

NOTE ON THE MAIN CALEDONIAN THRUSTING IN NORTHERN SCANDINAVIA

By

CHRISTOFFER OFTEDAHL

(Geologisk Institutt, Norges Tekniske Høyskole, Trondheim)

Abstract. In the Caledonian discussion of recent years, the results obtained by KAUTSKY (1946) have not been considered. In the Tysfjord area, the main Caledonian nappe has a proven stratigraphic displacement of 120 km, most likely 160 km and quite probably 240 km or more. These results are discussed.

The great overthrusts in the Caledonian zone of Norway and Sweden have been one of the major themes of discussion concerning Caledonian orogenic development since the days when TÖRNEBOHM (1896) first outlined the great overthrust structures along the Caledonian margin in Sweden and Norway. The last survey of Caledonian geology was published by STRAND (1960), and in a short article (STRAND 1961) he presented a summary of the Caledonian nappes in Norway and Sweden. But even in Strand's very instructive article, some important features in the Tysfjord area of northern Norway were not mentioned. The present article emphasizes some already published views concerning this area, views which have not entered into the recent Caledonian discussion in Norway.

In 1941 and 1942, FOSLIE published his geologic map sheets of Tysfjord, Hellemobotn, and Linnajavrre accompanied by comprehensive descriptions (see Fig. 1). These contributions represent a major break-through in the knowledge of Caledonian geology in northern Norway both in respect of distinguishable map units and general stratigraphy and structure. Foslie's main conclusion was that there is no major overthrust in the area of the three map sheets. A geosynclinal series of supposed Cambro-Silurian age, with total thickness

approaching 7,000 m, overlies a crystalline basement that seems to be Precambrian, but which Foslie thinks is a Caledonian intrusive granite. In his detail study in the area, Foslie found that the granite, the so-called Tysfjord granite, is overlain by a sheet of fine-grained granitic gneisses upon which rest the geosynclinal sediments and igneous rocks. On the contact between the Tysfjord granite and the gneiss complex, Foslie found traces of a mica schist formation and at times an underlying quartzite. He remarks in his description that during the mapping it seemed natural to consider this stratigraphy as primary, with the Tysfjord granite an old Precambrian basement, overlain by a basal quartzite and a mica schist of Eocambrian and Cambrian age, respectively. The overlying gneisses could then be Caledonian intrusives sheared into the lower part of the sediments.

In the summers of 1945 to 1947, Kautsky mapped an adjacent area in Sweden; he found that the quartzite and mica schist resting on the Tysfjord granite are basal sediments which farther north have been called the Hyolithes zone. In Kautsky's map area, the Hyolithes zone is overridden by the great overthrust nappe, which was named the Seve nappe by TÖRNEBOHM (1896). In a remarkable article, KAUTSKY (1946, with addition 1947) describes how the thrust plane of the Seve nappe can be followed through Foslie's map sheets and even farther west on the Salta map sheet published by REKSTAD (1929). He concludes that the Seve nappe continues to the Norwegian coast and may even continue to the west side of the large igneous province of the Lofoten area, indicating an overthrust length of at least 250–300 km, possibly 600 km, or as much as 1,000 km. These radical views of Kautsky were not followed by most Caledonian geologists in Norway and Sweden. Still, it is a bit surprising that, even though O. HOLTEDAHL (1953, p. 449) summarized parts of Kautsky's results, discussion was not taken up again after Kautsky's (1953) comprehensive description of his map area.

In my opinion, everybody has to accept that in the Swedish area of Kautsky there is a well established stratigraphy with Hyolithes zone sediments resting on Precambrian basement. The Hyolithes zone is overlain by the Seve thrust nappe, the base of which is made up of Precambrian rocks. In Kautsky's area, there is even a difference in the degree of metamorphism between the Hyolithes mica schist and the mica schist of the overlying Seve nappe. Further, it is inescap-

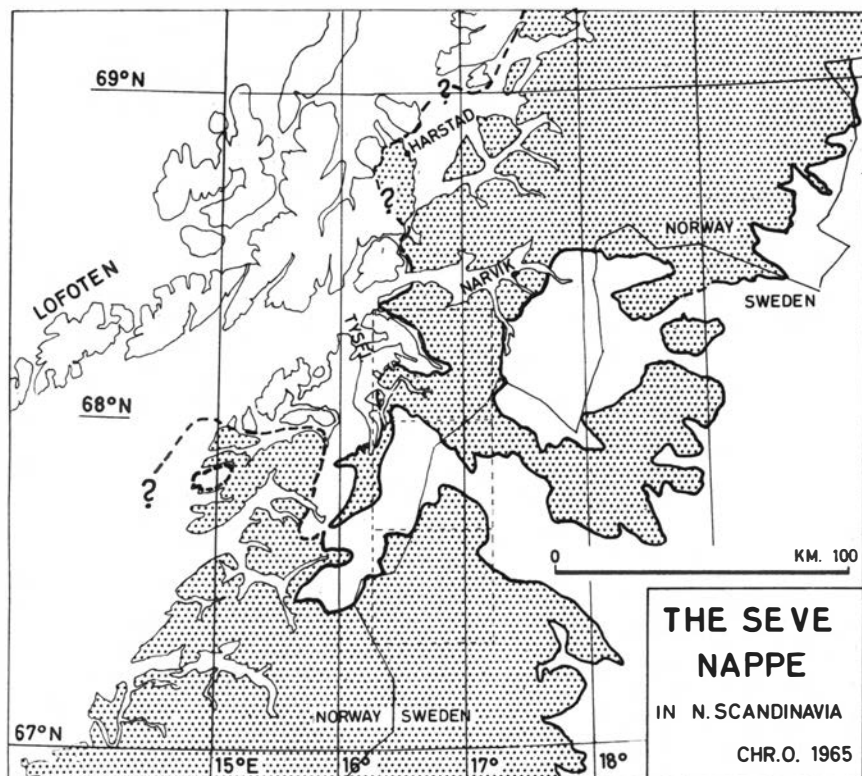


Fig. 1. The Seve nappe (grey) and the underlying Precambrian with foreland series of sedimentary rocks (white). Within the Caledonian zone, the Rombak window is located southeast of Narvik, and farther south the Tysfjord culmination cuts through the whole zone. Heavy line shows stratigraphically proven thrust fault, broken line where inferred. The areas of the Foslie maps Tysfjord, Hellembotn, and Linnajavre are shown with thin broken line.

able that the Seve nappe boundary can be followed from Sweden into Norway, and it can be traced with great accuracy throughout the three maps of Foslie. The presence of the Seve nappe boundary in these map sheets cannot be said to be merely a hypothesis, but rather a stratigraphic fact as far as it can be determined at all in such sheared and folded areas. Since the claims of Kautsky from 20 years ago have not been incorporated, or discussed, in the latest contributions to

Caledonian geology in Norway, I think it is necessary to publish Kautsky's views again.

The observations which make me so sure of the validity of Kautsky's claims rest on my field experience in another area which is surprisingly similar to the Tysfjord area. In the summers of 1952 to 1958, I worked in the Grong area, which had been mapped by Foslie; but, his maps were left as manuscript maps, in part without legend, when Foslie died in 1951. The southern half of the Grong area is dominated by a corridor of Precambrian rocks going from Sweden through the whole Caledonian belt in Norway and into the coastal basal gneisses. This corridor was termed the Grong culmination (OFTE DAHL 1956). In parts of this culmination, TÖRNEBOHM (1896) had already discovered a major thrust plane (from the Swedish boundary to Gresåmoen). Foslie's maps give the stratigraphic proof that such a nappe exists. On the centrally located area of Precambrian rocks rests a sedimentary series consisting of Eocambrian quartzite, Cambrian and lower Ordovician phyllite, and a limestone which is compared with the *Orthoceras* limestone. These sediments are overlain by a thick plate of Precambrian rocks, which carries the geosynclinal Cambro-Silurian sediments on its back. There is no doubt that the latter two units represent the great Seve nappe. From Foslie's map, I was able to trace the nappe boundary on both sides of the central area of Precambrian rocks. Westwards, the Precambrian rocks of the Grong culmination gradually become so deformed by the Caledonian recrystallization that they attain a completely new gneissic habit, and the rocks grade westwards into the larger area of 'caledonized basement'.

Luckily the situation is different in the *Tysfjord culmination*, as it should be called by analogy with the Grong culmination. The Precambrian basement consists of a granite which covers large areas and which did not recrystallize to anything different during the Caledonian deformation that followed the major overthrusting. Therefore, it is now possible to follow the Seve boundary to the Norwegian coast in the west, and across the Ofotenfjord to the north (according to a manuscript map left by the late Steinar Foslie).

STRAND (1961) showed the Seve nappe continuing north to Narvik on his tectonic sketch map, and farther north he called the continuation 'the upper nappe in northern Scandinavia'. However, if we follow the indications on the 1958 geological map of Sweden, the upper

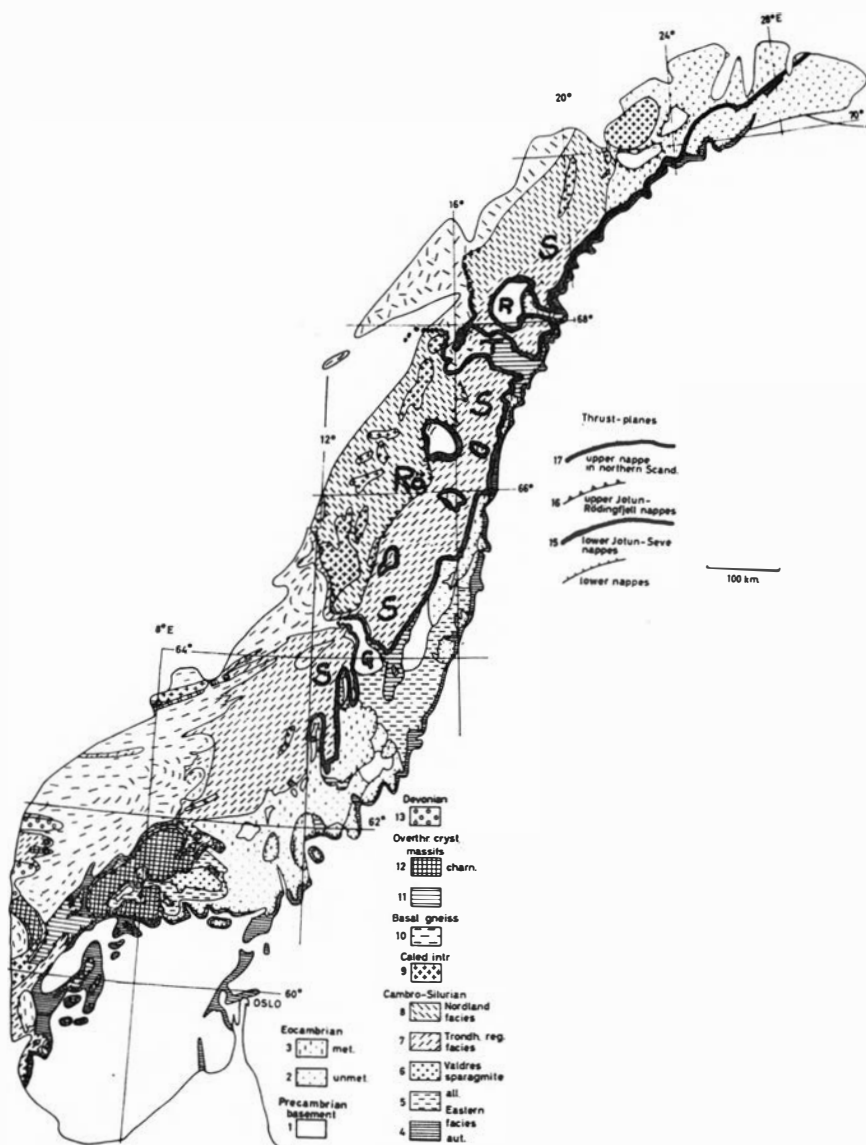


Fig. 2. Tectonic sketch map of Scandinavian Caledonides by STRAND (1961, pp. 164–165). The boundary of Seve nappe (legends 15 and 17) is accentuated and slightly modified (see Fig. 2). S = Seve nappe, Rø = Rødingfjell nappe, G = Grong culmination, T = Tysfjord culmination, R = Rombak window.

nappe in the north is just the continuation of the Seve nappe farther south. This means that the Seve nappe attains tremendous dimensions and may be considered as one of the large thrust units of the Earth. Its length along the tectonic axis is about 1,100 km, and it seems that the proven stratigraphic displacement in the Tysfjord culmination is 120 km, with a displacement of 160 km likely, and of 240 km, or more, possible. A series of windows found between the Grong culmination and the Tysfjord culmination, as well as farther north, shows that all along the 1,100 km axis there are underlying Precambrian rocks upon which foreland sediments were deposited. Thus, the surprising fact arises that the whole of northern Norway, which at present is thought of as the central zone of the northern Caledonides in Scandinavia, really is made up by a huge nappe underlain by the foreland. The root zone with eugeosynclinal development must have been lying just west of the present Norwegian coast line. Not considered in this connection is the fact that the basal Precambrian also forms local nappes along the eastern Caledonian margin.

A few major problems for future discussion may be mentioned. One important advance as shown by the tectonic sketch map of STRAND (1961) is the eastern thrust outline of the upper nappe in Nordland, the Rødingfjell nappe. Characteristically, this nappe contains abundant limestones (Nordland facies), while the underlying Seve nappe lacks limestone and contains greenstones, etc., more typical of the Trondheim facies. The continuation of the Rødingfjell nappe northwards across the Tysfjord culmination is an open problem, as is the facies distribution between the Trondheim and Nordland facies. South of the Grong culmination, PEACEY (1964) found a thrust nappe of geosynclinal sedimentary rocks overlying the Seve nappe. As yet it remains to be seen if this upper nappe can be compared with the Rødingfjell nappe farther north, and if this new upper nappe can be traced into the central parts of the Trondheim district.

Another big problem is whether the Seve thrust plane, which stops abruptly to the south (Fig. 2), continues under the Cambro-Silurian of the Trondheim district, and whether it is connected with the lower Jotun nappe of central Norway. If so, the Seve nappe length increases to 1,300 km.

With the areas of the Grong and Tysfjord culminations, no evidence points directly to possible age determination for the main thrusting,

and the later intense folding of the nappe. Since the sedimentary rocks just north of the Tysfjord sheet possibly go up into the Silurian (FOSLIE 1949; KULLING 1960, p. 75), both tectonic features may belong to the main Caledonian phase of folding and metamorphism in the end of the Silurian, but many other solutions are possible.

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