Comments on the Metamorphic Allochthon in Northern Trøndelag, Central Scandinavian Caledonides

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It is suggested here that the Tømmerås antiform is a composite window. The Olden Nappe is exposed in its core (Pre-Cambrian crystalline basement and Lower Palaeozoic sedimentary cover), overthrust by two separate major nappe units – the Offerdal Nappe (Pre-Cambrian crystalline basement and late Pre-Cambrian sedimentary cover) and the Trondheim Nappe (Lower Palaeozoic sediments and volcanic rocks). Translation of the Offerdal Nappe over the Olden Nappe exceeds 120 km. Translation of the Trondheim Nappe over the Offerdal Nappe exceeds 200 km.

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Western Jämtland and Trøndelag together make up the classical area for the development of nappe theory in the Scandinavian Caledonides. Törnebohm (1888, 1896) outlined the evidence for translation of metamorphosed units at least 100 km eastwards over the Jämtland Lower Palaeozoic and late Pre-Cambrian sediments. He considered the root-zone for this allochthon to be located in central Trøndelag. Asklund (1938) described the western extension of this major nappe (the 'Great Seve Nappe') and proposed that the basal thrust could be traced to the Norwegian west coast implying translation of at least 200 km. This interpretation had been preceded in the area south of Trøndelag by Holtedahl's (1936) interpretation of the Jotun Nappe as a klippe and later received support from areas further north in the mountain belt where Kautsky (1946, 1953), in the Sulitelma profile, emphasized the lack of a root-zone for the 'Great Seve Nappe'.

In 1956, Oftedahl presented a synthesis of the tectonics of the Grong-Olden Culmination mainly based on S. Foslie's mapping. The latter had shown that the Lower Palaeozoic quartzites, limestones and shales of 'eastern' (Jämtland) facies can be traced along the northern and southern margins of the Grong-Olden Culmination, overlain by Pre-Cambrian crystalline rocks. Oftedahl (1956) related this superposition to the basal thrust of Asklund's 'Great Seve Nappe', the underlying units being accepted as part of the Olden Nappe. From Foslie's maps it is possible to deduce a probable (but not certain) root-zone for this basal thrust, west of the Snåsa synform. This evidence was taken by most subsequent Trøndelag authors as support for Törnebohm's basic concept of a metamorphic allochthon with a root-zone in Trøndelag, and as a denial of Asklund's evidence for considerably greater transport.

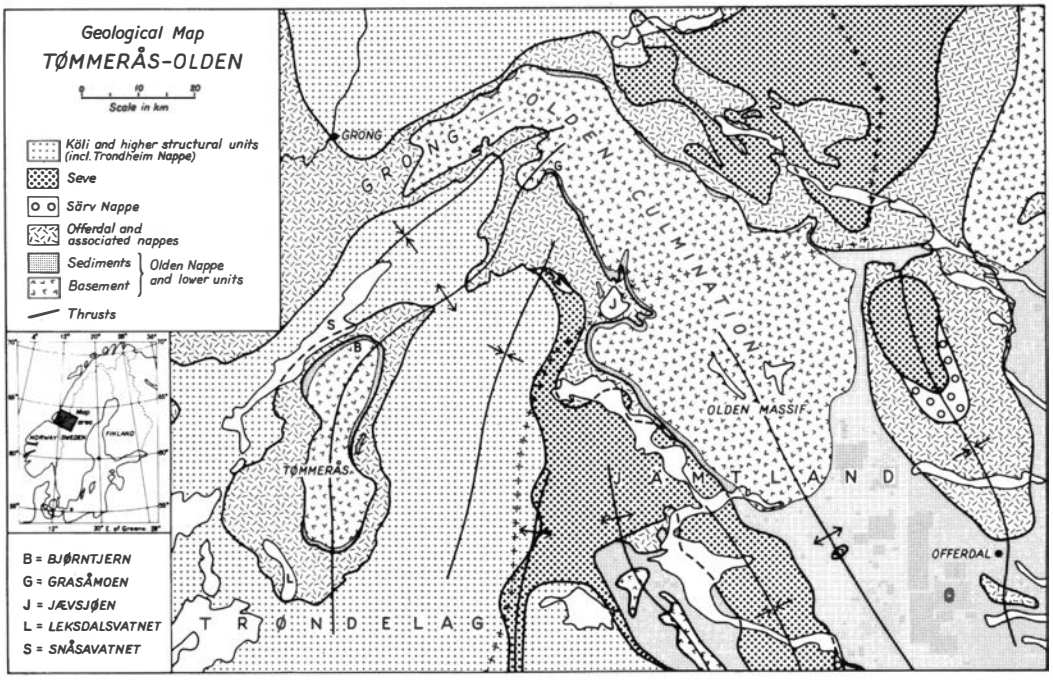

Fig. 1. Geological map of northern Trøndelag and northern Jämtland showing the distribution of the Olden, Offerdal and Särv Nappes and the Seve-Köli Nappe Complex (including the Trondheim Nappe).

In Sweden, the 'Great Seve Nappe' is a composite thrust nappe composed of a series of independent tectonic units. The basal unit is composed of Pre-Cambrian granites, porphyries and late Pre-Cambrian arkoses all subject to extensive penetrative deformation and variously referred to locally as the Offerdal, Fuda, Tännäs Augen Gneiss and Granite-mylonite Nappes (the first name is used here). It is the basal thrust to this unit that can be traced on Foslie's maps within the Grong-Olden Culmination (Fig. 1). Thrust over this nappe is the Särv Nappe (Strömberg 1955) composed essentially of an arkosic sandstone unit intruded by a basic dyke swarm. Superimposed on this is the Seve-Köli Nappe Complex (Zachrisson 1969), made up of a lower part in amphibolite-eclogite facies (Seve) and an upper part in greenschist facies (Köli). Both the Särv (Strömberg 1961) and the Seve (Zachrisson 1973) thin and wedge out westwards, and along with the Köli form an essential part of Asklund's 'Great Seve Nappe'. The allochthonous nature of the Särv and Seve-Köli Nappe Complex thrust over the Offerdal Nappe in Sweden, requires that units in a similar structural position in Norway above the Offerdal Nappe should likewise be allochthonous (Zachrisson 1973).

In Norway higher structural units above or in the upper part of the 'Great Seve Nappe' include the so-called 'Trondheim Nappe' (Kulling 1961, Wolff 1967) in Trøndelag. In the Tømmerås area, north Trøndelag, the entire cover sequence (Leksdalsvann, Snåsa and Hovin Groups) has been described

(Springer Peacey 1964: 26) as a 'normal undisturbed succession' resting with unconformity on the deformed crystalline basement (Tømmerås Group) at the base of the 'Great Seve Nappe'. Thus Springer Peacey (1964: 13) presented an interpretation of the Tømmerås anticline which suggested that the Tømmerås structure during the Late Pre-Cambrian and Lower Palaeozoic existed as a 'gently domed ridge against which the later sediments were deposited'. In support of this interpretation, Springer Peacey (1964: 29–30) described a basal conglomerate at one locality, separating the Tømmerås Group volcanic rocks from the overlying Snåsa Group. It was considered possible (Springer Peacey 1964: 83, Roberts, Springer & Wolff 1970) that the allochthonous units of the Trondheim Nappe might be traceable continuously into the Snåsa Group 'autochthon' implying local rooting of this nappe.

There is an obvious conflict between the geometrical constraints of the Swedish allochthon (Zachrisson 1973, Gee & Zachrisson 1974) and the evidence in Norway of 'autochthonous' cover at Tømmerås. Two aspects bearing on this conflict are examined here:

The extension of the basal 'Seve' thrust in northern Trøndelag.

The metamorphic condition of the Pre-Cambrian basement and its cover.

The extension of the basal 'Seve' thrust in northern Trøndelag

I have briefly examined the base of the 'Great Seve Nappe' in two areas, the one, on the western side of the Olden massif and the other, north of Snåsavatnet (in the area of Grasåmoen). Thereafter I visited the Tømmerås area (Fig. 1). In the vicinity of the Norwegian-Swedish border west of Olden (Jævsjøen), the basal thrust rests on Ordovician greywackes underlain by 'Orthoceras' type limestone, then black shales and quartzites. None of these units in this area have yielded fossils, but they can be mapped continuously south-eastwards into well established fossiliferous stratigraphy (Thorslund 1960). West of Jævsjøen, Foslie showed the limestones, quartzites and shale/phyllite association to be traceable more or less continuously to Grasåmoen. In this area the white and bluish (Varangian-Cambrian) quartzites rest with conglomeratic (Fig. 2) base on a foliated granitic basement. The quartzites pass transitionally up into limestones – a transition which appears primary, implying the probable lack of alum shales in this area. The thrust porphyries of the 'Great Seve Nappe' rest either on the limestone or on subordinate grey phyllites overlying the limestones.

In her account of the Tømmerås basement rocks, Springer Peacey (1964: 54) stated 'the most extensive marker horizon in the massif is the Bjørntjern schist band' consisting 'principally of muscovite schists and miceous leptites, but interbanded with them are graphitic schists, limestones (Skorovass A/S, pers. comm.), and very pure, sugary quartzites'. I have examined the schistose quartzites at Bjørntjern and am convinced that they should be correlated with the quartzites mapped by Foslie at Grasåmoen. This correlation is given support by the associated graphitic and carbonate rocks and the whole meta-

Fig. 2. Basal quartzite pebble conglomerates (Varangian/Cambrian) overlie the foliated granitic and volcanic basement of the Olden Nappe, ca. 2 km south of Grasåmoen.

sedimentary sequence is probably Cambro-Ordovician. Thus in Fig. 1 the base of the 'Great Seve Nappe' is placed above the Bjørntjern formation within the Tømmerås antiform. As in the Grong-Olden culmination to the north, this thrust is folded by the Tømmerås antiform. The rocks above the thrust have been translated at least 120 km eastwards (Fig. 1). Thus the concept of a Tømmerås anticline existing during late Pre-Cambrian and Lower Palaeozoic deposition is open to doubt.

The metamorphic condition of the Pre-Cambrian basement and its cover

Springer Peacey (1964) mentioned that the metamorphic grade in the cover increases downwards. The chlorite, muscovite greenschists in the upper part of the Snåsa synform, passing down into coarse garnetiferous schists and amphibolites, testifies to this relationship. However, the metamorphic condition of the Leksdalsvann Group arkoses and Pre-Cambrian crystalline basement is less easily defined, the fine-grained acid volcanic rocks and occasional biotite amphibolites of the Tømmerås Group possibly having been subject to pre-Caledonian metamorphism. However, the veneer of Cambro-Ordovician sediments below the 'Great Seve Thrust' indicates a lower metamorphic grade below the thrust. From Grasåmoen to Jævsjøen the metaargillites are fine-grained and phyllitic, in the former area crystallizing biotite, muscovite and small manganiferous garnets and in the latter only biotite, muscovite and chlorite. Nowhere in this thin sedimentary unit of the Olden Nappe does the metamorphic grade compare with that of the Snåsa Group

cover which rests on the overlying allochthonous crystalline basement. Neither does the grade compare in any way with the pyroxene amphibolites and eclogites of the Seve, which overlie this basement unit further east.

The question arises as to whether the metamorphic grade within the Tømmerås cover of Snåsa and Hovin Group rocks continues to increase downwards into the Leksdalsvann Group arkoses and crystalline basement to be interrupted at the basal thrust, or whether, as in Sweden, an important tectonic and metamorphic break occurs at a higher level. This problem is at present under investigation. The similarity of Pre-Cambrian fine-grained volcanic rocks above and below the 'Great Seve Thrust' favours the latter, testifying to the allochthonous nature of part of the cover (Snåsa and Hovin Groups), a conclusion favoured by Zachrisson (1973) and Gee & Zachrisson (1974). But this requires reinterpretation of the stratigraphic relationships in the western limb of the Tømmerås antiform. It implies that Springer Peacey's basal conglomerate to the Snåsa Group resting on Tømmerås Group basement must either be a pseudoconglomerate of tectonic origin or the basal conglomerate to the Leksdalsvann Group (a possibility shown in Springer Peacey 1964: fig. 32 legend). It also implies that the 'transitional' units between the Snåsa and Leksdalsvann Group are of tectonic origin. It is suggested here that the Särv and Seve nappe-geometry, supplemented by other lines of evidence as discussed above and elsewhere (Gee & Zachrisson 1974), not only denies the possibility of the Snåsa and overlying units being part of a normal, undisturbed succession on the Leksdalsvann Group; it requires a west to east translation of the Snåsa/Hovin Groups on to the Tømmerås/Leksdalsvann Groups over a distance of at least 200 km.

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