



Provenance characteristics and regional implications of Neoproterozoic, Timanian-margin successions and a basal Caledonian nappe in northern Norway



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ABSTRACT

The autochthonous/paraautochthonous lithostratigraphic successions of Varanger Peninsula, NE Norway, range in age from Tonian to Cambrian and constituted a passive (Baltican) margin depositional system throughout most of the Neoproterozoic. Sediment sources were mainly from the south on the Fennoscandian Shield. U–Pb zircon age spectra from sandstones of eight formations show significant input of Late Palaeoproterozoic and Mesoproterozoic age, as well as a prominent Neoproterozoic peak. These mostly reflect derivation from rock complexes and terranes that are exposed on the present-day Baltic Shield, although the abundance of Mesoproterozoic zircon grains is less easy to explain. Possible sources may represent (i) possible basement of this age now concealed beneath the Caledonian nappes, (ii) a northward continuation of the Sveconorwegian orogen, (iii) recycling of a sandstone-dominated thrust sheet derived from the Rodinian margin and emplaced in the Tonian or (iv) recycled material from pre-existing extensive river systems farther south on the Fennoscandian Shield. One major exception to the above age-spectral pattern is provided by the Late Ediacaran to earliest Cambrian Ståhpogieddi Formation in the immediately overlying Gaissa Nappe Complex. Sandstones in this unit are derived from a northeasterly source, and show a major zircon age peak at c. 550 Ma. The formation is considered to represent deposition in a foreland basin ahead of the rising Timanian orogen.

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1. Introduction

The siliciclastic-dominated, low-grade sedimentary successions of the Varanger Peninsula in Finnmark, northernmost Norway, constitute a distinctive feature of the latest Mesoproterozoic to Neoproterozoic, northeastern passive margin of Baltica (Fig. 1). Sedimentological research on this peninsula over the last half century, partly in conjunction with geochemical studies, has complemented detailed bedrock mapping and provides one of the most reliable and robust databases in Scandinavia for appraising the provenance of these thick, continental-margin successions. Palaeocurrent data are available from the majority of formations and members which is especially beneficial and significant for interpreting the derivation of radiometrically dateable, detrital mineral species, notably zircon.

To date, only a handful of provenance studies have been performed in the region. Previous work in Finnmark includes single-grain U–Pb dating of detrital zircon from metasandstones of the Kalak Nappe Complex (Kirkland et al., 2007, 2008a,b), one of the overlying Caledonian nappes. These authors presented novel and somewhat controversial interpretations for the provenance of the original sediments, but no account was taken of the sediment dispersal patterns or routing systems of these deposits, cf. Roberts (2007). On Varanger Peninsula, preliminary detrital zircon results were integrated with a variety of provenance and sediment routing parameters (Roberts and Siedlecka, 2012); this work also covered areas in NW Russia and the Kalak Nappe Complex on Nordkinn Peninsula to the northwest of Varanger. Orlov et al. (2011) included detrital zircon probability plots from Varanger Peninsula (originally presented by Nicoll et al., 2009), but no data tables were provided. These results were repeated by Kuznetsov et al. (2014, supplementary tables).

We present detrital zircon U–Pb results from seven additional samples and provide comprehensive stratigraphic coverage for the Varanger Peninsula. Results from two samples of the overlying

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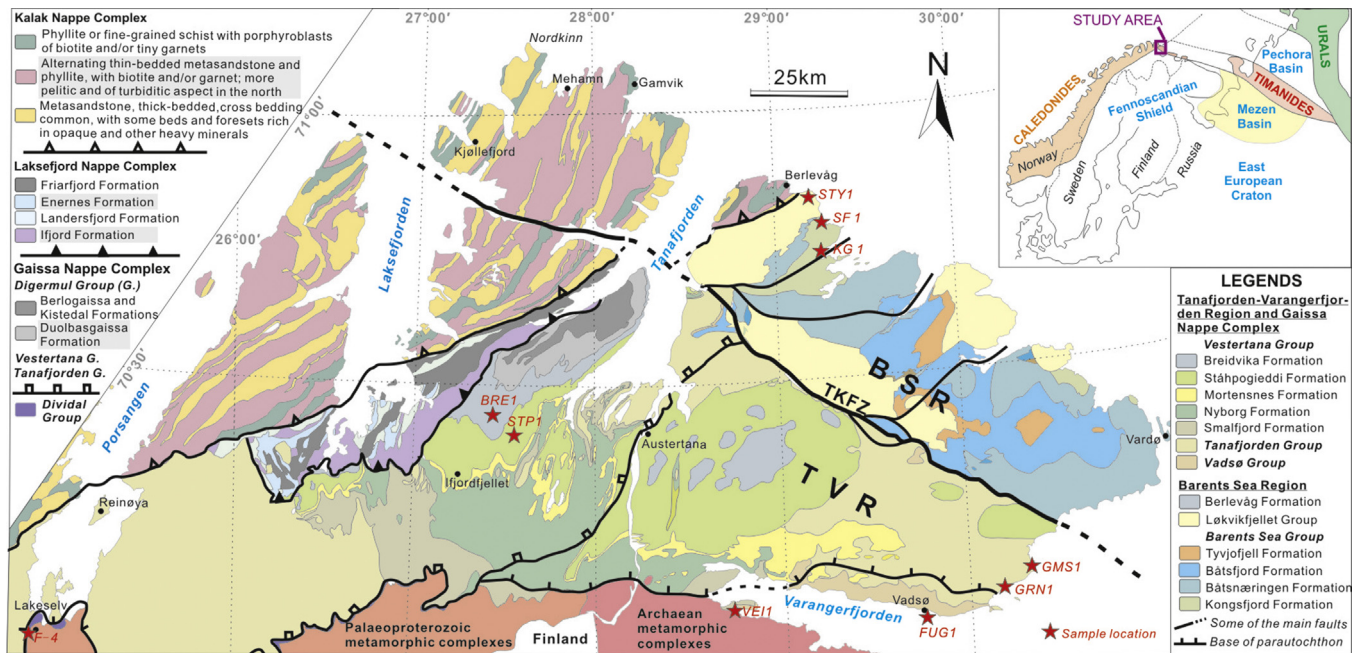


Fig. 1. (a) Location of the Timanides and the study area (after Roberts and Siedlecka, 2002); (b) simplified geological map of NE Finnmark showing the three main nappes and sample locations (modified after the 1:500,000 Bedrock Geology map of Finnmark; Siedlecka and Roberts, 1996). TKFZ – Trollfjorden-Komagelva Fault Zone.

Gaissa Nappe Complex to the west and from the basal part of the autochthonous, Ediacaran to Cambrian Dividal group farther to the southwest, close to Lakselv, are also included. These analytical data are significant, not least in confirming the presence of a Timanian foreland basin of regional extent in the Late Ediacaran to Cambrian succession, but also in recognising the profuse input of Mesoproterozoic zircons from southerly sourced, rock complexes of Fennoscandia. This latter discovery has important repercussions in terms of Neoproterozoic palaeogeography.

2. Synopsis of regional geology

In Finnmark and neighbouring areas of Russia and Finland, the crystalline basement of the Fennoscandian Shield is dominated by Archaean to Palaeoproterozoic granite-gneissic, granulitic and greenstone terranes. Along the southern shores of Varangerfjorden, 2.9 to 2.5 Ga, Meso- to Neoarchaeal, granite-granodiorite plutons form part of the Murmansk Terrane (Levchenkov et al., 1995; Nordgulen et al., 1995; Koistinen et al., 2001). To the south and southwest, these rocks are succeeded by the Neoarchaeal Inari Terrane and 2.0–1.9 Ga Lapland Granulite Belt, both of which were reworked during the 1.95–1.87 Ga Lapland-Kola orogeny (Daly et al., 2006) – an early manifestation of the Palaeoproterozoic Svecofennian orogeny (1.95–1.77 Ga) which is recorded over vast areas farther south in northern Finland, Sweden and Norway (Korja et al., 2006; Lahtinen et al., 2008). Rocks of Mesoproterozoic age exposed today are few, and mostly represented by 1.65–1.50 Ga rapakivi granite suites and 1.64–1.48 Ga Gothian plutons and rift-related rocks of the Sveconorwegian orogen (Bingen et al., 2008) and by bimodal magmatism (1.34–1.14 Ga) that preceded the c. 1.0 Ga Sveconorwegian orogen.

Varanger Peninsula is divided into two regions separated by the c. NW-SE-trending Trollfjorden-Komagelva Fault Zone (TKFZ) (Fig. 1), a major crustal lineament that can be followed offshore to the northwest and both onshore and offshore to the southeast along the northern coastline of Kola Peninsula into the Timanides of the Komi Republic, west of the Urals (Siedlecka et al., 2004). This lineament has been reactivated numerous times from the Archaean

to the Cenozoic and is perhaps best known for its dextral strike-slip translation of c. 200 km in Caledonian time (Rice et al., 1989; Bylund, 1994; Roberts and Siedlecka, 2012; Rice, 2014). The TKFZ functioned as a normal fault throughout the Neoproterozoic, only to be inverted as a thrust-fault during the Ediacaran Timanian orogeny (see below).

Southwest of the TKFZ in the Tanafjorden-Varangerfjorden Region (TVR), a c. 4 km-thick platformal to shallow basin succession is largely autochthonous or parautochthonous, comprising the fluvial to shallow-marine Vadsø, Tanafjorden and Vestertana groups (Siedlecka and Roberts, 1992). Based mainly on the presence of diverse body fossils and a variety of microfossils including age-diagnostic acritarchs, the complete TVR succession has been shown to range in age from Tonian to Early Cambrian (Føyn, 1967; Føyn & Glaessner, 1979; Vidal, 1981; Siedlecka et al., 1995; Vidal & Moczydlowska, 1995; Samuelsson, 1997; Högström et al., 2013). It also includes two Ediacaran diamictite formations (Edwards, 1984; Gorokhov et al., 2001; Rice et al., 2001). In innermost Varangerfjorden the basal Veidnesbotn Formation of the Vadsø Group lies unconformably upon Neoarchaeal granitoids (Banks et al., 1974; Rice et al., 2001, 2011). Just to the west of Varanger Peninsula, in the Gaissa Nappe Complex, the highest formation of the Vestertana Group passes up into low-grade, fossiliferous, Cambrian to Tremadocian metasedimentary rocks of the Digermul Group (Reading, 1965; Banks et al., 1971; Nikolaisen and Henningsmoen, 1985).

Northwest of the TKFZ, in what is termed the Barents Sea Region (BSR) of Varanger, an allochthonous succession includes the inferred Tonian to Cryogenian, 9 km-thick, mostly deep-marine submarine-fan to deltaic Barents Sea Group, and unconformably overlying c. 5.7 km-thick, fluvial to shallow-marine Løkvikfjellet Group. In the extreme northwest of the peninsula, slightly higher-grade metasediments and phyllites of the Berlevåg Formation occur in the Tanahorn Nappe, which has links with either the Kalak Nappe Complex on Nordkinn Peninsula to the west (Levell and Roberts, 1977) or the Laksefjord Nappe Complex (Laird, 1972; Kirkland et al., 2008a,b). The lithostratigraphic successions in the disparate platformal and deep-marine to deltaic domains of Varanger Peninsula are linked in just one small area close to

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