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The Precambrian of Transangaria, Yenisei Ridge (Siberia): Neoproterozoic microcontinent, Grenville-age orogen, or reworked margin of the Siberian craton?

Alexander B. Kuzmichev [a,*], Eugene V. Sklyarov [b,c]

[a] Geological Institute of Russian Academy of Sciences, 7 Pyzhevsky Pereulok, Moscow 119017, Russia
[b] Far Eastern Federal University, 8 Sukhanov Street, Vladivostok 690950, Russia
[c] Institute of the Earth's Crust, Siberian Branch of the Russian Academy of Sciences, 128 Lermontov Street, Irkutsk 664033, Russia

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ABSTRACT

The Yenisei Ridge was traditionally perceived as an uplifted segment of the western Siberian craton affected by Neoproterozoic collision events. However, the suggestions for Archaean or Palaeoproterozoic ('Siberian') basement in Transangaria have not been confirmed by reliable geochronological data. A new view regards most of the Ridge, namely, its Transangarian segment, to be an exotic Neoproterozoic terrane that collided with Siberia in the late Neoproterozoic. This paper presents new U–Pb SHRIMP zircon ages demonstrating that Archaean rocks (2611 ± 12 Ma) actually exist in this territory. We also provide a review of published U–Pb zircon ages for igneous and metamorphic rocks of Transangaria together with our new age data. This geochronological dataset clarifies the geology of the Yenisei Ridge and leads to new conclusions, as follows. (1) It is likely that Transangaria was originally underlain by an Archaean–Palaeoproterozoic basement, similar to that of the Siberian craton. (2) Geochronological data do not confirm the idea of widespread "Greenvillian age" granitoides in Transangaria. (3) The Neoproterozoic evolution of the Yenisei Ridge segment of the Siberian craton margin includes the following events. (i) Collision of an unidentified terrane with the western margin (in recent coordinates) of the Siberian craton during 900–855 Ma. The colliding terrane is no longer present in the current structure. (ii) Dextral shearing during 830–800 Ma may have been caused by counterclockwise rotation of the Siberian craton. (iii) Extensional conditions prevailed during 800–700 Ma. The Isakovka oceanic basin formed at this time interval. (iv) Thrusting of the Isakovka island arc and accretionary prism onto the Siberian margin occurred during the late Neoproterozoic (650–630 Ma) and caused high-pressure metamorphism.

1. Introduction

The Yenisei Ridge represents the largest region of Precambrian rocks exposed along the western margin of the Siberian Platform (Fig. 1). The Ridge has been a traditional gold mining region since the 19th century. In the 1950s and 1960s, the territory was covered by medium-scale (1:200000) State Geological Mapping. Later, 1:50000 scale surveys were conducted, and a new generation of geological maps is currently being compiled. Nonetheless, many geological issues of this area remain unresolved, including uncertainties concerning the general tectonic features and the Precambrian evolution. One of the reasons for many geological uncertainties is the fact that the entire territory of the Yenisei Ridge is densely forested, and outcrops are mainly found along river banks.

The Angara River divides the Yenisei Ridge into two unequal parts, which are the Angara-Kan block in the south and the Transangaria block in the north (Fig. 2). The Angara-Kan block is a fragment of the crystalline basement of the marginal part of the Siberian craton. It is composed of granulite, gneiss, charnockite and other early Precambrian rocks. Metamorphic rocks of the Angara-Kan block were described in detail by Kusnetsov (1941). This researcher distinguished two units, the Kan and Yenisei Groups. Transangaria is an area where late Precambrian rocks predominate. The cumulative thickness of the Meso- and Neoproterozoic metasedimentary sequences exceeds 15 km. For many years, these sequences were compared with the stratotype Riphean sedimentary series of the Ural Mountains. Not long ago, geologists had no doubt that Transangaria is underlain by an ancient

* Corresponding author.
E-mail addresses: nsi.kuzmich@yandex.ru (A.B. Kuzmichev), skl@crust.irk.ru (E.V. Sklyarov).

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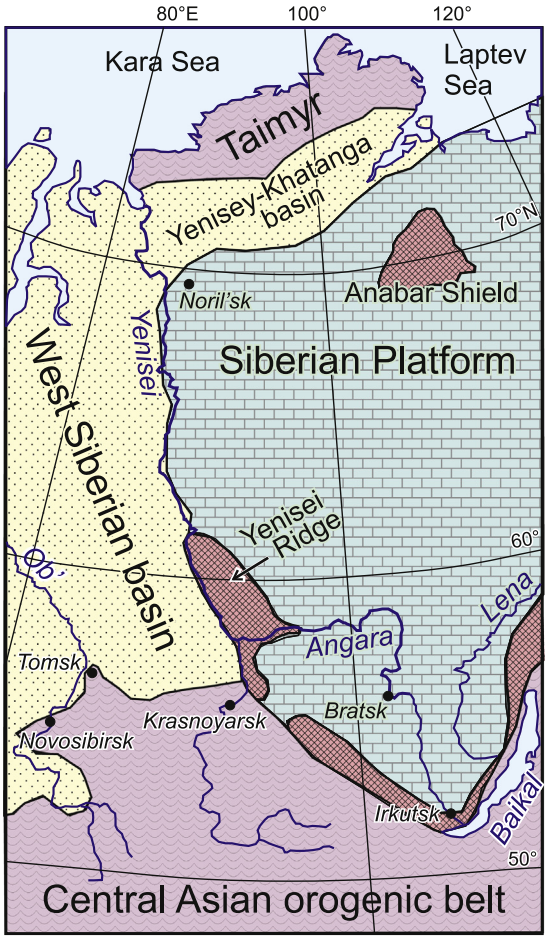

Fig. 1. General location of the Yenisei Ridge.

crystalline basement of the Siberian craton that is the same as in the southern part of the Ridge. The presence of old rocks appeared to be partly confirmed by isotopic ages (e.g., Volobuev et al., 1976, and references therein); however, none of these old age data have ever been reproduced using modern techniques of isotope geochronology. The oldest rock reliably dated in Transangaria is a granite-gneiss of the Nemtikha metamorphic unit (1360–1380 Ma; Popov et al., 2010). Therefore, the presence of Palaeoproterozoic and/or Archaean rocks has been questioned (Vernikovsky et al., 2003).

The tectonic interpretation of the Yenisei Ridge structure dependents on the basement age. According to Vernikovsky et al. (2003, 2007), most of Transangaria belongs to the so-called Central Angara terrane (Fig. 2), which is an exotic block unrelated to the Siberian craton. During most of the Precambrian, this terrane evolved as a part of another palaeocontinent or microcontinent that drifted in the Palaeo-Asian ocean. It was suggested that Transangaria collided with the Siberian craton in the late Neoproterozoic (760–720 Ma ago; Vernikovsky et al., 2003, 2007). Accepting this interpretation means that the geological events revealed in Transangaria for the time interval earlier than 760 Ma are related to the evolution of one of Precambrian terranes scattered within the Central Asian Orogenic Belt (CAOB), rather than the Siberian margin.

The above views are not shared by all researchers. Geologists who mapped Transangaria for several decades, have reinterpreted the earlier data and recognised two metamorphic units, namely Nemtikha and Malogarevka that presumably contain Archaean rocks (Kachevsky et al., 1994). These units were correlated with the Kan and Yenisei Groups of the Angara-Kan block and can thus be considered as belonging to the basement of the Siberian craton.

Kachevsky et al. (1998) published a geological map of the Yenisei Ridge (scale 1:500000) that shows the extent of the above units in a large portion of Transangaria, including the region of our investigation (Figs. 3 and 4). However, here are no geochronological data to confirm the ancient age of these units. On the other hand, the Archaean age of the Kan and Yenisei Groups of the Angara-Kan block is also not confirmed by isotopic dating. Granulite-facies metamorphism was dated as Palaeoproterozoic, whereas an Archaean age has only been obtained for rare relict zircon cores (Bibikova et al., 1993; Turkina et al., 2012; Urmantseva et al., 2012).

A new interpretation suggesting the presence of Grenville-age granitoids and metamorphic rocks in Transangaria has been proposed, based on chemical U–Pb ages for monazite (Likhanov et al., 2012, 2014, 2015 and references therein). Currently, all data published by the Likhanov team are presented in terms of either accretion or the break-up of Rodinia.

In view of these contradictory concepts of the Yenisei Ridge geology, the available geological data cannot be easily interpreted in terms of either the Precambrian evolution of the Siberian cratonic margins, the relationship between Siberia and Rodinia or the Neoproterozoic evolution of the CAOB. This paper attempts to clarify the situation.

The first author studied the Yenisei Ridge in the early 1980s when the traditional ideas of its geology were widely accepted (Kuzmichev, 1987). Later the territory was reinvestigated, including outcrops of metamorphic rocks that were classified as Archaean by Kachevsky et al. (1994, 1998). Information on two such sites is given below. These are the Vyatka region in the south and the Yenisei bank near the Proklyataya River in the north (Fig. 4). In addition, we review recently published zircon ages for Transangaria to correlate the recognised events with the geology

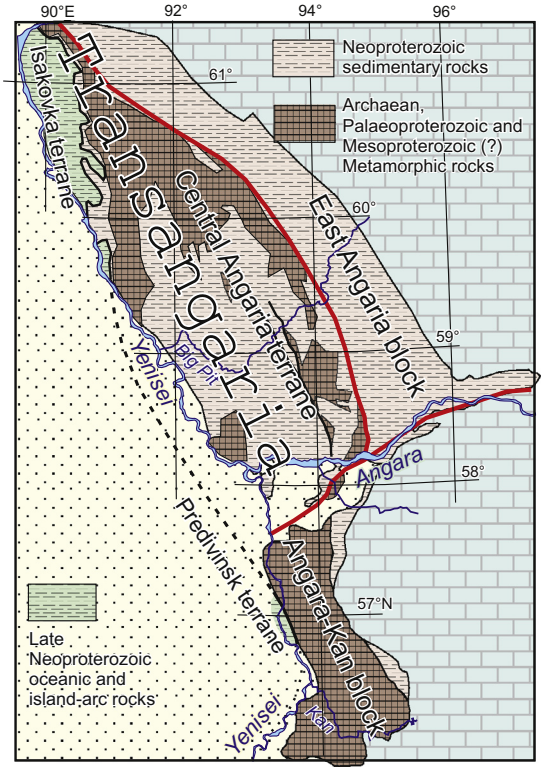

Fig. 2. Main geological subdivisions of the Yenisei Ridge. The red line is a contour of the Central Angara terrane of Vernikovsky et al. (2003, 2007), who suggested it to have collided with Siberia at 760–720 Ma. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)