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Extended Abstract

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Structural and geochronological evolution of the northeastern part of the Sveconorwegian orogen, south-central Sweden

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An important tectonic model for the Sveconorwegian orogen north and northeast of Lake Vänern, south-central Sweden, was presented by Berthelsen (1980). Both the Mylonite Zone and the frontal area of the Sveconorwegian orogen were interpreted to be related to large-scale compressional tectonics. Earlier thrusting to the west was inferred to be followed by later thrust movement to the east.

New structural and geochronological data from the northeastern part of the Sveconorwegian orogen have recently been presented (e. g. Wahlgren et al. 1994, 1996a, 1996b, Page et al. 1996, Stephens et al. 1996, Söderlund et al. 1999) and the following text presents an overview of the results in these studies. These data confirm the broad structural geometry and tectonic régime envisaged by Berthelsen (1980), but the new kinematic data demand some revision of the model presented earlier. Ongoing work is attempting to understand the deeper geometry of a part of this area using high resolution reflection seismic profiling (Juhlin et al. 1998).

North and east of Lake Vänern, the Eastern Segment of the Sveconorwegian orogen, i.e. the area between the Mylonite Zone (MZ) in the west and the Sveconorwegian Frontal Deformation Zone (SFDZ; Wahlgren et al. 1994) in the east, is dominated by intrusive rocks belonging to the c. 1.85–1.65 Ga Transscandinavian Igneous Belt (TIB). The SFDZ corresponds more or less to the Sveconorwegian front of Berthelsen (1980). All age-generations of TIB intrusions have been recorded in the area. The older c. 1.85–1.78 Ga intrusions dominate in the eastern, frontal part of the orogen, while U-Pb zircon and titanite ages demonstrate that the younger c. 1.70–1.65 Ga intrusions dominate farther west. In the easternmost part of the orogen (westernmost Bergslagen), Svecofennian c.

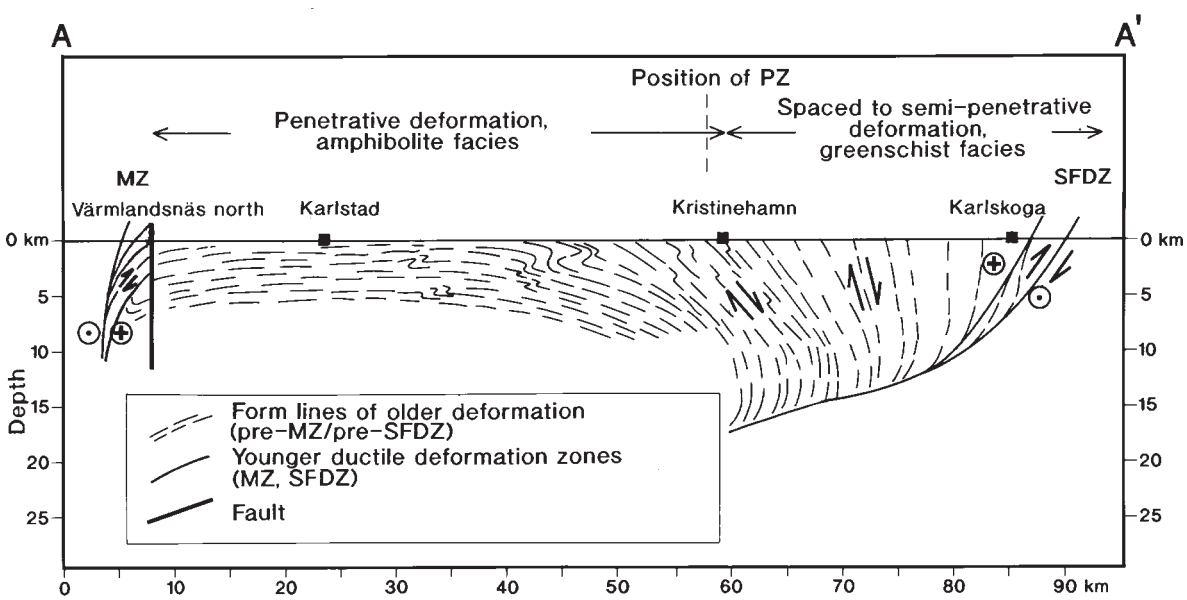

Fig. 1. Structural cross-section across the Eastern Segment of the Sveconorwegian orogen north of Lake Vänern, from the SFDZ in the Karlskoga area in the east to the MZ in the northern part of the Värmlandsnäs peninsula in the west. The cross-section is based on data in Wahlgren et al. (1994) and Stephens et al. (1996).

1.89 Ga supracrustal rocks, c. 1.89–1.85 Ga calc-alkaline intrusions and a suite of c. 1.81–1.75 Ga granites and pegmatites occur. The supracrustal and c. 1.89–1.85 Ga intrusive rocks, including the oldest TIB rocks, display older, pre-Sveconorwegian (Svecokarelian) deformation and metamorphism. In the northeasternmost part of the orogen, volcanic rocks belonging to the TIB ("Dala porphyries") and Mesoproterozoic sandstone ("Dala sandstone") are present. A significant lithological component in the TIB-dominated area north of Lake Vänern is c. 1.57 Ga dolerite dykes. The youngest rocks which are affected by ductile deformation are c. 1.00–0.90 Ga dolerite dykes, which mainly occur in the easternmost, frontal part of the orogen, east and northeast of Lake Vänern.

During the c. 1.1–0.9 Ga Sveconorwegian orogeny, all the above mentioned rocks were more or less strongly deformed and metamorphosed. In the eastern part of the orogen, the Sveconorwegian structural overprinting is spaced to semi-penetrative, whereas the deformation is more or less penetrative between Kristinehamn, at the northeastern shore of Lake Vänern, and the MZ. The transition from penetrative to semi-penetrative deformation coincides more or less with the location of the traditional "Protogine Zone", which is a brittle fault zone in this area. Besides new fabric development, the Sveconorwegian deformation is also responsible for reorientation of older Svecokarelian structures in the easternmost part of the orogen into the Sveconorwegian, approximately N-S structural trend. The syn-deformational metamorphic grade increases from low-grade in the east to medium- to high-grade in the western, penetratively deformed area, which is in accordance with the east to west increase in bulk strain.

In the area immediately north of Lake Vänern, between the MZ in the west and the SFDZ in the east, the shear foliation constitutes a strongly asymmetric fan-like structure (Fig. 1) in an east-west cross-section. In the penetratively deformed area between the MZ and Kristinehamn, the shear foliation is subhorizontal. In the Kristinehamn area, the shear foliation dips gently to moderately to the east, is vertical farther to the east and dips steeply to the west in the eastern frontal part of the orogen. Dip-slip movements predominate and a kinematic analysis based on several reliable kinematic indicators has revealed a constant top-to-the-east sense of displacement across the entire fan-like structure. Thus, the broad-scale structural geometry in the frontal part of the orogen is similar to that presented by Berthelsen (1980). However, the established top-to-the-east sense of displacement across the entire frontal part of the orogen, does not support thrusting to the west along the east-dipping shear zones in the western part of the area as suggested by Berthelsen (1980).

Two phases of Sveconorwegian deformation have been identified in the area. Apart from the predominant, more or less regionally developed, older shear foliation and ductile deformation zones which strike c. N-S, a set of younger well-defined deformation zones occurs in the easternmost part of the orogen. These zones define the SFDZ and the most prominent zones strike NNE-NE, dip westwards or are subvertical, and display dextral and reverse sense of shear.

The older fabric which is oriented in the fan-like configuration is interpreted to be the result of an east-verging thrust system which subsequently was rotated into the SFDZ. The thrust system is inferred to be the initial result of oblique collision and crustal shortening in a WNW-ESE direction. Shortening at this stage was absorbed by crustal thickening. Subsequently, the deformation was constrained to discrete zones at shallower crustal levels. The MZ overprints and defines the western flank of the east-verging thrust system, and is the result of sinistral transpression in connection with escape-like tectonics. Top-to-the-east, possibly out-of-sequence thrusting along the SFDZ marks the final expression of the oblique collision.

The fan-like configuration of the shear foliation east of Lake Vänern is confirmed in a 17 km long reflection seismic profile from the eastern shore of Lake Vänern south of Kristinehamn and eastwards (Juhlin et al. 1998). Apart from slight discrepancies, there is good general agreement between the fan-like configuration as interpreted from surface structural information and the seismic image. The interpretation of the seismic data also supports a two-stage structural development, where the west-dipping SFDZ overprints the east-dipping thrust system.

$^{40}Ar/^{39}Ar$ age determinations of hornblende in the penetratively deformed area north of Lake Vänern have yielded ages in the range 1009–965 Ma, which is inferred to be the minimum age for the crustal thickening event during which the regional foliation was developed (Page et al. 1996). U-Pb ages of c. 976 and 956 Ma for metamorphic titanites in metagranites from the same area (Söderlund et al. 1999) confirm the Sveconorwegian age of the regional foliation. The preservation of igneous titanites, which display U-Pb ages similar to U-Pb zircon ages of c. 1661 and 1674 Ma for the metagranites, indicate that no major tectonothermal event has affected the Eastern Segment north of Lake Vänern from the time of TIB emplacement until the late Sveconorwegian orogenic overprinting. $^{40}Ar/^{39}Ar$ white mica ages in the time range 930-904 Ma are interpreted to date the final compressional displacements along the SFDZ (Page et al. 1996).

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