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MAIN STAGES OF CONTINENTAL CRUST FORMATION IN THE WESTERN ALDAN SHIELD: CONSTRAINTS FROM SM-ND ISOTOPE SYSTEMATICS OF CENOZOIC SANDS IN THE CHARA AND TOKKA BASINS

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Previous geochronological and Sm-Nd isotope-geochemical studies have identified the main stages of the Precambrian continental crust formation in the central and eastern parts of the Aldan Shield [*Kotov et al., 2006*], while its western part (Chara-Olekma Geoblock) has not been adequately investigated yet in this respect. Extensive fields of Meso- and Paleoarchaean tonalite-trondhjemite orthogneisses and numerous massifs of Mesoarchean intrusive granit oids form much of the Chara-Olekma Geoblock, whose main geological features are defined by the NE- and near NS-trending fault zones of different type and age (Fig. 1). Within these zones there occur relatively small tectonic blocks of granulite facies metamorphic rocks and (or) numerous tectonic fragments consisting of weakly metamorphosed Mesoarchean sedimentary and volcanic rocks from the greenstone belts of the Subgan Complex. Paleoproterozoic terrigenous deposits of the Udokan Group, infilling the vast Kodar-Udokan basin and a great many smaller "graben-synclines", rest unconformably on the Archean orthogneisses and Mesoarchean rocks of greenstone belts.

In the central part of the Chara-Olekma Geoblock, there occur large Chara and Tokka basins of the Baikal Rift Zone eastern flank (Fig. 1), which are infilled by mainly Cenozoic arkosic sands of lacustrine and

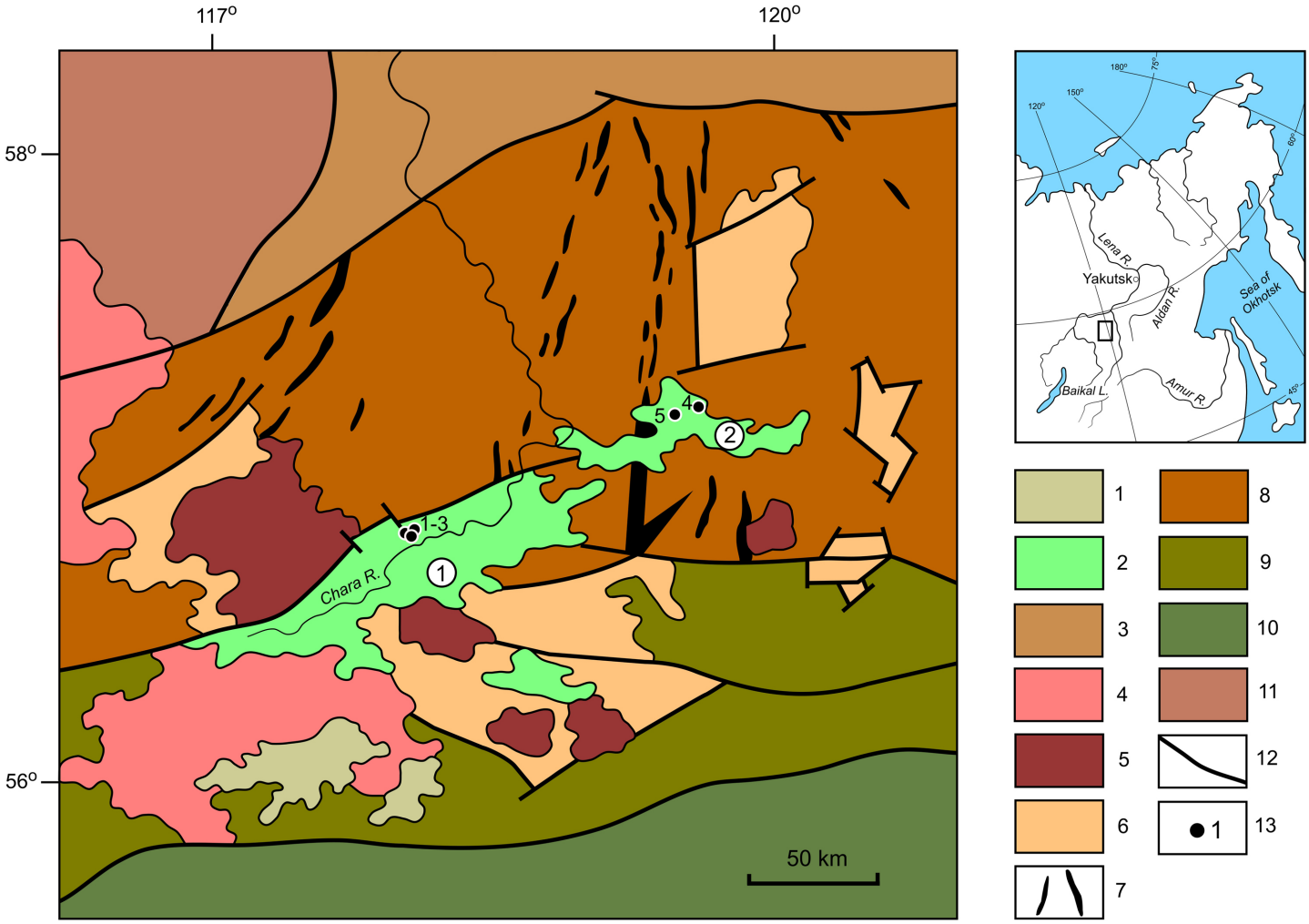

Fig. 1. Schematic geological structure of the western part of the Aldan shield.

1 – flood-basalts (N_2-Q); *2* – Cenozoic sand deposits; *3* – Mesozoic, Paleozoic and Upper Proterozoic platformal rocks; *4* – Phanerozoic granitoids; *5* – Paleoproterozoic granites of the Kodar complex; *6* – metasedimentary rocks of the Udokan Group; *7* – weakly metamorphosed sedimentary and volcanic rocks from the greenstone belts of the Subgan complex; *8* – Meso- and Paleoarchean tonalite-trondhjemite orthogneisses and Mesoarchean intrusive granitoids of the Chara-Olekma Geoblock of the Aldan shield; *9* – junction zone between the Aldan shield and Central Asian mobile belt (Stanovoi suture); *10* – Selenga-Stanovoi superterrane of the Central Asian mobile belt; *11* – Baikal orogenic zone; *12* – faults; i – localities sampled for Sm-Nd isotope-geochemical studies. Numbers in circles are basins: 1 – Chara, 2 – Tokka.

aeolian origin [*Lopatin, 1972*]. Owing to the relative constancy of $^{147}Sm/^{144}Nd$ values in clastic sedimentary rocks, their significant difference from those observed in mantle sources, as well as low susceptibility to modification by weathering, transport, diagenetic and metamorphic processes, Sm-Nd isotope-geochemical studies of these sediments allow estimates to be made for the average Nd model age of rocks from distributive provinces. In turn, this makes it possible to determine the starting material for sedimentary rocks, to locate sedimentary provenances and, thus, to obtain additional information on the continental crust growth in the Chara-Olekma Geoblock of the Aldan Shield.

Paleoproterozoic Nd model ages ($t_{Nd(DM)}$=2.4 Ga) and negative $\varepsilon_{Nd}(0)$=–27.2…–27.5 are characteristic of the Chara basin sands. Consequently, the source of these sands is rocks with the average Paleoproterozoic Nd model age. The sands of the Tokka depression have Mesoarchean Nd model ages ($t_{Nd(DM)}$=3.0 Ga) and lower values of $\varepsilon_{Nd}(0)$=–31.4…–42.4, suggesting the predominance of Mesoarchean or younger rocks with the average Mesoarchean Nd model age in their sources.

Based on the geological data (Fig. 1), the main contributors to the Chara and Tokka sand deposits could be:

1. Meso- and Paleoarchean tonalite-trondhjemite orthogneisses and Mesoarchean intrusive granitoids.
2. Paleoproterozoic metasedimentary rocks of the Udokan Group.
3. Paleoproterozoic granites of the Kodar Complex.

In the ε_{Nd} versus age diagram (Fig. 2), the Nd isotopic data points for the Chara samples plot within the

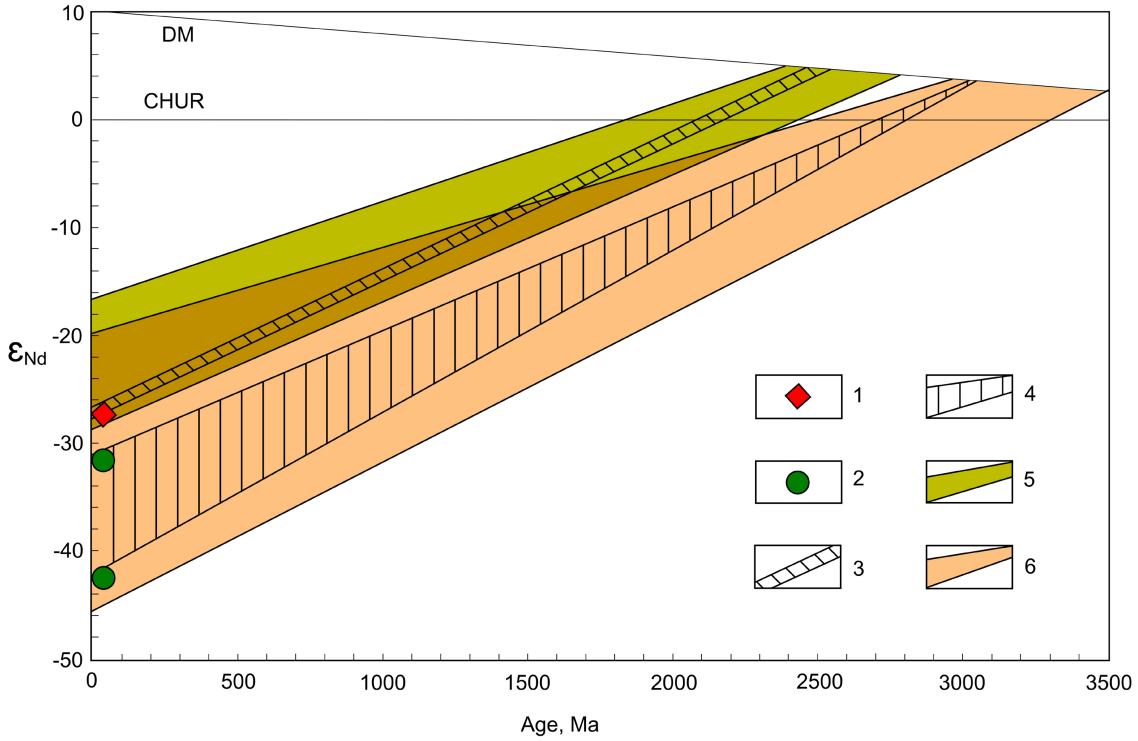

Fig. 2. ε_{Nd} versus age diagram for the sands from the Chara and Tokka basins.

1–2 – Nd isotopic data points for the sands: *1* – Chara basin, *2* – Tokka basin; *3–6* – Nd isotopic evolution fields: *3* – sands of the Chara basin, *4* – sands of the Tokka basin, *5* – Paleoproterozoic terrigenous sediments of the Udokan Group from the Kodar-Udokan trough, *6* – Meso- and Paleoarchean tonalite-trondhjemite orthogneisses and Mesoarchean intrusive granitoids of the Chara-Olekma Geoblock of the Aldan Shield.

range where Nd isotopic evolution fields for the Paleoproterozoic metasandstones and metaargillites of the Udokan Group from the southern part of the Kodar-Udokan trough and the Archean igneous rock associations from the Chara-Olekma Geoblock overlap.

Despite having overlapping Nd isotopic evolution fields and variation ranges of $\varepsilon_{Nd}(0)$ (Table, Fig. 2), the Nd model ages of sands from the Chara basin differ significantly from the Nd model ages of Meso- and Paleoarchean tonalite-trondhjemite orthogneisses and Mesoarchean intrusive granitoids from the Chara-Olekma Geoblock, as well as granites of the Kodar Complex. By their Nd isotopic characteristics, sands from the Chara basin are most similar to the Paleoproterozoic metasedimentary rocks of the Udokan Group (Table, Fig. 2). This allows us to consider the latter as the main source of sand deposits in the Chara basin.

The Nd isotopic data points of sands from the Tokka basin plot on the ε_{Nd} versus age diagram (Fig. 2) in the upper part of Nd isotopic evolution field of Meso- and Paleoarchean tonalite-trondhjemite orthogneisses and Mesoarchean intrusive granitoids of the Chara-Olekma Geoblock. By their Nd isotopic characteristics, sands from the Tokka basin show maximum similarity to

Comparison of the Nd-isotopic characteristics of sands from the Chara and Tokka basins and their possible sedimentary provenances

Rocks	$\varepsilon_{Nd}(0)$		$t_{Nd(DM)}$, Ga	
	min	max	min	max
Sands of the Chara basin	–27.5	–27.2	2.42	2.45
Sands of the Tokka basin	–42.4	–31.4	2.95	2.98
Paleoproterozoic granitoids of the Kodar complex [*Larin et al., 1999, 2000 2012*]	–35.8	–26.2	2.60	3.06
Paleoproterozoic metasedimentary rocks from the Udokan group of the Udokan subzone of the Kodar-Udokan trough [*Podkovyrov et al., 2006*]	–29.0	–17.0	2.29	2.74
Meso- and Paleoarchean tonalite-trondhjemite orthogneisses and Mesoarchean intrusive granitoids of the Chara-Olekma Geoblock [*Sal'nikova et al., 1996*]	–46.3	–20.2	2.98	3.69

the Mesoarchean igneous rock associations from the eastern part of the Chara-Olekma Geoblock (Table), which are probably their major source rocks. It can be inferred that Paleoproterozoic granitoids of the Kodar Complex were an additional source of sand deposits in the Tokka basin (Table), which are products of the Mesoarchean continental crust recycling, as well as Mesoarchean felsic metavolcanic rocks of the Tokka-Khani greenstone belt, which yielded an estimate of $t_{Nd(DM)}$=2.9–3.0 Ga [*Kotov et al., 2004*].

Findings of the Sm-Nd isotope-geochemical studies on sands from the Tokka basin support the view of [*Kotov et al., 2006*] that the Chara-Olekma Geoblock of the Aldan Shield is an area where processes of intense crust formation were at work not only in the Paleoarchean but also in the Mesoarchean. The accumulation of Paleoproterozoic terrigenous rocks of the Udokan Group which served as the main source of sands in the Chara basin, is related to the disintegration of the Archean igneous rocks in the Chara-Olekma Geoblock and rocks of the juvenile continental crust of the Paleoproterozoic orogens, probably located in its southern and western peripheries (in present-day coordinates) [*Podkovyrov et al., 2006*]. Hence, Paleoproterozoic Nd model age estimates characteristic of sands from the Chara basin cannot be regarded as a basis for recognising the Paleoproter ozoic stage in the formation of the Chara-Olekma Geoblock continental crust. However, it is not improbable that one of the sources of sands in the Chara basin were rocks directly reflecting the formation of the Paleoproterozoic juvenile continental crust in the western part of the Aldan shield, occurrence within the Chara-Olekma Geoblock of which has not been established yet.

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