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Precambrian terranes in the southwestern framing of the Siberian craton: isotopic provinces, stages of crustal evolution and accretion-collision events

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Abstract

We studied geology and main rock assemblages of the Precambrian Kan, Arzybei, and Derba terranes of the Central Asian Fold Belt which border the Siberian craton in the southwest. The Precambrian terranes include three isotopic provinces (Paleoproterozoic, Mesoproterozoic, and Neoproterozoic) distinguished from the Sm-Nd isotope compositions of granitoids, felsic metavolcanics, and metasediments. The terranes formed in three stages of crustal evolution: 2.3–2.5, 0.9–1.1, and 0.8–0.9 Ga. Proterozoic juvenile crust was produced by subduction-related magmatism; it was originally of transitional composition and transformed into continental crust by potassic plutonism as late as the Late Vendian-Cambrian. Terrigenous sediments in the Arzybei and Derba terranes vary in *T*(DM) Nd model ages from 1.0 to 2.0 Ga. The Nd ages of the underlying metavolcanics and lowest *T*(DM) of metasediments indicate that terrigenous sedimentation started in the Neoproterozoic. It was maintained by erosion of Mesoproterozoic-Neoproterozoic crust and, to a lesser extent, of Early Precambrian rocks on the craton margin or in Paleoproterozoic terranes. Ar-Ar dating of amphiboles and biotites from metamorphic rocks and U-Pb dating of zircons from granitoids yielded 600–555 and 500–440 Ma, respectively, corresponding to the Vendian and Early Paleozoic stages of nearly synchronous metamorphism and plutonism. Accretion and collision events caused amalgamation of the Paleoproterozoic, Mesoproterozoic, and Neoproterozoic terranes in the Vendian and their collision with the Siberian craton. The lateral growth of the paleocontinent completed in the Late Ordovician.

Keywords: Precambrian terranes, Central Asian Fold Belt, isotopic provinces, crustal growth, collision, accretion

Introduction

The Precambrian Kan, Arzybei, and Derba terranes bordering the Siberian craton in the southwest bear signature of Late Precambrian geological events and their studies can thus provide clues to the early crust evolution in the Central Asian Fold Belt. The age of Precambrian terranes in the Central Asian Fold Belt and their origin remain open to discussion. The high-grade metamorphic complexes that build Precambrian terranes in the belt were originally correlated to Early Precambrian basement complexes of the Siberian craton and the terranes were described as its former fragments (Polkanov and Obruchev, 1964). Later the Sangilen and Derba blocks were interpreted as microcontinents without Precambrian basement rifted away from Laurasia in the Riphean (Berzin et al., 1994). The recentmost views distinguish composite microcontinents with Early Precambrian crust (Baidarik block as part of the Hangayn microcontinent) (Dobretsov, 2003) and microcontinents with mostly metasedimentary Riphean crust (Sangilen, Barguzin-Vitim, etc.) (Yarmolyuk et al., 1999). Nd isotope data prompted an inference of mainly Early-Middle Riphean age of most microcontinents but the crust production was attributed to terrigenous deposition rather than magmatism for the lack of explicit geological and isotopic evidence of pre-Late Riphean juvenile crust (Kovalenko et al., 1999).

Recent data of isotopic ages and trace-element compositions of rocks from three Precambrian terranes (Kan, Arzybei, and Derba) bordering the southwestern margin of the Siberian craton (Fig. 1) revealed the presence of metavolcanic and plutonic complexes varying in age from Paleoproterozoic to Early Paleozoic. Our objective is to reconstruct the Proterozoic history of continental crust in the folded southwestern periphery of the Siberian craton. We synthesize the available geological, petrological, and isotopic evidence to constrain the

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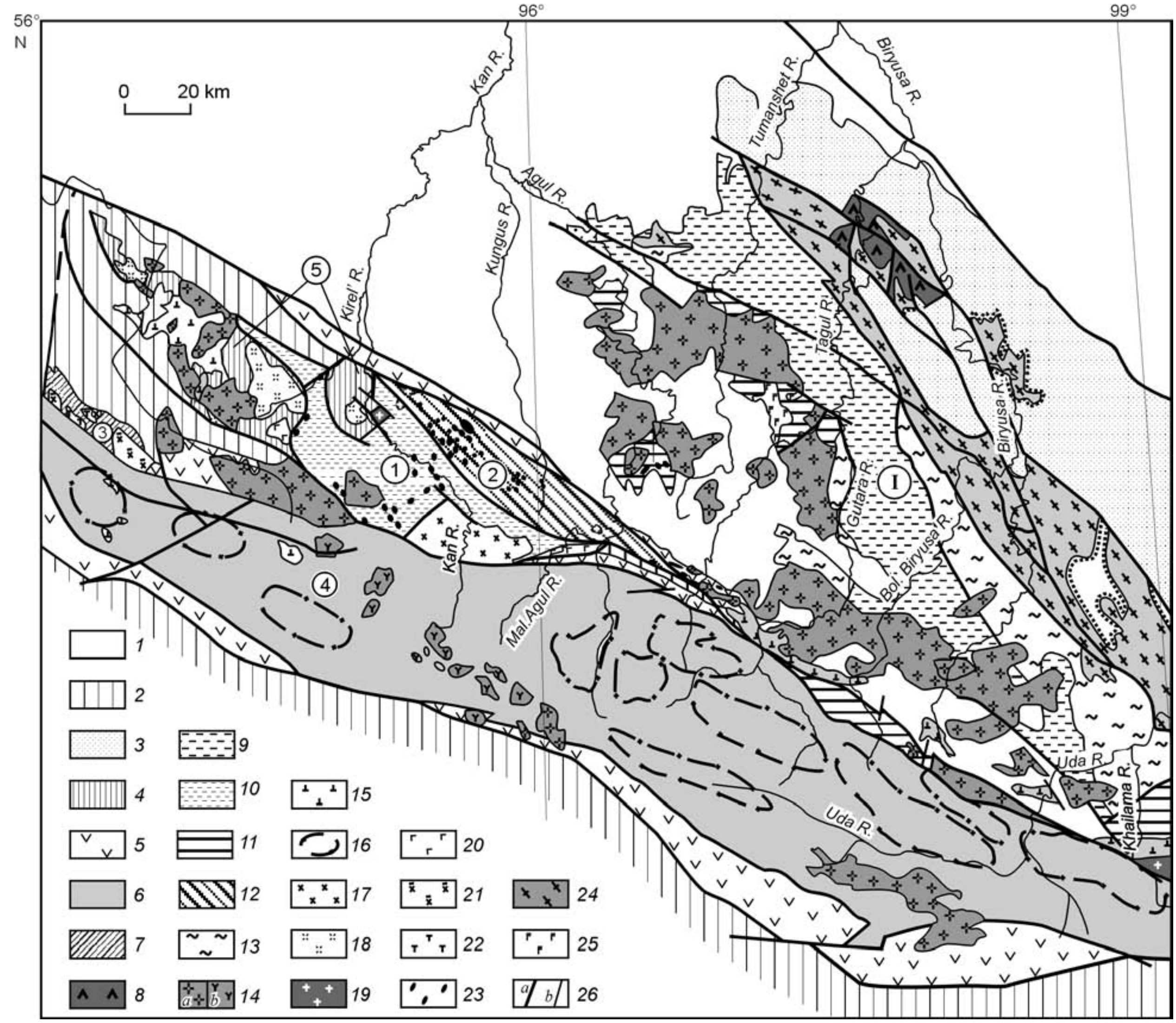

Fig. 1. Generalized geology of northwestern East Sayan. *1* — Phanerozoic sedimentary cover of Siberian Platform; *2* — Paleozoic complexes of Central Asian fold belt; *3–12* — Precambrian stratified complexes: *3–6* — Neoproterozoic sedimentary (Oselok, Karagas Groups) (*3*), metavolcanic (Shumikha-Kirel terrane) (*4*), metavolcanic-sedimentary (Kuvai Group, other formations) (*5*), and metaterrigenous-carbonate (Sayan Group, Derba terrane) (*6*) complexes; *7* — Mesoproterozoic metasedimentary-volcanic complex (Arzybei terrane); *8–11* — Paleoproterozoic metaterrigenous-volcanic (Subluk Group) (*8*), metacarbonate-terrigenous (Neroi Group) (*9*), metasedimentary-volcanic (Central terrane in Kan superterrane) (*10*) complexes and basement exposures in Agul basin (*11*); *12* — Paleoproterozoic-Mesoproterozoic metasedimentary-volcanic complexes in Idar terrane in Kan superterrane; *13* — Archean granulite gneisses (Khailama Group); *14–25* — intrusive complexes: *14–16* — Early Paleozoic complexes of granite (*14a*) and syenite (*14b*), gabbro (*15*), veins and small intrusions of Derba granitoids (*16*); *17* — Vendian trondhjemite; *18–20* — Neoproterozoic tonalites-trondhjemite (*18*), granite (*19*), and metagabbro (*20*); *21*, *22* — Mesoproterozoic tonalite (*21*) and metagabbro (*22*); *23* — Paleoproterozoic-Mesoproterozoic(?) ultramafics and ultramafic-mafics; *24*, *25* — Paleoproterozoic granitoids (*24*) and metaanorthosite-gabbro (*25*); *26* — geological boundaries: *a* — faults, *b* — other boundaries. Numbers in circles stand for names of terranes: I — Biryusa superterrane; 1 — Central, 2 — Idar, 3 — Arzybei, 4 — Derba, 5 — Shumikha-Kirel terranes.

main stages of crust evolution and accretion-collision events in the region.

Methods

Contents and isotope compositions of Sm and Nd were analyzed at the Laboratory of Geochronology of the Geological Institute (KSC, Apatity) following the method reported in (Bayanova, 2004), on a Finnigan MAT-262 (RPQ) 7-collector mass spectrometer in static mode. Total blanks were 0.06 ng for Sm and 0.3 ng for Nd. Sm and Nd contents and the $^{147}Sm/^{144}Nd$ ratios are determined to a two-sigma accuracy of ±0.2% (2σ); the accuracy of $^{143}Nd/^{144}Nd$ ratios is specified in Table 1. The average $^{143}Nd/^{144}Nd$ ratios are 0.511833±6 (2σ) for the La Jolla (*N*= 11) and 0.512072±2 (2σ) for Jindil (*N* = 44) standards during the period of study. Ar-Ar measurements were carried out at the Institute of Geology and Mineralogy (Novosibirsk) using the techniques from (Ponomarchuk et al., 1998). Uncertainty in age determination is