

The Brakfjellet tectonic lens: evidence of pinch-and-swell in the Caledonides of Nordland, north central Norway

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The Brakfjellet Lens occurs within the Köli nappes in Nordland at approximate lat. 65°50'N. It is interpreted as a mega-boudin, indicating that a pinch-and-swell mechanism was operating during the evolution of the Caledonian fold belt in a period immediately following the climactic Silurian collision phase and formation of the imbricated nappe pile. The occurrence of the Brakfjellet Lens also has a bearing upon the subdivision of the upper part of the Köli Nappe Complex into subordinate tectonic units.

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Fieldwork in the Brakfjellet area, east of Rössvatnet, (approximate Lat. 65°50'N) has led to the recognition of a megascopic tectonic lens within the Köli nappes. This is of interest since during the last few years it has become evident that such lenses represent a rather widespread element at various structural levels within the Caledonian allochthon of Scandinavia (Häggbom 1976, 1980, Gee 1977, Kautsky 1978, Zwaan & Roberts 1978). It is commonly agreed that the fold belt results from plate collision in the Lower Palaeozoic, (e.g. Dewey 1969, Roberts & Gale 1978), culminating in a major compressional episode in Silurian time, with nappe emplacement, imbrication, and involution. In a subsequent phase, gravity collapse and eastward extension were involved in the nappe displacement, as evidenced by the large-scale pinch-and-swell deformation of the nappes as well as by internal extensional features such as boudinage, rodding, etc. (Ramberg 1966, 1980, Gee 1977, 1978).

In the present note a brief description is given of the so-called *Brakfjellet Lens* and its tectonic setting. The occurrence of this lensoid body presents us with additional evidence for the evolutionary scheme mentioned above and demonstrates the important observation that the upper levels of the succession of Köli nappes seemingly offered the most favourable conditions for the mechanism of pinch-and-swell deformation during the main Silurian phase of the orogenesis.

Regional setting

The Brakfjellet Lens occurs within the Köli nappes below the Rödingsfjället thrust and above the level of the Krutfjellet Nappe (Fig. 1). The latter, defined and described by Häggbom (1980), appears as a winding string of megalenses connected by narrow zones of phyllonitic rocks. In Sweden, it includes the Norra Storfjället and Södra Storfjället Lenses. In Norway it is represented by the Krutfjellet Lens, recently studied by Mörk (1979).

The Seve-Köli and Rödingsfjället Nappe Complexes all belong to the so-called Upper Allochthon (Gee & Zachrisson 1979) of Swedish Caledonide terminology. The tectonostratigraphic succession thus consists of alternating high- and low-grade metamorphic nappes. Within the central, low-grade, and incompetent complex (Köli), we find remnants of a higher grade nappe, as well as the high-grade Brakfjellet Lens. The complete tectonostratigraphy is summarized in Table 1.

As more detailed knowledge has been gradually acquired of especially the upper parts of the Köli succession, there now exist conflicting opinions regarding the terminology as well as where to place the boundaries between some of the tectonostratigraphic units. A summary of the preferred terminology is presented in Table 1.

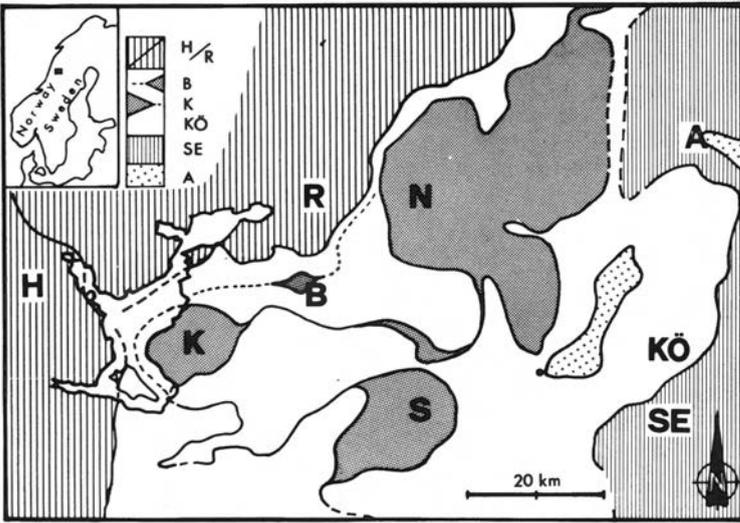


Fig. 1. Principal tectono-stratigraphic units of parts of the north central Scandinavian Caledonides (modified from Häggbom 1980 and L. A. Barkey, pers. comm. 1980). H - Helgeland Nappe, R - Rödingsfjället Nappe, KÖ - Köli Nappes, SE - Seve Nappes, A - Basal Allochthon, B - Brakfjellet, N - Norra Storfjället, K - Krutfjellet and S - Södra Storfjället tectonic lenses, respectively.

The Brakfjellet Lens

From aerial photographs (Fig. 2), it is clear that the generally more competent rocks of the Brakfjellet Lens depict a distinctly positive relief relative to the surrounding Köli phyllites and greenschists. The Brakfjellet Lens (Fig. 3), which has the typical form of a mega-boudin (in contrast to tectonic slices), also displays an internal S-shaped configuration of the lithologic units, indicating some rotation. The lens as a

whole dips to the north and is generally concordant with the foliation in the isoclinally folded lower-grade Köli rocks. It consists mainly of fairly high-grade (but strongly retrograded) mica schist with quartz, biotite, white mica, garnet (plagioclase), and epidote minerals. Other rocks include orthoquartzite with cross-cutting mafic dykes, and augen gneiss; more or less strongly tectonized rocks occur towards its base. The augen gneiss also occurs near the base of the lens and represents blastomylonites similar to those

Table 1: Tectonostratigraphic scheme of the Brakfjellet area, Nordland, based on Kulling 1964, Zachrisson 1969, Häggbom 1980, Stephens 1980, and the present study. BL-Brakfjellet lens.

Rödingsfjället Nappe			
Seve-Köli Nappe Complex	Köli Nappes	upper	Storfjället Nappe
			Akfjellet Nappe
			Jofjället Nappe
			lower
		middle	Laxfjället, Atofjället and several Middle Köli nappes
		lower	Björkvattnet Nappe Joesjö Nappe
			Seve Nappes

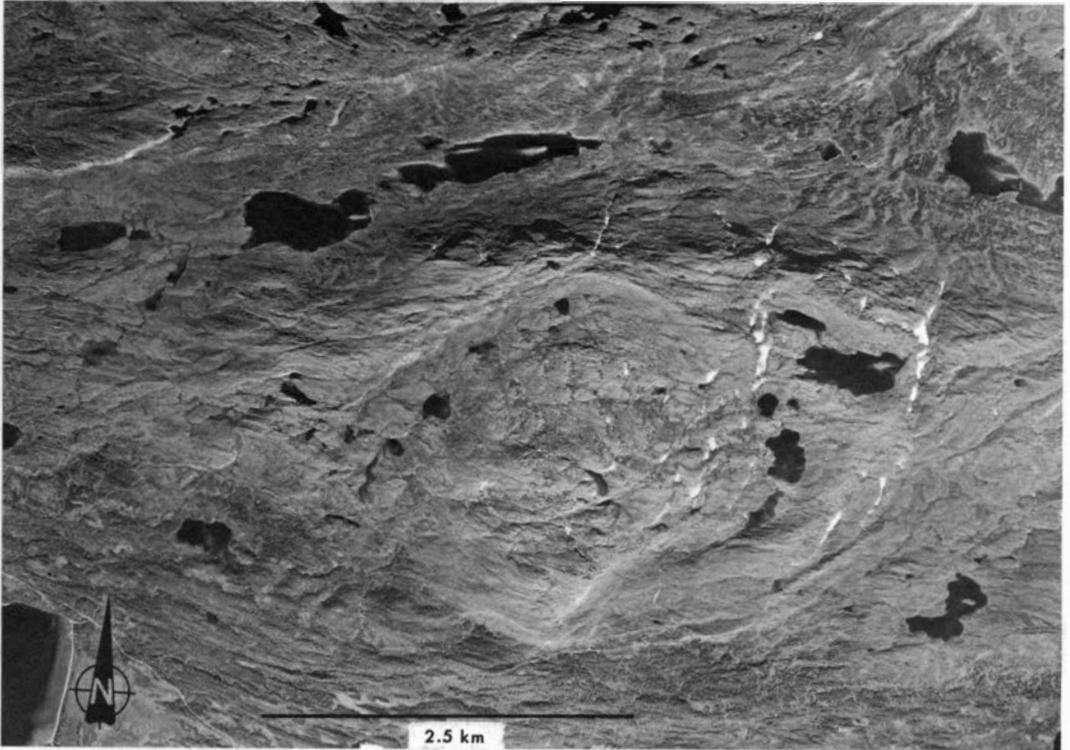


Fig. 2. Aerial photography of the Brakfjellet area. (Fjellanger-Widerö photo no. D31/5575).

present immediately above the Rödingsfjället Nappe thrust. Pseudomorphous aggregates of white mica after kyanite are also present. The mica schists in which they occur resemble the garnet- and kyanite-bearing schists and gneisses of the overlying Rödingsfjället Nappe. It is not certain whether the greenstone and meta-gabbroic rocks near the eastern flank of the lens (Fig. 3) represent a part of the Brakfjellet Lens or perhaps a tectonic lens on their own. They may also, and most likely, be part of the surrounding rock sequence, since coarse, meta-gabbroic rocks are common within the overlying Akfjellet succession (see below).

The lens itself, having a maximum thickness of about 1 km, is enveloped by phyllonitic rocks which in places are hard to distinguish from the Köli rocks. To the west the zone of phyllonites has been followed for several kilometres, and at one locality (ca. 3 km from the western termination of the Brakfjellet Lens) a lensoid body (less than 50 m thick) of coarser grained, garnet-bearing mica gneiss has been found within the phyllonites. The zone, which was termed a 'zone of

tectonic mixing' in an early field map from 1966 by N. Marklund, is difficult to trace in the thick vegetation on the hillside further westward to Rössvatnet. To the east of the Brakfjellet Lens there is a conspicuous zone of brecciation in meta-gabbroic rocks, and the phyllonitic zone continues into Sweden, towards the lake Skinnfällträsket.

Structurally the Brakfjellet Lens is situated north of the post-schistosity Joesjö Dome and within the Jofjället Synform (Zachrisson 1969, Häggbom 1980). From Fig. 3 it can be seen that the Köli rocks below the Rödingsfjället thrust are cut by several minor thrust zones, features that bear witness to the presence of a wide zone of imbrication below the Rödingsfjället Nappe. Furthermore, the Brakfjellet zone is seen to split the Jofjället Nappe (cf. Häggbom 1980). Hence it is suggested here that the latter term be retained for the unit below the Brakfjellet zone, and a new term, the *Akfjellet Nappe*, introduced for the uppermost tectonic unit within the Köli Nappe Complex (see Table 1).

The Akfjellet Nappe, which is clearly dis-

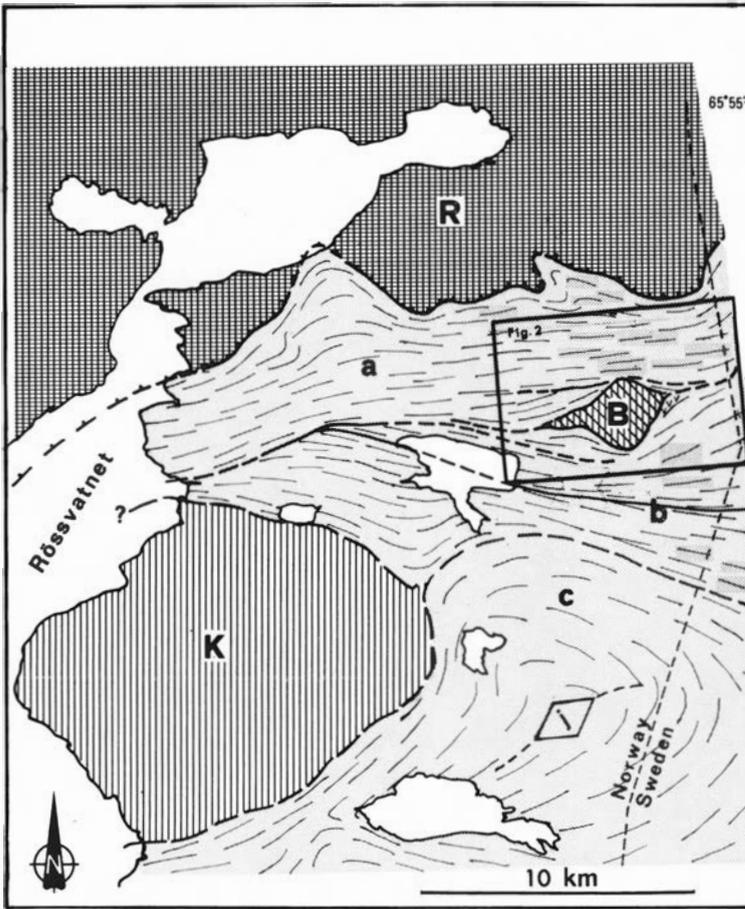


Fig. 3. Sketch map of the Brakfjellet and surrounding areas. Box shows outline of Fig. 2. B – Brakfjellet Lens, K – Krutfjellet Lens, R – Rödingsfjället Nappe, a – Akfjellet Nappe, b – Jofjället Nappe, c – Middle Köli Nappe, j – Joesjö Dome. The high-metamorphic rocks (B, K and R) are shown as ruled or crosshatched areas, the low-metamorphic Köli rocks (a, b and c) as lightly shaded areas with foliation lines.

cordant in relation to underlying tectonic units, is composed of a rock sequence markedly different from that below the Brakfjellet tectonic level. In addition to phyllitic rocks, thick marble units felsic and mafic metavolcanites (and meta-intrusives) as well as ultramafic bodies form a characteristic tectonostratigraphic sequence (the *Akfjellet succession*, as defined here). Between the Krutfjellet and Brakfjellet tectonic levels (the Jofjället Nappe, b in Fig. 3), and also below the Krutfjellet level (part of the Middle Köli Nappe, c in Fig. 3), the rock sequences comprise calcareous phyllites, grey phyllites, quartz and graphitic phyllites, tuffitic greenschists, a few marble horizons, and ultramafic bodies. Thus the Brakfjellet level, at the base of the Akfjellet Nappe, seems to constitute not only a tectonic, but also a lithological break in the uppermost part of the Köli tectonostratigraphic succession.

Concluding remarks

The Brakfjellet Lens may represent either a wedge torn away from the base of the Rödingsfjället Nappe, a remnant of a separate high-grade nappe, or an extension of the Krutfjellet Nappe.

Whether or not the Brakfjellet Lens actually represents the same tectonic level as the Krutfjellet Lens, has not been settled, but the fact that there are different lithologies enveloping the lenses in question is an argument against this alternative. Features such as the laterally continuous phyllonitic zones and the general geometric analogy with the Krutfjellet Nappe suggest tentatively that the lens was derived from a more continuous, high-grade unit (slice) within the imbricated nappe succession, either a part of the Krutfjellet Nappe or, more likely, an independent nappe unit, which was attenuated in

a subsequent deformation phase. In general, the occurrence of the many mega-lenses at these levels within the Köli allochthon may be taken as evidence of extreme pinch-and-swell deformation after the emplacement of the imbricated nappe pile. The presence of minor, high-grade, competent slices within relatively incompetent Köli rocks, themselves interlayered between the high-grade Seve and Rödingsfjället Nappes, may have created optimal conditions for the attenuation and development of such lensoid structures.

The marble-rich Akfjellet succession has been tentatively correlated (L. A. Barkey, pers. comm. 1980) with the Hattfjelldalen Nappe south of Rössvatnet (Strand 1955). Towards the east, in Sweden, it appears to be discordant in relation to the underlying Jofjället Nappe. Further to the north, through Sweden and into Norway again, marble-rich zones are present concordantly below the Rödingsfjället Nappe thrust, e.g. the Tespfjellet Group in Rana (Gjelle 1978). These lithologies may represent the continuation of the Akfjellet Nappe located above the level of the Brakfjellet Lens.

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