A Major Inversion of the Western Part of the Trondheim Nappe*

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Rohr-Torp, E.: A major inversion of the western part of the Trondheim nappe. *Norsk Geologisk Tidsskrift,* Vol. 52, pp. 453–458. Oslo 1972.

A section based on geological observations in the Oppdal-Innset area from the western 'basement contact' to the central Gula Schist Group in the east is presented. The inverted stratigraphy, as seen from the section, is extended from the Hjerkinn area towards the Horg area, thus indicating a general inversion of the western side of the southern Trondheim nappe.

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The opinions of various authors on the geology of the western part of the Trondheim nappe (a term used by Kulling (1961), Wolff (1967) and Roberts, Springer & Wolff (1970)) have changed a great deal during the last hundred years. The Hølonda-Horg district, which is a key area, has been studied by several authors, and their different interpretations are summarized by Th. Vogt (1945).

It is interesting to note that before the fossils from the Kalstad and Hølonda Limestones were properly determined, an anticlinal structure was proposed as a natural interpretation for the Horg area by Kjerulf (1871, 1875), Brøgger (1877) and C. Bugge (1912).

Further investigations, among others a proper assignment of the above-mentioned fossils to a comparatively low Ordovician age, resulted in a re-interpretation of the anticlinal as a synclinal structure. A complete list of references is given by Th. Vogt (1945). Slightly modified, Th. Vogt's (1945) model survived until recently.

The Oppdal-Innset area

The section shown in Fig. 1 sums up the author's interpretation of the main structures in the western part of the Trondheim nappe in the Innset-Trollheimen area. The interpretation is based on fieldwork during the summers 1970 and 1971.

The section starts in a lower tectonic unit in the west, which as shown by

* Main points from a lecture given at a meeting in Trondheim on 28 April 1972 entitled 'En norsk geotravers'.

Publication No. 69 in the Norwegian Geotraverse Project, and publication No. 4 in the 'Røros Project' of the Institute of Geology, University of Oslo.

Fig. 1. Section across the western part of the southern Trondheim nappe from (A) the Trollheimen area to (B) the Innset area. Legend and position of the section are seen from Fig. 2. Arrows indicate way up.

Holmsen (1955) is separated from the proper Trondheim nappe by a marked thrust zone; it passes through the Hovin and Støren Groups, and ends in the central Gula Schist Group. The position of the section is shown on the map (Fig. 2).

A metamorphic boundary near the border between the Støren and Gula Schist Groups exists towards an eastern area where the regional metamorphism is rapidly increased, and where the rocks become more strongly deformed in an isoclinal style; this situation has led to some discussion as to whether the border between these groups actually represents a thrust zone.

Detailed investigations south of Innset, however, have shown that this cannot be the case. Firstly, because the border towards the stronger deformed area runs somewhat west of the border between the Støren and the Gula Schist Groups. Secondly, because little-deformed pillow lavas of the Støren Group can be followed continuously from the north, through the deformation border and into the more deformed area, whereby they are altered to strongly deformed amphibolites.

Along the section (Fig. 1), ten lava horizons (partly represented as amphibolites in the east) are interbedded with alternating green lithic greywackes, sandstones, siltstones and tuffs. The geological section could have been made by marking off the ten lavas with their proper dips, thus giving an unfolded Støren Group of some 15 km thickness, a figure which can hardly be regarded plausible. Obviously the area, as also seen in the field, is folded.

The geological interpretation shown in Fig. 1 is based on eight up/down structures along the section (shape of pillows in the lavas, cross-lamination and graded bedding in the sediments). The localities of these structures are seen from the section, and the lavas are marked down with their correct dips. Even if the details are still simplified, there are several arguments which support this structural interpretation:

All of the ten lava/amphibolite horizons along the section have highly characteristic banded quartzites developed on their upper and lower sides. It is hardly plausible that ten different lavas should all be so intimately con-

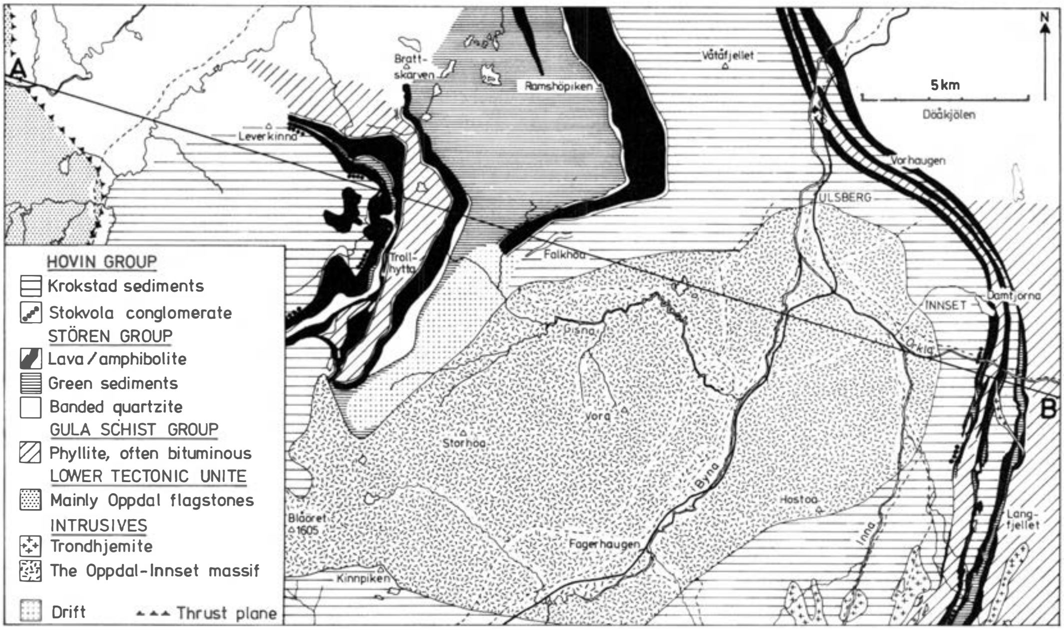

Fig. 2. Geological map of the Oppdal-Innset area.

nected to the banded quartzites, even if the volcanic extrusions may have caused precipitation of silica from the seawater.

A polymict conglomerate containing subangular pebbles of quartzite, greenstone, green sediments, keratophyre, jasper and occasionally limestone, is observed at seven localities along the zone of the section. The conglomerate, as seen from Figs. 1 and 2, is always found in the same stratigraphical position, namely at the bottom of the Hovin Group, by the boundary towards the older Støren Group. It thus seems to correspond to the Stokvola (Venna) conglomerate.

The older Gula Schist Group is infolded in the most westerly recumbent synform (Fig. 1), which is the only place in these western areas where bituminous shales occur locally. They are of the same character as those within the Gula Schist Group near the boundary towards the Støren Group in the eastern part of the section.

Investigations of the contact metamorphism around the Innset massif, which is situated at the central part of the section, have shown that the folding is younger than the intrusion. Thus the Innset massif has taken part in the folding, and has possibly distorted the stylized folding shown on the section above the massif. This, however, has no influence on the general theory that such folding is present.

Based on the structural model shown in Fig. 1, the total thickness of the Støren Group is estimated to be some 500 m, of which the two lavas together make up some 200–300 m. Between the lavas there are different amounts of green sediments of the greywacke type, sometimes alternating with tuffs.

From the section it is seen that most of the green sediments of the supposed Støren Group, as assumed already by C. Bugge (1912, p. 7), actually represent the Krokstad sediments of the younger Hovin Group. Interbedded tuffs towards the top of these sediments indicate that the youngest rocks in the Oppdal-Innset area were formed in the middle part of Middle Ordovician.

A general inversion of this south-western part of the Trondheim nappe is illustrated in the section (Fig. 1) by the succession from the youngest Hovin Group in the bottom, through the Støren Group, to the oldest Gula Schist Group at the top of the folded strata.

The structures which show top senses, the position of the conglomerate and the succession of the different rock types along the section line, could also fit a model of an upright folded sequence, if the most westerly recumbent synform were interpreted as an antiform (see Fig. 1). From the bedding measured on the surface, such an antiform would have to have the shape

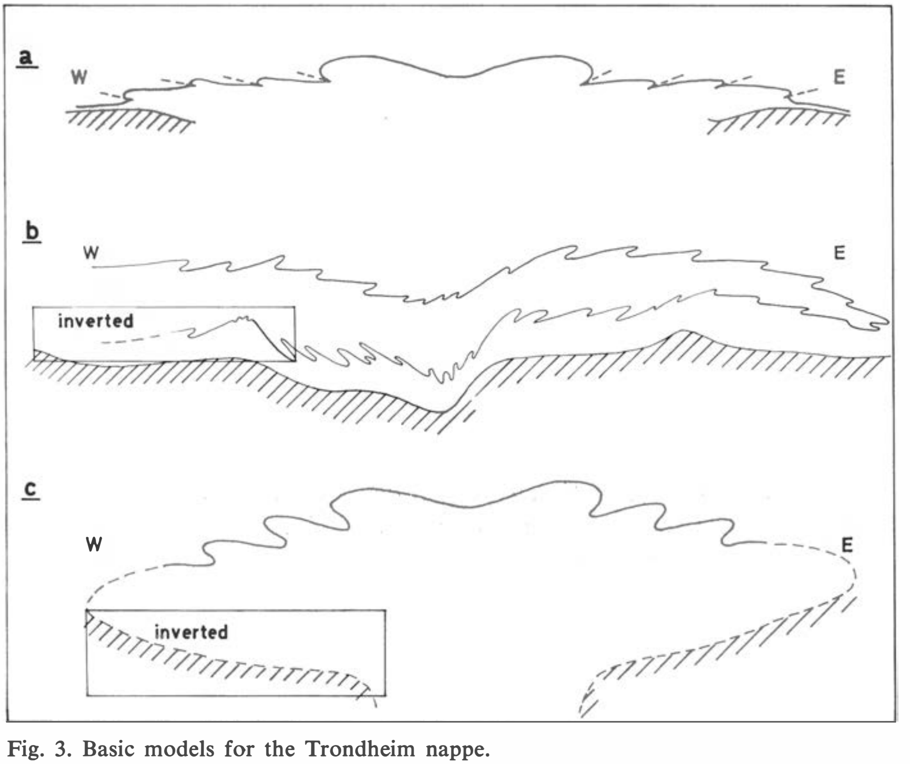

Fig. 3. Basic models for the Trondheim nappe.
A. The model proposed by C. Bugge (1954).
B. The model proposed by I. Rui (1971).
C. Modification of model A, as proposed by Wolff (1970), Roberts, Springer & Wolff (1970) and Oftedahl & Åm (1972). The present position of the western part of the southern Trondheim nappe is marked on B and C.

of a fan fold, a structure which is never observed in the field in any scale, and which according to Hills (1964, p. 215) usually occurs in an upright position.

The main objection against this structure being an antiform, however, is seen in the field, where the very well exposed core of a synformal structure is seen in the mountains Grythatten and Trollhytta. By no means can I make the structures, so well exposed in this area, fit the model of an antiform.

The south-western Trondheim nappe outside the Oppdal-Innset area

The interpretation of a general inversion of the western part of the Trondheim nappe, fits well with recent investigations on the 'Horg syncline' by C. Oftedahl & K. Åm, who at the meeting in Trondheim (28.4.72) presented a reinterpretation of this structure based on gravimetric measurements. They put forward the opinion that the 'Horg syncline' actually represents an antiformal structure in a totally inverted sequence.

H. Heim (pers. comm.) regards the sequence in the western part of the Trondheim nappe, in the Hjerkinn area, to be inverted.

J. Chaloupsky (1969) regards the sequence in the Hølonda-Hulsjøen area to be upright for this area which covers a section midway between the Horg and Innset areas. Gravimetric measurements along the central part of Chaloupsky's section C–D, would possibly prove or disprove his structural model. If, as Chaloupsky proposes, the Støren Group is situated at a rather shallow depth in the central part of this section, a positive anomaly will be obtained for this area. If, on the other hand, no anomaly is obtained, an inverted sequence seems plausible for this area also.

Accordance with the basic models for the Trondheim nappe

At present there are two basic models for the main structures of the Trondheim nappe. One is 'mushroom shaped' with a central root zone, as first proposed by C. Bugge (1954), and later, slightly modified by Roberts, Springer & Wolff (1970). The other, a large-scale recumbent fold nappe with its root zone somewhere west of the Trondheim region, was proposed by I. J. Rui in a lecture in Norsk Geologisk Forening (25.2.71). Fig. 3a & b shows the two models as presented by J. A. W. Bugge at the meeting in Trondheim. If the present erosion surface is regarded as representing the lower limb of the Trondheim nappe, the idea of a general inversion of the western part of this nappe fits Rui's model only.

Fig. 3c, however, shows Oftedahl & Åm's adaptation of the 'mushroom' model to the inverted western part of the Trondheim nappe, as presented at the meeting in Trondheim. This model seems to be much the same as that of Roberts, Springer & Wolff (1970) as presented by Wolff in his lecture in Norsk Geologisk Forening (9.4.70), and it fits the idea of an inverted western Trondheim nappe equally as well as the large-scale recumbent fold nappe.

In Fig. 3b & c, the position of the present western part of the Trondheim nappe is shown on the two actual models.

Acknowledgements. – I am grateful to Professor J. A. W. Bugge, I. J. Rui and O. Nilsen for discussions, comments and advice.

I am also indebted to Dr. W. L. Griffin who corrected and improved the English text, and to I. M. Rui who drew the figures.

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