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Palaeoproterozoic (2.0–1.95 Ga) pre-orogenic supracrustal sequences in the West Troms Basement Complex, North Norway

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ABSTRACT

New U–Pb-data from two supracrustal belts enclosed in Archaean crust in the West Troms Basement Complex (WTBC) of North Norway document the presence of volcanic, subvolcanic and sedimentary rocks formed in the pre-orogenic period of extension and basin formation after 2.0 Ga. The Mjelde-Skorelvvatn belt of highly deformed supracrustal rocks is dominated by mafic metavolcanic rocks, including metagabbro dated by zircon at 1992 ± 2 Ma. These mafic rocks are temporal correlatives of a number of occurrences in Fennoscandia and Laurentia such as the Pilguyarvi unit in the Pechenga structure in the Kola peninsula and the Purtuniq unit in northern Labrador. The Torsnes belt contains siliciclastic and metavolcanic mafic rocks unconformably overlying Neoarchaean crust. The indicated maximum deposition age of the Torsnes belt is given by the age of 1970 ± 14 Ma for the youngest detrital zircon. The absence of 1.95 Ga and younger detrital zircons, which are abundant in Svecofennian siliciclastic sequences in Fennoscandia, suggests that the Torsnes belt is a distinct pre-orogenic deposit, and we interpret it as a marginal continental or intracontinental siliciclastic-volcanic basin. The new data from the WTBC can be placed in the context of continental divergence and sea-floor formation in the period between 2.0 Ga and the commencement of orogeny in Fennoscandia and Laurentia at 1.92 Ga.

1. Introduction

The West Troms Basement Complex (WTBC) is an Archaean and Palaeoproterozoic basement outlier exposed west of the Scandian nappes, in an interior position within the Caledonian orogen (Fig. 1). Whereas comparable interior domains in southwestern Scandinavia have been deeply affected by deformation and metamorphism during the Caledonian collision between Baltica and Laurentia, those parts north of the Arctic Circle, and especially in the WTBC, show remarkably few mineralogical and structural effects that can immediately be linked to the Silurian-Devonian events. The weak Caledonian overprint has provoked some questions as to whether the WTBC, and its southward continuation in Vesterålen and Lofoten, really are just the extension of the Fennoscandian Shield underneath the Caledonian nappe stack, or whether they may instead represent Laurentian elements. The broad geophysical and structural features support a correlation of the WTBC with the Fennoscandian Shield (e.g., Olesen et al., 1997), and the geological and geochronological records also fits such a correlation (Zwaan et al., 1998; Corfu et al., 2003a; Corfu, 2004, 2007; Bergh et al., 2007, 2010). However, the latter are not uniquely diagnostic because such features are also present in potential analogues elsewhere in the North Atlantic and Arctic region (Fig. 1).

Baltica is commonly considered to have been connected to Laurentia by the end of the Archaean, based mainly on comparable Archaean and Palaeoproterozoic evolutions, especially the 2.5–2.4 Ga extensional intrusive complexes and mafic dyke swarms (e.g., Heaman and Tarney, 1989; Bleeker, 2003, 2004; Pesonen et al., 2003; Bleeker and Ernst, 2006; Ernst and Bleeker, 2010) but the geometry and nature of the correlation remain a matter of debate. Different late Palaeoproterozoic configurations have been discussed. The one shown in Fig. 1, proposed by Bridgwater et al. (1990) and modified by Connelly et al. (2000), links the domains of northern Baltica to those in Arctic Canada passing through the Nagssugtoqidian orogen in Greenland. The common element in all these regions is the presence of abundant Archaean crust reworked and locally rifted during the Palaeoproterozoic and eventually re-welded by convergent processes, collisions and magmatism in the period 1.95–1.75 Ga. Most critical for the verification of these correlations, however, are specific geological features such as the orientation, nature and age of mafic dyke swarms, sedimentary basins and contractional structures.

Many such features are present in the WTBC, which in virtue of its outboard position with respect to Baltica and the analogies to the Lewisian Complex in Scotland, play an important role in such reconstructions. The WTBC is geologically very diverse

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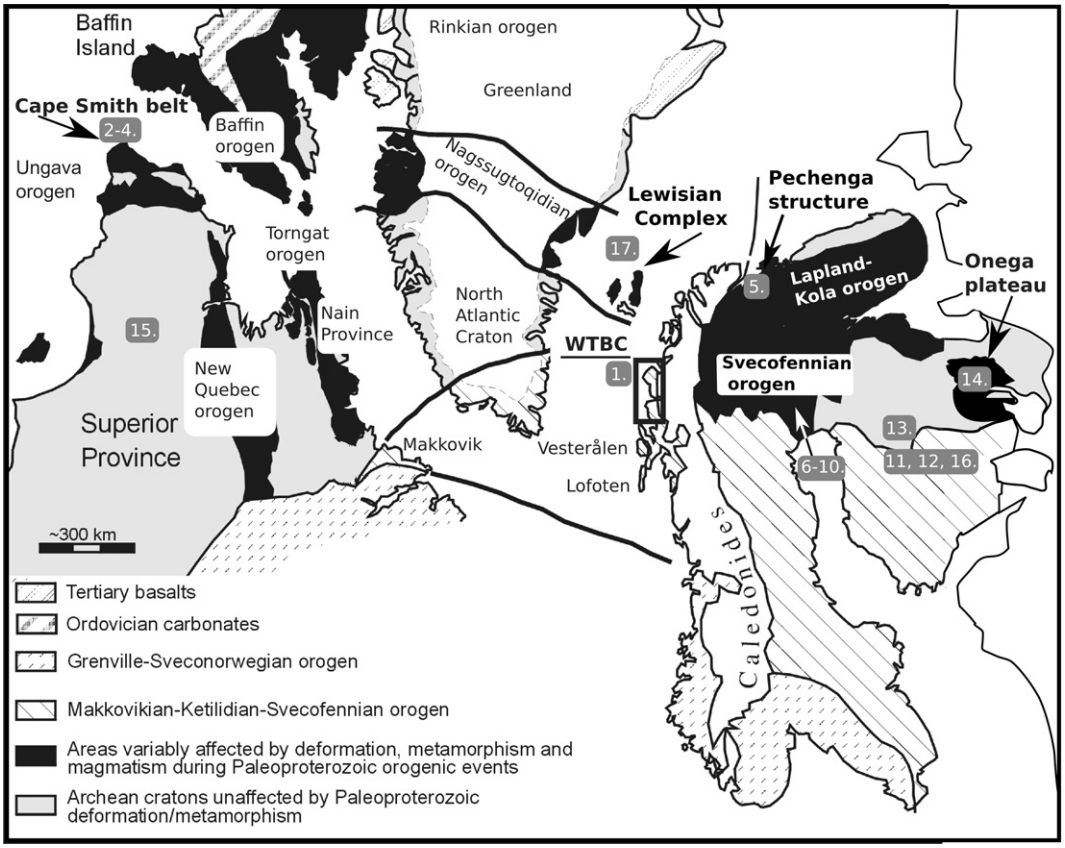

Fig. 1. Conceptual map illustrating the possible Palaeoproterozoic relationships between continental masses and terranes of the present day North Atlantic and Arctic region. Modified from Connelly et al. (2000) and Bridgwater et al. (1990). WTBC = West Troms Basement Complex, rectangle indicates location of Fig. 2. Names in bold typescript and accompanying numbered labels refer to data compilation in Fig. 7.

(Fig. 2). Its northern part consists of an Archaean greenstone-granite terrain, which is cut by a 2.40 Ga mafic dyke swarm, overlain by 2.40–2.22 Ga clastic sedimentary sequence with 2.22 Ga mafic sills, and only affected by Svecofennian greenschist facies metamorphism and local deformation. The southern part is also underlain by Archaean crust with local Palaeoproterozoic sedimentary rocks, but, in contrast to the northern part, it was strongly affected at 1.80–1.75 Ga by metamorphism, locally reaching granulite facies, and by the invasion of voluminous granitic and minor gabbroic complexes (Motuza et al., 2001; Kullerud et al., 2006; Bergh et al., 2007, 2010). The region is dissected into megalenses by northwest-trending belts of high strain composed mainly of supracrustal rocks (Armitage and Bergh, 2005; Bergh et al., 2007, 2010). The overall structural relationships reflect NE-SW orthogonal shortening, becoming increasingly transpressional, and indicating convergence of an orogenic front from the southwest into the less affected foreland to the northeast (Bergh et al., 2010). Subhorizontal NE-SW-directed contraction led to detachment of an upper plate consisting of amphibolite-facies gneisses and their sedimentary cover, from a lower plate consisting of higher grade metamorphic lithologies. This low-angle thrusting may either be a result of strain partitioning or represent a final Svecofennian tectonic stage, as discussed in detail in Bergh et al. (2010)

The timing of formation of the pre-orogenic basins into which the supracrustal rocks were deposited is only known for two of them, the Archaean Ringvassøya greenstone belt (2.85–2.83 Ga; Motuza et al., 2001) and the Palaeoproterozoic Vanna group (2.40–2.20 Ga; Bergh et al., 2007). The present study was aimed at resolving the depositional history and timing of two adjacent belts in Kvaløya, the Mjelde-Skorelvvatn belt and the Torsnes belt (Figs. 2 and 3) and in this paper we document U–Pb ages for metagabbro in the former and detrital zircons in a psammite of the latter. The ages constrain the time of formation of these belts, showing that they had distinct origins and settings, and permit us to compare and view their development within the larger scale North Atlantic/Arctic context.

2. Geological setting

The study was carried out in the central part of the WTBC (Fig. 3). The area comprises four major supracrustal belts: Steinskardtind, Mjelde-Skorelvvatn and Torsnes belts in Kvaløya, and the Astridal belt in Senja. The latter two belong to the 30 km wide Senja shear belt, which also includes the Svanfjellet belt in Senja. These belts have a WNW-ESE trend parallel to the regional Svecofennian structure. The supracrustal belts are bordered by different Neoarchaean gneiss complexes: from northeast to southwest the Kvalsund gneiss complex, the Gråtind migmatite, the Bakkejord pluton and the Kattfjord gneiss complex. These Neoarchaean gneiss complexes are intruded by the 1792 ± 5 Ma Ersfjord granite and related granitic dykes (Corfu et al., 2003a).

2.1. Steinskardtind belt

The Steinskardtind belt consists of paragneisses with mafic, silicic and calc-silicate lithologies and forms a steeply NE-dipping high-strain belt bordered by the Gråtind migmatite in the west and the Kvalsund gneiss in the east (Fig. 3). The Steinskardtind belt is thought to form the eastern limb of a large, regional antiform with the Gråtind migmatite in the core and the Mjelde-Skorelvvatn belt as the western limb (Armitage and Bergh, 2005).