Geology of the West Troms Basement Complex, northern Norway, with emphasis on the Senja Shear Belt: a preliminary account

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The West Troms Basement Complex (WTBC), North Norway, includes the islands west of Tromsø from Senja in the south to Vanna in the north (Fig. 1). The complex forms part of the western margin of the Fennoscandian Shield and is separated from the Caledonian nappes in the southeast by a combination of a basal, Caledonian, low-angle thrust fault and a system of post-Caledonian faults. The general NNW-SSE structural grain of the WTBC continues beneath the Caledonian fold belt, and parallels the Svecokarelian trend in northern Sweden and Finland (NGU 1993 a and b, Olesen et al. 1993). Because the length of the outcrop of about 200 km crosses the strike of the major tectonic features, a variety of rock-types and structures are exposed.

The results of this study place constraints on Precambrian crustal evolution of the WTBC with focus on: (1) definition of the previously poorly known petrological provinces, and (2) identification of a major province-bounding shear belt.

Tonalitic to anorthositic and gabbroic gneisses and banded migmatites of possible Archaean age are the main rock-types of the WTBC northeast of Senja. Two complexes are recognised there (Fig. 1): (1) a weakly banded to nebulitic rock complex in the northeast with a felsic to intermediate composition; (2) a strongly deformed complex of intermediate to mafic banded gneisses to the southwest of complex (1). Both rock complexes have undergone amphibolite-facies metamorphism.

The boundary between the two complexes coincides with a major magnetic discontinuity (Henkel 1991) wich is well defined on the Tromsø aeromagnetic map (NGU 1993 b). The northeastern tonalitic gneiss area is characterised by very deep-seated low and intermediate magnetic sources. The area of banded gneis to the south shows high-magnetic irregular patterns depicting shallow magnetic sources.

An assumed Earliest Proterozoic *supracrustal* sequence of intermediate to mafic metavolcanites and terrigenous metasediments variably metamorphosed to middle greenschist and lower amphibolite facies, tectonically overlies the tonalitic gneisses on Ringvassøya (Fig. 1). On Kvaløya, these supracrustal rocks occur as intervening, narrow, steep, NNW-SSE striking belts within the gneisses. The northern half of Senja is underlain by a 30 km-wide shear belt called the Senja Shear Belt (SSB) (Fig. 1) (Tveten & Zwaan 1993). The SSB consists of paragneisses, commonly associated with ultramafic rocks. The gneisses are interpreted as intermediate to mafic metavolcanites, and terrigenous, mainly quartzitic, sedimentary rocks. The rocks were initially metamorphosed under amphibolite-facies conditions, but in places reached granulite facies accompanied by extensive partial melting.

The SSB separates the tonalite province to the northeast from an area to the southwest dominated by *granitic rocks* with minor quartz diorite and gabbro bodies. The rather uniform 40 km-long and 20 km-wide Ersfjord granite body on Kvaløy (Landmark 1973) is part of this magmatic province, and intruded discordantly the surrounding tonalitic gneisses. The Ersfjord granite has a Rb-Sr whole-rock isochron age of 1706 $\pm$ 15 Ma (Andresen 1980), which is about the same age as the minimum Rb-Sr whole-rock isochron age of 1746 $\pm$ 93 Ma for quartz dioritic and 1768 +/-49 Ma for granitic rocks of southern Senja (Krill & Fareth 1984).

Dolerite dykes, mainly 10-20 m thick and several km long, and in places occurring as dyke swarms, play an important role in establishing age relationships for the tectono-magmatic history of the WTBC (Landmark 1973). They crosscut the weakly developed banding in the tonalitic to anorthositic gneiss complex in the northeast but are deformed to amphibolite lenses within the several km-wide shear zone underlying the supracrustal sequence on Ringvassøya and Rebbenesøya. Some dykes, however, intruded both the shear zone rocks and the supracrustal sequence. This assumed Svecokarelian shearing is also responsible for the tectono-metamorphic banding in the more mafic tonalite complex to the southwest. The granitoids in the tonalitic province are younger than both the dolerites and

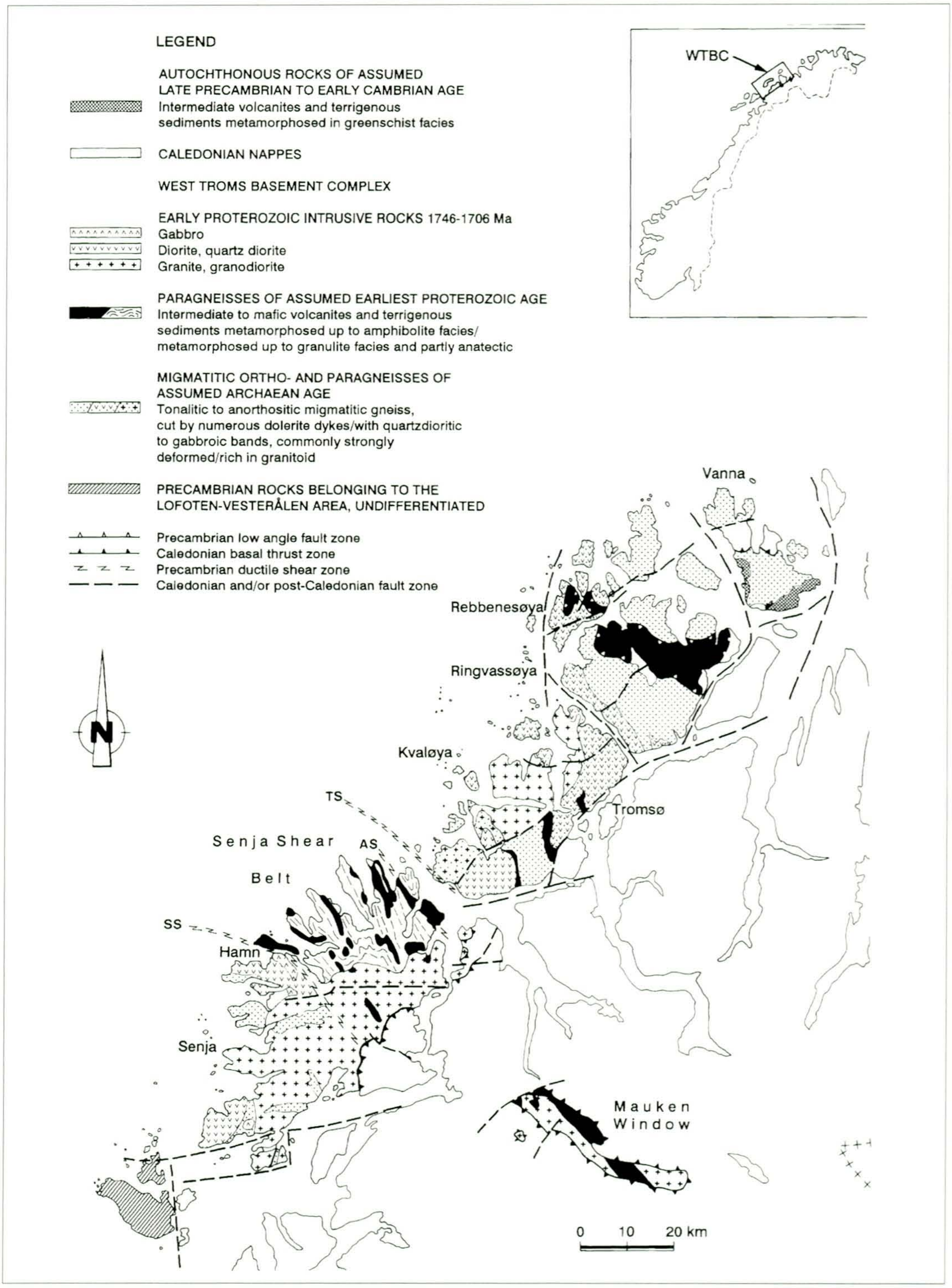

Fig. 1. Simplified map of the West Troms Basement Complex (WTBC). SS -- Svanfjell shear zone; AS -- Astridal shear zone; TS -- Torsnes shear zone.

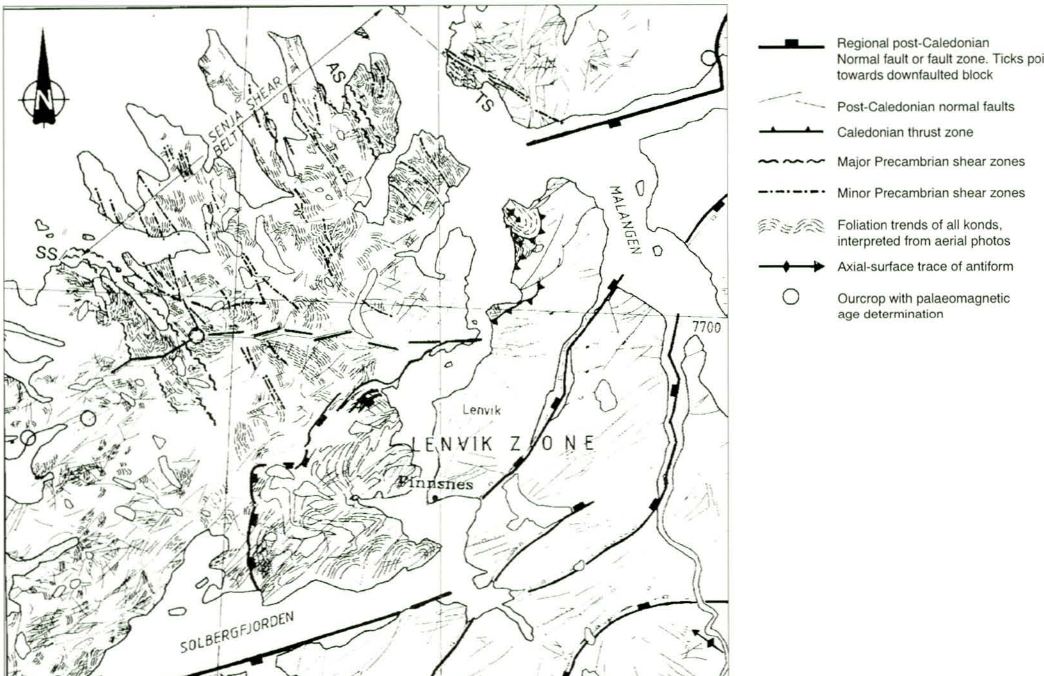

Fig.2: .
Structural element map, Senja area.
SS -- Svanfjell shear zone;
AS -- Astridal shear zone;
TS -- Torsnes shear zone.

the Svecokarelian shearing. Since the quartz diorite on southern Senja -- containing dolerite dyke swarms (Landmark 1973) -- is 1746 Ma old, the dolerites on Senja are unrelated to, and younger than those on Ringvassøya.

The Senja Shear Belt (SSB) is defined by air photo and satellite imagery interpretation and confirmed by subsequent mapping and geophysical measurements (Olesen et al. 1993). (Fig. 2). The SSB is bounded by two, *major, ductile shear zones* striking NNW-SSE. The SW border is defined by the steep to moderately dipping, 1.5 km-wide, Svanfjellet Shear Zone (SS) (Fig. 2) (Cumbest 1986, Tveten & Zwaan 1993). The NE border is defined by two steep shear zones, the ca. 1.5 km-wide Torsnes Shear Zone (TS) (Zwaan 1992) exposed along the southwest shore of Kvaløya, and the 800 m-wide Astridal Shear Zone (AS) farther to the southwest. The bending of axial-surfaces to megafolds in the lensoidal block between the TS and the SS depicts left-lateral strike-slip shearing (Fig. 2)(Tveten & Zwaan 1993, Zwaan & Bergh 1994).

Within the SSB, minor and major folds and *narrow shear zones*, together with the above-described boundary shear zones, form a coherent pattern suggesting some form of mutual relationship. Within the shear zones, the migmatitic country rocks and granitoid rocks are penetratively mylonitised and recrystallised under lower amphibolite-facies conditions. The late stages of the granitoid intrusions are represented by pegmatites and aplites, which are less deformed, indicating that the intrusions are contemporaneous with the shear zone development.

In a regional context the SSB appears to link up with Henkel's *Bothnian-Senja Fault Zone* (BSF) defined on geophysical grounds (Fig. 3) (Henkel 1987, 1991). In Henkel`s interpretation the BSF is genetically related to the Bothnian-Seiland Fault Zone -- renamed the Bothnian-Kvænangen Fault Complex by Olesen & Sandstad (1993) (BKF) -- further to the northeast (Fig. 3). This relationship is of interest. The 30 km-wide belt of paragneisses, which is the locus of the SSB, resembles the Kautokeino Greenstone Belt -- the locus of the BKF. Olesen & Sandstad (1993) interpret the greenstone belt as an Early Proterozoic rift infill. Furthermore, along strike the rocks of the SSB may conceivably be correlated with a sequence of earliest Proterozoic volcanic and sedimentary rift infill in Sweden descri-

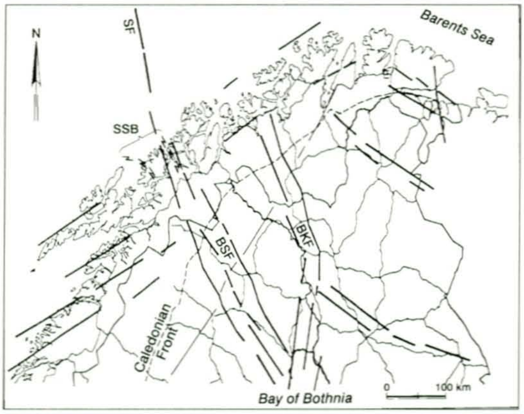

Fig. 3. Botnian-Senja (BSF) and Bothnian-Seiland/Kvænangen (BKF) Fault Zones and the Early Tertiary Senja Fracture Zone (SF) (slightly modified from Henkel 1991). SSB -- the Senja Shear Belt. Black lines -- generalised magnetic dislocations.

bed by Gorbatchev & Bogdanova (1993). These correlations suggest that the SSB started as a narrow rift, with subsidence to great depth witnessed by the presence of granulite-facies rocks. This period of subsidence was followed by uplift shown by the juxtaposition of deeper and shallower metamorphic levels of supracrustal sequences within the internal Astridal Shear Zone (Zwaan & Bergh 1994). Since the 1.7 Ga granitoids are coeval with or post-date the amphibolite-facies ductile shearing, compression and uplift possibly occurred in the Early Proterozoic.

The extensive, *Late Palaeozoic, semi-ductile fracturing* of the crust, dated palaeomagnetically by Olesen et al. (1993) (Fig. 2), was discordant both to the SSB and to the trend of the Caledonian thrusts (Forslund 1988, Olesen et al. 1993). Rejuvenation of the SSB, as a result of formation of the offshore Senja Fracture Zone (SF) (Fig. 3) , was related to the opening of the Atlantic in the Early Tertiary. This is documented geophysically as the offshore continuation of the Botnian-Senja Fault Zone (Henkel 1987, Olesen et al. 1993).

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