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Integrated provenance analysis of Carboniferous deposits from Northeastern Siberia: Implication for the late Paleozoic history of the Arctic

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ABSTRACT

An integrated provenance analysis based on sandstone petrography, distribution of REE and trace elements, and U/Pb detrital zircon dating of Carboniferous sedimentary rocks of northern Verkhoyansk Fold and Thrust Belt (FTB) provides new insights into the tectonic evolution of NE Siberia. According to petrographic and geochemical data, Lower Visean sandstones had local provenance that contained mafic magmatic rocks. Wide distribution of ca. 2075 Ma detrital zircons known in the basement of neighboring Olenek and Ust'-Lena uplifts supports local provenance of the Lower Visean sandstones. Starting from Late Visean, clastic sediments have geochemical and petrographic compositions that are characteristic for erosion predominantly felsic rocks in a more remote source region. Detrital zircon age distributions in the Upper Visean – Upper Carboniferous sandstones, point to Taymyr – Severnaya Zemlya FTB and Central Asian Orogenic Belt (CAOB) as the most likely provenances for clastic rocks. However, wide distribution of Neoproterozoic and early Paleozoic detrital zircons that are not typical for synchronous CAOB-derived clastic rocks in the West Verkhoyansk, provide evidence for other than CAOB source area. We infer that the most likely source for Neoproterozoic – early Paleozoic detrital zircons in the Upper Visean – Upper Carboniferous sandstones is the Taimyr-Severnaya Zemlya FTB. The shift to sources from the Taimyr-Severnaya Zemlya FTB suggests an earlier (Late Visean) age for the collision between Kara terrane and Siberia than has been previously assumed (Late Carboniferous – Permian). Our paleogeographic restoration reveals the existence of two major fluvial systems draining eastward across the Siberian Craton during the Carboniferous: the Paleo-Lena in the south and the Paleo-Khatanga in the north.

1. Introduction

The number of detrital zircon U/Pb studies has increased dramatically in the past years, providing new constraints on the paleogeographic and tectonic evolution of sedimentary basins and their flanking continents. However, only a few U/Pb detrital zircon studies have been carried out on the Paleozoic and Mesozoic successions of Siberia (Miller et al., 2006; Prokopiev et al., 2008; Miller et al., 2013; Harris et al., 2013).

This paper presents a provenance study of Carboniferous clastic strata deposited along the northern part of the Verkhoyansk passive margin of the Siberian continent (Figs. 1 and 2 show location of study). Preliminary data on the provenance of these sediments, based primarily on U/Pb dating of detrital zircon populations, were presented in Ershova et al. (2013) and Prokopiev et al. (2013). Here we use an integrated provenance approach, including whole-rock geochemistry and sandstone petrography combined with the U/Pb age distributions of detrital zircon populations. This more in depth study helps refine the nature of sediment source regions and leads to implications about the tectonic setting of both the sedimentary sequences studied as well as their surrounding landmasses.

The study area is located on the northeastern margin of the Siberian Craton in the Kharaulakh Anticlinorium (a northern segment of the Verkhoyansk FTB) near the Lena Delta and town of Tiksi (Figs. 1 and 2). The Siberian Craton forms the northeastern portion of the Eurasian plate and is bounded on all sides by fold belts of varying age, mainly the result of terrane accretion along the margins of Siberia during the Phanerozoic. The Verkhoyansk FTB was formed during the late Mesozoic collision of the Kolyma-Omolon Superterrane with the Siberian Craton (Parfenov, 1991). The Kharaulakh Anticlinorium consists of deformed Proterozoic to Mesozoic age sedimentary rock (Fig. 2a). Upper

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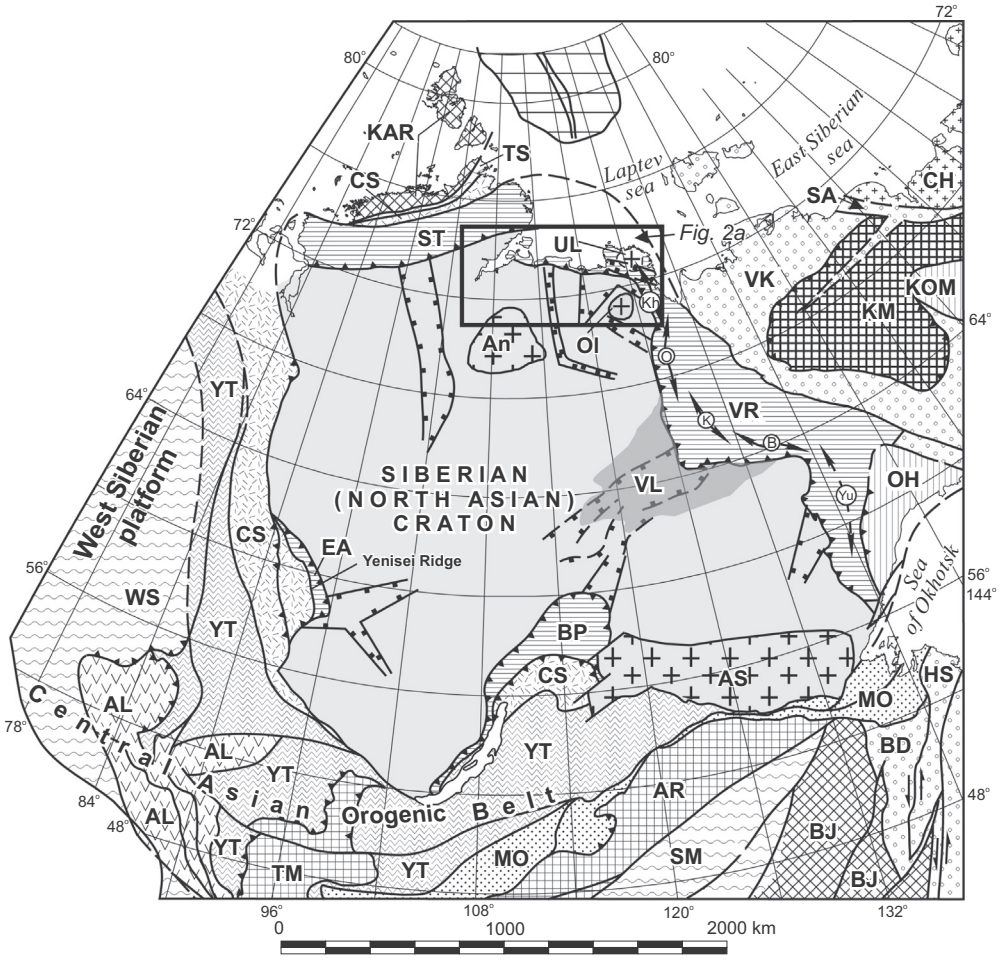

Siberian (North Asian) Craton

Sedimentary cover

Shields and uplifts of the crystalline basement (An – Anabar Shield, AS – Aldan-Stanovoy Shield, Ol – Olenek Uplift, Ul – Ust'-Lena Uplift)

Subsided craton margin – fold and-thrust belt (ST – South Taimyr, EA – East Angara, BP – Baikal-Patom, VR – Verkhoyansk)

Meso- and Neoproterozoic rifts

Middle-Paleozoic rifts (VL – Vilyui Basin)

Orogenic belts

Circum-Siberia (CS), Neoproterozoic

Mongol-Okhotsk (MO), Late Paleozoic-Early Mesozoic

Yenisey-Transbaikal (YT) (Late Cambrian to Early Ordovician)

Chukotka (CH), Middle-Late Jurassic

Altay (AL), Silurian

Verkhoyansk-Kolyma (VK), South Anyui (SA), Honshu-Sikhote-Alin (HS), Late Jurassic-Early Cretaceous

South Mongolia-Khingan (AM), West Siberian (WS) and Taimyr-Severnaya Zemlya (TS), Late Paleozoic

Kolyma-Omolon superterrane (KM)

Cratonal terranes: OH – Okhotsk, KOM – Omolon

Fragments of Neoproterozoic orogenic belts: TM – Tuva-Mongolia terrane and AR – Argun terrane

Fragments of Early Paleozoic orogenic belts: BJ – Bureya-Jiamusi terrane and KAR – Kara terrane

Oceanic crust

Thrust

Strike-slip fault

Other faults

Anticlinorium (Kh – Kharaulakh, O – Orulgan, K – Kuranakh, B – Baraya)

Synclinorium (Yu – South Verkhoyansk).

Fig. 1. Map of cratons and orogenic belts of Northeast Asia (modified from Parfenov et al., 2003, 2009).