren Group		Greenstone Complex		Støren Nappe	Greenstone, tuffite
Gula	Brek schist	Røros Group	Grey-green mica schist	Phyllite Complex	Western schists	Orkla Nappe = Gula	Svorkmo Formation Phyllite and metasandstone Hoston Formation Greenschist and phyllite
	Røros schist					Rinna Nappe = *Köli*	Chlorite mica schist
Åre Schist (crystalline sparagmite) = Seve	Brown mica gneiss Hornblende schist		Brown mica schist	'Gula' Group		Surna Nappe = Seve	Mica schist, amphibolite
	Pale quartz mica schists	Sparagmite Formation				Tingvoll Nappe	Flagstone Granitic augen gneiss Mica augen gneiss
	Augen gneiss					Basement	Granitic gneiss, granite

Tectonostratigraphy

A simplified geological map of the Surnadal-Orkdal district is shown in Plate 1. In the Surnadal synform (Kollung 1984), five main rock units were distinguished:

5. Greenstone, metalava
4. 'Upper schist'. Phyllite/mica schist and limestone
3. Greenschist, metatuff
2. Rinna schist. Chlorite-mica schist and phyllite
1. Surna Group. Mica schist and amphibolite.

The idea that the amphibolite-facies Surna Group is separated from the lower-grade rocks above by a major thrust (Krill 1980,1985) has been accepted. (Krill's Surna unit comprises only the upper part of the Surna Nappe of this paper). Also, large discordances are present between the greenschist unit and undoubted Støren greenstone in the eastern continuation of the Surnadal synform, in the northern limb at Trønsdal (Råheim 1979) and in the southern limb in the Romundstad area. The tectonostratigraphic position of the 'Upper schist' could not be conclusively determined. Due to early isoclinal folding, this schist is situated within greenschist in the western part of the Surnadal synform and within greenstone farther to the east.

From studies in eastern areas it has become clear that the 'Upper schist' is situated tectonostratigraphically between the greenschist (unit 3) and the greenstone (unit 5), and that it is separated from the greenstone by a thrust. Also, an additional tectonic boundary has been recognised, between the Rinna schist and the greenschist.

The distribution of rock units in the Hoston-Svorkmo area is shown in Plate 2, which includes a cross-section from Haukåskammen to Vasslivatnet. The tectonostratigraphy of the area is shown in Table 1 and compared with the interpretations of Törnebohm (1896), Carstens (1920, 1951) and Prestvik (1983) from neighbouring areas. The proposed correlations with the Gula, Köli and Seve Nappes are discussed in a later section. The upper phyllite unit, including metasandstone, is referred to as the Svorkmo Formation and corresponds to the 'Upper schist' in Surnadal. It lies with tectonic contact beneath the Støren volcanites in an open E-W synform between Ringevatnet and Svorkmo, here called the Ringevatnet synform. The underlying greenschist unit, termed the Hoston Formation, includes phyllite, which is different from the corresponding formation in Surnadal. The Svorkmo and the Hoston Formations together form the Orkla Nappe. The Rinna Nappe is represented by a

chlorite-mica schist, the lower of its two units in Surnadal. The Surna Nappe is composed of mica schists, mica gneisses and amphibolites. Lower units, the Tingvoll Nappe and Basement, are shown undifferentiated in Plates 1 & 2, but are not described in the text. A NNE-SSW striking fault in the western part of Hostovatnet and Ringevatnet displaces most of the rock units. It is referred to below as the Hoston fault.

The Surna Nappe

In Surnadal and in the area east of the Hoston fault, only the uppermost part of the Surna Nappe is indicated on the maps (Plates 1 & 2). In the intervening area the unit attains apparent thicknesses up to 2-3000 metres. The nappe is composed of mica schists and amphibolites, the former grading into gneisses in the east. The thickest amphlibolites occur in lower parts of the nappe, while micaceous rocks dominate in the upper part.

The mica schists and gneisses have a brownish colour due to abundant biotite. Garnet is commonly present, in some areas together with hornblende. Between the Hoston fault and Gåsvatn, a 10-50 m thick, white to brownish, pure limestone is interbedded with mica schist in the upper part of the nappe. The amphibolites, believed to be metavolcanites, are greenish-black in colour, commonly with abundant, paler, keratophyric bands. Garnet is common. Syn- to post-tectonic minor intrusions of pegmatitic trondhjemite invade these schists and amphibolites. A large trondhjemite body is situated south of Romundstad. Such intrusions are absent in the overlying rocks.

The Rinna Nappe

The Rinna Nappe has a maximum tectonic thickness of 300 m, and may be as thin as 20 m on the northern side of the synform. It consists of two principal units. The main rock-type in the lower unit is a rather coarse, quartz-rich chlorite-mica schist. This shows a grey, greenish or brownish colour depending on the variable content of muscovite, chlorite and biotite. The schist is rich in garnet, locally also in hornblende porphyroblasts. Abundant thin quartz veins and intense small-scale folding are characteristic features. In the east, the following additional rock-types are represented: fine-grained, brown, biotite schist, quartz-rich biotite-porphyroblast schist, quartzite, fine-grained hornblende-porphyroblast schist, calcareous hornblende-porphyroblast schist, greenschist and amphibolite. The upper unit, which is mostly lacking in the north, consists of a green to grey, fine-grained phyllite with biotite porphyroblasts. In the western part of Surnadal the phyllite grades into mica schist due to increasing metamorphism. In Surnadal, within the Rinna schist, there is a zone of dark greenschist, which is most continuous in the south. It may, however, represent an infolded part of the Orkla Nappe.

The Orkla Nappe

The Hoston Formation. Basic metavolcanites of the Hoston Formation occur extensively throughout the district; east of the Hoston fault the formation includes phyllite. A lower phyllite at the base of the formation is up to 50 m thick, grey coloured, and has calcareous bands and thin intercalated beds of graphite schist. Near Hoston a ca. 10 m-thick limestone occurs at the top of the unit.

The main metavolcanic unit has a maximum thickness of about 500 m. It is dominated by a dark, fine-grained, amphibolitic greenchist with a finely banded structure which indicates a tuffaceous origin. In thin-section the main minerals are plagioclase and green to brownish-green amphibole, with epidote and some quartz and calcite. In the Romundstad area a paler green, tuffaceous schist constitutes the upper and greater part of the unit. It contains plagioclase, quartz, chlorite, epidote, muscovite, biotite ± calcite. In Surnadal there are, in some areas, more massive and paler coloured bands, thought to be metalava.

In a poorly exposed area east of Hoston the uppermost unit of the Hoston Formation consists of interfolded greenschist and grey to green, partly calcareous phyllite.

The Svorkmo Formation. This unit is up to about 500 m thick in the Hoston-Svorkmo area and northwest of Rindal. On the southern side of the synform the unit disappears 2 km east of Rindal. The main rock is a grey to green phyllite with quartz, muscovite and chlorite as the principal minerals. Grey phyllite in the Hoston-Svorkmo area locally grades into black, graphitic phyllite. In the greater part of the district, biotite-rich schist is subordinate and garnet is scarce or absent. In Surnadal, the phyllite is commonly rich in biotite

porphyroblasts, and westwards from Krokvatnet the biotite content in the groundmass increases, so that the unit grades into mica schist. Garnet is fairly abundant here. Thin calcareous metapelites, phyllites and hornblende-porphyroblast schist occur locally in and to the east of the Gåsvatn area.

Grey to white banded limestones appear between Laksøyan and the Gåsvatn area at two different levels, in the lower part of the formation and at the contact to the Støren volcanites. In Surnadal, the upper limestone occurs on the southern side of the synform, at two different structural levels; the lower one within phyllite and the upper one within Støren greenstone or Hoston greenschist (Kollung 1984, fig.1).

Grey to grey-green metasandstones occur on the southern side of the Ringevatnet synform, at two levels. The upper sandstone, which is up to 300 m thick, occurs at the contact to the Støren volcanites. In addition to plagioclase, quartz, biotite and muscovite, the sandstones have a rather high content of epidote and chlorite, suggesting that basic rock debris formed a substantial part of the original sediment. A schistose quartzite, 10 - 50 m thick, occurs from Laksøyan to west of Rørvatnet, close to a tight fold core containing Støren greenstone. Quartzite bands are locally common in Surnadal, on the northern side of the synform, whereas volcanites are scarce; a thin greenschist appears east of Laksøyan. Also east of Laksøyan, a 2000 x 800 m lensoid body of pale green porphyritic trondhjemite occurs within the Svorkmo Formation.

The Støren Nappe

In most areas, only the lower part of the Støren volcanite unit is represented. Greenstone (metalava) is the most widespread lithology and is variably deformed, in part very strongly, and does not show any distinct pillow structures. With increasing metamorphism west of Lomunda, and throughout Surnadal, dark amphibolitic bands appear which commonly show sharp contacts with the paler greenstone. The greenstone disappears west of Svorka, near the western limit of the map area, due to the presence of an easterly plunging fold.

In the Hoston-Svorkmo area, this lower unit also includes large amounts of clastic rocks. Tuffites are most abundant in the Ringevatnet synform and in a narrow zone between Valstad and Ringevatnet to the south of the synform. In places, the tuffites alternate with greenstone or occur as thicker units in which strongly schistose, phyllitic bands alternate with more massive, sandy layers with a granular texture. A granular, homogeneous tuffite is also present locally. The main minerals of the tuffites are plagioclase, quartz, chlorite, epidote and muscovite. Even the greenstones may contain abundant quartz and muscovite. Gradational contacts between tuffite and greenstone are common.

In the southernmost part of the map area (Plate 2), greenschists, interpreted as metatuffs, constitute an essential part of the volcanite sequence. Interbeds of tuffite and greenstone are common. At Malisætra, the thickness of this formation, which has a sharp boundary with pillowed greenstone above, is about 400 metres. Both to the east and to the west of Malisætra, the amount of pyroclastic material decreases, and greenstone becomes the dominant rock-type.

Acidic volcanites are uncommon. In the northwest, a grey to brown, fine-grained, schistose quartz keratophyre with a faintly porphyritic texture occurs in the Ringevatnet synform, at the base of the nappe. A few bodies of hornblende gabbro intrude the lower volcanites. One large body, 4 x 2 km in area, occupies most of the western part of the Ringevatnet synform. Except for foliated outer parts it is mediumgrained and massive. Another gabbro located at the base of the nappe in the south does not exceed 50 m in thickness, but is continuous from Valstad to near Malisætra. A large sheet-like gabbro, 6 km x 500 m, intrudes lavas on both sides of Lomunda.

The upper part of the Støren Group, occurring between Øvre Rindal and Romundstad, is composed of lavas with subordinate fine-grained basic intrusions and a large body of medium-grained hornblende gabbro west of Grønlivatnet. These lavas are also strongly deformed. They occur in a stacked pile of about 10 inverted thrust slices (Kollung 1984, fig. 1), and the thrusts can be followed over long distances towards the east. There, the lavas are less deformed, with well-preserved pillow structures. The inversion is indicated by the pillow form and by an upward increase in the number of intrusions in each slice. Both fine-grained gabbro and dykes are abundant.

In the Romundstad area, within the greenstone there are two tight folds containing pelites of the Lower Hovin Group. The Hovin schist is distinguished from the Svorkmo schist by its typically low-grade metamorphic character; i.e., it is fissile and very fine-grained.

Structures

Folds

Early isoclinal folds, F1, are common both in the Surna Nappe and in the overlying rocks. This F1 folding led to a marked thinning of all rock units. In the Gåsvatn and Ringevatnet areas, Støren greenstone and Svorkmo sediments have been tightly folded in the F1 phase, along ENE-WSW axes.

The above-mentioned two tight folds with Hovin schist in the Støren greenstone near Romundstad are also considered to belong to an early phase of deformation. In the same area, Rinna schist and Hoston greenschist are tightly folded.

Folds of a later generation, F2, are coaxial with F1, trending about E-W. The main Surnadal synform is ascribed to this phase (see also Rickard 1985). In the west, the southern limb of the synform is inverted, but it reverts to a normal attitude about 4 km west of Rindal. The western closure of a second-order F2 fold is found west of Øvre Rindal. This fold is the main structure in an area to the south of the present one. It verges to the north and is inverted (Prestvik 1983). The central part of the Hoston-Svorkmo area has been strongly influenced by F2 folding, the open Ringevatnet synform belonging to this phase. Minor folds vary in style from tight to open and show variable axial surface dips.

Late F3 folding along NE-SW axes has deformed the westernmost part of the Ringevatnet synform. Furthermore, open to gentle, N-S F3 folding farther north has affected the Rinna and Orkla thrusts.

Thrust faults

Thrust contacts occur below each of the four large rock units described. Mapping west of the present area has revealed several examples of discordant relationships between the Surna Nappe and the underlying rocks. The rocks of the Surna Nappe overlie different members of the Tingvoll Nappe, or may even be in contact with basement rocks (Kollung 1983). Within the present map area, Tingvoll Nappe flagstone is up to 200 m thick near the Hoston fault, but pinches out at Kulia 6 km farther southwest, where granitic augen gneiss underlies the rocks of the Surna Nappe. One kilometre southwest of Kulia, the lowest mica schist in the Surna Nappe wedges out, with an angle of discordance of about 20°.

The boundary between the biotite-rich schists of the Surna Nappe and the chlorite-rich schists of the overlying Rinna Nappe is very pronounced. Also, the abrupt disappearance of the trondhjemitic pegmatites at the contact to the Rinna Nappe is thought to be a major argument for a thrust contact at this level. The strong tectonization along the contact varies from mylonitic, as seen in the river Brandå west of Rød, to a more brittle tectonization distributed over a wide zone. The latter type is most pronounced in the westernmost part of Surnadal, and south of Rinna, and is assumed to relate to movements later than the main thrusting. Large discordances were seen at two localities. West of Laksøyan, an amphibolite in the Surna Nappe is cut out at an angle of about 25° beneath the Rinna Nappe. Near the farm Heggem, Romundstad, where the contact is exposed, the foliation in the Surna schist is oriented at 335/45°, and in the the Rinna schist at 380/45°.

Strong tectonization is also present at the base of the Orkla Nappe, as seen on Hostokammen, at Berge and at Østre Tokstad. On the southern side of the synform mylonitic contacts are found in the Kjerkholten-Stomprød area, 2 - 4 km east of Romundstad and outside the map area. Both the Rinna schist and the overlying Hoston greenschist are strongly deformed and extremely fissile near the contact.

Indications of thrusting below the greenstone of the Støren Nappe are abundant. In the western parts of the Ringevatnet synform and in the zone Ringevatnet Valstad, the Svorkmo phyllite is strongly crushed and the greenstone converted into a phyllonite. Likewise, phyllonitized greenstone occurs west of Gåsvatn and in some areas in Surnadal. Tectonic discordances are common between greeenstone and rocks of the Svorkmo Formation in Surnadal, and are also present at Gåsvatn. At Trønsdal northeast of Rindal, a discordance is present between greenstone and Hoston greenschist (Råheim 1979). In the Romundstad area, a

major discordance between greenstone and greenschist can be observed over a distance of 4 km, and the greenstone directly above the thrust is strongly deformed. A clear contact relationship can be seen above Heggem, with the greenschist oriented at 320/20° and the greenstone at 355/35°.

The basal thrust to the Støren Nappe is clearly a very early deformation structure, as it is deformed by the F1 folds. If the interfolding of the Rinna schist and the Hoston greenschist at Romundstad is of the same age, then the same holds for the Orkla Nappe. Quite possibly, the thrusting may be almost coeval with the folding. The age relationship between F1 folding and thrusting of the Rinna and Surna Nappes has not been determined, but the thrusts are deformed by the F2 folds.

The imbricate thrusts within the upper greenstone in the area between Øvre Rindal and Romundstad (Kollung 1984, fig.1) are not affected by the main F2 fold and are accordingly of a later age. They are, however, deformed by gentle, transverse F3 folds (but not within the map area). The greenstone close to these thrusts is generally mylonitic, and the thrust character is also revealed by the abrupt transection of the fine-grained intrusions below the thrust planes. Chloritization is a characteristic feature, and the rock also contains disseminated calcite.

High-angle faults

These late structures are found in areas east of Rindal. The faults strike N-S to NNE-SSW. Along the Hoston fault, the eastern block has subsided, with an apparent displacement up to 5 km. This fault continues over a long distance to the north, but dies out rapidly to the south. Displacements of up to 1500 m occur along a fault in the Lomunda valley, and along a fault west of Trønsdal. The fault at Romundstad has an apparent displacement of about 1 km.

Correlations

Northwestern Orkdal

Outside the map area, the Surna Nappe east of the Hoston fault is of great thickness, and continues northeastward to Orkdalsfjorden (Fig. 1). This unit was termed the Gangåsvann Group by Peacey (1963). It consists of hornblende-mica schists and amphibolites, and is underlain by psammites and semi-pelites of the Songsjø Group, corresponding to the Tingvoll Nappe. A thrust fault marks the contact between these two rock units.

Mica schists and amphibolites of the Surna Nappe also occur in two large synformal structures farther to the west, of which the southwestern one is known to the present author (Kollung 1983). Peacey (1963) erroneously included the Surna rocks here in the Songsjø Group; Johnsen (1979) termed them the Sjuråsen Group, and on account of lithological differences he separated this group from the Gangåsvann Group in the southeast. In both areas, however, Johnsen's Sjuråsen and Gangåsvann Group occupy the same tectonostratigraphic position, that of the Surna Nappe. In a geological map compiled by Ramberg (1973), based purely on lithological criteria, the metapelites of the Surna Nappe in Orkdal were designated 'biotite schist'. This rock-type occurs extensively within Ramberg's (1973) map area.

The Oppdal - Dombås district

A tectonic boundary corresponding to that above the Surna Nappe in the Surnadal-Orkdal district has earlier been recognised farther south on the western side of the Trondheim region.

In the Oppdal area, a major tectonic discordance has been recognised between a lower complex including flagstone, mica schist and amphibolite in the west, and an upper complex metamorphosed under low-grade conditions, in the east, with greenstones, green metasandstones and schists (Holmsen 1955). Farther south, in the Dombås-Lesja area, Guezou (1978) defined the western boundary of the Trondheim Nappe Complex by the same tectonic contact, i.e. between the Andbergshøi Complex, including amphibolites and mica schists of the Bottheim Group in the upper part, and the Ståkåhøi Group. While the latter is an equivalent to the Gula Group, the Bottheim Group was compared with the Seve unit. In the Oppdal-Surnadal area, Krill (1980, 1985) separated two nappes of mica schists and amphibolites, the lower Blåhø and the upper Surna Nappe, the latter distinguished by its abundant bodies of trondhjemite. In an uppermost tectonic unit, the Tronget-Støren Nappe, there are phyllites and basic volcanites.

Table 2. Tectonostratigraphic correlation between the Surnadal - Orkdal district and the central/eastern Trondheim Region. According to Roberts & Wolff (1981) and Nilsen (1988), the Støren and Meråker Nappes constitute the same, uppermost unit. Nilsen (1988) has informally combined the Essandsjø and Øyfjell units into one — the Essandsjø-Øyfjell Nappe.

Compiles from Gee et al. (1985) and Nilsson (1988)	Present paper
Central and eastern Trondheim region	Surnadal - Orkdal District
Støren Nappe	Støren Nappe
Gula Nappe Undal Formation Singsås Formation Åsli Formation	Orkla Nappe Svorkmo Formation Hoston Formation
Meråker Nappe	
Øyfjell Nappe	Rinna Nappe
Essandsjø Nappe	Surna Nappe
Remsklepp Nappe	Tingvoll Nappe
Osen-Røa Nappe	
Parautochthon	
Autochthonous cover	
Basement	Basement

Central and eastern Trondheim region

Comparing the Surnadal-Orkdal district with central and eastern parts of the Trondheim region, there are many striking similarities in rock succession; some units are substantially thicker, and many units occur which are not present in the west (Table 2). The pyroclastic rocks in the Støren Group of the Hoston-Svorkmo area are correlated with tuffites forming the eastern and possibly oldest part of the Støren Group sensu stricto, the Elgsjø Formation of Nilsen (1978,1983). These tuffites form a continuous zone between Støren and Hjerkinn, in direct contact with rocks of the Gula Nappe to the east.

It has been shown, in the present account, that the 'western schists' can be subdivided into the Surna, Rinna and Orkla Nappes. The Gula Group of central Trøndelag is bounded by pelitic units, while the middle part consists mainly of calc-pelitic to calc-psammitic schists and gneisses (Wolff 1973, Olesen et al.1973, Nilsen 1978). The western, partly graphitic pelites, the Brek schist or the Undal Formation (Nilsen 1978), were correlated by Törnebohm (1896) with the upper unit of the western schists, that is the Svorkmo Formation. Considering the similarity in lithology and metamorphic grade between the two formations, this seems to be a well founded correlation.

Comparing the rest of the Gula with the Hoston Formation, there are significant differences. The Hoston phyllite is more calcareous than the main Svorkmo phyllite, and may be compared to the calcareous schists in the middle Gula unit, the Singsås Formation (Nilsen 1978). Also, basic volcanites, here considered to be correlatable with the Hoston greenschist, are present in the Singsås Formation, although only as thin, discontinuous layers (Nilsen 1978). There is thus a decreasing volume of volcanic rocks in the Hoston/Singsås Formations, from Surnadal and Rindal, where greenschist is the only rock, to Orkdal, where both pelites and volcanites are thick, to the central Trondheim region where the volcanites form only a minor proportion of the sequence. A further argument for correlating the Hoston and Singsås Formations is that no tectonic break has been observed between the Svorkmo and Hoston Formations. The eastern Gula pelites, the Åsli Formation (Nilsen 1978), may possibly be represented by the lowest phyllite of the Hoston Formation.

As recognised by Kjerulf (1871) and Törnebohm (1896), there are lithologies within the western schists which are similar to the Røros schist in eastern Trøndelag. This is a Köli unit, forming the Øyfjell Nappe (Wolff 1979, Roberts & Wolff 1981). The Røros unit is composed mainly of garbenschist and biotite-porphyroblast schist, i.e. the Stuedal schist (Kjerulf 1871, Reusch 1890, Törnebohm 1896, Bryn 1959). The Rinna schist in the Hoston Svorkmo area is, in places, rich in hornblende porphyroblasts, while an upper unit of the Rinna Nappe consists of biotite-porphyroblast phyllite. In the underlying Essandsjø schist (Bryn 1959) or Essandsjø Nappe (Wolff 1979), equivalent to the Seve Nappe, there are lithologies which are similar to those in the Surna Nappe, i.e. amphibolite, mica schist and metasandstone.

Conclusions

The long neglected three-fold division of the 'Gula' in the southwestern Trondheim Region, proposed by Törnebohm (1896), has been shown to be basically correct, and should be revived. The rock sequence in this district belongs to three nappes, termed the Surna, Rinna and Orkla Nappes, and these are correlated with the Essandsjø (Seve), Øyfjell (Köli) and Gula Nappes of the eastern and central Trondheim Region.

Acknowledgements

I am grateful to Orkla Industrier A.s for financing the work, and to G.Grammeltvedt for discussions and help. I am also indebted to M.Stephens and A.Krill for critically reading an early version of the manuscript and correcting the English. Three anonymous referees recommended several improvements to a later version.

References

Askvik, H. & Rokoengen K. 1985: Geologisk kart over Norge, berggrunnskart Kristiansund 1:250000. *Nor. geol. unders.*

Bryn, K.Ø. 1959: Geologien på søndre del av Kartblad Essandsjø. *Nor. geol. unders. 205,* 5–16.

Carstens, C.W. 1920: Oversigt over Trondjemsfeltets bergbygning. *Kgl.Nor.Vidensk.Selsk. Skr.1919, 1,* 152 pp.

Carstens, C.W.1951: Løkkenfeltets geologi. *Nor.Geol. Tidsskr. 29,* 9–25.

Chaloupsky,J.1977: Hølonda. Berggrunnskart 1521 II. *Nor. geol.unders.*

Gee, D.G. 1978: Nappe displacement in the Scandinavian Caledonides. *Tectonophysics 47,* 393–419.

Gee. D.G., Guezou, J.C., Roberts, D & Wolff, F.C.1985: The central-southern part of the Scandinavian Caledonides. *In* Gee, D.G. & Sturt, B.A. (eds.) *The Caledonide Orogen - Scandinavia and related areas.* John Wiley & Sons, Chichester, 109–134.

Guezou, J.C. 1978: Geology and structure of the Dombås-Lesja area, southern Trondheim region, south central Norway. *Nor.geol.unders. 340,* 1–34.

Holmsen, P. 1955: Trekk av Oppdalsfeltets geologi. *Nor. Geol. Tidsskr. 35,* 135–150.

Johnsen, S.O.1979: Geology of the area west and northwest of Orkdalsfjorden, Sør-Trøndelag. *Nor.geol. unders. 348,* 33–46.

Kjerulf, Th. 1871: Om Trondhjems stifts geologi. *Nyt Mag.f. Naturv. 18,* 1–79.

Kollung, S. 1983: Geologiske undersøkelser på kartblad Løkken. *Unpubl.report Orkla Industrier A.s.*

Kollung, S. 1984: The Surnadal syncline revisited. *Nor.Geol. Tidsskr.64,* 257–262.

Krill, A.G.1980: Tectonics of the Oppdal area, central Norway. *Geol.Fören. Stockh. Förh. 102,* 523–530.

Krill, A.G.1985: Relationships between the Western Gneiss Region and the Trondheim Region: Stockwerk tectonics reconsidered. *In* Gee, D.G. & Sturt B.A. (eds.): *The Caledonide Orogen - Scandinavia and related areas.* John Wiley & Sons, Chichester, 475–484.

Nilsen, O. 1978: Caledonian sulphide deposits and minor iron formations from the southern Trondheim region, Norway. *Nor.geol.unders. 340,* 35–85.

Nilsen, O. 1983: The nature and tectonic setting of mélange deposits in Soknedal, near Støren, Central Norwegian Caledonides. *Nor. geol. unders. 378,* 65–81.

Nilsen, O. 1988: The tectonstratigraphic setting of stratabound sulphide deposits in the southern Trondheim region, Central Norwegian Caledonides. *Nor.geol. unders. Bull. 412,* 55–66.

Olesen, N.O., Hansen, E.S., Kristensen, L.H & Thyrsted, T. 1973: A preliminary account on the geology of the Selbu-Tydal area, the Trondheim region, Central Norwegian Caledonides. *Leidse Geol. Meded. 49,* 259–276.

Peacey, J.S. 1963: Deformation in the Gangåsvann area. *Nor.geol.unders. 223,* 275–293.

Prestvik, T. 1983: Rapport vedrørende kartlegging i Dragsetområdet i Meldal, Sør-Trøndelag. *Unpubl.report Geologisk Inst., Universitet i Trondheim.*

Ramberg, H. 1973: Beskrivelse til berggrunnsgeologisk kart over strøket Agdenes - Hemnefjord, Sør-Trøndelag. *Nor.geol.unders. 299.*

Reusch, H. 1890: Geologiske iaktagelser fra Trondhjems Stift. *Kgl. nor. Vidensk.Selsk. Skr. 7,* 1–60.

Rickard, M.J. 1985: The Surnadal synform and basement gneisses in the Surnadal-Sunndal district of Norway. *In* Gee, D.G. & Sturt, B.A. (eds.). *The Caledonide Orogen Scandinavia and related areas.* John Wiley & Sons, Chichester, 485–498.

Roberts, D. & Wolff, F.C. 1981: Tectonostratigraphic development of the Trondheim region Caledonides, Central Norway. *J. Struct. Geol. 3,* 487–494.

Rutter, E.H.,Chaplow, R.E.& Matthews, J.E.1967: The geology of the Løkken area, Sør-Trøndelag. *Nor.geol. unders. 255,* 21–36.

Råheim, A. 1979: Structural and metamorphic break between the Trondheim basin and the Surnadal synform. *Nor. Geol. Tidsskr. 59,* 195–198.

Sigmond, E.M.O., Gustavson, M.& Roberts, D. 1984: Berggrunnskart over Norge 1:1 million. *Nor. geol. unders.*

Törnebohm, A.E.1896: Grunddragen af det centrala Skandinaviens bergbygnad. *Kgl. Sv. Vet.Akad.Handl. 28,* 210 pp.

Wolff, F.C. 1967: Geology of the Meråker area as a key to the eastern part of the Trondheim region. *Nor.geol. unders. 245,* 123–146.

Wolff, F.C. 1973: Meråker og Færen. Beskrivelse til de berggrunnsgeologiske kart (AMS M711) 1721 I og 1722 II - 1: 50 000. *Nor.geol.unders. 295,* 42 pp.

Wolff, F.C.1976: Geologisk kart over Norge, berggrunnskart Trondheim 1:250 000. *Nor. geol. unders.*

Wolff, F.C.1979: Beskrivelse til de berggrunnsgeologiske kartbladene Trondheim og Østersund 1: 250 000. *Nor. geol. unders. 353,* 77 pp.

Manuscript received October 1988; final revised typescript January 1990; accepted February 1990.

Simplified geological map of the Surnadal - Orkdal district

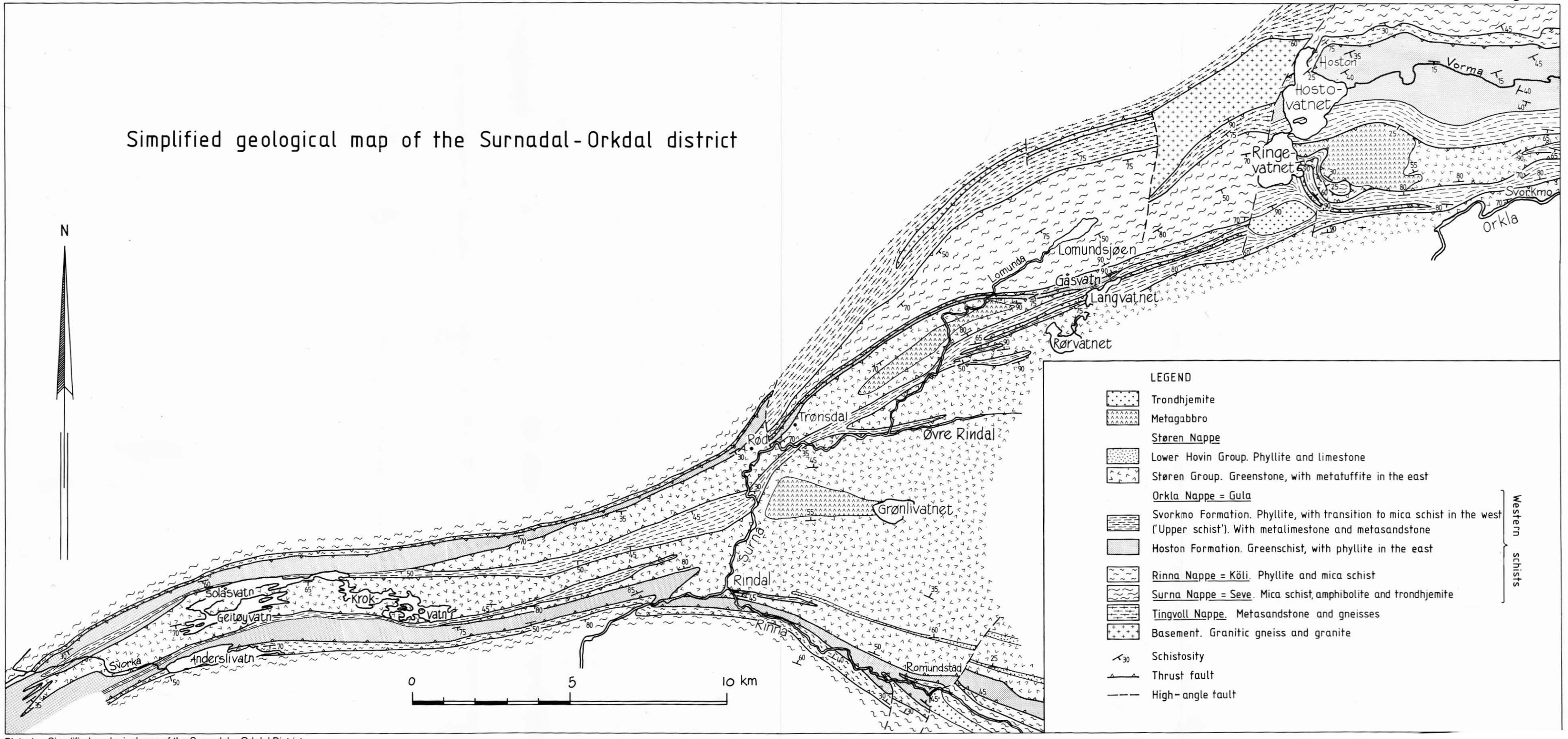
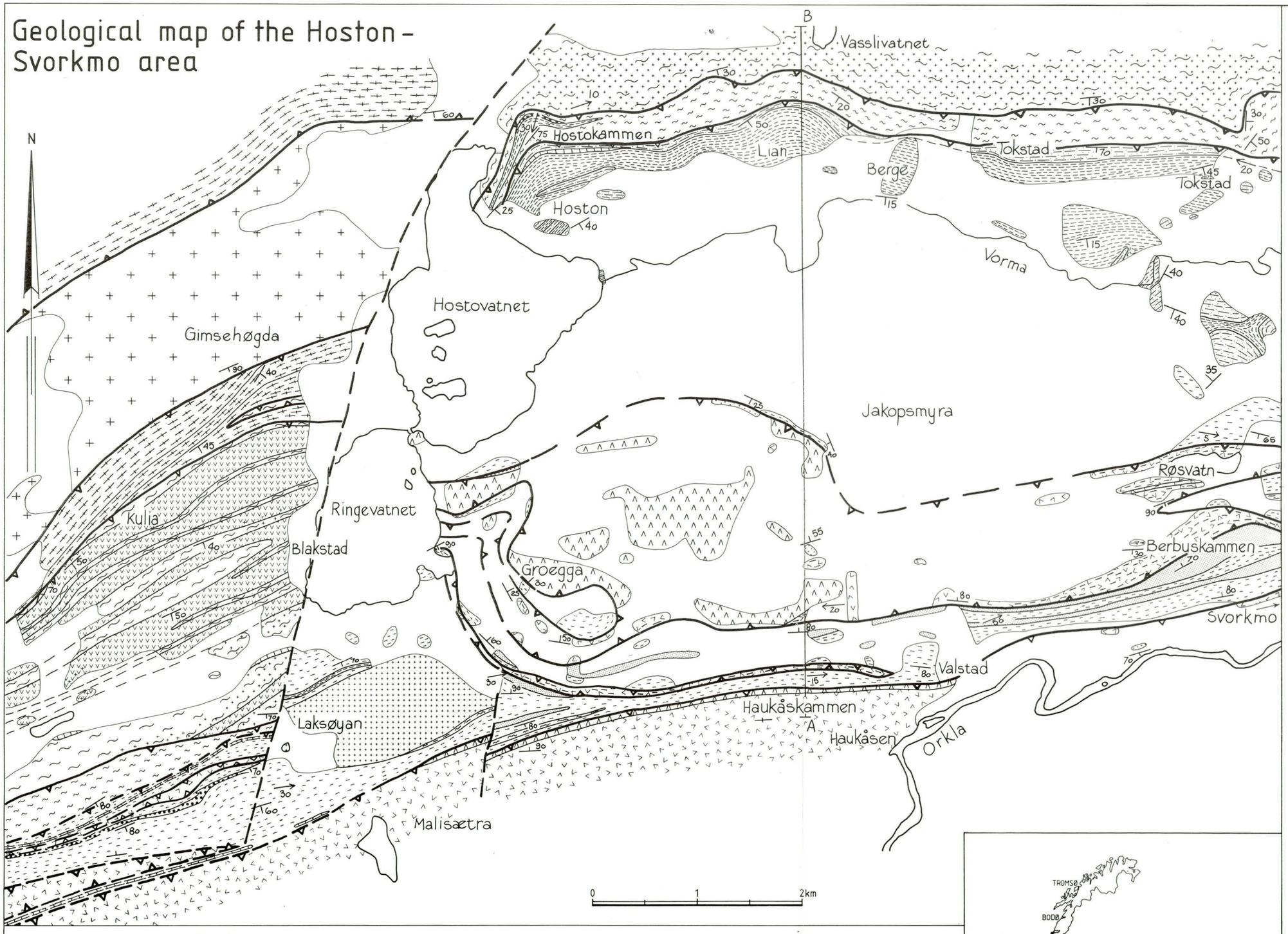
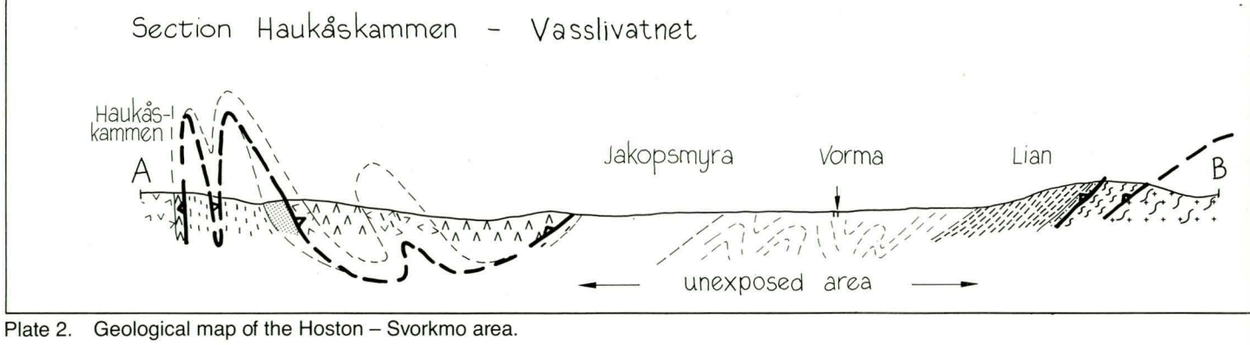
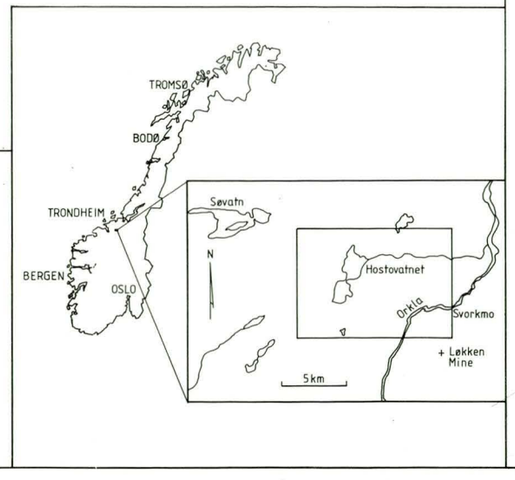


Plate 1. Simplified geological map of the Surnadal – Orkdal District.

Geological map of the Hoston – Svorkmo area







Legend

- Quaternary deposits

Støren Nappe

- Metagabbro
- Basic metavolcanites
- Metatuffite ± basic metavolcanites
- Quartz keratophyre

Orkla Nappe

Svorkmo Formation

- Trondhjemite
- Quartzite
- Metasandstone
- Greenish calcareous phyllite
- Greenschist
- Metalimestone
- Grey to black phyllite

Hoston Formation

- Metalimestone
- Greenschist
- Grey to green, partly calcareous phyllite

Rinna Nappe

- Greenschist
- Quartzite
- Chlorite-mica schist, biotite schist, hornblende porphyroblast schist

Surna Nappe

- Metalimestone
- Mica schist and gneiss / with trondhjemite intrusions
- Amphibolite / with trondhjemite intrusions

Tingvoll Nappe

- Undifferentiated gneisses and schist

Basement

- Undifferentiated granitic gneiss and granite
- 45 Schistosity
- 20 Lineation
- Thrust-fault
- High-angle fault
- A — B Section line

Plate 2. Geological map of the Hoston – Svorkmo area.