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# Trans-Siberian Permian rivers: A key to understanding Arctic sedimentary provenance

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ABSTRACT

Permian strata of northern Siberia contain a rich record of the late Paleozoic history of Siberia and surrounding fold and thrust belts (FTB). More than 850 uranium–lead (U–Pb) detrital zircon ages collected from the Permian strata provide vital information about sediment source areas and history of the sedimentary basins. The detrital zircon populations obtained from the Permian clastics of northern Siberia are characterized by large percentages of late Paleozoic and early Paleozoic zircons, whose ages can be correlated with magmatic events known from the Ural-Mongolian Orogen. Our data suggest that Permian clastics of northern Siberia were mainly sourced from orogens developed along the western and southwestern margins of the Siberian Craton (in present-day coordinates), with an additional sediment contribution from the reworked sedimentary cover and basement of Siberia. The contribution from Siberian sources is distinguished in the Precambrian part of the detrital zircon populations by wide distribution of ca. 1700–2000 Ma and 2500–2750 Ma zircons with an almost total lack of zircons ranging in age from 800 to 1700 Ma. We propose that a major fluvial system, which we here term the "Paleo-Khatanga", was the main sediment transport pathway along the western and northern margins of Siberia during the Permian. From a regional overview of detrital zircon populations in Permian deposits across the Arctic realm, we propose that the New Siberian Islands, Alexander and Farewell terranes were sourced from the western framework of the Ural-Mongolian Orogen and were located along the northern margin of Baltica during the late Paleozoic. The Arctic–Alaska–Chukotka Terrane on the other hand does not have Uralian signatures in the detrital zircon populations of the Permian sediments, and can be reconstructed adjacent to the northern margin of Laurentia. Our new data presented here help to better define the enigma of Arctic paleogeography during the Paleozoic.


## 1. Introduction

The number of detrital zircon U–Pb studies in the Arctic has substantially increased in recent years, providing new constraints on the paleogeographic and tectonic evolution of this complex region. However, only a handful of U–Pb detrital zircon studies have been conducted on the Paleozoic successions of Siberia and its margins (Prokopiev et al. 2008; Miller et al. 2013; Ershova et al. 2013, 2015d; Prokopiev et al. 2013, Zhang et al. 2013; Glorie et al. 2014; Khudoley et al. 2015). Here we provide an overview of the stratigraphy and depositional environments of Permian deposits across northern and central Siberia, along with a provenance study based on U–Pb dating of detrital zircons from 9 samples collected from the Permian strata in northern Siberia.

The Permian deposits of northern Siberia are represented by a thick succession of clastic rocks deposited in various continental, brackish and marine paleoenvironmental settings. These strata provide a record of the Permian tectonic history along the northern margin (present-day coordinates) of Siberia and surrounding fold and thrust belts (FTB). Consequently, they form an important basis for the reconstruction of fluvial pathways across Siberia in late Paleozoic. Our detrital zircon data obtained from the Permian strata of northern Siberia provide a unique signature which can be used to locate and identify other terranes of Siberian affinity, which are now scattered across the Arctic and Cordilleran realm following opening of the Mesozoic-Cenozoic sedimentary basins.

## 2. Geological background

The study area is located along the northern margin of the Siberian Craton and surrounding FTB (Figs. 1 and 2). The Siberian Craton represents the northeastern part of the Eurasian Plate and is bound on all

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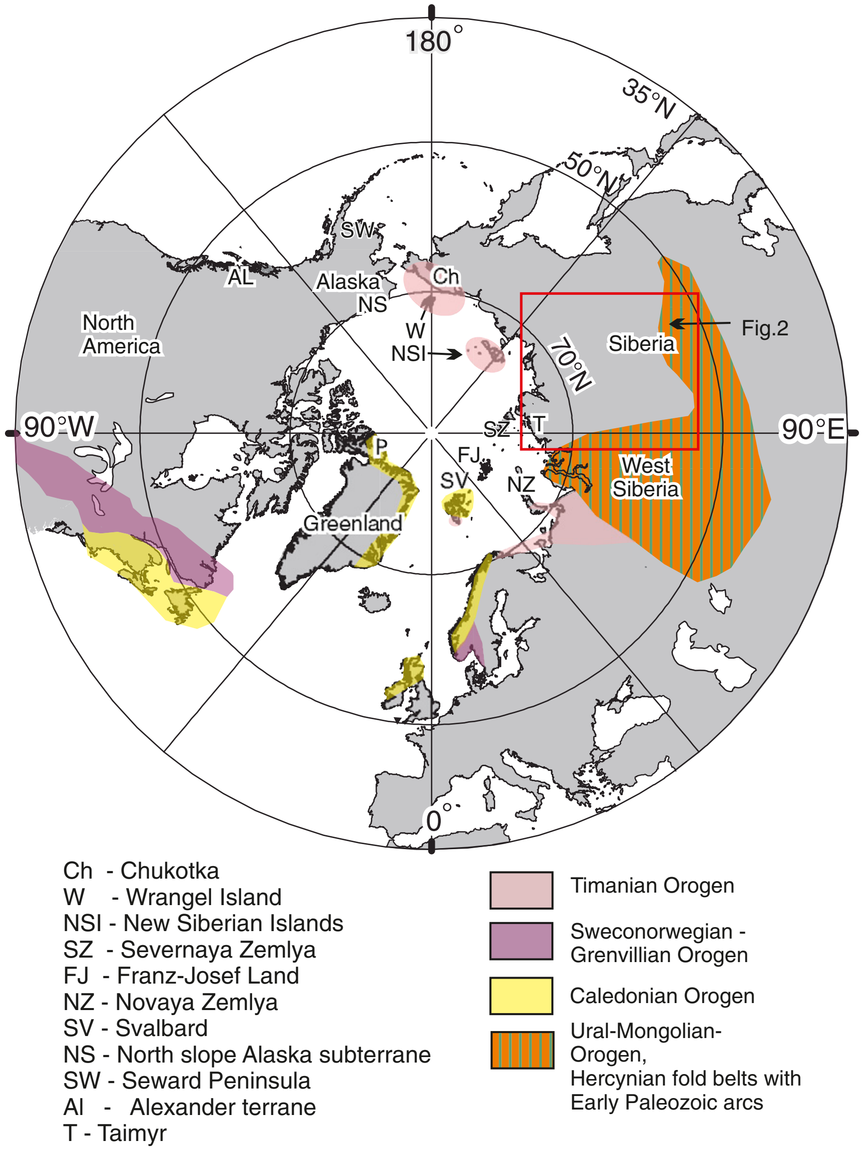


**Fig. 1.** Regional setting of the study area depicting the locations discussed in the text and the major orogenic systems that have affected the Arctic region (modified after Colpron and Nelson, 2011).

sides by FTB of Precambrian-Mesozoic age, mainly the result of terrane accretion onto the margins of Siberia during the late Precambrian — Jurassic. The Siberian Craton is an ancient Precambrian complex of Archean and Paleoproterozoic terranes, which were amalgamated at 2.0–1.85 Ga (Rozen, 2003; Smelov and Timofeev, 2007). Precambrian basement outcrops in the Anabar Shield and Olenek Uplift in the north of the craton, and in the Aldan Shield in the south (Fig 2). Neoproterozoic magmatic rocks have not been described from the basement of Siberia, but have been described from the Yenisey Ridge along the southwestern margin (Vernikovsky et al., 2004; Vernikovskaya et al., 2006; Nozhkin et al., 2008, 2013), and from the Taimyr Peninsula along the northern margin (Fig.2) (Vernikovsky, 1996; Vernikovsky et al., 2004; 2011; Zakharov et al., 1993; Pease and Vernikovsky, 1998; Pease et al., 2001; Proskurnin et al., 2014). The Siberian basement is overlain by a Proterozoic to Mesozoic sedimentary cover of varying thickness and composition, including the Permian stratigraphy described below.

## 3. Overview of stratigraphy

In the present-day structural framework, Permian deposits are widely distributed along the northern, eastern and western margins of Siberia, including the surrounding South Taimyr and Verkhoyansk FTB which represent deformed Paleozoic-Mesozoic passive margins of Siberia (Figs. 2 and 3). Within the Siberian Craton and in the Yenisey-Khatanga and Lena–Anabar depressions information on the Permian rock unit composition and thickness is based mainly on the well and seismic studies. The thickness and facies of Permian deposits vary significantly across Siberia. Brief descriptions are provided below.

### *3.1. Tunguska area*

The Lower Permian deposits are mostly represented by alternating sandstones, siltstones and clays, mainly deposited in continental environments, with numerous relatively thick coal beds described through the succession (Fig. 4) (Budnikov, 1976). Shallow-marine to brackish water deposits have been reported from the northern part of the area, where the uppermost Lower Permian deposits comprise clayey limestone with numerous bivalves. The Middle–Upper Permian deposits are mainly sandstones with beds of clays and siltstones. Thick coal beds are reported from the upper part of the succession and conglomeratic layers occur

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