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The Beiarn Nappe Complex: A record of Laurentian Early Silurian arc magmatism in the Uppermost Allochthon, Scandinavian Caledonides

Lars Eivind Augland *, Arild Andresen, Fernando Corfu, Siri L. Simonsen, Tom Andersen

Department of Geosciences, University of Oslo, P.O. Box 1047, Blindern, 0316 Oslo, Norway

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ABSTRACT

We report new data on a suite of compositionally variable igneous rocks intruding amphibolite grade schists and marbles of the Beiarn Nappe Complex of the Uppermost Allochthon, Scandinavian Caledonides, to better understand the pre-collisional position and evolution of this exotic continental terrane within the Scandinavian Caledonides. Major and trace element data on bulk samples combined with U–Pb ID–TIMS and Lu–Hf solution-ICP-MS data on zircons from 8 plutons indicate that this suite of magmatic rocks formed in a continental margin arc setting between 434 Ma and 428 Ma, and are characterized by a range of $\varepsilon_{Hf(t)}$-values between +5.8 for mafic intrusives to −5.3 for granites. In terms of age the Beiarn Nappe Complex is correlative to Silurian magmatic rocks i) in the Upper Nappe of the Helgeland Nappe Complex further south within the Uppermost Allochthon, ii) in several complexes of the Upper Allochthon, and iii) in the Caledonides in NE Greenland. A similar source for the magmatic rocks in the Beiarn Nappe Complex and the Hurry Inlet plutonic terrane in Liverpool Land, NE Greenland is supported by a similar range of $\varepsilon_{Hf(t)}$-values for the two magmatic complexes, also indicating that the magmatic rocks had a mixed juvenile mantle and crustal source, the latter with minimum crustal residence time of 1.75 Ga.

1. Introduction

The Scandinavian Caledonides have traditionally been divided in a four-fold structure of composite allochthons resting on (par)autochthonous Baltic basement. The uppermost of these allochthons (Uppermost Allochthon) is characterized by Laurentian faunal and isotopic signatures (e.g. Roberts and Gee, 1985). It is composed of rocks of microcontinental or island arc origin representing the peri-Laurentian continental margin and reflecting the Paleozoic evolution of subduction complexes. Knowing the timing of magmatism in these arc terranes is crucial in order to understand the evolution of the active Laurentian margin prior to the final continent–continent collision between Baltica and Laurentia during the Scandian orogenic event (Late Silurian–Early Devonian). The chronology of magmatic arc development can also help us reconstruct different segments of the orogen and refine the paleogeography prior to, during and after the Scandian continent–continent collision. For example, paleogeographic reconstructions may be used to test the amount of strike-slip displacement between the continents during and after the Scandian collision in Late Silurian to Early Devonian time. In order to refine models of the Caledonian orogeny, we have conducted a geochemical (major and trace elements), geochronological (U–Pb ID–TIMS) and isotopic (Lu–Hf ICP-MS) study of magmatic rocks in the uppermost tectonostratigraphic level in the Salten area, the Beiarn Nappe Complex, North Norway. We also report Lu–Hf isotopic data on zircons from Late Ordovician–Silurian magmatic arc granitoids from Liverpool Land (Augland et al., 2012) to test the hypothesis that the Beiarn plutons originated in the East Greenland segment of Laurentia.

2. Geological setting

The four main tectonostratigraphic elements of the Scandinavian Caledonides that lie structurally on top of Precambrian (par)autochthonous, Baltic basement with its Paleozoic cover (Fig. 1a) are commonly divided into: the Lower, Middle, Upper and Uppermost Allochthons (Gee and Sturt, 1985; Roberts and Gee, 1985). The two lower allochthons are composed of crystalline basement slices and overlying shelf and continental rise sediments of Baltic affinity (Andréasson, 1994; Roberts and Gee, 1985). The Upper Allochthon includes 1) metamorphic complexes of the Seve Nappe, traditionally interpreted to represent the former Baltic–Iapetus continent–ocean transition (Stephens and Gee, 1985), and 2) ophiolites and island arc terranes of the Iapetus Ocean (Harland and Gayer, 1972) represented by the Køli Nappes (Andréasson, 1994; Grenne et al., 1999; Stephens et al., 1985). Some of the structurally higher tectonic units of the Køli Nappes lack fossils of Baltic affinity but host instead a Laurentian fauna (Bergström, 1979; Bruton and Bockelie, 1979, 1980; Bruton and Harper, 1988; Spjeldnæs, 1985), testifying to the remote origin of this unit with respect to Baltica. The Uppermost Allochthon,

* Corresponding author. Tel.: +47 95700108.
E-mail address: larseau@geo.uio.no (L.E. Augland).

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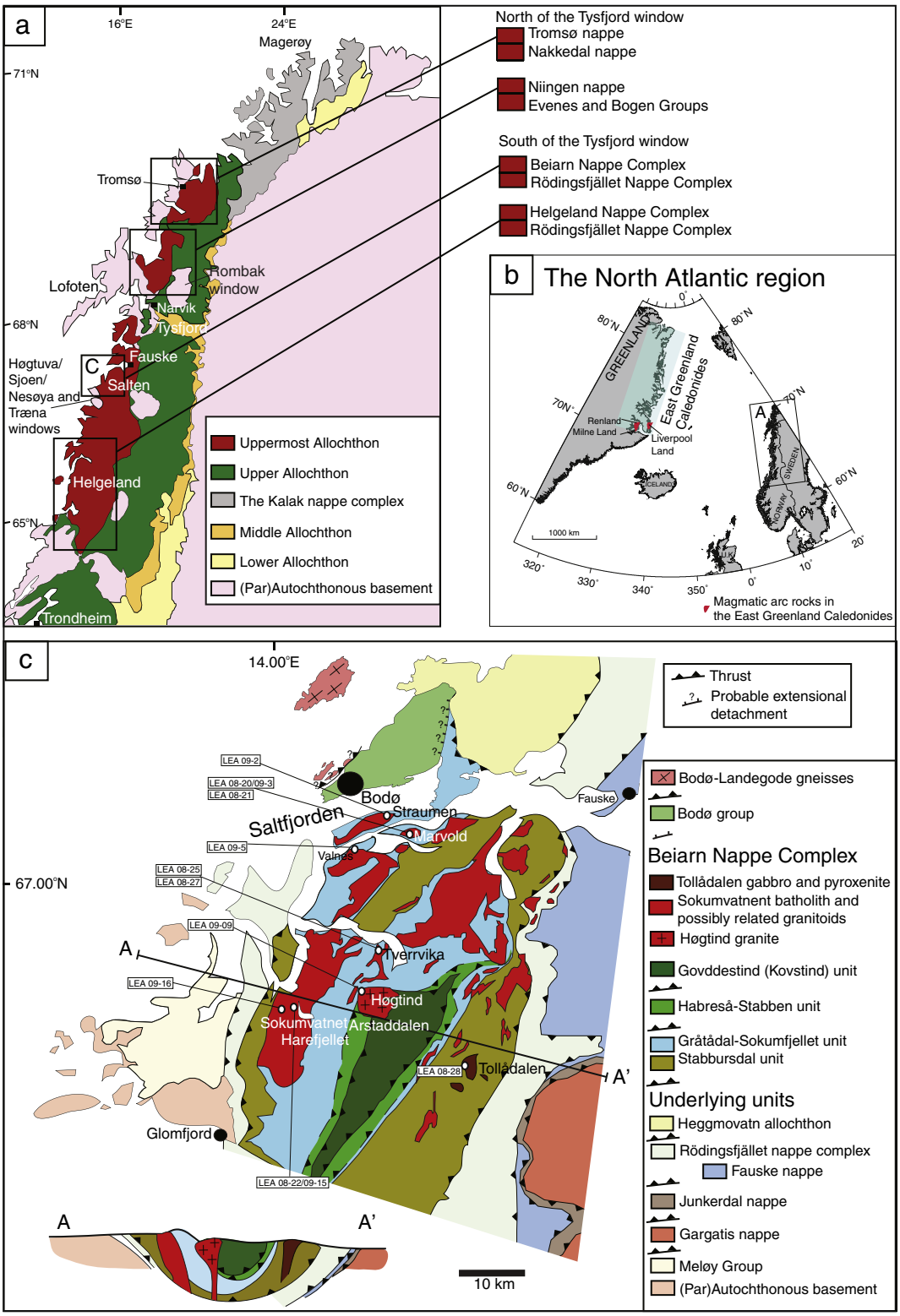

Fig. 1. a) Tectonostratigraphic map of the northern Scandinavian Caledonides. After Barnes et al. (2007) and Corfu et al. (2011). Regional subdivisions of the Uppermost Allochthon are shown to the left. b) Map of the present day North Atlantic region. The East Greenland Caledonides with known occurrences of Paleozoic magmatic arc rocks are outlined in red. c) Geological map of the Salten area. Modified from Gustavson and Blystad (1995). Sample locations are indicated by black and white dots.

covering an along strike length of more than 700 km in the Central Scandinavian Caledonides (Fig. 1a), only interrupted by the Tysfjord basement culmination, is interpreted to have formed in a continental margin setting and to be of Laurentian origin (Barnes et al., 2007; Roberts et al., 2002, 2007; Stephens et al., 1985). North of the Tysfjord culmination (Fig. 1a) the Uppermost Allochthon includes the Evenes and Bogen "groups" and the Niingen Nappe Complex in the Ofoten area (Andresen and Bergh, 1985; Tull et al., 1985), and the Nakkedal and eclogite bearing Tromsø Nappe Complexes in the Tromsø region (Andresen et al., 1985; Corfu et al., 2003; Krogh Ravna and Roux,