BEITRÄGE ZUR REGIONALEN GEOLOGIE DER ERDE

Band 32

The Central Asian Orogenic Belt

Geology, Evolution, Tectonics, and Models

edited by Alfred Kröner

With 109 figures and 2 tables

2015

Borntraeger Science Publishers · Stuttgart

A. Kröner (ed.): Composition and evolution of Central Asian Orogenic Belt

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Front cover: Kröner, A., The Central Asian Orogenic Belt – Present knowledge and comparison with the SW Pacific; p. 1–5; Fig. 1. Geological map of Central Asia showing location of contributions in this volume. Based on Geological Map of Central Asia and Adjacent Areas 1 : 2 500 000 (2008), Geological Publishing House, Beijing, China.

ISBN 978-3-443-11033-8

Information on this title: **www.borntraeger-cramer.com/9783443110338**

Publisher: Gebr. Borntraeger Verlagsbuchhandlung
Johannesstr. 3A, 70176 Stuttgart, Germany
mail@borntraeger-cramer.de
www.borntraeger-cramer.de

∞ Printed on permanent paper conforming to ISO 9706-1994

Typesetting: DTP + TEXT Eva Burri, Stuttgart
Printed in Germany by 00000000 GmbH, Tübingen

Neoproterozoic accretion of the Tuva-Mongolian massif, one of the Precambrian terranes in the Central Asian Orogenic Belt

A.B. Kuzmichev

Abstract. The Tuva-Mongolian massif (TMM) is one of the numerous Precambrian terrranes scattered over the Central Asian Orogenic Belt (CAOB). It is likely that most of these terranes are the dispersed fragments of a large continent. This paper provides a schematic overview of the TMM Neoproterozoic tectonics. These data can be compared with those for similar terranes to restore the early history of CAOB evolution. The TMM shows an asymmetric structure with its eastern part representing a Neoarchaean block. Early and late Neoproterozoic arcs were successively accreted to its western margin in the course of two collision events (~800 and ~600 Ma). The first event occurred when the TMM was still attached to the parental continent, whereas during the second stage the TMM was already a microcontinent. The early Neoproterozic Dunzhugur island arc was created not later than 1034 ± 9 Ma existed up to 810 Ma when it collided with the passive margin of the ancient continent. At the end of the early Neoproterozoic (about 850 Ma) the Dunzhugur arc split up, giving birth to the Shshkhid island arc. The mid-Neoproterozoic orogeny involved obduction of the Dunzhugur forearc ophiolite onto the passive margin that produced gravitational nappes in the foreland basin. Subsequently the subduction polarity changed and the subduction channel became inclined beneath the continental margin. This caused Andean-type magmatism on the continental margin to occur that still belonged to the continent. Three tectonic units can be reconstructed in the early late Neoproterozoic. These are the Sarkhoi volcanic belt resting on the above continental margin. The Oka accretionary prism grew outward from it, and the Shishkhid island arc drifted in the Palaeo-Asian ocean. At ~750 Ma an oceanic spreading ridge arrived at the subduction zone and this produced voluminous basaltic magma intrusions into the prism sediments. This event may have triggered back-arc rifting in the rear of the Sarkhoi continental arc. It is likely that, at about the same time, the Shishkhid arc collided with the Sarkhoi margin and generated a triple junction. At least from the middle of late Neoproterosoic the Tuva-Mongolian massif existed as a micrcontinent, separated from its ancestor by a newly formed oceanic basin. By ~600 Ma the Shishkhid arc was completely accreted onto the Sarkhoi margin, and the TMM reached its full size. In the latest Neoproterozoic and Cambrian the Tuva-Mongolian microcontinent drifted through the Palaeo-Asian ocean as a carbonate platform. Collision of the island arc and continental terranes began in late Cambrian and culminated in the Early Ordovician when the TMM and surrounding terranes were squeezed between Siberia and one of the Gondwana-derived continents.

Introduction

General information

The Central Asian Orogenic Belt (CAOB) includes numerous Precambrian terranes dispersed throughout anastomosing intervening Palaeozoic belts (e.g., Şengör and Natal'in 1996, Yakubchuk 2004, Windley et al. 2007, Levashova et al. 2011b). It is likely that most of these terranes are fragments of a large continent and its restoration is uncertain. The Precambrian terranes provide a record of the early geological history of the CAOB that is still poorly understood. This paper concerns the geologic structure and evolution of one such terrane,

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namely the Tuva-Mongolian massif (TMM). It would appear that some CAOB Precambrian terranes show structural patterns similar to that of the TMM. Therefore, this paper provides data for geological correlations with other Precambrian terranes in the CAOB.

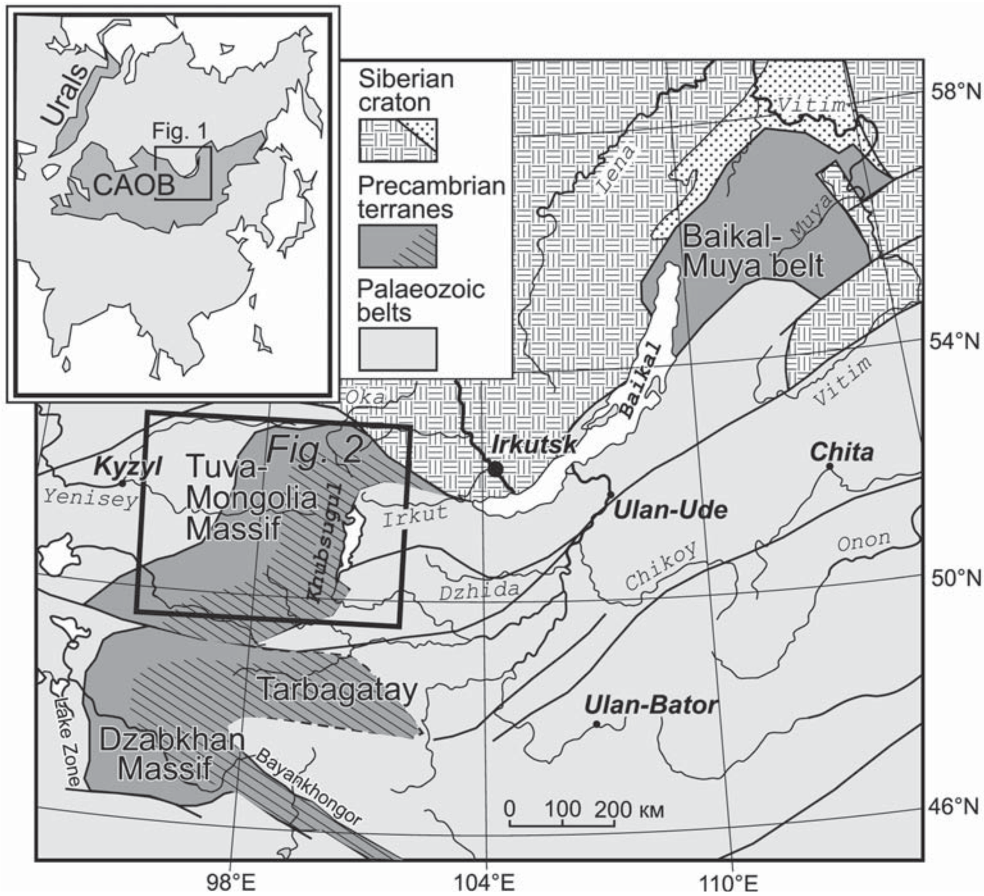

Fig. 1. Location of the Tuva-Mongolian and Dzabkhan massifs in the CAOB. The striped eastern portion of the massifs is the ancient core with pre-Neoproterozoic basement. Location of Fig. 2 is outlined.

The Tuva-Mongolian Massif and the related Dzabkhan (or Zavkhan) terrane are located in the Sayan-Baikalian region that fringe the southern part of the Siberian craton (Fig. 1). This area preserves an almost complete record of Neoproterozoic to early Palaeozoic tectonic events and can be regarded as one of the key regions to reconstruct the early phases of CAOB evolution. The paper deals mostly with the northern TMM (Figs. 2, 3), whose Neoproterozoic evolution is reasonably well understood. Some features may be correlated with that of the Dzabkhan terrane where new geochronological data were recently published. A substantial part of the TMM is covered by Palaeozoic rocks and intruded with Palaeozoic granitoids. Both have been removed from the majority of figures in this paper to show the Precambrian structures. In spite of the review style of the paper it does not include a complete bibliography and review of previous work. It should be noted that all Neoproterozoic units discussed below were previously thought to be Palaeozoic in age. The complete references lists on each subject discussed in the paper can be found in the cited works.

Outline and structure of the TMM

The Tuva-Mongolian Massif is a traditional name, proposed by Ilyin (1971), though most of the "Massif" is built up of sedimentary and volcanic rocks, which underwent low-grade metamorphism. The TMM is predominantly composed of Neoproterozoic rocks that are unconformably covered by Vendian-Cambrian shallow-water carbonate deposits. These were folded and faulted during an Early Ordovician orogeny and no longer look like a platform cover. Yet this carbonate unit is a distinguishing feature of the massif: in the surrounding regions rocks of the same age are represented by an island-arc volcanic suite, ophiolites and shale-sandstone clastic sediments. The boundaries of the TMM terrane differ significantly, depending on the literature cited (e.g., Windley et al. 2007, Badarch

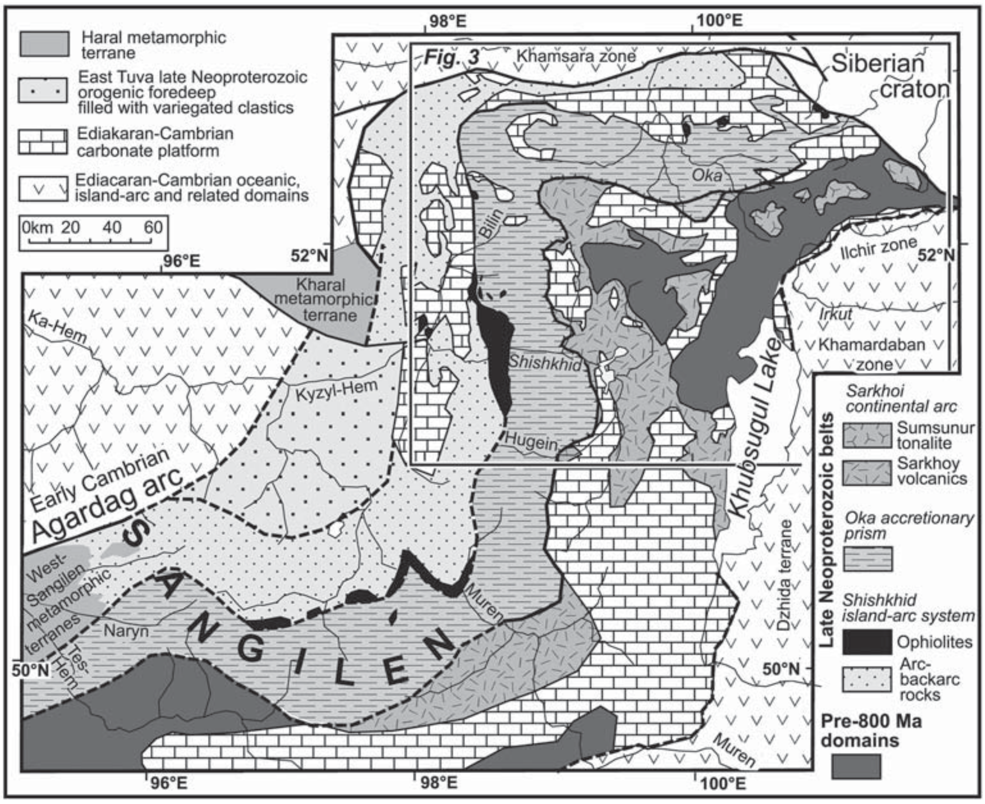

Fig. 2. Early and late Neoproterozoic belts in the Tuva-Mongolian massif. Location of Fig. 3 is outlined.

et al. 2002, Kovalenko et al. 2004, Kozakov et al. 2011). In this paper all units that were accreted to the ancient core of the TMM by the end of the Precambrian are included in the terrane.

The TMM exhibits an asymmetric structure. Its eastern part comprises a Neoarchaean block (Figs. 1, 3), and early to late Neoproterozoic arcs were successively accreted to its western part in the course of two collision events (~800 and ~600 Ma). Therefore, the Neoproterozoic history of the massif includes two phases: early and late Neoproterozoic. The general trend of this evolution is the successive growth of the continent through the addition of new continental crust due to island arc accretion. During both phases the continental margin faced towards the Palaeo-Asian Ocean and an island arc at some distance. The long duration of each phase (about 200 Ma) leads to a question concerning the life span of oceanic arcs which is discussed below.

The Tuva-Mongolian and Dzabkhan combined terrane shows an arcuate eastern (inner) margin (Fig. 1). It is fringed on the inner side by Vendian-early Palaeozoic belts, i.e. the Dzhida and Ilchir belts on the northern limb (Fig. 2) and Bayankhongor belt in the south (Fig. 1). They include island-arc volcanic rocks, ophiolites and related rocks of latest Neoproterozoic to Cambrian age (e.g., Belichenko et al. 2003, Gordienko 2006, Jian et al. 2010a). The outer, western margin of the massif is also fringed by ocean-related Vendian-Cambrian belts namely the Agardakh in the west (Fig. 2) and the Lake Zone of Mongolia in the southwest (Fig 1) (e.g., Pfänder and Kröner 2004, Yarmolyuk et al. 2011).

The Precambrian units constituting the TMM are discussed below from old to young, namely the pre-Neoproterozoic basement, followed by the early and then late Neoproterozoic belts. Two palaeogeographic features can be restored in the early Neoproterozoic (1000–800 Ma), namely a passive margin of the ancient continent and an oceanic arc (Dunzhugur arc). The late Neoproterozoic segment of the TMM embraces three distinct belts (Fig. 3). The eastern one is the Sarkhoi volcanic belt built upon the ancient cratonic

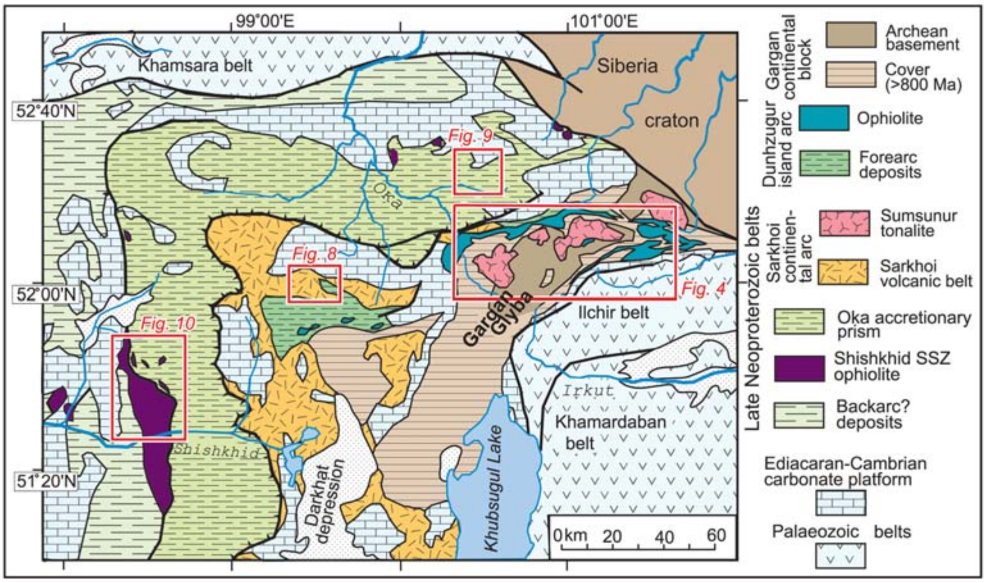

Fig. 3. The structure of the Northern TMM, the area studied by author. Locations of Figs. 4-6 are outlined.

terrain. It represents a continental magmatic arc (Kuzmichev and Larionov 2011) and is adjoined in the west to the Oka belt, composed of shales, sandstones, and greenschists corresponding to a late Neoproterozoic accretionary prism (Kuzmichev et al. 2007). The western zone is a discontinuous ophiolite belt that includes the Shishkhid ophiolite as the largest body. Ophiolites and related sedimentary and metasedimentary rocks constitute most of the outer zone of the TMM and in the Neoproterozoic belonged to the Shishkhid island arc system (Kuzmichev et al 2005).

Fragments of an ancient continent in the core of the massif

The ancient continental block in the core of northern TMM is named the Gargan salient (Gargan Glyba, Figs. 3, 4) and is composed of a Neoarchaean crystalline basement unconformably overlain by an early Neoproterozoic carbonate platform cover. The basement is composed of amphibolite, quartzo-felspathic gneiss, and garnet-pyroxene gneiss with plagioclase oikocrysts. These rocks exhibit a retrograde amphibolite-facies mineral assemblage that was superimposed on granulite-facies rocks. Zircons extracted from a biotite-amphibole metatonalitic gneiss were dated with TIMS and yielded a magmatic age of 2727 ± 6 Ma, whereas recrystallized metamorphic zircon was dated at about 2.6 Ga (Anisimova et al. 2009b).

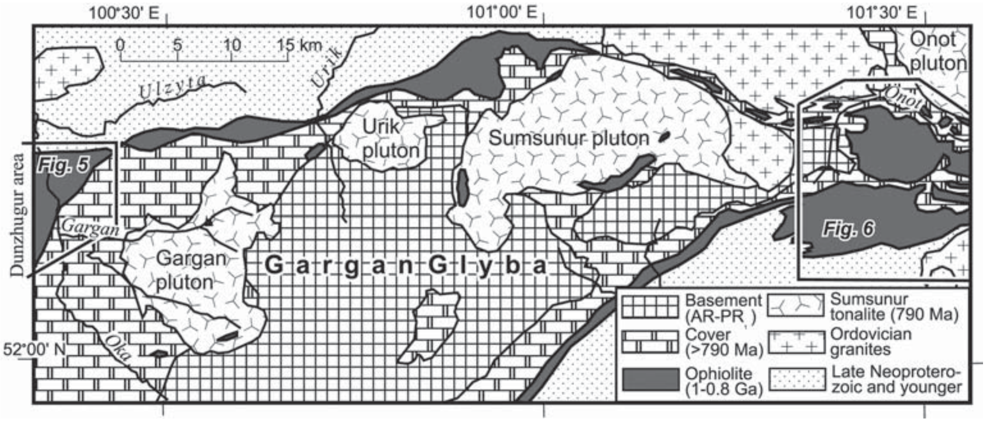

Fig. 4. The Gargan Glyba Archaean salient covered by a carbonate platform and fringed by ophiolite. All three units are intruded by ~800 Ma tonalite. Based on USSR State Geologic Mapping and the authors' surveys. Locations of Figs. 5 and 6 are indicated.

The early Precambrian crystalline rocks are more widespread in the Dzabkhan and Tarbagatai terranes (Fig. 1). In the eastern Dzabkhan massif (Baidarik uplift) metatonalite gneiss and two-pyroxene gneiss revealed three zircon populations, namely ~ 2.8 Ga (protolith age), 2.65–2.5 Ga (granulite-facies metamorphism and ~ 1.8 Ma (amphibolite-facies metamorphism) (Kozakov et al. 2007). These rocks were cut by hyperstene diorite at

2364 ± 6 Ma and undeformed isotropic granite at 2308 ± 4 Ma (Kozakov et al. 2007 and references therein). Similar and younger ages were obtained using $^{206}Pb/^{207}Pb$ evaporation and SHRIMP techniques (Demoux et al. 2009a, b). A granite-gneiss in the Tarbagatai terrane was dated as 2219 ± 25 Ma and an anorthosite as 1784 ± 10 Ma (zircon, TIMS, Anisimova et al. 2009a, Kozakov et al. 2011).

The asymmetry of the combined TMM and Dzabkhan terrane implies that it broke off along its eastern side from an ancestral ancient continent. The identification of this continent is a challenging problem: many similar Precambrian fragments are dispersed throughout the CAOB, and at least three competing hypotheses are discussed for their origin. The first postulates that all terranes are fragments of East Gondwana and drifted away from it during the late Neoproterozoic (e.g., Kheraskova et al. 2003, Buslov et al. 2001). This hypothesis is supported by some palaeomagnetic data (Levashova et al. 2011a). The second point of view restores the Precambrian terranes to the southern (recent) margin of the Siberian craton (Kuzmichev 2004, Windley et al. 2007). This view is also supported by palaeomagnetic evidence (Kravchinsky et al. 2010). The third hypothesis reconstructs the Neoproterozoic TMM as a sliver of continental crust attached to the Siberian craton (Sengor and Natal'in 1996, Yakubchuk 2004). The present author believes that the second model is most likely. The known ages for the crystalline basement of the TMM, Dzabkhan and Tarbagatai terranes cannot help in seeking the parental continent. Archaean and Proterozoic rocks with similar ages are known from the South China craton, the Aldan-Stanovic region in the southern part of the Siberian craton and in other places. Furthermore, many of the published zircon ages were obtained using the multigrain TIMS technique, which is hardly applicable for polymetamorphic rocks.

Early Neoproterozoic continental margin deposits

The crystalline basement of Gargan Glyba in the northern TMM is unconformably covered by a platform sedimentary succession (Fig. 4). This cover consists of the Irkut Formation marbles at the bottom and the Ilchir Formation shales above. The Irkut Formation consists of a thickly-bedded dolomitic marble up to 600 m thick, in places stromatolitic, and contains recrystallized chert beds. A basal conglomerate contains pebbles of quartz and metamorphic rocks. The lowermost layers also contain muscovite schist that probably represents a metamorphosed high-alumina weathering product. The Ilchir Formation is composed of dark grey shale along with sporadic interbeds of fine-grained sandstone and limestone. The uppermost Ilchir Formation is exposed between ophiolite klippen in the inner zone of the Gargan block and is noted for the presence of olistostromes with ophiolite and Irkut dolomite exotic clasts up to a few hundred metres long.

The above sedimentary succession is interpreted as a passive-margin shelf deposit. These rocks were intruded at 790 Ma by the Sumsunur tonalite (see below) that defines the upper age limit of sedimentation. It is likely that the sedimentary cover is not older than early Neoproterozoic, because its uppermost horizon is an olistostrome that was deposited synchronously with ophiolite obduction in the course of a mid-Neoproterozioc orogeny.

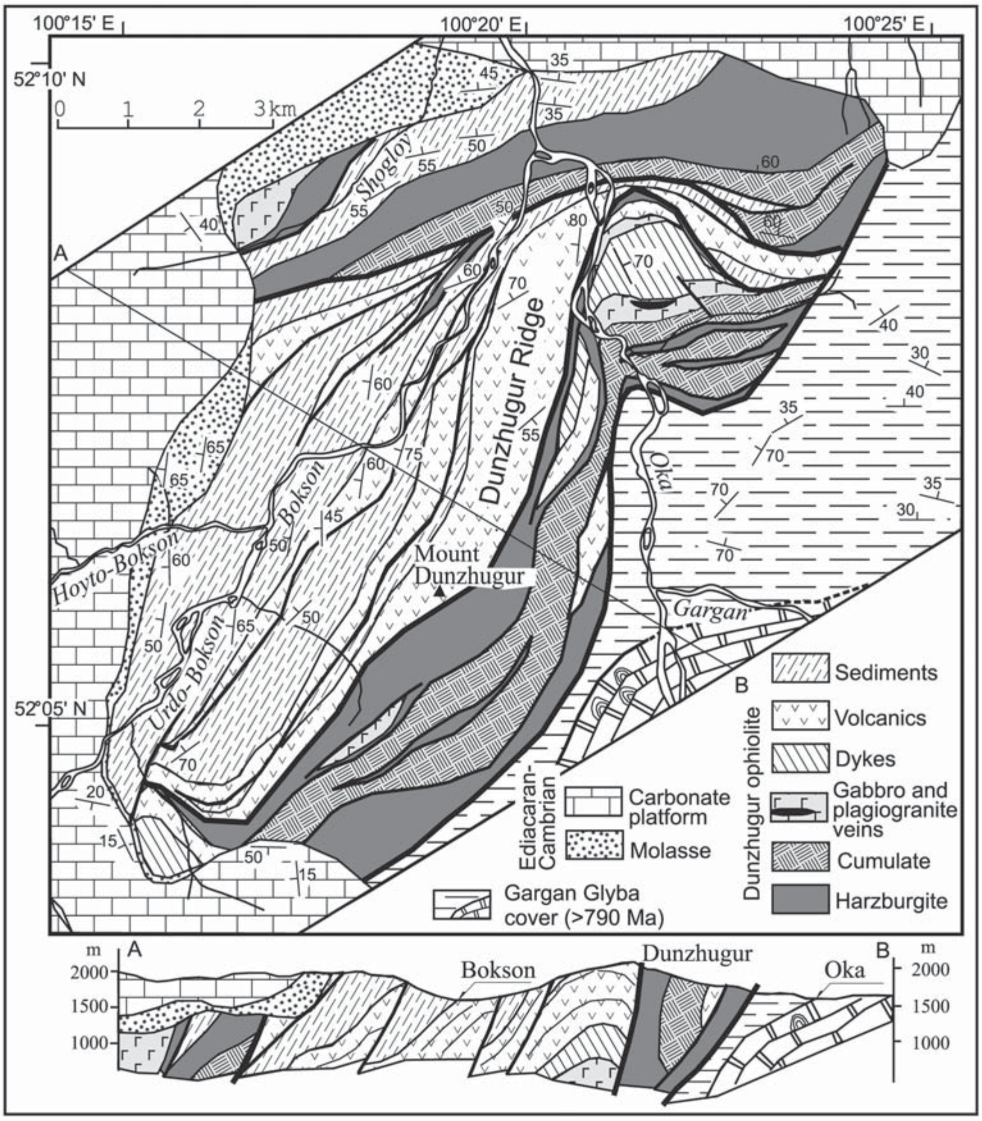

Fig. 5. Ophiolite nappes in the Dunzhugur area. Cenozoic rocks and diabase sills omitted. See Fig. 4 for location.

Early Neoproterozoic Dunzhugur oceanic arc

The Dunzhugur island arc is represented by a supra-subduction zone (SSZ) ophiolite that forms two belts fringing the Gargan Glyba (Fig. 4). These belts are reminders of an eroded allochthon, whose klippen also occur on top of Glyba. The most representative ophiolite section is exposed in the Dunzhugur area (west of the Gargan Glyba) (Fig. 5) where a complete typical succession from harzburgite to oceanic pillow basalt was mapped and sampled in detail (Sklyarov 1990, Kuzmichev et al. 2001, Khain et al. 2002, Kuzmichev 2004). This area composed of steeply inclined stacked ophiolite slivers, which are shuffled without regularity (Fig. 5). On the opposite, eastern side of the Gargan block the ophiolite allochthon forms synforms separated by crest-like anticlines into which the Ilchir shales have been squeezed (Fig. 6). The allochthon shows erosional windows and klippen and is much less disturbed than in the Dunzhugur region. It is chiefly composed of serpentinized harzburgite. Layered ultramafic rocks, massive gabbro, sheeted dykes and basalts are confined to the allochthon foot and display a reverse sequence (Kuzmichev 2001). The presence of low-Ti basalt and boninite among the ophiolitic sheeted dykes and volcanic rocks was revealed by Sklyarov et al. (1990). These features indicate a supra-subduction setting for the ophiolite suite.

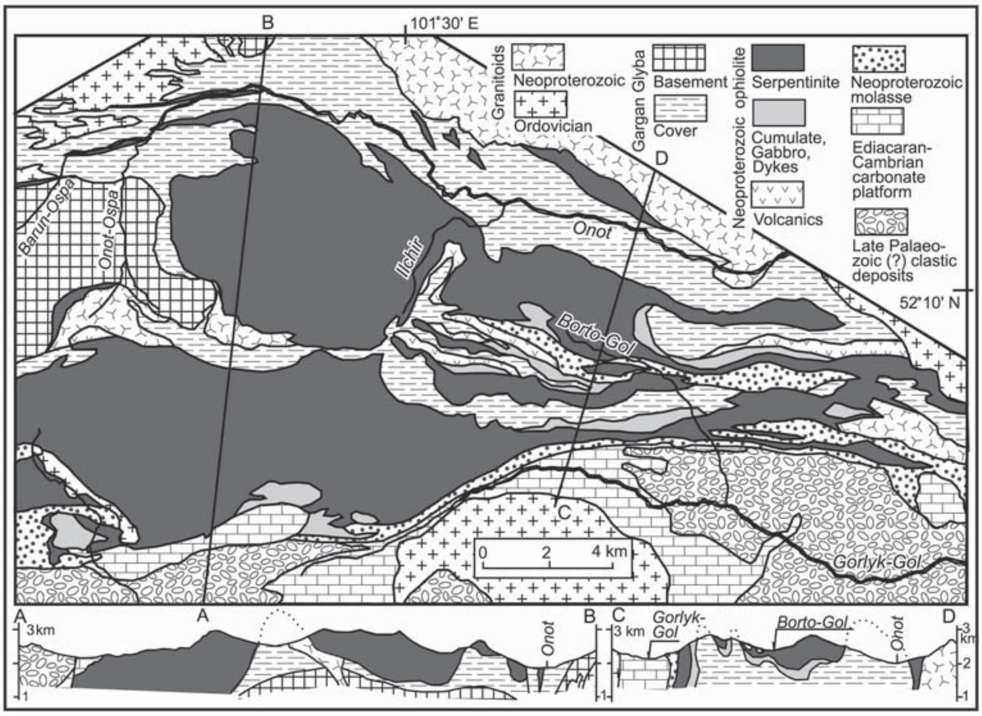

Fig. 6. Sketch map of ophiolite nappes and underlying Ilchir olistostrome in the Onot–Gorlyk-Gol region.

The sedimentary rocks associated with the ophiolite form the upper parts of thrust sheets in the Duzhugur area. The lower member of this sedimentary succession conformably rests upon the pillow basalt. It is represented by turbidites with lenses of clastic rocks composed of basaltic debris and occasional blocks of gabbro and ultramafic rocks. The upper part of the sedimentary section is composed of sandstone and conglomerate with volcanic clasts including andesite, dacite, rhyolite and their plutonic counterparts. They correspond to the later phases of Dunzhugur arc magmatism.

The Dunzhugur ophiolite succession and especially the sedimentary rocks at its top are densely intruded by diabase sills and dykes with MORB affinity. This igneous suite evidentially indicates extension in the island arc that can be attributed to intra-arc rifting that is discussed in the last section.

The age of the Dunzhugur arc is constrained by dating ophiolitic plagiogranite that forms veins in the layered gabbro on the eastern bank of the Oka River (Fig. 5). The zircon U–Pb conventional and $^{207}Pb/^{206}Pb$ evaporation age is 1020 Ma (Khain et al. 2002). Keeping in mind the boninitic composition of the ophiolite volcanic rocks, this age probably correspond to the incipient phase of oceanic arc evolution (Shervais 2001, Dilek and Furnes 2011). Subsequently such ophiolite successions form a basement to the forearc zone adjoining the trench. Such a setting is applicable to the Dunzhugur ophiolite and overlying sediments. The later phases of island-arc magmatism are represented by felsic volcanic rocks redeposited in forearc sediments of the Dunzhugur area. As shown in the next section, collision of the Dunzhugur arc and Gargan continental margin occurred at about 810 Ma. Such a long-lived volcanic arc (ca. 200 Ma) inevitably influenced the crustal composition and thickness. Some portions of the inferred mature island arc are masked by Vendian-Cambrian sediments or are overlapped by the Oka thrust (see below). However, it must be admitted that such large newly-formed crustal terrain as can be expected for a 200 Ma old island arc is not documented from field relationships in the TMM.

In order to constrain the time-span of island arc volcanism we dated zircons separated from volcanic sandstone that belong to the upper part of the sedimentary succession associated with the ophiolite. All crystals are near-euhedral and show morphologies, oscillatory CL images, Th/U ratios and U contents that are typical for zircon from felsic igneous rocks (Kuzmichev and Larionov 2013). Twelve zircons were analyzed using a SHRIMP II instrument.The age interval calculated from $^{206}Pb/^{238}U$ ratios is 910 ± 27 to 1048 ± 12 Ma (1σ). The five most ancient grains make up a concordant cluster with a mean age of 1034 ± 9 Ma age (2σ). One more grain that shows a similar $^{207}Pb/^{206}Pb$ age (1037 ± 17 Ma, 1 σ) can also be included in the cluster. Therefore, mature island-arc volcanism appears to be slightly older than the inferred incipient phase of arc formation because, at 1034 Ma, the Dunzhugur arc already produced felsic volcanic rocks. Analytical points for other grains are dispersed along the concordia curve toward younger ages. The youngest grain yielded a discordant analysis with a $^{207}Pb/^{206}Pb$ age of 910 ± 27 Ma. These results show that the arc indeed existed for a long time. A metamorphosed counterpart of the Dunzhugur silicic volcanic rocks was found in the northern Dzabkhan massif where rhyolite and dacite transformed into gneiss yielded a U-Pb zircon age 856 ± 2 Ma (Kozakov et al. 2012).

Mid-Neoproterozoic orogeny: collision of the island arc and continent

A forearc setting for the Dunzhugur ophiolite indicates that the arc was facing the continent and the oceanic plate separating them was subducting beneath the arc. After complete subduction of the oceanic lithosphere of the marginal basin, the Gargan continental margin was also partly subducted beneath the arc. Passive margins, thinned by rifting, can subduct as deep as 100 km (e.g., Cloos 1993). Simultaneously, the island arc lithosphere overrode the continental margin. A similar situation was considered as a most plausible reason for ophiolite obduction (Coleman 1977).

The obduction model for the Dunzhugur ophiolite can be deduced from different patterns of nappes in the marginal and inner parts of the Gargan block. On the northern and western margins of Gargan Glyba the ophiolite overlaps different horizons of Glyba's cover, and in places its crystalline basement (Figs. 4, 5), and the allochthon base is strongly disrupted. In the inner, eastern part the allochthon rests almost conformably on the Ilchir Formation upper horizons, containing a carbonate olistostrome (Fig. 6). The obduction in places shows no sign of strain affecting the underlying rocks. These relationships can be interpreted as follows: the allochthon has overthrust the continental margin, tearing off its platform cover. The cover's fragments were unloaded into the foreland basin, yielding olistostromes on which the ophiolites glided during sedimentation. First, their upper portion slid down to form the base of the packet of sheets, thus producing a reverse sequence where ophiolite appears in inverse stratigraphic order. This model also accounts for the difference in the structure of the allochthon in the inner and marginal areas. In the inner

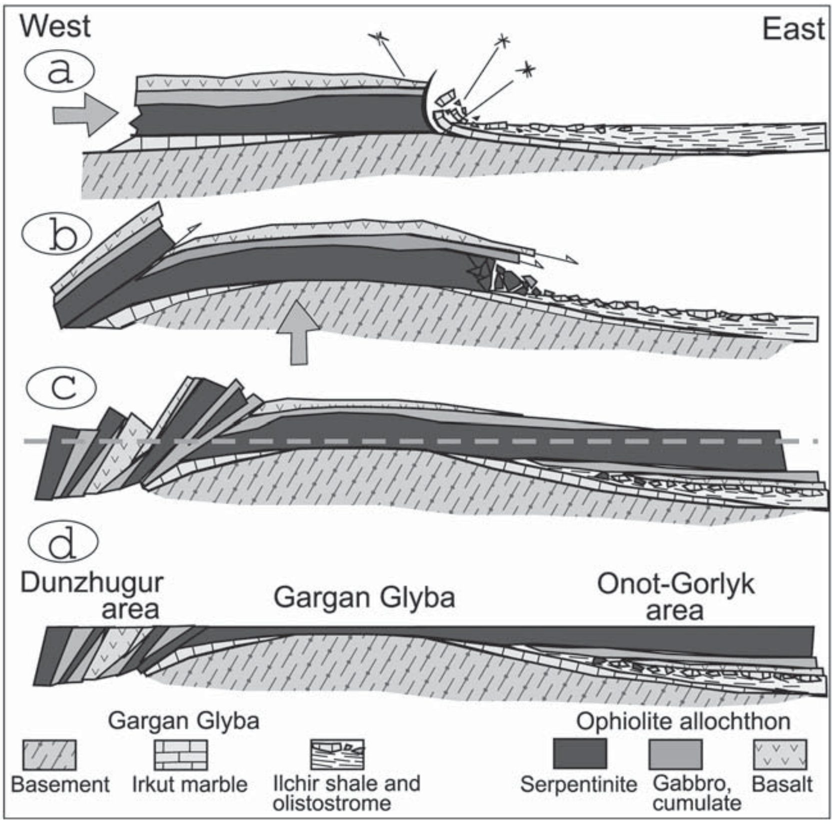

Fig. 7. The ophiolite obduction model. Note difference in the allochthon setting and structure east and west of Gargan Glyba. Most symbols correspond to Figs. 5 and 6. a) Initial stage of obduction. The allochthon was overthrust on the continental margin, tearing off its platform cover, whose fragments were unloading into the foreland basin, yielding olistostrome. b) Uplift of the Gargan margin crowned with ophiolite nappe whose sheets began sliding into the basin above the olistostrome. First, the ophiolite upper horizons slid down to form the base of the packet of sheets, thus producing a reverse tectonic sequence. c) The bulk of ophiolite nappe is sliding down to the east, while in the west ophiolite thrust sheets were stacked in front of the bulging edge of the Gargan block. d) Same situation after erosion.

site, a slightly disrupted gravitational nappe is reconstructed. In the marginal area, ophiolite stacks are piled up, which can be explained by stacking in front of the rising edge of the continent (Fig. 7).

This model is in accordance with a typical scenario suggested by McKenzie (1969) for arc–continent collision. After jamming of the original subduction zone by the edge of a continent, a new subduction zone arises, inclined beneath the continent. The break in the lithosphere puts an end to pulling the continental margin into the subduction zone. As a result, the submerged continental margin with the overthrust forearc ophiolites was torn off its root and floated upwards. This caused the gravitational sliding of the ophiolite allochthon towards the foreland basin. A split off part of the heated island-arc lithosphere, probably with active magma chambers, was involved in the initial portion of the slab subducted beneath the continental margin, provoking generation of the first melts in a newly formed continental arc (see next section).

The age of these melts (~790 Ma), which form the tonalite plutons intruding the ophiolite nappes on Gargan Glyba, was used to constrain the age of obduction (Kuzmichev et al. 2001). It is obvious that collision occurred some time earlier in the northern TMM where syncollisional granitoids are not exposed. However, new age data have recently been obtained in the southern region. In the northern Dzabkhan massif (Songin block) a synkinematic granite has a zircon age of 810 ± 2 Ma (Kozakov et al. 2009b). In the Tarbagatai terrane (see Fig. 1) a similar granite was found with a zircon age of 809 ± 4 Ma (Kozakov et al. 2009a). These ages are close to the expected age of the collision, and it is therefore reasonable to interpret the above granitoids as syncollisional intrusions. Therefore, the age of the Dunzhugur arc and continent collision is probably around 810 Ma.

As a result of collision, the volume of the former continent increased as the mature arc lithosphere was attached to it and partly obducted. The island-arc magma production rate estimated for the Aleutians (average for 75 Ma) and Izu-Ogasawara (average for 47 Ma) is 60 ± 10 km^3/km per 1 Ma (Holbrook et al. 1999). The Dunzhugur arc could have produced an enormous volume of sialic crust during its 200 Ma life time to enlarge the continent, if the above calculation is applicable to the Neoproterozoic situation.

Late Neoproterozoic Sarkhoi continental arc

General geology

The Sarkhoi volcanic suite comprises a notable unit in East Sayan and Mongolia (Sarkhoi, Darkhat and Dzabkhan Groups) due to their specific appearance: they are mostly variegated rocks, which can easily be recognized and mapped. This volcanic belt, formed on the active continental margin, is traceable for almost 1500 km and is a major unit in the TMM and Dzabkhan terranes. The geodynamic setting and age of the Sarkhoi volcanic suite are uncertain, and some authors still suggest that they are Ordovician in age and form a tectonic nappe (e.g., Fedotova and Khain 2002).

Fig. 8. Geologic map of the Sarkhoi volcanic suite in the stratotype area (see Fig. 3 for location). Legend: 1 – Quaternary; 2 – Neogene–Quaternary intraplate basalt; 3 – Ediacaran-Cambrian carbonate platform; 4 – variegated clastic rocks at the base of the carbonate sucession resting unconformably on the Sarkhoi volcanic rocks (wavy line); 5–8 Sarkhoi Group: 5, ignimbrite; 6, greenstone; 7, granophyre; 8, sandstone; 9 – Dibi turbidite; 10 – Ordovician(?) granite; 11 – dykes and other small intrusions; 12 – faults; 13 – structural lines.


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In the northern TMM the Sarkhoi Group rocks lie on a carbonate turbidite, which is somehow related to the Dunzhugur sediments (see above), thrust upon the continent. The roof is the Vendian–Cambrian Tuva-Mongolian carbonate cover. The lower horizons of this cover are composed of variegated clastic rocks that rest with an angular unconformity on volcanic rocks and grade into the overlying carbonates. The Sarkhoi Group is composed of three lithological units, named as sandstone, greenstone and ignimbrite units (Fig. 8). The sandstone unit consists of variegated polymictic or volcanic coarse-grained sandstone and conglomerate. The latter contains pebbles of the underlying sedimentary rocks, quartz, jasper, andesite and dacite. This unit was deposited in a fluvial and deltaic setting. The thickness is up to 2 km.

The greenstone unit consists of olivine basalt, andesite and more abundant dacite. Volcanic rocks occur as massive lava flows, block lava, clastic tuff and rare pillow lava. The rocks are green and greenish-grey or, occasionally, violet-grey. At the top of the section there are flows of megaporphyritic andesite with large (1 cm) plagioclase laths passing into block tuffs and rhyolite flows. The thickness of this unit in the Zabit River basin reaches 550 m. It gradually decreases to the west, and the lower part is replaced by greenish sandstone and conglomerate whereas the upper part is replaced by reddish rocks indistinguishable from those of ignimbrite unit.

The ignimbrite unit is mainly composed of welded and non-welded, usually reddish, rhyolitic ignimbrite and ash. Two other main components of the section are dark-lilac tuff and volcanic gritstone. Typical ignimbrite is a dark coloured rock in the welded lower part and lighter coloured in the upper part. Usually it bears scarce phenocrysts of feldspar and rare quartz in some varietes. Xenogenic clasts of andesite, felsic lava and sandstone are common. Some ignimbrite flows show deep narrow pockets filled with crystals and xenogenic clasts. According to Branney and Kokelaar (2002), such pockets are outgassing tubes because fine material is removed from them with a gas jet. The unit also contains andesite lapilli and pisolite tuff. The latter formed as a result of the sticking of rain drops with volcanic ash in a terrestrial setting. Cross-bedded gritstone consisting of white (plagioclase) and red (glass) grains is also a typical rock deposited by temporary water flows. Another typical facies is poorly sorted coarsely layered dark lilac mudstone representing mudflows. Locally rhyolite, dacite and rare andesite flows were observed. The roof of the ignimbrite unit is washed out. Its visible thickness in the Zabit River basin reaches 1.2 km.

Near the Zabit River source the lower part of ignimbrite unit is transformed into an unusual rock called granophyre in Fig. 8. These are massive non-layered red coloured aphyric or porphyritic (alkali feldspar phenocrysts) jasper-like rocks, sometimes with an indistinct fluidization. Some varieties show a granophyric groundmass. The red jasperoid rock, saturated with opal and iron hydroxides, is a usual product of the hydrothermal alteration of ash tuffs.

Age of the Sarkhoi volcanic rocks

Eleven zircons extracted from a welded rhyolitic ignimbrite were analysed on a SHRIMP II ion microprobe. All analyses showed a Neoproterozoic age of zircon crystallization, and eight of these form a concordant cluster with a mean age of 782 ± 7 Ma (2σ), which is interpreted as the time of ignimbrite eruption (Kuzmichev and Larionov 2011). The other three analyses were ignored for different reasons. The presence of volcanic clasts in the sandstone unit indicates that volcanism began earlier than the dated sample.

The related Dzabhan volcanic rocks show a great similarity with the Sarkhoi suite. They are mafic volcanic rocks in the lower part and dacites and rhyolites (mainly Na-ignimbrites) in the upper part. The reported age for the felsic volcanic rocks is close to the above estimate. Six of thirteen analyzed zircons (LA-ICP-MS) from the upper rhyolite yelded a concordant cluster with an age of 774 ± 4 Ma. For the second sample from the lower part of the section analytical data on five zircon crystals were reported (Levashova et al. 2010, 2011b). Three of these form a concordant cluster with an age of 803 ± 8 Ma. Therefore, the age of Sarkhoi and Dzabkhan volcanic suites is in a range of 805–770 Ma.

Origin of magmas and geodynamic setting

The greenstone unit consists of volcanic rocks that form a continuous series from basalt to rhyolite, with andesite and dacite being predominant. This series probably is the direct product of supra-subduction zone magmatism, which includes differentiation and assimilation of crustal material. These products partly inherited low Ti contents and high Th/Nb and Ce/Nb ratios from the primary magma. The generation of huge masses of rhyolitic ignimbrites of rather homogeneous composition most likely proceeded with melting of the crustal source caused by the intrusion of basaltic magma (see discussion in Kuzmichev and Larionov 2011). This source may have been tonalitic gneisses of the early Precambrian basement, which determined the Na-enrichment of the melts. A crustal source is confirmed by isotopic data. A dacite of the greenstone unit shows a whole-rock $\varepsilon_{Nd(t)}$ value of –1.4 (calculated for 800 Ma) and t_{DM} = 1623 Ma; an andesite of the same unit has an $\varepsilon_{Nd(t)}$ value of –5.5 (800 Ma) and t_{DM} = 2018 Ma (Vescheva et al. 2008). Independent isotopic analysis of three felsic volcanic samples obtained by V.P. Kovach (personal communication) confirm the strongly negative $\varepsilon_{Nd(t)}$ values and Paleoproterozoic model ages for the source. The Sarkhoi volcanic suite is similar to volcanic associations of Andean-type continental arcs which are characterized by a predominance of terrestrial felsic ignimbrites associated with subordinate andesites (e.g., Mamani et al. 2010). Similar volcanic suites are widespread in the Central volcanic zone of the Andes, in Mexico, and in the western USA.

Plutonic rocks comagmatic with the Sarkhoi volcanic rocks

The eruption of large masses of silicic magma resulted from drainage of a magma chamber localized at some depth beneath the ignimbrite caldera. According to general concepts, the volume of non-erupted magma solidified as a tabular intrusion is significantly larger than the volume of erupted magma (e.g., Bachmann and Bergantz 2008b). Therefore, we can suggest the presence of comagmatic granite or diorite-granite batholiths beneath the volcanic units of the Tuva–Mongolian and Dzabhan massifs. The well-known Sumsunur granitoid suite shows a similar age (785 ± 11 Ma) and composition (Kuzmichev 2004). The suite includes several plutons that intrude the Gargan Glyba basement, its early Neoproterozoic cover and the obducted Dunzhugur ophiolite (Fig. 4). The suite is composed of tonalite with some trondhjemite, diorite and gabbro. It reveals a supra-subduction zone setting and a sodic character (Kuzmichev et al. 2001). Some geochemical and mineralogical differences between comagmatic plutonic and volcanic rocks are predictable and were reported elsewhere. According to Bachmann et al. (2007), these differences are mainly due to the fact that the volcanic rocks represent a melt squeezed from a crystal-rich porridgelike mass, which then crystallized as plutonic rocks. The comagmatic character of the Sumsunur and Sarkhoi rocks is also confirmed also by their similar Nd and Sr isotopic patterns (Kuzmichev and Larionov 2011).

Recent geochronological studies revealed granitic massifs coeval with the Sarkhoi (Dzabhan) volcanic suite in the Dzabkhan and Tarbagatai terranes. A Neoproterozoic gabbro-diorite-granodiorite-granite pluton in the northern Dzabkhan massif (the Songa uplift) yielded a zircon age of 790 ± 3 Ma (Yarmolyuk et al. 2009) that is identical to that of the Sumsunur suite. Subalkalic porphyritic granitoids were also discovered within the Tarbagatai uplift (Fig. 1), and a U-Pb zircon age of 774 ± 3 Ma was determined (Kirnozova et al. 2009). The number and volume of such granitoids is probably underestimated. Further studies may reveal other granite batholiths that are comagmatic with volcanic rocks in Precambrian massifs of southern Siberia and Mongolia. In contrast to the Sarkhoi ignimbrites with their characteristic appearance, the Neoproterozoic granitoids look like common Palaeozoic rocks.

Oka accretionary prism

The Oka belt is composed of clastic sedimentary rocks and greenschists and extends for about 600 km (Fig. 2). It is bordered by thrust zone dipping east or north (Fig. 3). These are distinct mappable faults in the northern segment and can be traced to the south. The age and tectonic setting of the Oka belt were controversial for a long time. Kuzmichev et al. (2007) suggested that the belt formed in the late Neoproterozoic as an accretionary prism. The imbricated structure, occurrence of oceanic rocks and blueschists and some other features of the Oka belt are typical for modern accretionary prisms.

Structure

The studied northern portion of the Oka belt contains both strongly deformed mélange zones and more coherent blocks. The least altered rocks are exposed in the Yakhoshop and Dayalyk river basins (Fig. 9). In this area, the Oka belt consists of numerous tectonic slivers separated by sublatitudinal high-angle faults dipping north. Some features indicate that this fault system was originally inclined towards the south and had a "seaward" vergence, typical of modern accretionary prisms. Today the sedimentary strata are steeply inclined to the northwest, which is nearly parallel to the faults, and shows an overturned position. It is very likely that in the Neoproterozoic these strata were in a normal position and were inclined towards the southeast as well as the thrust faults. The orientation of drag folds is inconsistent with a recent southward vergence and suggests original northward thrusting.

Rotation of the thrust planes from flat to steep most likely occurred during early Palaeozoic deformation and did not require significant rotation since the recent thrust planes in the Oka prism dip at angles of 70–85°. Moreover, on the banks of the Hugein River in northern Mongolia (Fig. 2), the lower portion of the Oka belt preserved its original seaward vergence, which is discordant to the sole thrust of the belt.

In the Tustuk River region the majority of sedimentary rocks show disturbed layering that occurs either at microscopic, hand specimen, or outcrop scale. This produced a specific rock appearance, namely the fragments rarely look like slates or slabs, but usually occur in the form of irregular blocks due to an irregular inner structure. This was caused

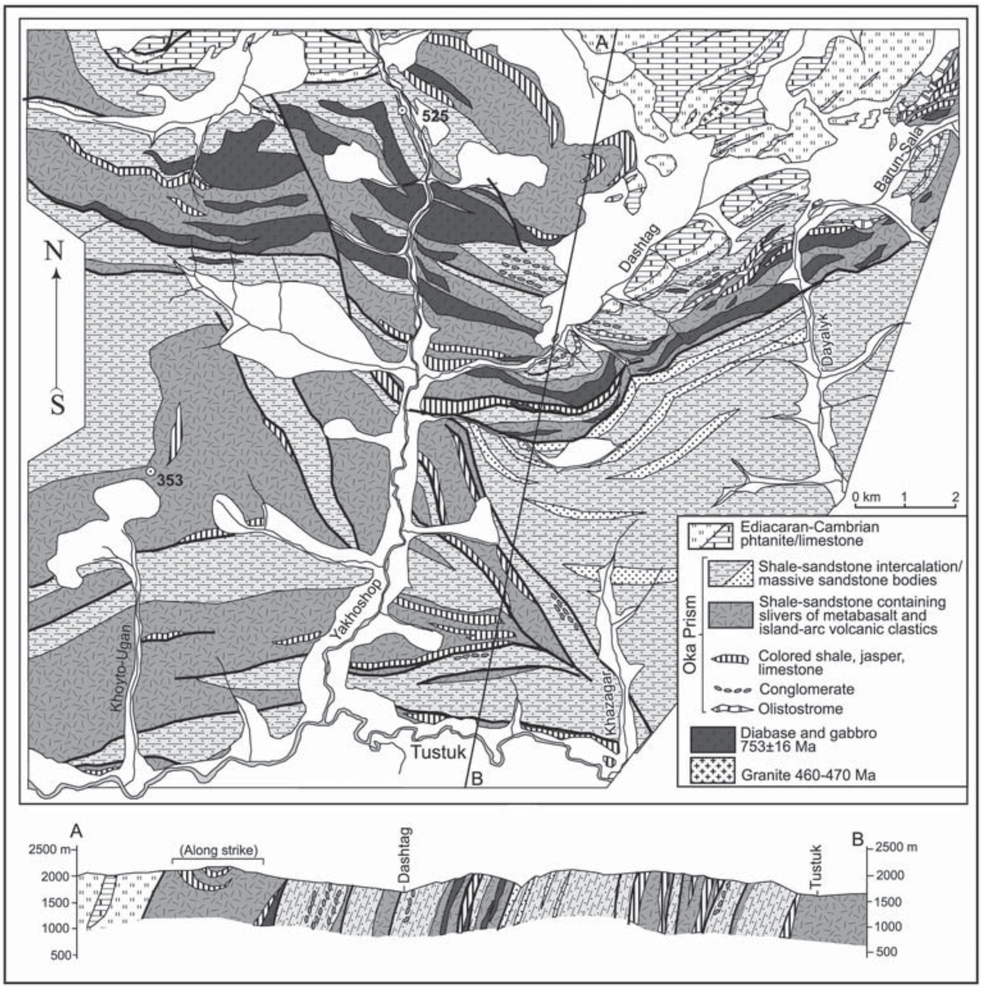


Fig. 9. Mapped region of the northern Oka prism in the northern Tustuk area (see Fig. 3). The map does not display the imbricated structure of the Oka prism. Due to poor exposure only the main boundaries between different lithologies can be mapped.

by layer-parallel extension and shearing, following layer-parallel contraction, which can be attributed to underthrusting. Layer-parallel extension is exemplified by stretched layers. Boudinage of sandstone layers is common in the Oka clastic rocks. Flattening is most evident in conglomerates where some pebbles were stretched to an enormous degree. Cleavage is oriented at a high angle to bedding and indicates compression directed almost opposite to primary flattening. In Recent and Mesozoic accretionary complexes such wedge shortening, resulting in seaward thrusting and imbrication accompanied by cleavage, was attributed to tectonic underplating (e.g., Hashimoto and Kimura 1999).

Sample and Moore (1987) noted that the above structural features cannot be attributed solely to accretionary wedges but may be expected in any type of thrust belt. However, on both sides of the Oka belt there are terrains that include similar lithologies but demonstrate different structures. The Dunzhugur ophiolite described before is overlain by a thick and coherent turbidite sequence that preserves all primary sedimentary textures and does not show the structural features inherent to the Oka belt rocks except for slaty cleavage in the upper portion. On the other side of the Oka belt there occurs the Shishkhid ophiolite that is overlain by the Kharaberin Formation including turbidite and mudstone deposits accumulated in the back-arc setting (see below). These sediments, though folded, were substantially less deformed than the Oka belt. Both Neoproterozoic terrains adjacent to the Oka belt do not show any imbrication. These rocks neither demonstrate early extension nor late stage shortening. All three terranes experienced the same events of deformation at the end of the late Neoproterozoic and at the beginning of the Ordovician (Kuzmichev 2004). Moreover, the Dunzhugur unit underwent one more phase of thrusting in the mid-Neoproterozoic. This implies that in spite of superposed collision events in the region, the Oka belt preserved its specific structural style inherited from the accretionary phase of prism formation.

Trench deposits

The Oka belt is mainly composed of shale-sandstone intercalations. These rocks have usually lost their primary depositional features, though coherent flysch packages occur to the west and southwest of the area shown in Fig. 9. The prevalent sediments in the northern Oka belt are laminated or massive mudstone alternating with siltstone and fine-grained sandstone. Sandstone layers locally show basal erosion and normal grading, indicating a turbidite origin. Soft sediment deformation is common. These packages occasionally include massive sandstone layers up to several metres thick that may represent amalgamated strata. The northern portion of the Oka belt also contains volcanoclastic rocks that were originally mapped by the author as part of the Oka prism but are now interpreted as tectonic slivers of the Shishkhid arc (see below). There is also an olistostrome horizon that probably underlies the isolated stratigraphic member (Kuzmichev et al. 2007).

Oceanic rocks incorporated into the prism

Ocean floor basalt consists of lenses and tectonic slivers that can be found in any part of the Oka belt, though these rocks are more abundant in the Oka inner zone adjacent to the continent. The northern limb of the Oka belt contains rare metabasalt layers that are confined to the soles of thrust planes and are altered into actinolite-chlorite-epidote schist. Southwards their thickness gradually increases. The best occurrence of oceanic basalts (about 1000 m), including both MORB- and OIB-like varieties, is the Hugein River basin (Fig. 2) (Sklyarov et al. 1996). The rocks are generally altered into epidote-chlorite-albite schist although pillow basalt and hyaloclastic breccias are occasionally recognizable.

The metabasalts show a homogenous chemical composition and are classified as tholeiitic basalts with moderate titanium (1.2–1.5% TiO_2) and iron (12–14% FeO) contents, low alumina and low potassium. These features as well as REE patterns and Ti-V and Ti-Zr relations indicate N-MORB signatures. Several kilometres northwest of the Hugein River a picritic basalt is exposed, showing high concentrations of titanium (up to 4%), niobium (up to 83 ppm), and zirconium (up to 340 ppm). Such incompatible element enrichment may indicate an ocean island setting.

Metagabbro, serpentinite and metapyroxenite make up lenses and blocks, enclosed witrhin a greenschist matrix. Such mélange was encountered in the northern part of the Oka belt in areas located to the south and southwest of the area shown in Fig. 9 (see Fig 3), in association with high-pressure metamorphic rocks. These exotic rocks along with basalt form a specific dismembered ophiolitic association that represents oceanic lithosphere.

Oceanic sediments are found in the northern Tustuk River basin. On the map (Fig. 9) these are shown by a general symbol for coloured rocks, which embrace variegated claystone, jasper and associated limestone. Thinly laminated coloured (mostly reddish) and sometimes black argillite may represent a pelagic ooze (Kuzmichev et al. 2007). Jasper is associated with metabasalt and forms brightly coloured layers, up to several metres thick.

Blueschist

A narrow zone, including high pressure-low temperature (HP-LT) metamorphic rocks, was traced along the inner part of the Oka belt (Sklyarov and Postnikov 1990, Sklyarov et al. 1996). It comprises greenschist-facies rocks, mainly metabasites, that contain occasional relicts of HP-LT minerals. Such rocks were found in numerous locations on the area shown in Fig. 3. Most of the zone is composed of actinolite-chlorite-epidote-albite greenschist, formed after basalt and gabbro, and some phengite-chlorite-quartz-albite schist. Winchite is a common mineral, and crossite was found as rare relicts fringed by winchite or actinolite. The Na_2O content reaches 5.6% in the core and decreases towards the rim. White micas are characterized by a high celadonite component (Si = 3.3–3.4 pfu), both in metabasic and associated metapelitic schists. The fact that crossite was only found in rocks of favourable chemical composition as well as the absence of lawsonite and glaucophane tentatively suggests the metamorphic conditions as intermediate between glaucophane-schist and greenschist-facies with the pressure ranging approximately from 5 to 7 kbar. The temperature of metamorphism was about 380–450 °C, judging from the mineral associations and an absence of stilpnomelane.

Tholeiitic intrusions and age of the Oka prism

The northern segment of the Oka belt was intruded by basaltic magma and contains numerous diabase and gabbro-diabase sills and dykes (Fig. 9). These are several metres to several tens of metres wide. In the northern Oka belt the sills are least altered and locally preserve initial intrusive contacts with the Oka shales. Southwards alteration increases and some bodies are completely altered into greenschists that can hardly be distinguished from oceanic metabasalts.

Some intrusions are differentiated into trondhjemite compositions. The siliceous end-member is strongly enriched in rare-earth elements (REE), Zr and other incompatible elements. Differentiation affected the bulk concentration of REE, but has had minor effects on the REE patterns. The latter shows depletion in light REE, typical of N-MORB magmas. A Sm-Nd mineral isochron for gabbro-diabase reveals a crystallization age of 736 ± 43 Ma and $\varepsilon_{Nd(t)}$ as high as +7.8 ± 0.5, indicating a strongly depleted mantle source. A felsic member of this intrusion was dated by three zircon multigrain fractions (TIMS technique) at 753 ± 16 Ma (Kuzmicher et al. 2007). This is the upper age limit for the Oka Group host rocks. It is suggested that the host sediments are not much older and are also late Neoproterozoic in age. Most sills are shallow-level igneous bodies that intruded poorly lithified sediments.

Oka belt summary and similarities with the Shimanto belt of Japan

The matrix of the Neoproterozoic Oka belt is composed of turbidite that contains bodies of exotic rocks. There are distinct structural and compositional features that identify the belt as a fossil accretionary prism. These are: (1) an imbricated structure with a presumably seaward vergence; (2) slivers of MORB- and OIB-like oceanic basalts, and (3) mélange with blueschists.

Apart from the above features, the northern Oka belt demonstrates some uncommon features including tholeiitic intrusions, felsic volcanic material and a carbonate olistostrome. All these features are also inherent to the northern Shimanto belt in Shikoku Island and Kii Peninsula, Japan (e.g., Hibbard and Karig 1990b, Taira et al. 1992). It is possible that tholeiitic sills were emplaced during oceanic ridge subduction. The occurrence of diabase dykes and sills in the Oligocene and Miocene portions of the Shimanto belt was caused by the Shikoku spreading ridge arrival into the subduction zone (e.g., Kimura et al. 2005). Such mode of ocean ridge subduction is not unique (e.g., Sisson et al. 2003). It is therefore likely that mafic igneous bodies in the Oka accretionary prism are of the same origin as in the Shimanto belt. An oceanic spreading centre arrived beneath the Oka accretionary prism in the late Neoproterozoic and produced N-MORB-like melts at 753 ± 16 Ma ago. Such intrusions occurred only in the northern limb of the Oka belt, which may indicate a near-orthogonal position of the ocean ridge against the convergent margin.

The prism piled up in front of the Sarkhoi continental arc through the second half of the Neoproterozoic though its exact lifetime is unknown. Sediment accumulation in accretionary wedges is one of the major geodynamic mechanisms operating at convergent margins. A huge volume of sialic material has been accumulated in the Oka prism. This reveals that the mechanism was as intensive in the Neoproterozoic as it is at present. The size of the Oka belt is comparable with the adjacent arc terranes even in its present, tightly compressed structure (Fig. 2). The Oka belt is possibly an exceptional example of a well-preserved Precambrian accretionary prism.

Shishkhid island arc

General overview

The late Neoproterozoic Shishkhid arc, similar to the Dunzhugur arc, is mainly represented by an SSZ ophiolite. The Shishkhid ophiolite corresponds to the uppermost oceanic lithosphere, comprising depleted mantle tectonites (~6 km thick) and oceanic crust of basaltic composition with andesite at the top (~7.5 km thick). The Shishkhid area shows a meridional structural trend and eastern vergence (Fig. 10). The ophiolite was thrust eastward onto the Oka belt and is underlain by a mélange zone (up to 1 km thick) comprising serpentinite lenses intercalated with shales of the Oka Formation. In the west, the ophiolite is covered by a 3 km-thick sedimentary sequence showing progressive subsidence of the volcanic edifice after cessation of volcanism. This sequence is unconformably overlain by Ediacaran-Cambrian platform sediments (Fig. 10). Therefore, the Shishkhid island-arc ophiolite was thrust upon the Oka prism before the end of the Neoproterozoic.

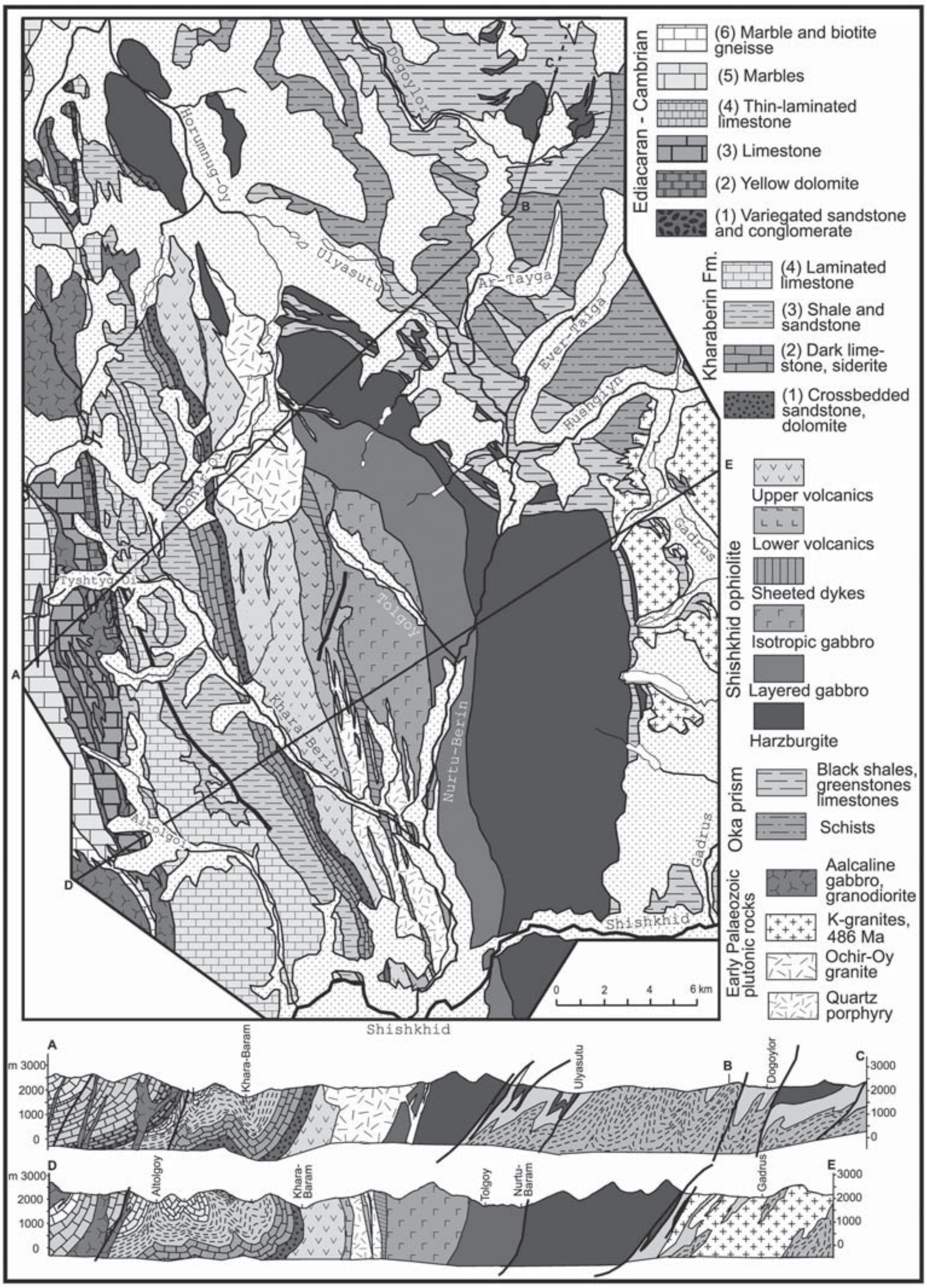


Fig. 10. Geological map of the Shishkhid ophiolite and surrounding units (see Fig. 3).

Shishkhid arc stratifiication

The ophiolite comprises (from bottom to top): residual ultramafic rocks (~6 km), layered and isotropic gabbro (~4.5 km), sheeted dykes (up to 0.5 km), a bimodal assemblage of basalt and rhyolite (up to 0.7 km), as well as andesite pyroclastic rocks at the top (~2 km) (Kuzmichev et al. 2005). In brief, the composition of the Shishkhid ophiolite is as follows (from bottom to top).

The ultramafic unit is dominated by harzburgite containing 10–15% enstatite and about 1% chromite. Dunite is also abundant, forming lenses and layers. Cpx-bearing harzburgite is rare. Graphitic harzburgite was also observed. The uppermost part of the ultramafic unit is a cumulate sequence (0 to 200 m thick) consisting of harzburgite, lherzolite, dunite, wehrlite and pyroxenite. Ultramafic rocks are completely or partly altered to antigorite serpentinite.

The lower gabbro is composed of cumulates and some isotropic gabbro. Its lower boundary is a distinct thrust zone corresponding to the MOHO, whereas the upper boundary is a vague transition to non-layered gabbro lacking ultramafic rocks. Most of the unit is composed of eucritic (meta)gabbro whose composition changes from anorthosite to pyroxenite end members. Ti- and Fe-rich cumulates were recorded in places. Minor ultramafic cumulates consist of meta-dunite, wehrlite, and clinopyroxenite. The unit also contains cataclasites, mylonites, and small bodies of plagiogranite.

The upper gabbro is dominated by homogeneous isotropic, eucritic gabbro. The rocks locally turn into gabbro breccia. Gradual transitions to fine-grained diabase-like varieties were also observed. There are also diabase dykes cutting the upper part of the unit.

Sheeted dykes are recognized only in the rare good outcrops where typical one-sided chilled set of dykes were observed. The unit decreases in thickness to the north, where part of it is composed of non-parallel dykes.

The lower volcanic unit comprises a bimodal basalt-rhyolite assemblage. Basalt or basaltic andesite are represented by pillowed or massive lava flows. Rhyolite and rare dacite occur as flows or breccias. Phyric varietes contain plagioclase, quartz and rare hornblende phenocrysts. In places rhyolite fragments occur within basaltic hyaloclastite, filling the space between basaltic pillows. Some rhyolite breccia also contains occasional basaltic fragments and pillows.

The upper volcanic unit is composed of andesite, basaltic andesite, and pyroclastic rocks. The latter show chaotically-oriented angular fragments 1 to 25 cm in size. They were mainly erupted in a submarine environment, though above the explosive compensation level, which is generally defined for andesitic magma at a water depth of 500 m or less (Stix 1991). The least altered phyric andesite contains crystals (up to 50% by volume) of greenish-brown hornblende and zoned andesine. Thin flows of basaltic lava were observed within the lower part of the unit.

The sedimentary section overlying the volcanic rocks (Kharaberin Formation) is divided into four units (Fig. 10). The lowermost unit is about 300 m thick and composed of polymictic sandstone, siltstone, as well as sandy and stromatolitic dolomite. The unit contains conglomerate, composed predominantly of porphyry fragments derived from the underlying volcanic rocks and comagmatic intrusions. Some conglomerates show a high abundance of basalt and andesite fragments.

The second unit is about 600 m thick and consists of dark-coloured limestone, and dolostone. Its middle portion contains unsorted greywacke. The third unit is 1000 to 1200 m thick and is mainly composed of rhythmically interbedded (5–20 cm) dark grey shale and sandstone. Locally the rocks exhibit slump folds and graded bedding. There are also unsorted non-layered greywacke and pebble conglomerate, up to 50 m thick. The unit also contains syndepositional volcanic material concentrated in tephra layers that consists of pumice, andesite, and felsite fragments. The upper unit is represented by laminated grey limestone with an exposed thickness of 800–1000 m.

The Kharaberin Formation is a transgressive sedimentary sequence. The lower horizons include storm-broken layers deposited in a shallow-water environment near a volcanic edifice. The third unit is mainly composed of relatively deep-water turbidites. The presence of tephra indicates synchronous volcanic activity and a temporal shift of the volcanic front towards the west (in present coordinates) and away from the depositional area. The fourth unit is composed of carbonate ooze and was deposited far away from the source of volcanic or terrigenous clastic material.

Geodynamic model for the Shishkhid ophiolite

High alumina andesite at the top of the igneous section evidently indicates an island arc setting for the Shiskhid ophiolite. Some geochemical features of the basaltic members also imply the supra-subduction setting. These are the low Fe/Mg ratios in the majority of basaltic rocks, classifying them as calc-alkaline. High abundances of fluid-mobile elements as well as a distinct negative Nb-anomaly, high Th, and high La/Nb ratios for most samples suggest subduction-modified mantle sources. Some volcanic rocks show no Nb-anomaly and these were presumably derived from a different mantle source. The felsic magma of the bimodal volcanic unit was produced by partial melting of an amphibole-plagioclase metagabbro protolith, which is the most likely source based on the REE patterns and Nd isotopic composition (see Kuzmichev et al. 2005 for discussion).

The Nd isotopic composition was analyzed for 10 whole-rock samples representing all crustal units of the Shishkhid ophiolite. The data show variable initial ε_{Nd} ranging from +6.9 to 0. This may be due to non-uniform overprinting of a depleted mantle by melts from subducted sediment or isotopic heterogeneity of the upper mantle source, or both. A comparison of geochemical and isotopic features suggests that both options were involved in melt production (see Kuzmichev et al. 2005 for discussion). Two different mantle reservoirs were probably involved in the genesis of the Shishkhid igneous rock assemblage. The main reservoir was depleted sub-arc mantle, metasomatized by subduction-related fluids and slab-derived melts. The second mantle source was possibly upwelling asthenosphere in a back-arc(?) environment. The latter source may account in particular for samples showing only poorly developed subduction-related signatures such as negligible Nb-anomalies.

Taking into account the unusual composition of the volcanic members of Shishkid ophiolite assemblage, an extensional back arc setting is suggested, similar to the "back-arc knolls zone" of the Izu-Bonin island arc system. The latter is a region of crustal extension encompassing a 100 km-wide zone of generally shallow bathymetry between the frontal chain of large stratovolcanoes and the Shikoku oceanic basin (Hochstaedter et al. 2001 and references therein). In such a setting the mantle source was influenced by subduction-slab fluids, whereas some magma portions may have originated from fresh upwelling asthenosphere after stretching the subduction-modified upper mantle. Both magma types filled the extensional gaps in the arc crust and formed magma chambers with sheeted dykes at their roofs. Continued extension probably caused the Shishkhid ophiolite to move away from the active volcanic zone. Magmatism continued for some time to the west of the ophiolite which implies that the frontal part of the Shihkhid arc was facing westwards (in modern coordinates), whereas its eastern, rear part, including the ophiolite section, was facing the back-arc oceanic basin.

The Shishkhid ophiolite belt

The thrust zone underlying the Shishkhid ophiolite is a distinct suture demarcating two terranes that were separated by an oceanic basin in the late Neoproterozoic. The suture becomes obscured to the NE and SW of the Shishkhid area due to metamorphism and deformation. Its presumed SW continuation is marked by a chain of serpentinite bodies and associated basalts trending through eastern and central Sangilen (Fig. 2). It is conceivable that the Shishkhid arc farther extends into western Sangilen composed of metamorphic rocks which conforms to detrital zircon ages (see below).

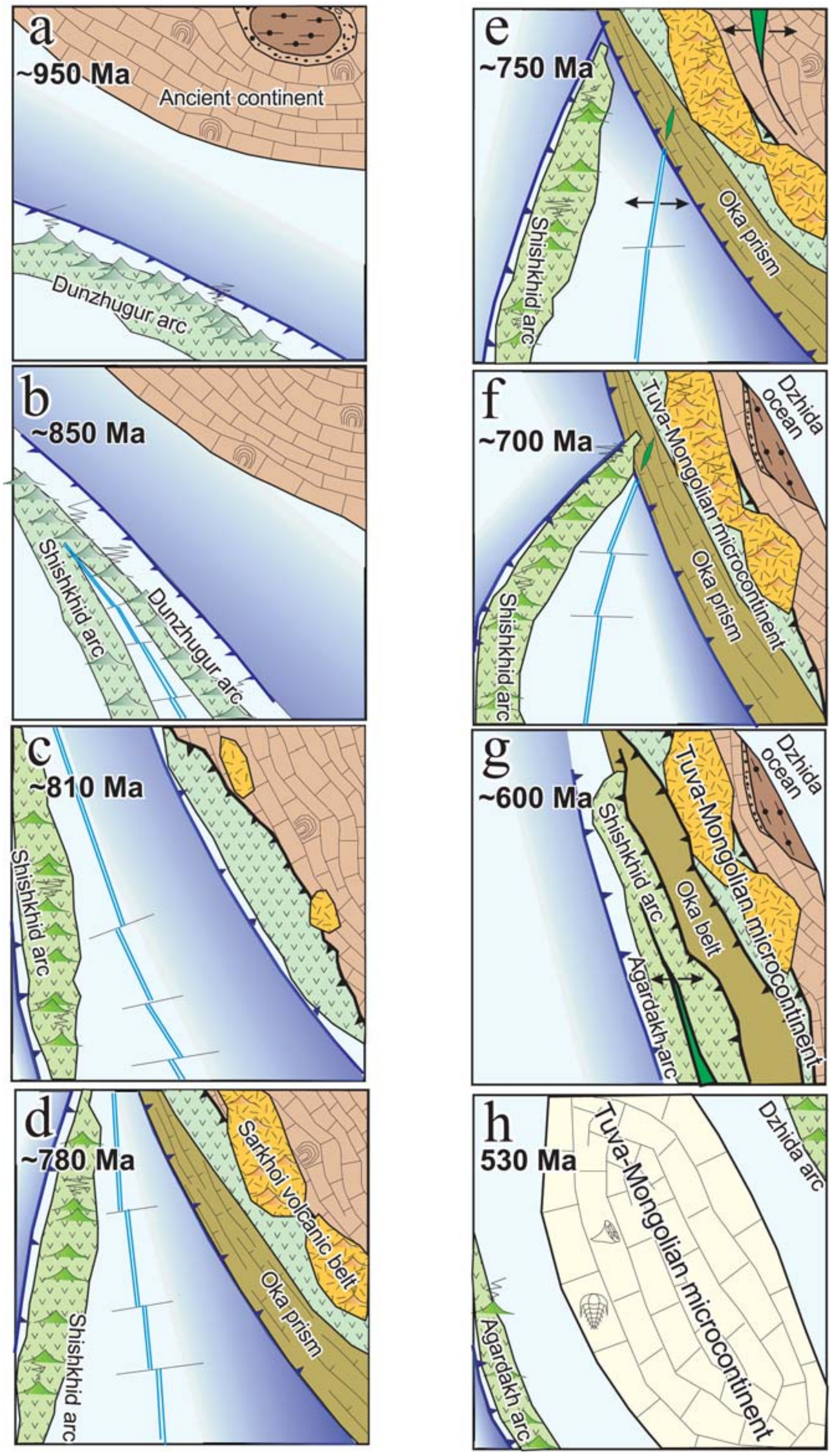
The NE continuation of the Shishkhid ophiolite belt is manifested by a chain of fragmented ophiolites along the northern limb of the Tuva-Mongolia Massif (Figs. 2, 3). These rocks are mostly composed of serpentinite, though several major bodies also contain gabbro, basalt, and minor felsic intrusions. Basaltic members are characterized by low contents in TiO_2 and FeO and exhibit calc-alkaline affinities. They probably belonged to the Shishkhid island-arc system in late Neoproterozoic times. It is suggested that the NE tip of the arc protruded into the Oka prism in its northen part and delivered volcanoclastics rocks to the trench deposits in the Tustuk region (see Fig. 9).

Age of Shishkhid arc

The age of volcanic members of the Shishkhid arc is constrained by U-Pb SHRIMP zircon dating of rhyolite of the bimodal unit. Seven zircons were analyzed and produced concordant data with a mean $^{206}Pb/^{238}U$ age of 800.0 ± 2.6 Ma (Kuzmichev et al. 2005). Hence, the Shiskhid arc already existed in the mid-Neoproterozoic.

To constrain its life span two samples of the volcanoclastic deposits were dated at the northeastern end of the arc where it is attached to the Oka prism. The first was a volcanic breccia consisting of andesite and dacite fragments. Ten zircons yielded $^{206}Pb/^{238}U$ ages ranging from 801 to 833 Ma with a mean of 813 ± 7 Ma (2σ). The second sample was a volcanic conglomerate containing rounded pebbles represented by qartz-porphyry, plagiocalse-porphyry, aphyric felsite and granophyre. The $^{206}Pb/^{238}U$ ages of the 12 zircons range between 770 ± 16 and 819 ± 13 Ma (Kuzmichev and Larionov 2013), and the data define two clusters: 819 ± 17 Ma (3 grains), which is the same as the age of the first sample, and 775 ± 8 Ma (2σ, 9 crystals). The data show that Shishkhid arc volcanism began somewhat earlier than Oka prism generation.

Dating of zircons from tephra and volcanic sandstones of the Kharaberin Fm. would be more reliable to determine the duration of the arc. Up to now age data are only available for suggested metamorphosed counterparts of the Kharaberin clastic deposits located in western Sangilen. 58 detrital zircons were analyzed on SHRIMP II, 19 grains from polymictic metasandstone, 9 from metashale and 30 from arkosic metasandstone (Kozakov et al. 2005). Almost all zircons have Neoproterozoic ages in the range of 900–660 Ma using the $^{206}Pb/^{238}U$ ratios, three grains are Palaeo- and Mesoproterozoic, and one metamorphic rim yielded an age of granulite metamorphism (474 ± 22 Ma). 16 zircons of the first sample yielded a concordant cluster with a mean at 767 ± 15 Ma (2σ, whereas all grains but one from the third sample define a cluster at 809 ± 17 Ma (Kozakov et al.


a
~950 Ma
Ancient continent
Dunzhugur arc
b
~850 Ma
Shishkhid arc
Dunzhugur arc
c
~810 Ma
Shishkhid arc
d
~780 Ma
Sarkhoi volcanic belt
Oka prism
Shishkhid arc
e
~750 Ma
Shishkhid arc
Oka prism
f
~700 Ma
Dzhida ocean
Tuva-Mongolian microcontinent
Oka prism
Shishkhid arc
g
~600 Ma
Dzhida ocean
Tuva-Mongolian microcontinent
Shishkhid arc
Oka belt
Agardakh arc
h
530 Ma
Tuva-Mongolian microcontinent
Dzhida arc
Agardakh arc

2005). On the basis of these data the recorded age interval of arc magmatism is in the range of 810–750 Ma for the majority of zircons.

Late Neoproterozoic orogeny and Vendian-Cambrian Tuva-Mongolian microcontinent

After the oceanic lithosphere of the basin dividing the Sarkhoi and Shishkhid terranes had been completely subducted, the terranes collided, and the upper lithosphere of the rear part of the Shishkhid arc was thrust upon the Oka accretionary prism. Collision-related granitoids in the Tuva-Mongolian Massif have not yet been identified, therefore, the age of collision has been inferred from geological evidence. An Ediacaran (late Vendian) to middle Cambrian carbonate platform sequence covers most of the Tuva-Mongolian Massif, and its basal horizons are composed of red clastic sediments filling grabens (Kuzmichev 2004). The lowermost carbonate rocks are Ediacaran, suggesting an age of ~600 Ma for the collision event that may have been related to the late Baikalian orogenic phase which is widely manifested in southern Siberia (Kuzmichev 2004) though it may be somewhat older.

After the Shishkhid arc was accreted to the Sarchoi continental terrane, the Tuva-Mongolian microcontinent evolved as a carbonate platform fringed by a passive margin. The origin of the passive margin on the Shishkhid side of the microcontinent needs to be explained because, prior to being accreted, the Shishkhid arc was fringed by a convergent boundary on the oceanic side. Based on an analogy with northern Taiwan, the collisional orogen could have been rifted off, and the front active zone may have drifted away. In Taiwan the rift gave rise to the Okinawa back-arc basin as the Ryukyu arc moved away from the continent (Teng 1996). Some features in the Shishkhid area are compatible with such a scenario (Kuzmichev et al. 2005).

Synopsis of the Neoproterozoic and early Palaeozoic evolution of the TMM

The author suggests that during most of the Neoproterozoic the TMM represented a marginal region of a large old (Siberian?) continent. In the early Neoproterozoic this margin was a shallow-marine shelf area (Fig. 11a). At the same time the Dunzugur arc that originated not later than 1034 ± 9 Ma drifted in the surrounding ocean. The arc faced the continent, and subduction occurred beneath it (Figs. 11a, 12a). It is likely that such palaeogeography did not change for 200 million years. At the end of this time interval the Shishkhid arc was created by splitting off from the former Dunzhugur arc (Fig. 11b).

Fig. 11. Summary of the Neoproterozoic evolution of the TMM. The time windows for palaeogeographic cartoons are indicated. a) Early Neoproterozoic: The Dunzhugur island arc faces the passive continental margin of an old continent. b) Splitting up of the Dunzhugur arc and birth of the Shishkhid arc. c) Mid-Neoproterozoic orogeny: collision of the Dunzhugur arc with the continent; forearc SSZ ophiolite obduction. d) Main units of the late Neoproterozoic palaeogeography: Sarkhoi supra-subduction Andean-type volcanic belt, Oka accretionary prism, and Shishkhid arc looking with its rear side to the continent. e) Ocean spreading ridge subduction beneath Oka prism and back-arc rifting in the rear of the Sarkhoi continental arc. f) Tuva-Mongolian micricontinent as a Japan-style continental arc facing the back of the Shishkhid arc. The latter was attached to the active continental margin creating a triple junction. g) Collision of Shishkhid arc and core of the Tuva-Mongolian microcontinent. Birth of the Agardakh arc by rifting of the orogen. h) Completely constructed Tuva Mongolian microcontinent drifting through the Palaeo-Asian ocean.

The two arcs faced in opposite directions and co-existed for at least 50 Ma (Fig. 12b). This evolutionary model can explain the narrowness of the exposed Dunzhugur arc that hardly matches the long time of island arc evolution. It may also explain the reason for dense basaltic intrusions in the arc upper horizons.

Collision of the Dunzhugur arc with the continental margin may have occurred in the middle Neoproterozoic at ~810 Ma (Figs. 11c, 12c). The forearc lithospere was obducted onto the passive margin and produced gravitational nappes in the foreland basin. From

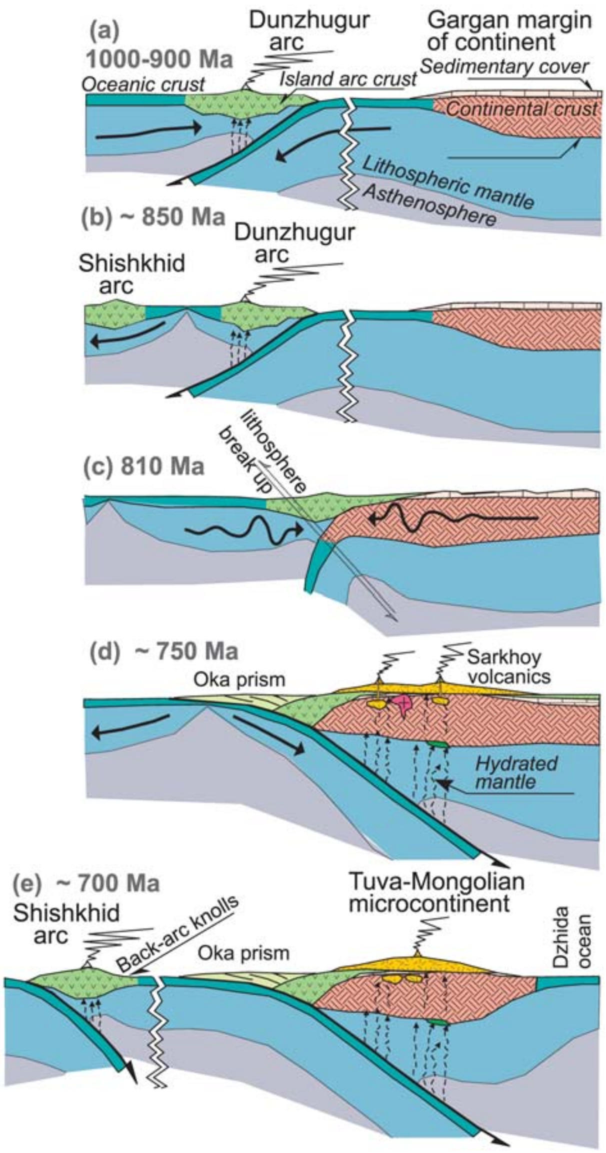


Fig. 12. Main evolutionary phases of the TMM as displayed in Fig. 11 but in section view.

this time on, the subduction occurred beneath the continental margin, and an Andean-type volcanic belt began to evolve.

The palaeogeography at the beginning of the late Neoproterozoic included three tectonic units, namely the Sarkhoi volcanic belt resting on the continental margin, the Oka accretionary prism growing in the front of active continental margin, and the Shishkhid island arc (Fig. 11d). The Sarkhoi belt at present can be traced up to 1500 km, and it was probably much longer originally. Such disposition did not last long. At ~750 Ma an oceanic spreading ridge approached the subduction zone (Figs. 11e, 12d) and produced voluminous basaltic magma intrusions into the prism sediments. Back-arc rifting in the rear of the Sarkhoi continental arc was probably triggered by this event (Fig. 11e). As a result, the massif was cut-off from its parent continent. At about the same time or somewhat later the Shishkhid arc most likely collided with the Sarkhoi margin and generated the next triple junction (Fig. 11f). The life span of all the above three units is not well constrained. At least since the middle late Neoproterosoic the Tuva-Mongolian massif existed as a micrcontinent separated from its ancestor by a newly formed oceanic basin (Fig. 12e).

By ~600 Ma the Shishkhid arc was completely accreted to the Sarkhoi margin and partly thrust upon the Oka prism (Fig. 11g). The age of collision is unknown. Grabens filled with terrestrial clastic deposits presumably formed at around 600 Ma but maybe somewhat earlier. They are interpreted as a result of collisional collapse of the late Neoproterozoic orogen. These clastic rocks are overlain by carbonate deposits that constitute a platform cover on the entire Tuva-Mongolian massif. The latter drifted across the Palaeo-Asian ocean as a microcontinent fringed by passive margins during the terminal Neoproterozoic and most of the Cambrian (Fig. 11h). The palaeogeography of the surrounding ocean during this period of time became much more complicated. Numerous island arcs originated and evolved on both sides of the microcontinent. The well-known Agardakh arc presumably orinated by rifting of the margnal part of the Shishkhid collisional orogen (Fig. 11g).

The region was finally amalgamated by numerous collisions of island arcs and continental terranes. The process began in the late Cambrian and culminated in the Early Ordovician when the entire mass was accreted to the southwestern (recent coordinates) Siberian Platform. This was the principal event that formed the main structural style of the region. In the present erosional level about half of the TMM surface exposes Ordovician post-collisional granites and related plutonic rocks. The cause of this event is not yet ascertained. In the author's opinion such large-scale processes imply continental collision. The TMM and surrounding latest Neoproterozoic and Cambrian island arcs were squeezed between Siberia and one of the Gondwana continents.

References for the entire volume

Abdrakhmatov, K.E., Weldon, R., Thompson, S., Burbank, D., Rubin, Ch., Miller, M., Molnar, P., 1996. Relatively recent construction of the Tien Shan inferred from GPS measurement of present-day crustal deformation rates. Nature 384, 450–453.

Abdulin, A.A., Avdeev, A.V., Seitov, N.S., 1995. On the study of microcontinents and ophiolite zones in Kazakhstan. ESRI Occasional Publications, New Series No. 12B, University of South Carolina, USA, p. 97–112.

Abrajevitch, A., Van der Voo, R., Levashova, N.M., Bazhenov, M.L., 2007. Palaeomagnetic constraints on the palaeogeography and oroclinal bending of the Devonian volcanic arc in Kazakhstan. Tectonophysics 441, 67–84.

Abrajevitch, A., Van der Voo, R., Bazhenov, M.L., Levashova, N.M., McCausland, P.J.A., 2008. The role of the Kazakhstan orocline in the late Palaeozoic amalgamation of Eurasia. Tectonophysics 455, 61–76.

Adiya, M., Ankhtsetseg, D., Baasanbat, Ts., Bayar, G., Bayarsaikhan, Ch., Erdenezul, D., Mungunsuren, D., Munkhsaikhan, A., Munkhuu, D., Narantsetseg, R., Odonbaatar, Ch., Selenge, L., Tsembel, B., Ulziibat, M., Urtnasan, Kh., 2003. One century of seismicity in Mongolia (1900–2000): Coordinators: Dr. Dugarmaa T., and Dr. Schlupp A., Research Centre of Astronomy & Geophysics of the Mongolian Academy of Sciences (RCAG), Mongolia and Laboratoire de Teledetection et Risque Sismique, BP12, Bruyeres le Chatel, France.

Afonichev, N.A. (ed.), 1978. Geological map of the USSR (new series), scale 1:1 000 000, sheet L(43), (44)-Taldy-Kurgan. Moscow, “Aerogeologiya” (in Russian).

Afonichev, N.A. (ed.), 1980. Geological Map of the USSR. Sheet L-(43), (44) – Taldy-Kurgan. Explanatory text. VSEGEI, Leningrad, 160 pp. (in Russian).

Afonichev, N.A., Vlasov, N.G. (eds.), 1981. Geological map of Kazakhstan and Middle Asia. Scale 1:1 500 000. VSEGEI, Leningrad (in Russian).

Afonin, A.I., 1976. The conjectural skeletal protospongia and chancelloria faunas from the Precambrian rocks of the Gorny Altai. Geologiya i Geofizika 11, 16–21 (in Russian).

Alexeiev, D.V., 1993. Tectonics of the Malyi Karatau (Southern Kazakhstan). Unpubl. Ph.D. thesis, State University of Moscow, 24 pp. (in Russian).

Alexeiev, D.V., 2011. Palaeozoic accretion of the Kazakhstan continent. In: Comparative evolution of past and present accretionary orogens, Central Asia and the Circum-Pacific. Penrose Conference, Urumqi, China, pp. 1.

Alexeiev, D.V., Cook, H.E., Buvtyshkin, V.V., Golub, L.Y., 2009. Structural evolution of the Ural – Tian-Shan junction: a view from Karatau ridge, South Kazakhstan. Comtes Rendus Geosciences 341, 287–297.

Alexeiev, D.V., Ryazantsev, A.V., Kröner, A., Tretyakov, A.A., Xia, X., Liu, D.Y., 2010. Geochemical data and zircon ages for rocks in a high-pressure belt of Chu-Yili Mountains, southern Kazakhstan: Implications for the earliest stages of accretion in Kazakhstan and the Tianshan. J. Asian Earth Sci. 42, 805–820.

Alexyutin, M., Bachtadse, V., Alexeiev, D., Nikitina, O., 2005. Palaeomagnetism of Ordovician and Silurian rocks from the Chu-Yili and Kendyktas mountains, south Kazakhstan, Geophysical Journal International 16, 321–331.

Amante, C., Eakins, B., 2009. ETOPO1 1 Arc-Minute Global Relief Model: Procedures, Data Sources and Analysis. NOAA Technical Memorandum NESDIS NGDC-24. National Geophysical Data Center, NOAA.

Andryushchenko, S.V., Vorontsov, A.A., Yarmolyuk, V.V., Sandimirov, I.V., 2010. Evolution of Jurassic-Cretaceous magmatism in the Khambin volcanotectonic complex (Western Transbaikalia). Russian Geology and Geophysics 51, 734–749.

Anisimova, I.V., Kozakov, I.K., Yarmolyuk, V.V., Kozlovsky, A.M., Kovach, V.P., Kudryashova, E.A., Savatenkov, V.M., Terent’eva, L.B., Fedoseenko, A.M., Yakovleva, S.Z., Enzhin, G., 2009a. Age, sources, and geological position of anorthosites of Precambrian terranes of Central Asia: Example from the Khunzhilingol Massif, Mongolia. Doklady Earth Sciences 428, 1120–1125.

Anisimova, I.V., Levitskiy, I.V., Sal’nikova, E.B., Kotov, A.B., Levitskiy, V.I., Reznirskiy, L.Z., Efremova, S.V., Velikoslavinskiy, S.D., Barash, B.U., Fedoseenko, A.M., 2009b. The age of Gargan block basement (East Sayan): U-Pb geochronological study. In: Isotope systems and duration of geological processes. Transaction of the IV Russian geochronological conference. Sankt-Petersburg. v. I, pp. 34–35.

Antoniuk, R.M., 1974. The oceanic crust of the eugeosynclinal in the east of Central Kazakhstan. In: Muratov, N.V. (ed.), Tectonics of Urals-Mongolian fold belt. Nauka, Moscow, 67–74 (in Russian).

Apayarov, F.H., 2010. Early Devonian intrusions of the Northern Tien-Shan. Natural Resources, Bishkek 1, 14–21 (in Russian).

Aristov, V.A., Mossakovskiy, A.A., Pospelov, I.I., Ruzhentsev, S.V., Samygin, S.G., 1993. Ophiolite associations of the western Dzhungariya (PR China). Doklady of Russian Academy of Sciences 332, 746–751 (in Russian).

Avdeyev, A.V., 1984. Ophiolite zones and the geologic history of Kazakhstan from the mobilist standpoint. International Geological Review 26, 995–1005.

Avdeyev, A.V., 1994. Paleogeodynamic map of the Southern Kazakhstan. Russian Geology and Geophysics 35, 111–115 (in Russian).

Avdeyev, A.V., Khalilov, V.A., Seliverstov, V.A., Ilyin, L.I., Tsygankov, A.L., 1995: New data on geochronology of metamorphic and magmatic formations of South Kazakhstan. Geology and Exploration in Kazakhstan 4, 2–6 (in Russian).

Bachmann, O., Bergantz, G.W., 2008. The magma reservoirs that feed supereruptions. Elements 4, 17–21.

Bachtadse, V., Van der Voo, R., Haynes, F., Kesler, E., 1987. Late Palaeozoic magnetization of mineralized and unmineralized Ordovician carbonates from east Tennessee: Evidence for a post-ore chemical event. Journal of Geophysical Research 92, 14,165–14,176.

Badarch, G., Cunningham, W.D., Windley, B.F., 2002. A new terrane subdivision for Mongolia: implications for the Phanerozoic crustal growth of Central Asia. Journal of Asian Earth Sciences 21, 87–110.

Bakirov, A., 1999. The evolution of Tien-Shan lithosphere. Proceedings of National Academy of Sciences, Kyrgyz Republic, pp. 3–14.

Bakirov, A.B., 1978. Tectonic position of the metamorphic complexes in the Tien-Shan. Ilim, Frunze, 262 pp. (in Russian).

Bakirov, A.B., Kiselev, V.V., Ivleva, E.A., Lukashova, E.M., 1996. On the age of the Kasan metamorphic complex. Proceedings of the National Academy of Science of the Kyrgyz Republic. Echo Nauki 1, 31–37 (in Russian).

Bakirov, A.B., Tagiri, M., Sakiev, K.S., Ivleva, E.A., 2003. The Lower Precambrian rocks in the Tien Shan and their geodynamic setting. Geotectonics 37, 368–380.

Baljinnyam, I., Bayasgalan, A., Borisov, B.A., Cisternas, A., Dem'yanovich, M.G., Ganbataar, L., Kochetkov, V.M., Kurushin, R.A., Molnar, P., Hervé, P, Vashchilov, Yu.Ya. 1993. Ruptures of major earthquakes and active deformation in Mongolia and its surroundings. Boulder, Colorado, Geological Society of America Memoir 181, 62 p.

Barash, I.G., Sal'nikova, E.B., Reznitsky, L.Z., Kotov, A.B., Kovach, V.P., Yakovleva, S.Z., Fedoseenko, A.M., 2006. Age relations between metamorphism of the Slyudyanka granulite and the Khamar Daban zoned metamorphic complexes: Evidence from U-Pb geochronological data. Doklady Earth Sciences 409, 905–908.

Baratov, R.B. (ed.), 1976. Stratification of sedimentary and intrusive formations of Tajikistan. Donish, Dushanbe, 270 pp.

Barry, T.L., Kent, R.W., 1998. Cenozoic magmatism in Mongolia and the origin of central and east Asian basalts. In: Flower, M., Chung, S.-L., Lo, C.-H., Lee, T.-Y. (eds.), Mantle dynamics and plate interactions in East Asia. American Geophysical Union Monograph, Geodynamics Series, 27, 347–364.

Bayasgalan, A., Jackson, J., Ritz, J.F., Carretier, S., 1999a. 'Forebergs', flower structures, and the development of large intracontinental strike-slip faults: The Gurvan Bogd fault system in Mongolia. Journal of Structural Geology 21, 1285–1302.

Bazhenov, M.L., Burtman, V.S., Dvorova, A.V., 1999. Permian paleomagnetism of the Tien Shan fold belt: post-collisian rotations and deformation. Tectonophysics 312, 303–329.

Bazhenov, M.L., Collins, A.Q., Degtyarev, K.E., Levashova, N.M., Mikolaichuk, A.V., Pavlov, V.E., Van der Voo, R., 2003. Paleozoic northward drift of the North Tien Shan (Central Asia) as revealed by Ordovician and Carboniferous paleomagnetism. Tectonophysics 366, 113–141.

Bazhenov, M.L., Mikolaichuk, A., 2004. Structural evolution of Central Asia to the north of Tibet: A synthesis of palaeomagnetic and geological data. Geotectonics 38, 379–393.

Beck, M.E., 1991. Coastwise transport reconsidered: lateral displacements in oblique subduction zones, and tectonic consequences. Physics of the Earth and Planetary Interiors, 68, 1–8.

Bekzhanov, G.R. (ed.), 1996. Geological Map of Kazakhstan at 1:1 000 000 scale. National Acad. of Science of the Republic of Kazakhstan, Almaty.

Bekzhanov, G., Koshkin, V. and Nikitchenko, I., 2000. Geologic structure of Kazakhstan. Gylym Press, Almaty, 394 pp. (in Russian).

Belichenko, V.G., 1969. Lower Paleozoic of the Western Transbaikalia. Nauka Publ. House, Moscow, 205 p. (in Russian).

Belichenko, V.G., 1977. The Caledonides of the Baikal Mountain Region. Nauka Publ. House, Novosibirsk, 133 p. (in Russian).

Belichenko, V.G., Boos, R.G., Kolosnitsyna, T.N., Lepin, V.S., Solodyankina, V.N., Snytko, A.V., 1988. New data on the age of metamorphic group of Tunka Goltsy (East Sayan). Dokl. Akad. Nauk 301, 402–405.

Belichenko, V.G., Sklyarov, E.V., Dobretsov, N.L., Tomurtogoo, O., 1994. Geodynamic map of the Paleoasian Ocean: Eastern segment. Russian Geology and Geophysics 35, 22–32.

Belichenko, V.G., Reznitskii, L.Z., Geletii, N.K., Barash, I.G., 2003. Tuva-Mongolia terrane (in the context of microcontinents in the Paleoasian ocean Russian). Geology and Geophysics 44, 554–565.

Belichenko, V.G., Geletii, N.K., Barash, I.G., 2006. Barguzin microcontinent (Baikal mountain area): The problem of outlining. Russ. Geol. Geophys. 47, 1045–1055 (In Russian with English Abstr.).

Belyaeva, G.V., 1987. Biogeography of the Early Cambrian of the Far East. In: Evolution of geologic processes of the Far East. Vladivostok, DVNTs AN SSSR, 92-109 (in Russian).

Berkey, C.P., Morris, F.K., 1924. The peneplanes of Mongolia. American Museum Novitates, Number 136, 1–11.

Berzin, N.A., Dobretsov, N.L., 1993. Geodynamic evolution of southern Siberia in late Precambrian–Early Paleozoic time, in: Reconstruction of the Paleoasian Ocean. VSP Intern. Sci. Publishers, The Netherlands, pp. 45–62.

Berzin, N.A., Coleman, R.G., Dobretsov, N.L., Zonenshain, L.P., Xiao, X., Chang, E.Z., 1994. Geodynamic map of the western part of the Paleoasian Ocean. Russian Geology and Geophysics 35, 5–22.

Berzin, N., Dobretsov, N., 1994. Geodynamic evolution of the southern Siberia in late Precambrian early Palaeozoic time. In: Coleman, R.G. (Ed.), Reconstruction of the Palaeo-Asian Ocean: Proceeding of the 29th International Geological Congress, Part B, 53–70, vSP, Utrecht, The Netherlands.

Besse, J., Courtillot, V., 2003. Apparent and true polar wander and the geometry of the geomagnetic field over the last 200 Myr. Journal of Geophysical research 108 (10), 2469, doi: 10.1029/2003JB002684.

Betekhtina, O.A., 1983. Paleobiogeography of late Paleozoic nonmarine bivalves. In: Betekhtina, O.A., Zhuravleva, I.T. (Eds.), Environment and life in the geological past, paleobiogeography and paleoecology. Nauka Publ. House, Novosibirsk, pp. 98–107 (in Russian).

Bibikova, E.V., Karpenko, S.F., Sumin, L.V., Bogdanovskii, O.G., Kirnozova, T.I., Lyalikov, A.V., Makarov, V.A., Arakelyants, M.M., Korikovskii, S.P., Fedorovskii, V.S., Petrova, S.I., Levitskii, V.I., 1990. U-Pb, Sm-Nd, Pb-Pb and K-Ar ages of metamorphic and magmatic rocks of Priolkhonie (western Baikal area). In: Shemyakin, V.M. (Ed.), Precambrian geology and geochronology of the Siberian platform and its surroundings. Nauka Publ. House, Leningrad, 170–183 (in Russian).

Biske, Yu.S., 1987. The lower Paleozoic of the southern Ferghana: Structural position, stratigraphy, geological history. Proceedings of Leningrad University, Series 7, 1 (7), 3–11 (in Russian).

Biske, Yu.S., 1991. Island arcs in Paleozoic of the southern Tien-Shan. Geotectonics 2, 41–46 (in Russian).

Biske, Yu.S., 1995. Late Paleozoic collision of the Tarimskiy and Kirghiz-Kazakh paleocontinents. Geotectonics 29, 26–34.

Biske, Yu.S., 1996. Palaeozoic structure and history of the South Tian-Shan. St. Petersburg University Publishing House, St. Petersburg, 192 p. (in Russian).

Biske, Y.S., Shilov, G.G., 1998. Structure of the northern margin of Tarim Massif (eastern Kokshaal area, Tianshan). Geotectonics 32, 114–121.

Biske, Y.S., Seltmann, R., 2010. Paleozoic Tian-Shan as a transitional region between the Rheic and Urals-Turkestan oceans. Gondwana Research 17, 602–613.

Biske, Yu.S., Porshniakov, G.S., Talashmanov, Yu.A., 1982. Hercynides of Ferghana Range and adjacent southern Tien-Shan. Leningrad University Press, Leningrad. 128 pp. (in Russian).

Biske, Yu.S., Konopelko, D.L., Seltmann, R., 2013. Geodynamics of Late Paleozoic magmatism in the Tien Shan and its framework. Geotectonics 47, 291–309.

Blight, J.H.S., Cunningham, D., Petterson, M.G., 2008. Crustal evolution of the Saykhandulaan Inlier, Mongolia: Implications for Palaeozoic arc magmatism, polyphase deformation and terrane accretion in the Southeast Gobi Mineral Belt. J. Asian Earth Sci. 32, 142–164.

Bochkarev, V.S., Brekhuntsov, A.M., Deshchenia, N.P., 2003. The Paleozoic and Triassic evolution of West Siberia. Geology and Geophysics 44, 120–143.

Bogdanov, A.A., 1965. Tectonic setting of Paleozoides of the Central Kazakhstan and Tienshan. Bull. Moscow Society of Naturalists, XL, 5, p. 40–68; 6, p. 8–42. (in Russian).

Boos, R.G., 1991. Paleozoic of the Tunka Bald Mountains of Eastern Sayan. Nauka Publishing House, Novosibirsk, 143 p. (in Russian).

Borisenko, A.S., Sotnikov, V.I., Izokh, A.E., Poliakov, G.V., Obolenskiy, A.A., 2006a. Perm to Triassic ore processes in Asia and connection with manifestation of plume magmatism. Russian Geology and Geophysics 47, 166–182.

Borisenko, A.S., Sotnikov, V.I., Izokh, A.E., Polyakov, G.V., Obolensky, A.A., 2006b. Permo-Triassic mineralization in Asia and its relation to plume magmatism. Russian Geology and Geophysics 47, 170–186.

Borisova, E.B., Bibikova, E.V., Dobrzhenetskaya, L.F., Makarov, V.A., 1995. Geochronological investigation of zircons on the gneissic granites of the Kokchetav diamond-bearing field. Doklady Russian Academy of Sciences 343, 801–805 (in Russian).

Branney, M.J., Kokelaar P., 2002. Pyroclastic density currents and the sedimentation of ignimbrites. Geological Society, London, Memoir 27, 143 p.

Briggs, S.M., Yin, A., Manning, C.E., Chen, Z.-L., Wang, X.-F., Grove, M., 2007. Late Paleozoic tectonic history of the Ertix Fault in the Chinese Altai and its implications for the development of the Central Asian Orogenic System. Geol. Soc. Am. Bull. 119, 944–960.

Buchan, C., Cunningham, D., Windley, B.F., Tomurhuu, D., 2001. Structural and lithological characteristics of the Bayankhongor ophiolite zone, central Mongolia. J. Geol. Soc. Lond. 158, 445–460.

Buchan, C., Pfander, J., Kröner, A., Brewer, T.S., Tomurtogoo, O., Tomurhuu, D., Cunningham, D., Windley, B.F., 2002. Timing of accretion and collisional deformation in the Central Asian Orogenic Belt: implications of granite geochronology in the Bayankhongor ophiolite zone. Chem. Geol. 192, 23–45.

Buchko, I.V., Sorokin, A.A., Kudryashov, N M., 2011. Late Paleozoic Gabbroids of the Malokhingansk Terrane in the Eastern Area of the Central Asian Fold Belt: First Geochronological Data. Doklady Earth Sciences 440, 1298–1302.

Buckman, S., Aitchison, J.C., 2004. Tectonic evolution of Palaeozoic terranes in West Junggar, Xinjiang, NW China. In: Maplas, C.J., Fletcher, J.N., Ali, J.R., Aitchison, J.C. (eds.), Aspects of the Tectonic Evolution of China. Geol. Soc. Lond., Spec. Publ. 226, pp. 101–129.

Burakov, K.S., Didenko, A.N., 1984. Evaluation of the geomagnetic field in the Middle Devonian by baked chert and gabbro in southern Mugodzhary. Izv. Acad. Sci. USSR Ser. Fizika Zemli 8, 45–59 (in Russian).

Burtman, B.S., 2008. Nappes of the southern Tianshan. Russ. J. Earth Sci. 10, ES1006, doi: 10.2205/2007ES000223.

Burtman, V.S., 1964. The Talas-Ferghana wrench faults (Tien-Shan). Akad. Nauk SSSR Geological Institute, Trudy, 104–144 (in Russian).

Burtman, V.S., 1975. Structural geology of the Variscan Tien Shan. American Journal of Science 275-A, 157–186.

Burtman, V.S., 2006a. Tien Shan and High Asia: Tectonics and geodynamics in the Paleozoic. Moscow, Geos, 216 p. (in Russian).

Burtman, V.S., 2006b. The Tien Shan early Paleozoic tectonics and geodynamics. Russian Journal of Earth Sciences 8: 1–23.

Burtman, V.S., Porshniakov G.S., 1974. Tectonics of Tien-Shan and Kyzylkum Variscides. In: Muratov, N.V. (ed.), Tectonics of Urals-Mongolian fold belt. Nauka, Moscow, pp. 92–106 (in Russian).

Burtman, V.S., Skobelev, S.F., Molnar, P., 1996. Late Cenozoic slip on the Talas-Ferghana fault, the Tien Shan, Central Asia. Geological Society of America Bulletin 108, 1004–1021.

Burtman, V.S., Gurarii, G.Z., Belen'kii, I.A., Kudasheva, I.A., 1998. Kazakhstan and Altai in Devonian time (from paleomagnetic data). Geotektonika 6, 63–71.

Buslov, M.M., 2011. Tectonics and geodynamics of the Central Asian Foldbelt: the role of Late Paleozoic large-amplitude strike-slip faults. Russian Geology and Geophysics 52, 52–71.

Buslov, M.M., Sintubin, M., 1995. Structural evolution of the Lake Teletskoe zone, Altai–Sayan folded area. Russian Geology and Geophysics 36, 81–87.

Buslov, M.M., Watanabe, T., 1996. Intra-subduction collision and its role in the evolution of an accretionary wedge: the Kurai zone of Gorny Altai, Central Asia. Russian Geology and Geophysics 36, 83–94.

Buslov, M.M., Berzin, N.A., Dobretsov, N.L., Simonov, V.A., 1993. Geology and Tectonics of Gorny Altai. Novosibirsk. Guidebook for post-symposium excursion. 4th international symposium of IGCP

Project 283 “Geodynamic evolution of the Paleoasian ocean”. United Institute of Geology, Geophysics and Mineralogy, Siberian Branch, Russian Academy of Sciences, Novosibirsk, 122p.

Buslov, M.M., Sennikov, N.V., Iwata, K., Zybin, V.A., Obut, O.T., Gusev, N.I., Shokalsky S.P., 1998. New data on the structure and age of olistostromal and sand-silty rock masses of the Gorny Altai series in the southeast of the Gorny Altai, Ahui-Chuya zone. Russian Geology and Geophysics 39, 789–798.

Buslov, M.M., Fujiwara, Y., Safonova, I.Y., Okada, T., Semakov, N., 2000. The Junction zone of the Gorny Altai and Rudny Altai terranes: structure and evolution. Russian Geology Geophysics 41, 377–390.

Buslov, M.M., Saphonova, I.Yu., Watanabe, T., Obut, O.T., Fujiwara, Y., Iwata, K., Semakov, N.N., Sugai, Y., Smirnova, L.V., Kazansky, A.Yu., 2001. Evolution of the Paleo-Asian ocean (Altai–Sayan region, Central Asia) and collision of possible Gondwana-derived terranes with the southern marginal part of the Siberian continent. Geosciences Journal 5, 203–224.

Buslov, M.M., Watanabe, T., Saphonova, I.Y., Iwata, K., Travin, A., Akiyama, M., 2002. A Vendian-Cambrian island arc system of the Siberian continent in Gorny Altai (Russia, Central Asia). Gond. Res. 5, 781–800.

Buslov, M.M., Watanabe, T., Smirnova, L.V., Fujiwara, Y., Iwata, K., de Grave, I., Semakov, N.N., Travin, A.V., Kir’ynova, A.P., Kokh, D.A., 2003. Role of strike-slip faulting in Late Paleozoic–Early Mesozoic tectonics and geodynamics of the Altai–Sayan and East Kazakhstan regions. Russian Geology and Geophysics 44, 47–71.

Buslov, M.M., Fujiwara, Y., Iwata, K., Semakov, N.N., 2004a. Late Paleozoic-Early Mesozoic geodynamics of Central Asia. Gond. Res. 7, 791–808.

Buslov, M.M., Watanabe, T., Fujiwara, Y., Iwata, K., Smirnova, L.V., Safonova, I.Y., Semakov, N.N., Kiryanova, A.P., 2004b. Late Paleozoic faults of the Altai region, Central Asia: tectonic pattern and model of formation. J. Asian Earth Sci. 23, 655–671.

Buslov, M.M., Kokh, D.A., De Grave, J., 2008. Mesozoic-Cenozoic tectonics and geodynamics of Altai, Tien Shan, and northern Kazakhstan, from apatite fission-track data. Russian Geology and Geophysics 49, 648–654.

Buslov, M.M., Ryabinin, A.B., Zhimulev, F.I., Travin, A.V., 2009. Manifestations of the Late Carboniferous and Early Permian stages of formation of nappe-fold structures in the southern framework of the Siberian Platform (East Sayany, South Siberia). Dokl. Earth Sci. 428, 1105–1108 (496–499).

Buslov, M.M., Safonova, I.Yu., Fedoseev, G.S., Reichow, M.K., Davies, K., Babin, G.A., 2010. Permo-Triassic plume magmatism of the Kuznetsk Basin, Central Asia: geology, geochronology, and geochemistry. Russian Geology and Geophysics 51, 1021–1036.

Buslov, M.M., Geng, H., Travin, A.V., Otgonbaatar, D., Kulikova, A.V., Chen, M., Stijin, G., Semakov, N.N., Rubanova, E.S., Abildaeva, M.A., Voitishek, E.E., Trofimova, D.A., 2013. Tectonics and geodynamics of Gorny Altai and adjacent structures of the Altai–Sayan folded area. Russian Geology and Geophysics 54, 1250–1271.

Bussien, D., Gombojav, N., Winkler, W., von Quadt, A., 2011. The Mongol–Okhotsk Belt in Mongolia – An appraisal of the geodynamic development by the study of sandstone provenance and detrital zircons. Tectonophysics 510, 132–150.

Butler, R.F., 1992. Paleomagnetism: magnetic domains to geologic terranes. Boston, Blackwell Sci. Publ., 319 pp.

Bykadorov, V.A., Bush, V.A., Fedorenko, O.A., Filippova, I.B., Miletenko, N.V., Puchkov, V.N., Smirnov, A.V., Uzhkenov, B.S., Volozh, Y.A., 2003. Ordovician-Permian palaeogeography of central Eurasia; development of Palaeozoic petroleum-bearing basins. J. Petrol. Geol. 26, 325–350.

Cai, K., Min, S., Yuan, C., Long, X., Xiao, W., 2011. Geological framework and Paleozoic tectonic history of the Chinese Altai, NW China: A review. Russian Geology and Geophysics 52, 1619–1633.

Calais, E., Vergnolle, M., San’kov, V., Lukhnev, A., Miroshnitchenko, A., Amarjargal, S., Deverchere, J., 2003. GPS measurements of crustal deformation in the Baikal-Mongolia area (1994-2002): Implications for current kinematics of Asia. Journal of Geophysical Research B: Solid Earth 108, ETG 14-1 to 14-13.

Cao, R., Zhao, W., Xiao, Z., 1983. Precambrian classification and correlation in China. In: Nanjing Institute of Geology and Palaeontology and Academia Sinica (Eds.), Palaeontologia Cathayana, 1, Science Press, Beijing, pp. 421–451.

Cao, X., Dang, Z.X., Zhang, X.Z., Jiang, J.S., Wang, H.D., 1992. The composite Jiamusi terrane. Jilin Publishing House of Science and Technology, Changchun, 224 pp. (in Chinese with English and Russian abstracts).

Carroll, A.R., Graham Stephen, A., Chang Edmund, Z., McKnight, C., 2001. Sinian through Permian tectonostratigraphic evolution of the northwestern Tarim basin, China. In: Hendrix, M.S., Davis, G.A. (eds.), Paleozoic and Mesozoic Tectonic Evolution of Central Asia: From continental assembly to intracontinental deformation. Geol. Soc. Am. Mem. 194, pp. 47–69.

Cawood, P.A., Kröner, A., Collins, W.J., Kusky, T.M., Mooney, W.D., Windley, B.F., 2009. Accretionary orogeny through Earth history. Geological Society of London, Special Publication 318, 1–36.

Chai, F., Mao, J., Dong, L., Yang, F., Liu, F., Geng, X., Zhang, Z., 2009. Geochronology of metarhyolites from the Kangbutiebao Formation in the Kelang basin, Altay Mountains, Xinjiang: Implications for the tectonic evolution and metallogeny. Gond. Res. 16, 189–200.

Charvet, J., Shu, L., Laurent-Charvet, S., 2007. Paleozoic structural and geodynamic evolution of eastern Tianshan (NW China); welding of the Tarim and Junggar plates. Episodes 30, 162–186.

Charvet, J., Shu, L., Laurent-Charvet, S., Wang, B., Faure, M., Cluzel, D., Chen, Y., De Jong, K., 2011. Palaeozoic tectonic evolution of the Tianshan belt, NW China. Sci. China: Earth Sci. 54, 166–184.

Chen, B., Jahn, B.M., Wilde, S., Xu, B., 2000. Two contrasting Paleozoic magmatic belts in northern Inner Mongolia, China: petrogenesis and tectonic implications. Tectonophysics 328, 157–182.

Chen, B., Jahn, B.M., Tian, W., 2009. Evolution of the Solonker suture zone: Constraints from zircon U-Pb ages, Hf isotopic ratios and whole-rock Nd-Sr isotope compositions of subduction- and collision-related magmas and forearc sediments. J. Asian Earth Sci. 34, 245–257.

Chen, C., Lu, H., Jia, D., Cai, D., Wu, S., 1999. Closing history of the southern Tianshan oceanic basin, western China; an oblique collisional orogeny. Tectonophysics 302, 23–40.

Cheng, R.Y., Wu, F.Y., Ge, W.C., Sun, D.Y., Yang, J.H., 2006. Emplacement age of the Raohe Complex in eastern Heilongjiang Province and the tectonic evolution of the eastern part of Northeastern China. Acta Petrologica Sinica 22, 353–376.

Chi, Z., Zhai, M., Allen, M.B., Saunders, A.D., Ghangrei, W., Xuan, H., 1993. Implications of Paleozoic ophiolites from Western Junggar, NW China, for the tectonics of Central Asia. J. Geol. Soc., London 150, 551–561.

Chiaradia, M., Konopelko, D., Seltmann, R., Cliff, R., 2006. Lead isotope variations across terrain boundaries of the Tien Shan and Chinese Altay. Mineralium Deposita 41, 411–428.

Chikov, B.M., Zinoviev, S.V., 1996. Post-Hercynian collisional structures of Western Altai. Russian Geology and Geophysics) 37, 59–67.

Chitalin, A.F., 1996. Variscan Structural Evolution of Central Kazakhstan. In: Seltmann, R., Shatov, V., Kremenetsky, A., Lehmann, B., Popov, V., Ermolov, P. (eds.). Granite-related ore deposits of Central Kazakhstan and adjacent areas. Glagol Publishing House, St.-Petersburg, 93–102.

Cloos, M., 1993. Lithospheric buoyancy and collision orogenesis: subduction of oceanic plateaus, continental margins, island arcs, spreading ridges and seamounts. Geological Society of America Bulletin 105, 715–737.

Cobbold, P.R., Davy, P., Gapais, E.A., Rossello, E., Sadybakasov, J.C., Thomas, J.J., Tondji B., de Urreiztieta, M., 1993. Sedimentary basins and crustal thickening. Sedimentary Geology 86, 77–89.

Cocks, L.R.M., Torsvik, T.H., 2007. Siberia, the wandering northern terrane, and its changing geography through the Palaeozoic. Earth-Science Reviews 82, 29–74.

Cogné, J.P., Kravchinsky, V.A., Halim, N., Hankard, F., 2005. Late Jurassic–Early Cretaceous closure of the Mongol-Okhotsk Ocean demonstrated by new Mesozoic palaeomagnetic results from the Trans-Baikal area (SE Siberia). Geophysical Journal International 63, 813–832.

Coleman, R.G., 1977. Ophiolites. Ancient oceanic lithosphere? Springer-Verlag, Berlin, 229 p.

Collins, A.Q., Degtyarev, K.E., Levashova, N.M., Bazhenov, M.L., van der Voo, R., 2003. Early Paleozoic paleomagnetism of east Kazakhstan: implications for paleolatitudinal drift of tectonic elements within the Ural-Mongol belt. Tectonophysics 377, 229–247.

Collins, W.J., 2003. Slab pull, mantle convection, and Pangaean assembly and dispersal. Earth and Planetary Science Letters 205, 225–237.

Coney, P.J., 1980. Cordilleran metamorphic core complexes: An overview. In: Crittendon, M.D., Coney, P.J., Davis, G.H. (Eds.), Cordilleran metamorphic core complexes. Geological Society of America, Memoir 153, 7–31.

Coney, P.J., Jones, D.L., Monger, J.W.H., 1980. Cordilleran suspect terranes. Nature 288, 329–333.

Constenius, K.N., Coogan, J.C., Erdenebat, B., Tully, J., Johnson, C., Graham, S., Cunningham, D., 2012. Late Jurassic-Early Cretaceous rifting in the Tugrug and Taatsiin Tsagaan Nuur basins, Gobi-Altai

region of SW Mongolia – Implications for petroleum exploration. AAPG Abstracts with Programs, Long Beach, USA, p. 66.
Cook, H.E., Zhemchuzhnikov, V.G., Zempolich, W.G., Buvtyshkin, V.M., Valentina, Ya., Zhaimina, V.Ya., Kotova, E.A., Golub, L.Ya., Zorin, A.Ye.,. Lehmann, P.J., Alexeiev, D.V., Giovanneli, A., Viaggi, M., Fretwell, N., Lapointe, P., Corboy, J.J., Bowman, M. & De Coo, J.C.M., 2002. Devonian and Carboniferous carbonate platform facies in the Bolshoi Karatau, southern Kazakhstan: outcrop analogs for coeval carbonate oil and gas fields in the North Caspian Basin, western Kazakhstan. In: Zempolich, W.G., Cook, H.E. (eds.): Paleozoic carbonates of the Commonwealth of thr Independant States (CIS): Subsurface Reservoirs and Outcrop Analogs. SEPM, Special Publications 74, 81–122.
Cunningham, D., 2005. Active intracontinental transpressional mountain building in the Mongolian Altai: Defining a new class of orogen. Earth and Planetary Science Letters 240, 436–444.
Cunningham, D., 2007. Structural and topographic characteristics of restraining bend mountain ranges of the Altai, Gobi Altai and easternmost Tien Shan. In: Cunningham, W.D., Mann, P. (eds.), Tectonics of strike-slip restraining and releasing bends. Geological Society, London, Special Publication 290, 219–237.
Cunningham, D., 2010. Tectonic setting and structural evolution of the Late Cenozoic Gobi Altai Orogen. In: Kusky, T.M., Zhai, M.G., Xiao, W.J. (eds.), The evolving continents: Understanding processes of continental growth and stabilization. Geological Society, London, Special Publication 338, 361–387.
Cunningham, D., Owen, L.A., Snee, L.W., Li, J., 2003. Structural framework of a major intracontinental orogenic termination zone: The easternmost Tien Shan, China. Journal of the Geological Society 160, 575–590.
Cunningham, D., Mann, P., 2007. Tectonics of strike-slip restraining and releasing bends. In: Cunningham, W.D., Mann, P. (eds.), Tectonics of strike-slip restraining and releasing bends. Geological Society, London Special Publication 290, 1–12.
Cunningham, D., Davies, S., McLean, D., 2009. Exhumation of a Cretaceous rift complex within a Late Cenozoic restraining bend, southern Mongolia: Implications of the crustal evolution of the Gobi Altai region. Journal of the Geological Society, London 166, 1–13.
Cunningham, W.D., 1998. Lithospheric controls on late Cenozoic construction of the Mongolian Altai. Tectonics 17, 891–902.
Cunningham, W.D., Windley, B.F., Dorjnamjaa, D., Badamgarov, J., Saandar, M., 1996. Late Cenozoic transpression in southwestern Mongolia and the Gobi Altai-Tien Shan connection. Earth and Planetary Science Letters 140, 67–81.
Cunningham, W.D., Windley, B.F., Owen, L.A., Barry, T., Dorjnamjaa, D., Badamgarav, J., 1997. Geometry and style of partitioned deformation within a late Cenozoic transpressional zone in the eastern Gobi Altai Mountains, Mongolia. Tectonophysics 277, 285–306.
Dalimov, T.N., Ganiyev, I.N, 2010. The evolution and classification of magmatism in the western Tien-Shan. Tashkent University, 225 pp. (in Russian).
Dalimov, T.N., Ganiyev, I.N., Shpotova, L.V., Kadyrov, M.Kh., 1993. Geodynamics of the Tien-Shan, 1. The magmatism and Paleozoic geodynamic environments. University of Tashkent. 297 pp. (in Russian).
Danelian, T., Popov, L.Ye., Tolmacheva, T.Yu., Mansoureh, G.P., Neyevin, A.V., Mikolaichuk, A.V., 2011. Ordovician radiolaria and conodonts from the peri-Gondwanan Karatau-Naryn microplate (Sarydzhaz, eastern Kyrgyzstan). Geobios 44, 587–599.
Dang, Y., Li, D., 1993. Discussion on isotope geochronology of Precambrian Jiamusi Block. Journal of Changchun University (Earth Science) 23, 332–318 (in Chinese with English abstract).
Davis, G.A., Darby, B.J., 2010. Early Cretaceous overprinting of the Mesozoic Daqing Shan fold-and-thrust belt by the Hohhot metamorphic core complex, Inner Mongolia, China. Geoscience Frontiers 1, 1–20.
Davis, G.H., Coney, P.J., 1979. Geologic development of Cordilleran metamorphic core complexes. Geology 7, 120–124.
De Grave, J., Buslov, M.M., Zhimulev, F.I., Vermeesch, P., McWilliams, M.O., Metcalf, J., 2006. The Early Ordovician age of deformations in the Kokchetav subduction-collision zone: New structural and 40Ar/39Ar data. Geologiya i Geofizika 47, 445–454.
De Grave, J., Buslov, M.M., Van den Haute, P., Metcalf, J., Dehandschutter, B., McWilliams, M.O., 2009. Multimethodchronometry of the Teletskoye graben and its basement, Siberian Altai Mountains: new insights on its thermo-tectonicevolution. In: Lisker, F., Ventura, B., Glasmacher, U.A. (Eds.), Thermochronological methods – from palaeotemperature constraints to landscape evolution models: Geological Society Special Publication, London, pp. 237–259.

De Grave, J., Glorie, S., Ryabinin, A., Zhimulev, F., Buslov, M.M., Izmer, A., Elburg, M., Vanhaecke, F., Van den Haute, P., 2012. Late Palaeozoic and Meso-Cenozoic tectonic evolution of the southern Kyrgyz Tien Shan: Constraints from multi-method thermochronology in the Trans-Alai, Turkestan-Alai segment and the southeastern Ferghana K. E. Basin. Journal of Asian Earth Sciences 44, 149–168.

De Jong, K., Xiao, W., Windley, B.F., Masago, H., Lo, C.H., 2006. Ordovician 40Ar/39Ar phengite ages from the blueschist-facies Ondor Sum subduction-accretion complex (Inner Mongolia) and implications for the early Paleozoic history of continental blocks in China and adjacent areas. Am. J. Sci. 306, 799–845.

Degtyarev, K.E., 1999. Tectonic evolution of the early Paleozoic active margin in Kazakhstan. Nauka, Moscow. 123 pp. (in Russian).

Degtyarev, K.E., 2003. Position of the Aktau-Dzungar microcontinent in the structural framework of the Paleozoides of central Kazakhstan. Geotectonics 37, 271–288.

Degtyarev, K.E., 2011. Tectonic evolution of early Paleozoic island arc systems and continental crust formation in the Caledonides of Kazakhstan and the North Tien Shan. Geotectonics 45, 23–50.

Degtyarev, K.E., Shatagin, K.N., Kotov, A.B., Sal'nikova, E.B., Luchitskaya, M.V., Yakovleva, S.Z., Plotkina, Y.V., Fedoseenko, A.M., 2006. Early Paleozoic granitoids of the Aqtau-Dzungar microcontinent (Central Kazakhstan). Doklady Earth Sci. 411, 1204–1208.

Degtyarev, K.E., Ryazantsev, A.V., 2007. Cambrian arc-continent collision in the Paleozoides of Kazakhstan. Geotectonics 41, 63–86.

Degtyarev, K.Ye., Stupak, A.F., Yakubchuk, A.S., 1993. Devonian ophiolites in the Junggar Alatau. Doklady Russian Academy of Sciences 320, 206–211.

Degtyarev, K.Ye., Shatagin, K.V., Kotov, A.B., Salnikova, E.B., Luchitskaya, M.V., Shershakova, M.M., Shershakov, A.V., Tret'yakov, A.A., 2008. Early Ordovician volcanic complex of the Stepnyak zone (Northern Kazakhstan): age substantiation and geodynamic setting. Doklady Earth Science 419, 248–252.

Demoux, A., Kröner, A., Badarch, G., Jian, P., Tomurhuu, D., Wingate, M.T.D., 2009a. Zircon ages from the Baydrag Block and the Bayankhongor Ophiolite Zone: time constraints on late Neoproterozoic to Cambrian subduction and accretion related magmatism in Central Mongolia. Journal of Geology 117, 377–397.

Demoux, A., Kröner, A., Liu, D.Y., Badarch, G., 2009b. Precambrian crystalline basement in southern Mongolia as revealed by SHRIMP zircon dating. International Journal of Earth Sciences 98, 1365–1380.

Devyatkin, E.V., 1974. Structures and formational complexes of the Cenozoic activated stage. In: Tectonics of the Mongolian People's Republic. Moscow, Nauka Publ. House, 182–195 (in Russian).

Devyatkin, E.V., 1981. The Cenozoic of Inner Asia (Stratigraphy, geochronology and correlation). In: Nikiforova, K.V. (ed.), The Joint Soviet-Mongolian Scientific-Research Geological Expedition. Transactions 27, Nauka Publ. House, Moscow, 196 p. (in Russian).

Devyatkin, E.V., Smelov, S.B., 1980. Position of basalts in the Cenozoic sedimentary sequence of Mongolia. International Geology Review, 22, No. 3, 307–317.

Dewey, J., Cande, S., Pitman, W., 1989. Tectonic evolution of the India/Eurasia Collision Zone. Eclogae geologicae Helveticae 82, 717–734.

Dewey, J.F., Shackleton, R.M., Chengfa, C., Yiyin, S., 1988. The tectonic evolution of the Tibetan Plateau. Phil. Trans. R. Soc. Lond. A 327, 379–413.

Deyev, E.V., Votakh, O.A., Beliayev, S.Yu., Zinoviev, S.V., Levchuk, M.A., 2001. Tectonics of the basement of the Middle Ob region (Western Siberia). Geology and Geophysics, 42, 968–978.

Didenko, A.N., Pechersky, D.M., 1993. Revised Paleozoic Apparent Polar Wander Paths for E. Europe, Siberia, N. China and Tarim plates. In: Zonenshain, L.P., Memorial conference on Plate Tectonics. Moscow, 47–48.

Didenko, A.N., Mossakovskii, A.A., Pecherskii, D.M., Ruzhentsev, S.V., Samygin, S.G., Kheraskova, T.N., 1994a. Geodynamics of the Central-Asian Paleozoic oceans. Russian Geology and Geophysics 35, 59–75.

Didenko, A.N., Mossakovsky, A.A., Pechersky, D.M., Ruzhentsev, S.V., Samygin, S.G., Kheraskova, T.N., 1994b. Geodynamics of Paleozoic oceans of central Asia. Geology and Geophysics 35, 118–145 (in Russian).

Didenko, A.N., Mossakovsky, A.A., Pechersky, D.M., Ruzhentsev, S.V., Samygin, S.G., Kheraskova, T.N., 1994c. Geodynamics of Paleozoic oceans of Central Asia. Geologiya i Geofizika 7-8, 59–75 (in Russian).

Didenko, A.N., Kaplun, V.B., Malyshev, Yu.F., Shevchenko, B.F., 2010a. The structure of the lithosphere and Mesozoic geodynamics of the Central Asian fold belt eastern part. Geologiya i Geofizika 51, 629–647 (in Russian).

Didenko, A.N., Malyshev, Yu.F., Saksin, B.G. (eds.), 2010b. Deep structure and metallogeny of East Asia. Vladivostok, Dalnauka, 332 pp. (in Russian)

Dijkstra, A.H., Brouwer, F.M., Cunningham, W.D., Buchan, C., Badarch, G., Mason, P.R.D., 2006. Late Neoproterozoic proto-arc ocean crust in the Dariv Range, western Mongolia; a type-example of a supra-subduction zone ophiolite. J. Geol. Soc. Lond. 163, 363–373.

Dilek, Y., Furnes, H., 2011. Ophiolite genesis and global tectonics: Geochemical and tectonic fingerprinting of ancient oceanic lithosphere. Geological Society of America Bulletin 123, 387–411.

Distanov, E.G., 1962. Strike-slip faulting as control over the formation of the North East shear zone (Altai) and polymetamorphic mineralization. Geologiya i Geofizika 2, 52–56.

Distanova, A.N., 2000. Early Paleozoic granitoidas sociations of the Altai- Sayanfolded area: their types and importance in paleogeodynamic reconstructions. Russian Geology and Geophysics 41, 1244–1257.

Dobkin, S.N., Novoselov, B.A., Borodin, A.M., et al. 1999. State Geological Map of the Russian Federation. Scale 1:200 000. Issue 2. Bureya series. M_52_XXX. VSEGEI, St. Petersburg (in Russian).

Dobretsov, N.L., 1985. On the thrust tectonics of Eastern Sayan. Geotektonika 1, 39–50.

Dobretsov, N.L. (Ed.), 1988. Geology and metamorphism of East Sayan. Nauka Publ. House, Novosibirsk, 190 p. (in Russian).

Dobretsov, N.L., 2003. Evolution of structures of the Urals, Kazakhstan, Tien Shan, and Altai–Sayan region within the Ural-Mongolian fold belt (Paleoasian Ocean). Russian Geology and Geophysics 44 (1–2), 3–26; 5-27

Dobretsov, N.L., 2005. 250 Ma large igneous provinces of Asia: Siberian and Emeishan traps (plateau basalts) and associated granitoids. Russian Geology and Geophysics 46, 847–868.

Dobretsov, N.L., Buslov, M.M., 2004. Serpentinitic mélanges associated with HP and UHP rocks in Central Asia. Intern. Geol. Rev. 46, 957–980.

Dobretsov, N.L., Buslov, M.M., 2007. Late Cambrian–Ordovician tectonics and geodynamics of Central Asia. Russian Geology and Geophysics 48, 71–82.

Dobretsov, N.L., Buslov, M.M., 2011. Problems of geodynamics, tectonics, and metallogeny of orogens. Russian Geology and Geophysics 52, 1505–1515.

Dobretsov, N.L., Ponomareva, L.G., 1969. Basement composition and age of the Zaisan geosyncline: New data. Geologiya i Geofizika 3, 121–125.

Dobretsov, N.L., Ermolov, P.V., Khomyakov, V.D., 1979. Ophiolites and basement composition in the axial part of the Zaisan geosyncline. In: Kuznetsov, Yu.A. (Ed.), Mafic and Ultramafic complexes of Siberia. Nauka Publishing House, Novosibirsk, 196–219 (in Russian).

Dobretsov, N.L., Karsakov, L.P., Sklyarov, Ye.V., 1988. Glaucophane schist belts of South Siberia and the Amur region. Geologiya i Geofizika 1, 3–11 (in Russian).

Dobretsov, N.L., Dook V.L., Kitsul V.I., 1990. Geotectonic evolution of the Siberian platform during the Precambrian and comparison with the lower Precambrian complexes of eastern Asia. Journal of Southeastern Asian Earth Sciences 4, 259–266.

Dobretsov, N.L., Berzin, N.A., Buslov, M.M., 1995. Opening and tectonic evolution of the Paleo-Asian ocean. International Geology Reviews 35, 335–360.

Dobretsov, N.L., Teunissen, K., Smirnova, L.V., 1998. Structural and geodynamic evolution of diamond-bearing metamorphic rocks in the Kokchetav Massif. Geology and Geophysics 39, 1631–1652.

Dobretsov, N.L., Buslov, M.M., Safonova, I.Y., Kokh, D.A., 2004a. Fragments of oceanic islands in the Kurai and Katun' accretionary wedges of Gorny Altai. Russ. Geol. Geophys. 45, 1381–1403.

Dobretsov, N.L., Buslov, M.M., Yu, U., 2004b. Fragments of oceanic islands in accretion-collision areas of Gorny Altai and Salair, southern Siberia, Russia: early stages of continental crustal growth of the Siberian continent in Vendian–Early Cambrian time. Journal of Asian Earth Sciences 23, 673–690.

Dobretsov, N.L., Buslov, M.M., Zhimulev, F.I., 2005a. Cambrian-Ordovician tectonic evolution of the Kokchetav metamorphic belt, northern Kazakhstan. Russ. Geol. Geophys. 46, 785–795.

Dobretsov, N.L., Buslov, M.M., Zhimulev, F.I., Travin, A.V., 2005b. The Kokchetav Massif as a deformed Cambrian-early Caradocian collision-subduction zone. Doklady Earth Sci. 402, 501–505.

Dobretsov, N.L., Buslov, M.M. & Zhimulev, F.I., 2005c. Cambrian–Ordovician tectonic evolution of the Kokchetav metamorphic belt (northern Kazakhstan). Geologiya I Geofizika 46, 806–816.

Dobretsov, N.L., Borisenko, A.S., Izokh, A.E., Zhmodik, S.M., 2010. A thermochemical model of Eurasian Permo-Triassic mantle plumes as a basis for prediction and exploration for Cu–Ni–PGE and rare-metal ore deposits. Russian Geology and Geophysics 51, 903–924.

Donskaya, T.V., Sklyarov, E.V., Gladkochub, D.P., Mazukabzov, A.M., Sal'nikova, E.B., Kovach, V.P., Yakovleva, S.Z., Berezhnaya, N.G., 2000. The Baikal collisional metamorphic belt. Doklady Earth Sciences 374, 1075–1079.

Donskaya, T.V., Gladkochub, D.P., Mazukabzov, A.M., Paderin, I.P., 2008a. Hercynian metamorphic events in western Transbaikalia: Geodymanic implications, in: Geodynamic lithospheric evolution of the Central Asian Mobile Belt: From ocean to continent. Institute of the Earth's Crust, Siberian Branch, Russian Academy of Sciences. Vol. 1, 113–115 (in Russian).

Donskaya, T.V., Windley, B.F., Mazukabzov, A.M., Kröner, A., Sklyarov, E.V., Gladkochub, D.P., Ponomarchuk, V.A., Badarch, G., Reichow, M., Hegner, E., 2008b. Age and evolution of late Mesozoic metamorphic core complexes in southern Siberia and northern Mongolia. Journal of the Geological Society 165, 405–421.

Donskaya, T.V., Gladkochub, D.P., Mazukabzov, A.M., DeWaele, B., Presnyakov, S.L., 2012a. The Late Triassic Kataev volcanoplutonic association in western Transbaikalia, a fragment of the active continental margin of the Mongol-Okhotsk Ocean. Russian Geology and Geophysics 53, 22–36.

Donskaya, T.V., Gladkochub, D.P., Mazukabzov, A.M., 2012b. The Late Permian–Early Triassic magmatism of western Transbaikalia. In: Sklyarov, E.V. (Ed.), Geodynamic evolution of the lithosphere in the Central Asian mobile belt (from ocean to continent). Izd. Instituta Zemnoi Kory, Irkutsk, Issue 10, vol. 1, pp. 85–87 (in Russian).

Donskaya, T.V., Gladkochub, D.P., Mazukabzov, A.M., Ivanov, A.V., 2013. Late Paleozoic–Mesozoic subduction-related magmatism at the southern margin of the Siberian continent and the 150 million-year history of the Mongol-Okhotsk Ocean. Journal of Asian Earth Science 62, 79–97.

Doroshkevich, A.G., Ripp, G.S., Sergeev, S.A., 2012a. U-Pb (SHRIMP-II) isotope dating of zircons from alkali rocks of Vitim province, West Transbaikalia. Doklady Earth Sciences 443, 297–301.

Doroshkevich, A.G., Ripp, G.S., Izbrodin, I.A., Savatenkov, V.M., 2012b. Alkaline magmatism of the Vitim province, West Transbaikalia, Russia: Age, mineralogical, geochemical and isotope (O, C, D, Sr and Nd) data. Lithos 152, 157–172.

Doroshkevich, A.G., Ripp, G.S., Sergeev, S.A., Konopel'ko, D.L., 2012c. U-Pb (SHRIMP-II) geochronology of Mukhalski alkaline massif, West Transbaikalia. Russian Geology and Geophysics 53, 169–174.

Dril, S.I., Kuzmin, M.I., 1998. Geochemistry of rocks of the Bureya paleoisland arc in the central sector of the Mongol-Okhotsk fold belt. Geokhimiya 360, 241–245 (in Russian).

Dril, S.I., Sorokin, A.A., 1998. Geochemistry, Rb-Sr isotope systematics, and geodynamic position of granitoids of the Urusha complex, Mongol-Okhotsk fold belt eastern segment. In: Materials of the II metallogenic meeting. Irkutsk, 242–243 (in Russian).

Duk, G.G., 1995. Glaukophan-slate, glaukophan-greenstone and ophiolite complexes of the Ural-Mongolian fold belt. Unpublished D.Sc. thesis, Institute of Precambrian Geology, Russian Academy of Sciences, St. Petersburg. 271 pp. (in Russian).

Dumler, L.F. (Ed.), 1981. Geological map of Kazakh SSR at 1:500000 scale. Central Kazakhstan series. Explanatory Notes. Almaty, Ministry of Geology and Mineral Protection, 322 p.

Egorov, A.S., Chistyakov, D.N., 2003. Deep structure of the basement of the West Siberian Platform and its folded surroundings. Russian Geology and Geophysics 44 (1–2), 99–114.

Faure, M., Natal'in, B., 1992. The geodynamic evolution of the eastern Eurasian margin in Mesozoic times. Tectonophysics 208, 397–411.

Faure, M., Natal'in, B.A., Monie, P., Vrublevsky, A.A., Borukaiev, C.H., Prikhodko, V., 1995. Tectonic evolution of the Anuy metamorphic rocks (Sikhote Alin, Russia) and their place in the Mesozoic geodynamic framework of East Asia. Tectonophysics 241, 279–301.

Fedorovskii, V.S., Khain, E.V., Vladimirov, A.G., Kargopolov, S.A., Gibsher, A.S., Izokh, A.E., 1995. Tectonics, metamorphism, and magmatism of collisional zones of the Central Asian Caledonides. Geotectonics 29, 193–212.

Fedorovsky, V.S., 1997. Dome tectonics in the Caledonian collision system of western Cisbaikalia. Geotectonics 6, 485.

Fedorovsky, V.S., Dobrzhenetskaya, L.F., Molchanova, T.V., Likhachev, A.B., 1993. A new type of melange (Baikal, Ol'khon region). Geotektonika 4, 30–45.

Fedorovsky, V.S., Vladimirov, A.G., Khain, E.V., Kargopolov, S.A., Gibsher, A.S., Izokh, A.E., 1995. Tectonics, metamorphism and magmatism of Caledonian collisional zones of Central Asia. Geotektonika 3, 322.

Fedorovsky, V.S., Donskaya, T.V., Gladkochub, D.P., Khromykh, V.P., Mazukabzov, A.M., Mekhonoshin, A.S., Sklyarov, E.V., Sukhorukov, V.P., Vladimirov, A.G., Volkova, N.I., Yudin, D.S., 2005. The Olkhon collision system. In: Sklyarov, E.V. (Ed.), Structural and tectonic correlation across the Central Asia orogenic collage: North-Eastern segment (Guidebook and abstract volume of the Siberian workshop of IGGP-480). Institute of Earth Sciences, Siberian Branch, Russian Academy of Sciences, Irkutsk, 5–76.

Fedorovsky, V.S., Sklyarov, E.V., Izokh, A.E., Kotov, A.B., Lavrenchuk, A.V., Mazukabzov, A.M., 2010. Strike-slip tectonics and subalkaline mafic magmatism in the Early Paleozoic collisional system of the western Baikal region. Russian Geology and Geophysics 51, 534–547.

Feininger, T., 1987. Allochthonous terranes in the Andes of Ecuador and northwestern Peru. Canadian Journal of Earth Sciences 24, 266–278.

Feng, Z.Q., Jia, C.Z., Xie, X.N., Zhang, S., Feng, Z.H., Cross, T.A., 2010. Tectonostratigraphic units and stratigraphic sequences of the nonmarine Songliao basin, northeast China. Basin Research 22, 79–95.

Filimoniv, A.V., Minina, O.R., Neberekutina, L.N., 1999. The Urma Strata, a reference Upper Devonian stratotype in western Transbaikalia. Vestnik Voronezhskogo Gosudarstvennogo Universiteta, Seria Geologicheskaya, 46–57 (in Russian).

Filippova, I.B., Suetenko, O.D., Hasin, R.A., 1984. Mesozoic paleogeodynamic situation and some of the features of metallogeny in Eastern Mongolia. Geology and Mineral Resources of the Mongolian People's Republic. Moscow, Nedra, 27–46 (in Russian).

Filippova, I., Bush, V., Didenko, A., 2001. Middle Palaeozoic subduction belts: The leading factor in the formation of the Asian fold-and-thrust belt. Russian Journal of Earth Sciences 3, 405–426.

Fisher, R., 1953. Dispersion on a sphere, Proceedings of the Royal Society, London A217, 295–305.

Florensov, N.A., Solonenko, V.P. (ed.), 1963. The Gobi-Altai earthquake. Moscow, Akademiya Nauk USSR (in Russian; English translation, 1965, U.S. Department of Commerce, Washington, D.C.), 424 p.

Foden, J., Sandiford, M., Dougherty-Page, J., Williams, I., 1999. Geochemistry and geochronology of the Rathjen Gneiss: Implications for the early tectonic evolution of the Delamerian Orogen. Australian Journal of Earth Sciences 46, 377–389.

Fortey, R.A., Cocks, L.R.M., 2003. Palaeontological evidence bearing on global Ordovician-Silurian continental reconstructions. Earth Sci. Rev. 61, 245–307.

Galitskiy, V.V., 1967. Tectonics of Karatau ridge (South Kazakhstan). In: Tectonics and dynamo-metamorphism of the Paleozoides of Kazakhstan. Transactions of the Institute of Geological Sciences 19, Nauka Publisher, Alma-Ata, pp. 3–47 (in Russian).

Gao, F.H., Xu, W.L., Yang, D.B., Pei, F.P., Liu, X.M., Hu, Z.C., 2007. LA-ICP-MS zircon U–Pb dating from granitoids in southern basement of Songliao basin: constraints on ages of the basin basement. Science in China (D) 50, 995–1004.

Gao, J., Klemd, R., 2003. Formation of HP-LT rocks and their tectonic implications in the western Tianshan Orogen, NW China; geochemical and age constraints. Lithos 66, 1–22.

Gao, J., Maosong, L., Xuchang, X., Yaoqing, T., Guoqi, H., 1998. Paleozoic tectonic evolution of the Tianshan Orogen, northwestern China. Tectonophysics 287, 213–231.

Gao, J., Long, L., Klemd, R., Qian, Q., Liu, D., Xiong, X., Su, W., Liu, W., Wang, Y., Yang, F., 2009. Tectonic evolution of the South Tianshan orogen and adjacent regions, NW China: geochemical and age constraints of granitoid rocks. Intern. J. Earth Sci. 98, 1221–1238.

Ge, W.C., Wu, F.Y., Zhou, C.Y., Abdel Rahman, A.A., 2005a. Emplacement age of the Tahe granite and its constraints on the tectonic nature of the Erguna block in the northern part of the Da Hinggan Range. Chinese Science Bulletin 50, 2097–2105.

Ge, W.C., Wu, F.Y., Zhou, C.Y., Zhang, J.H., 2005b. Zircon U–Pb ages and its significance of the Mesozoic granites in the Wulanhaote region, central Da Hinggan Mountain. Acta Petrologica Sinica 21, 749–762.

Ge, W.C., Sui, Z.M., Wu, F.Y., Zhang, J.H., Xu, X.C., Cheng, R.Y., 2007a. Zircon U–Pb ages, Hf isotopic characteristics and their implications of the Early Paleozoic granites in the northwestern Da Hinggan Mts., northeastern China. Acta Petrologica Sinica 23, 423–440.

Ge, W.C., Wu, F.Y., Zhou, C.Y., Zhang, J.H., 2007b. Porphyry Cu-Mo deposits in the eastern Xing'an-Mongolian Orogenic Belt. Mineralization ages and their geodynamic implications. Chinese Science Bulletin 52, 3416–3427.

Geologic Map of the Amur region and adjacent territories. Explanatory Note to the Geologic Map, scale: 1:2,500,000, 1999. St.-Petersburg, Blagoveshchensk, Harbin, 135 pp. (in Russian).
Geologic Map of the Chita region, scale 1: 500,000., 1992. I.G. Rutshtein (Ed.) (in Russian).
Geologic structure of the Chita region, 1997. Explanatory Note to the Geologic Map, scale 1:500,000. Chita, 239 pp. (in Russian).
Geological Map of Amur Region and adjacent areas. Krasnyi, L.I., Yungbiao, P. (eds.), 1996. Harbin – Sankt-Petersburg – Blagoveshchensk.
Geology of the People's Republic of Mongolia, 1973. Stratigraphy. 1, 583 pp. (in Russian).
Geology of the USSR, 1966. V. XIX. Khabarovsk Territory and Amur region, Moscow, Nedra, 736 pp. (in Russian).
Gerasimova, N.A., Novikova, M.Z., Kurkovskaya, A.A., Yakubchuk A.S., 1992. New data on the stratigraphy of the lower Paleozoic of Tekturmas ophiolitic belt. Bulletin of the Moscow Society of Naturalists (MOIP), Geology 67, 60–76 (in Russian).
German, L.L., Budianskiy, L.D., 1990. Trans-spreading magmatism: a geodynamic model. Doklady of the Academy of Sciences of the USSR, 314, 1467–1471 (in Russian).
Ghes', M.D., 1999. Magmatism and geodynamic evolution of the Caledonian orogen in the Tian Shan. Proceeding of the National Academy of Science of the Kyrgyz Republic, 33–42 (in Russian).
Ghes', M.D., 2008. Terrane structure and geodynamic evolution of the Caledonides of Tian Shan. Altyn Tamga Publishing House, Bishkek, 158 p. (in Russian).
Ghes', M.D., Makarychev, G.I., 1985. Tectonic significance of Riphean and Cambrian basites in the Northern Tien-Shan. Proceedings of the Academy of Science of the USSR, Geol. Series 3, 66–76 (in Russian).
Gladkochub, D., Pisarevsky, S., Donskaya, T., Natapov, L., Mazukabzov, A., Stanevich, A., Sklyarov, E., 2006. The Siberian Craton and its evolution in terms of the Rodinia hypothesis. Episodes 29, 169–174.
Gladkochub, D.P., Donskaya, T.V., Wingate, M.T.D., Poller, U., Kröner, A., Fedorovsky, V.S., Mazukabzov, A.M., Todt, W., Pisarevsky, S.A., 2008a. Petrology, geochronology, and tectonic implications of c. 500 Ma metamorphic and igneous rocks along the northern margin of the Central-Asian Orogen (Olkhon terrane, Lake Baikal, Siberia). Journal of the Geological Society, London 165, 235–246.
Gladkochub, D.P., Donskaya, T.V., Fedorovsky, V.S., Mazukabzov, A.M., Wingate, M.T.D., Poller, U., Todt, W., 2008b. New data on the age and protolith of granulites of the Olkhon collisional system (Baikal Region). Doklady Earth Sciences 419, 417–422.
Gladkochub, D.P., Donskaya, T.V., Fedorovsky, V.S., Mazukabzov, A.M., Larionov, A.N., Sergeev, S.A., 2010. The Olkhon metamorphic terrane in the Baikal region: An Early Paleozoic collage of Neoproterozoic active margin fragments. Russian Geology and Geophysics 51, 447–460; 571–588.
Glorie, S., De Grave, J., Buslov, M.M., Zhimulev, F.I., Izmer, A., Vandoorne, W., Ryabinin, A., van den Haute, P., Vanhaecke, F., Elburg, M.A., 2011. Formation and Palaeozoic evolution of the Gorny-Altai–Altai-Mongolia suture zone (South Siberia): Zircon U/Pb constraints on the igneous record. Gond. Res. 20, 465–484.
Glorie, S., De Grave, J., Delvaux, D., Buslov, M.M., Zhimulev, F.I., Vanhaecke, F., Elburg, M.A., Van den Haute, P., 2012. Tectonic history of the Irtysh shear zone (NE Kazakhstan): New constraints from zircon U/Pb dating, apatite fission track dating and palaeostress analysis. Journal of Asian Earth Sciences, 45, 138–149.
Glorie, S., Zhimulev, F.I., Buslov, M.M., Andersen, T., Plavsa, D., Izmer, A., Vanhaecke, F., De Grave, J., 2014. Formation of the Kokchetav subduction-collision zone (northern Kazakhstan): insights from zircon U-Pb and Lu-Hf isotope systematics. Gondwana Research, in press, doi.org/10.1016/j.gr.2013.10.012.
Glukhan, I.V., Serykh, V.I., 1996. Geology and tectonic evolution of central Kazakhstan. In: Seltmann, R., Shatov, V., Kremenetsky, A., Lehmann, B., Popov, V., Ermelov, P. (Eds.), Granite-related ore deposits of central Kazakhstan and adjacent areas. St. Petersburg, Glagol Publishing House, 11–24.
Gordienko, I.V., 1987. Paleozoic magmatism and geodynamics of the Central Asian fold belt. Moscow, Nauka, 238 pp. (in Russian).
Gordienko, I.V., 1994. Paleozoic geodynamic evolution of the Mongol-Okhotsk fold belt. J. Southeast Asian Earth Sci. 9, 429–433.
Gordienko, I.V., 2001. Geodynamic evolution of the Central Asian and Mongol-Okhotsk fold belts and formation of the endogenic deposits. Geoscience Journal 5, 233–241.

Gordienko, I.V., 2006. Geodynamic evolution of late Baikalides and Paleozoids in the folded periphery of the Siberian Craton. Russian Geology and Geophysics 47, 51–67.
Gordienko, I.V., 2006. Geodynamic evolution of Riphean and Vendian-Paleozoic island arcs and marginal paleobasins in the zone of interaction of the Siberian continent and Paleo-Asian Ocean. Materials of the meeting, Irkutsk, Issue 6, 70–74 (in Russian).
Gordienko, I.V, Klimuk, V.S., 1995. Bimodal volcanism of the Tugnui rift depression (Transbaikalia). Russian Geology and Geophysics 36, 23–37.
Gordienko, I.V., Kuzmin, M.I., 1999. Geodynamics and metallogeny of the Mongol-Transbaikal region. Geologiya i Geofizika 40, 1545–1562 (in Russian).
Gordienko, I.V., Mikhal'tsov, N.E., 2001. Position of Vendian-Early Cambrian ophiolitic and island-arc complexes of the Dzhida zone of Caledonides in Paleoasian oceanic structures: Interpretation of paleomagnetic data. Doklady Earth Sciences 379, 622–626.
Gordienko, I.V., Filimonov, A.V., 2005. The Dzhida zone of the Paleo-Asian Ocean: main stages of geodynamic evolution (Vendian-Early Paleozoic oceanic, island-arc and back-arc basin complexes). In: Sklyarov, E.V. (ed.), Structural and tectonic correlation across the Central Asia Orogenic Collage: North-Eastern Segment. Guidebook, Abstr. Vol., Siberian Workshop IGCP-480, Irkutsk, pp. 98–163.
Gordienko, I.V., Klimuk, V.S., Ivanov, V.G., Posokhov, V.F., 1997. New data on composition and age of bimodal volcanic series of the Tugnui riftogenic depression, Trans-Baikal region. Doklady Earth Sciences 353, 273–276.
Gordienko, I.V., Kovach, V.P., Gorokhovsky, D.V., Sal'nikova, E.B., Kotov, A.B., Yakovleva, S.Z., Zagornaya, N.Yu., Fedoseenko, A.M., Plotkina, Y.V., 2006. Composition, U-Pb age, and geodynamic setting of island-arc gabbroids and granitoids of the Dzhida Zone (Southwestern Transbaikalia, northern Mongolia). Russian Geology and Geophysics 47, 948–955.
Gordienko, I.V., Filimonov, A.V., Minina, O.R., Gornova, M.A., Medvedev, A.Y., Klimuk, V.S., Elbaev, A.L., Tomurtogoo, O., 2007. Dzhida island-arc system in the Paleoasian Ocean: structure and main stages of Vendian-Paleozoic geodynamic evolution. Russ. Geol. Geophys. 48, 91–106.
Gordienko, I.V., Bulgatov, A.N., Lastochkin, N.I., Sitnikova, V.S., 2009. Composition and U–Pb Isotopic Age Determinations (SHRIMP II) of the Ophiolitic Assemblage from the Shaman Paleospreading Zone and the Conditions of Its Formation (North Transbaikalia). Doklady Earth Sciences 429, 1420–1425.
Gordienko, I.V., Bulgatov, A.N., Ruzhentsev, S.V., Minina, O.R., Klimuk, V.S., Vetluzhskikh, L.I., Nekrasov, G.E., Lastochkin, N.I., Sitnikova, V.S., Metelkin, D.V., Goneger, T.A., Lepekhina, E.N., 2010. The Late Riphean-Paleozoic history of the Uda-Vitim island arc system in the Transbaikalian sector of the Paleoasian ocean. Russian Geology and Geophysics 51, 461–481.
Gordienko, I.V., Kovach, V.P., Elbaev, A.L., Kotov, A.B., Sal'nikova, E.B., Reznitskii, L.Z., Yakovleva, S.Z., Anisimova, I.V., 2012. Collisional granitoids of the Dzhida zone of the Central Asian Fold belt, Southwestern Transbaikalia: Age and conditions of the formation. Petrology 20, 40–58.
Gordon, R.G., 1998. The plate tectonic approximation: Plate nonrigidity, diffuse plate boundaries, and global plate reconstructions. Annual Reviews in Earth and Planetary Sciences 26, 615–642.
Gradstein, F.M., Ogg, J., van Kranendok, M., 2008. On the geological time scale. Newsletters on Stratigraphy 43 (1), 5–13.
Graham, S.A., Hendrix, M.S., Johnson, C.L., Badamgarav, D., Badarch, G., Amory, J., Porter, M., Barsbold, R., Webb, L.E., Hacker, B.R., 2001. Sedimentary record and tectonic implications of Mesozoic rifting in southeast Mongolia. Bulletin of the Geological Society of America 113, 1560–1579.
Gratsianova, R.T., Shishkina, G.R., 1982. The features of paleobiogeography of continents and seas in the Devonian (from brachiopod study evidence). In: Environment and life in the geologic past. Paleolandscapes and biofacies. Moscow, Nauka, 27–45 (in Russian).
Guo, S.Z., 1991. Timing of convergence process of Sino-Korean plate and Siberian plate inferred from biostratigraphic evidences. In: Ishii, K., Liu, X.Y., Ichikawa, K., Huang, B.-H. (eds.), Pre-Jurassic Geology of Inner Mongolia, China, China-Japan Cooperative Group, Osaka, pp. 113–125.
Gusev, G.S., Khain, V.Y., 1995. Interrelations between the Baikal-Vitim, Aldan-Stanovoy, and Mongol-Okhotsk terranes (southern part of Middle Siberia). Geotektonika 5, 68–82 (in Russian).
Gusev, G.S., Khain, V.Y., 1996. On relations between the Baikal-Vitim, Aldan-Stanovoy, and Mongol-Okhotsk terranes (south of mid-Siberia). Geotectonics 29, 422–436.
Gusev, G.S., Peskov, A.I., 1996. Geochemistry and conditions of ophiolite formation in the Transbaikal region. Geokhimiya 8, 723–737 (in Russian).

Hall, R., 2002. Cenozoic geological and plate tectonic evolution of SE Asia and the SW Pacific: computer-based reconstructions, model and animations. Journal of Asian Earth Sciences 20, 2353–2431.
Hall, R., 2009. The Eurasian SE Asian margin as a modern example of an accretionary orogen. Geological Society of London, Special Publication 318, 351–372.
Hall, R., Sevastjanova, I., 2012. Australian crust in Indonesia. Journal of Australian Earth Sciences 59, 827–844.
Hall, R.M., 2010. Australia-SE Asia collision: plate tectonics and crustal flow. Geological Society of London, Special Publication 355, 75–109.
Han, B.F., He, G.Q., Wang, X.C., Guo, Z.J., 2011. Late Carboniferous collision between the Tarim and Kazakhstan–Yili terranes in the western segment of the South Tian Shan Orogen, Central Asia, and implications for the Northern Xinjiang, western China. Earth Sci. Rev. 109, 74–93.
Harley, S.L.,1992. Proterozoic granulite terranes. In: Condie, K.C. (ed.), Developments in Precambrian Geology 10, Proterozoic Crusta1 Evo1ution, Elsevier Scientific Publishing, The Netherlands, pp. 301–359.
Hashimoto, Y., Kimura, G., 1999: Underplating process from mélange formation to duplexing: example from the Cretaceous Shimanto belt, Kii Peninsula, southwest Japan. Tectonics 18, 92–107.
HBGMR (Heilongjiang Bureau of Geology and Mineral Resources), 1993. Regional Geology of Heilongjiang Province, Geological Publishing House, Beijing, 347–418 (in Chinese with English abstract).
Hegner, E., Klemd, R., Kröner, A., Corsini, M., Alexeiev, D.V., Iaccheri, L.M., Zack, T., Dulski, P., Xia, X., Windley, B.F., 2010. Mineral ages and P-T conditions of late Paleozoic high-pressure eclogite and provenance of melange sediments from Atbashi in the South Tianshan orogen of Kyrgyzstan. American Journal of Science 310, 916–950.
Heidbach, O., Tingay, M., Barth, A., Reinecker, J., Kurfeß, D., Müller, B., 2008. The 2008 release of the World Stress Map (available online at www.world-stress-map.org).
Heinhorst, J., Lehmann, B., Ermolov, P., Serykh, V., Zhurutin, S., 2000. Paleozoic crustal grouth and metallogeny of central Asia: evidence from magmatic-hydrotermal ore systems of Central Kaazakhstan. Tectonophysics 328, 69–87.
Helo, C., Hegner, E., Kröner, A., Badarch, G., Tomurtogoo, O., Windley, B.F., Dulski, P., 2006. Geochemical signature of Paleozoic accretionary complexes of the Central Asian Orogenic Belt in South Mongolia: Constraints on arc environments and crustal growth. Chem. Geol. 227, 236–257.
Heubeck, C., 2001. Assembly of Central Asia during the middle and late Paleozoic. In: Hendrix, M.S., Davis, G.A. (Eds.), Paleozoic and Mesozoic tectonic evolution of central Asia: from continental assembly to intracontinental deformation. Boulder, Colorado, Geological Society of America Memoir 194, 1–22.
Hibbard, J.P., Karig, D.E., 1990. Structural and magmatic responses to spreading ridge subduction: An example from southwest Japan. Tectonics 9, 207–230.
Hochstaedter, A., Gill, J., Peters, R., Broughton, P., Holden P., 2001. Across arc geochemical trends in the Izu-Bonin arc: Contributions from the subduction slab. Geochemistry, Geophysics, Geosystems. 2, Paper 2000GC000105, 44 pp.
Höck, V., Daxner-Höck, G., Schmid, H.P., 1999. Oligocene–Miocene sediments, fossils and basalts from the Valley of Lakes (Central Mongolia). – An integrated study. Mitt. Österr. Geol. Ges. 90, 83–125.
Holbrook, W.S., Lizarralde, D., McGeary, S., Bangs, N., Diebold, J., 1999. Structure and composition of the Aleutian island arc and implications for continental crustal growth. Geology 27, 31–34.
Holt, W.E., Chamot-Rooke, N., Le Pichon, X., Haines, A.J., Shen-Tu, B., Ren, J., 2000. Velocity field in Asia inferred from Quaternary fault slip rates and Global Positioning System observations. Journal of Geophysical Research B: Solid Earth 105, 19185–19209.
Horton, B.K., Constenius, K.N., Tully, J., Coogan, J.C., Menotti, T., Buyan-Arivjikh, D., Yasli, M., Erdenejav, U., Payton, A., 2012. Late Jurassic-Early Cretaceous synrift sedimentation in the Tsagaan Suvarga basin, Gobi-Altai region of SW Mongolia. AAPG Annual Meeting, Abstracts with Program, Long Beach, USA, p. 76.
Hou, G.T., Santosh, M., Qian, X.L., Lister, G.S., Li, J.H., 2008. Configuration of the late Paleoproterozoic supercontinent Columbia: insights from radiating mafic dykes warms. Gondwana Research 14, 395–409.
Howell, D.G., Jones, D.L., Schermer, E.R., 1985. Tectonostratigraphic terranes of the Circum-Pacific region. In: Howell, D.G. (Ed.), Tectonostratigraphic terranes of the Circum-Pacific region. Circum-Pacific Council for Energy and Mineral Resources Earth Science Series, no. 1, 3–30.

Hsü, K.J., Wang, Q., Li, L., Hao, J., 1991. Geologic evolution of the Neimonides; a working hypothesis. Eclog. Geolog. Helvetiae 84, 1–31.
Huang, B., Zhou, Y., Zhu, R., 2008. Discussions on Phanerozoic evolution and formation of continental China, based on paleomagnetic studies. Earth Science Frontiers 15 (3), 348–359.
Huang, B.H., 1983. On the Late Paleozoic palaeophytogeographic regions of eastern Tianshan-Hingan foldbelt and its geological significance (in Chinese with English abstract). In: Li, C.Y (ed.), Contributions for the Project of Plate Tectonics in Northern China, Chinese Academy of Geological Sciences, Beijing, 1, 128–153.
Huang, B.H., 1991. Biogeography of Late Plaeozoic Floras of northeastern China. In: Ishii, K, Liu, X.Y., Ichikawa, K., Huang, B.H. (eds.), Pre-Jurassic Geology of Inner Mongolia, China. China-Japan Cooperative Group, Osaka, 159–174.
Huang, Q.H., Wu, H.C., Wan, X.Q., He, H.Y., Deng, C.L., 2011. New progress of integrated chronostratigraphy of the Cretaceous in Songliao Basin. Journal of Stratigraphy 33, 1–10 (in Chinese with English abstract).
Huang, Y.C., Ren, D.H., Zhang, X.Z., Xiong, X.S., Zhang, C.Y., Wang, Y., Zhao, L.L., 2008. Zircon U–Pb dating of the Meizuo granite and geological significance in the Huanan uplift, east Heilongjiang Province. Journal of Jilin University (Earth Science) 38, 631–638 (in Chinese with English abstract).
Huang, Y.C., Zhang, X.Z., Zhang, H.B., Xiong, X.S., Liu, C.L., Zhao, L.L., 2009. Geochemical characteristics and sedimentation age of the Majiajie Group in eastern Heilongjiang province, China. Acta Geologica Sinica 83, 295–303.
Ilyin, A.V., 1971. The Tuva-Mongolia Massif. Proceedings of the Research Institute on Foreign Geology, VSEGEI, Leningrad, 22, 67–71 (in Russian).
IMBGMR (Inner Mongolian Bureau of Geology and Mineral Resources), 1990. Regional geology of Inner Mongolian Automo (in Chinese with English summary). Beijing, Geological Publishing House, 725 pp.
Ishiwatari, A., Tsujimori, T., 2003. Paleozoic ophiolites and blueschists in Japan and Russian Primorye in the tectonic framework of East Asia: A synthesis. The Island Arc 12, 190–206.
Isozaki, Y., 1987. End-Permian convergent zone along the northern margin of Kurosegawa landmass and its products in central Shikoku, Southwest Japan. Journal of Geoscience, Osaka City University 30, 51–131.
Isozaki, Y., 1997. Jurassic accretion tectonics in Japan. The Island Arc 6, 25–51.
Isozaki, Y., Aoki, K., Nakama, T., Yanai, S., 2010. New insight into a subduction-related orogen: a appraisal of the geotectonic framework and evolution of the Japanese Islands. Gondwana Research 18, 82–105.
Ivanov, K.S., Koroteev, V.A., Pecherkin, M.F., Fedorov, Yu.N., Erokhin, Yu.V., 2009. The western part of the West Siberian petroleum megabasin: Geologic history and structure of the basement. Russian Geology and Geophysics 50, 365–379.
Iwata, K., Watanabe, T., Akiyama, M., Dobretsov, N.L., Belyaev, S.Yu., 1994. Paleozoic microfossils of the Chara Belt in Eastern Kazakhstan. Russian Geology and Geophysics 35, 125–130.
Iwata, K., Obut, O.T., Buslov, M.M., 1996. Devonian and Lower Caboniferous radiolaria from the Chara ophiolite belt, East Kazakhstan. News of Osaka Micropaleontologist 10, 27–32.
Jahn, B.M., 2004. The Central Asian Orogenic Belt and growth of the continental crust in the Phanerozoic. Geological Society Special Publication 226, 73–100
Jahn, B.M, Wu, F.Y., Chen, B., 2000a. Massive granitoid generation in central Asia: Nd isotopic evidence and implication for continental growth in the Phanerozoic. Episodes 23, 82–92.
Jahn, B.M., Wu, F.Y., Hong, D.W., 2000b. Important crustal growth in the Phanerozoic: Isotopic evidence of granitoids from East-Central Asia. Proceedings of Indian Academy of Sciences (Earth and Planetary Sciences) 109, 5–20.
Jahn, B.M., Windley, B., Natal'in, B., Dobretsov, N., 2004. Phanerozoic continental growth in Central Asia. Journal of Asian Earth Sciences 23, 599–603.
Jahn, B.M., Litvinovsky, B.A., Zanvilevich, A.N., Reichow, M., 2009. Peralkaline granitoid magmatism in the Mongolian–Transbaikalian Belt: Evolution, petrogenesis and tectonic significance. Lithos 113, 521–539.
JBGMR (Jilin Bureau of Geology and Mineral Resources), 1988. Regional geology of Jilin Province. Geological Publishing House, Beijing, 698 pp. (in Chinese with English abstract).
Jenchuraeva, R.J., 2001. Paleozoic geodynamic, magmatism and metallogeny of the Tien-Shan. In: Paleozoic geodynamics and gold deposits in the Kyrgyz Tien-Shan. Excursion guidebook. Natural History Museum, London; Institute of Geology, National Academy of Science, Bishkek, 29–70.

Jerzykiewicz, T., Russell, D.A., 1991. Late Mesozoic stratigraphy and vertebrates of the Gobi Basin. Cretaceous Research 12, 345–377.

Jia, D.C., Hu, R.Z., Lu, Y., Qiu, X.L. 2004. Collision belt between the Khanka block and the North China block in the Yanbian region, northeast China. Journal of Asian Earth Sciences 23, 211–219.

Jian, P., Liu, D., Kröner, A., Windley, B.F., Shi, Y., Zhang, F., Shi, G., Miao, L., Zhang, W., Zhang, Q., Zhang, L., Ren, J., 2008. Time scale of an early to mid-Paleozoic orogenic cycle of the long-lived Central Asian Orogenic Belt, Inner Mongolia of China: Implications for continental growth. Lithos 101, 233–259.

Jian, P., Kröner, A., Windley, B.F., Shi, Yu., Zhang, F., Miao, L., Tomurhuu, D., Zhang, W., Liu, D., 2010a. Zircon age of the Bayankhongor ophiolite mélange and associated rocks: time constraints on Neoproterozoic to Cambrian accretionary and collisional orogenesis in Central Mongolia. Precambrian Research 177, 162–180.

Jian, P., Liu, D., Kröner, A., Windley, B.F., Shi, Y., Zhang, W., Zhang, F., Miao, L., Zhang, L., Tomurhuu, D., 2010b. Evolution of a Permian intraoceanic arc–trench system in the Solonker suture zone, Central Asian Orogenic Belt, China and Mongolia. Lithos 118, 169–190.

Jiang, J., 1992. Peak regional metamorphism of the khondalite series of Mashan Group and its evolution. Acta Petrologica et Mineralogica 11, 97–108 (in Chinese with English abstract).

Johnson, C.L., Webb, L., Graham, S., Hendrix, M., Badarch, G., 2001. Sedimentary and structural records of late Mesozoic high-strain extension and strain partitioning, East Gobi basin, southern Mongolia. Geological Society of America Memoir 194, 413–433.

Jolivet, M., Ritz, J.F., Vassallo, R., Larroque, C., Braucher, R., Todbileg, M., Chauvet, A., Sue, C., Arnaud, N., De Vicente, R., Arzhanikova, A., Arzhanikov, S., 2007. Mongolian summits: An uplifted, flat, old but still preserved erosion surface. Geology 35, 871–874.

Kassin, N.G., 1934. The sketch of the tectonic of Kazakhstan. Problems of Soviet Geology, 2, 161–180 (in Russian).

Kazimirovskiy, M.E., 2004. Geochemistry of Paleozoic granitoid magmatism of the West Stanovoy zone, Transbaikal region. Geologiya i Geofizika 45, 347–362 (in Russian).

Kazimirovsky, M.E., Dril', S.I., Sandimirova, G.P., 2000. Paleozoic granitoid massifs in the West-Stanoyoy zone of Transbaikalia: Comparative geochemistry and age. Geologya i geophizika 41, 990–1002.

Kelty, T.K., Yin, A., Dash, B., Gehrels, G.E., Ribeiro, A.E., 2008. Detrital-zircon geochronology of Paleozoic sedimentary rocks in the Hangay–Hentey basin, north-central Mongolia: Implications for the tectonic evolution of the Mongol–Okhotsk Ocean in central Asia. Tectonophysics 451, 290–311.

Kepezhinskas, P.K., Kepizhinskas, K.B., Pukhtel, I.S., 1991. Lower Palaeozoic oceanic crust in Mongolian Caledonides: Sm–Nd isotope and trace element data. Geophys. Res. Lett. 18, 1301–1304.

Khain, V.Y., 2001. Tectonics of continents and oceans. Moscow. Nauchnyi Mir, 606 pp. (in Russian).

Khain, V.Y., Limonov, A.F., 2004. Regional geotectonics (tectonics of continents and oceans). GERS publishers, Tver, 270 p. (in Russian).

Khain, E.V., Bibikova, E.V., Kroner, A., Zhuravlev, D.Z., Sklyarov, E.V., Fedotova, A.A., Kravchenko-Berezhnoy, I.R., 2002. The most ancient ophiolite of the Central Asian fold belt: U–Pb and Pb–Pb zircon ages for the Dunzhugur Complex, Eastern Sayan, Siberia, and geodynamic implications. Earth and Planetary Science Letters 199, 311–325.

Khain, E.V., Bibikova, E.V., Salnikova, E.B., Kröner, A., Gibsher, A.S., Didenko, A.N., Degtyarev, K.E., Fedotova, A.A., 2003. The Palaeo-Asian ocean in the Neoproterozoic and early Palaeozoic: new geochronologic data and palaeotectonic reconstructions. Precambrian Research 122, 329–358.

Khanchuk, A.I., 2000. Paleogeodynamic analysis of formation of ore deposits in the Far East. In: Ore deposits of continental margins. Vladivostok, Dalnauka, 5–34 (in Russian).

Khanchuk, A.I., ed., 2006. Geodynamics, magmatism and metallogeny of the Russian East. Book 1. Vladivostok, Dalnauka, 572 pp. (in Russian).

Khanchuk, A.I., Belyaeva, G.V., 1993. Relationship between the terranes of Paleoasian and Paleopacific oceans in the Far East, Russia. In: Dobretsov, N.L., Berzin, N.A. (eds.), Report No. 4 of IGCP Project 283: Geodynamic evolution of Paleoasian ocean. Novosibirsk, 84–86.

Khanchuk, A.I., Golozubov, V.V., Panchenko, I.V., Ignatyev, A.V., Chudaev, O.V., 1992. Ganychalan terrane of the Koryak Upland. Tikhookeanskaya Geologiya 4, 82–93 (in Russian).

Khanchuk, A.I., Ratkin, V., Ryazantseva, M.D., Golozubov, V.V., Gonokhova, N.G., 1996. Geology and Mineral Deposits of Primorsky Krai (Territory). Dalnauka, Vladivostok (in Russian).

Khanchuk, A.I., Didenko, A.N., Popeko, L.I., Sorokin, A.A., Shevchenko, B.F., 2015. Structure and evolution of the Mongol-Okhotsk Orogenic Belt. Composition and evolution of central asian orogenic Belt. Stuttgart, Gebr. Borntraeger, p. 211–234.

Khand, Yo., Badamgarav, D., Ariunchimeg, Ya., Barsbold, R., 2000. Cretaceous system in Mongolia and its depositional environments. Developments in Palaeontology and Stratigraphy 17 (C), pp. 49–51, 53–65, 67–79.

Kheraskova, T.N., 1986. Vendian-Cambrian formations of the Asian Caledonides. Nauka Publisher, Moscow, 248 p. (in Russian).

Kheraskova, T.N., Didenko, A.N., Bush, V.A., Volozh, Y.A., 2003. The Vendian-early Palaeozoic history of the continental margin of eastern Palaeogondwana, Palaeoasian ocean, and Central Asian Foldbelt. Russian Journal of Earth Sciences 5, 165–184.

Kheraskova, T.N., Bush, V.A., Didenko, A.N., Samygin, S., 2010. Breakup of Rodinia and early stages of evolution of the Paleoasian ocean. Geotectonics 44, 3–24.

Khil'ko, S.D., Kurushin, R.A., Kochetkov, V.M., Baljinnyam, I., Monkoo, D., 1985. Earthquakes and the bases for seismic zoning of Mongolia, Transactions 41, The joint Soviet-Mongolian Scientific Geological Research Expedition. Moscow, Nauka Publ. House, 215 p.

Khristov, Ye.V., 1981. On the structural position of the Atbashi metamorphic formation. Doklady Academy of Sciences of the USSR 257, 1437–1439 (in Russian).

Khristov, Ye.V., Ivanov, K.S., Mikolaychuk, A.V., Puchkov, V.N., Voitovich, I.I., Nasedkina, V.A., 1999. Structural position and age of the ophiolites of Karaterek massif. In: Bakirov, A.B., Dikikh, A.N. (Eds.), Problems of geology and geography in Kyrgyzstan. Ilim Publisher, Bishkek, pp. 65–69 (in Russian).

Khromykh, E.V., Sergeev, S.A., Matukov, D.I., Vladimirov, A.G., Mekhonoshin, A.S., Fedorovsky, V.S., Volkova, N.I., Rudnev, S.N., Khlestov, V.V., Yudin, D.S., 2004. U-Pb age (SHRIMP-II) of hypersthene plagiogranites of the Chernorudskaya granulitic zone (Ol'khon region, West Transbaikalia). In: Geodynamic evolution of the lithosphere of the Central Asian mobile belt (from ocean to continent). Institute of Geography Publisher, Irkutsk, vol. 1, 141–145.

Khubanov, V.B., 2009. Bimodal dyke belt of the central part of western Transbaikalia: age, composition and petrogenesis. Unpubl. PhD thesis. Geological Institute of SB RAS, Ulan-Ude (in Russian).

Kimura, J.-I., Stern, R.J., Yoshida, T., 2005. Reinitiation of subduction and magmatic responses in SW Japan during Neogene time. Geological Society of America Bulletin 117, 969–986.

Kirillova, G.L., 2003. Late Mesozoic–Cenozoic sedimentary basins of active continental margin of southeast Russia: paleogeography, tectonics, and coal-oil-gas presence. Marine and Petroleum Geology 20, 385–397.

Kirillova, G.L., Turbin, M.T., 1979. Formations and tectonics of the Dzhagdy link, Mongol-Okhotsk fold area. Moscow, Nauka, 116 pp. (in Russian).

Kirscher, U., Zwing, A., Alexeiev, D., Mikolaichuk, A., Bachtadse, V., 2013. Paleomagnetism of Paleozoic sedimentary rocks from the Karatau Range, Southern Kazakhstan: Multiple remagnetization events correlate with phases of deformation. Journal of Geophysical Research: Solid Earth 118, 3871–3885.

Kiselev, V.V., 2001. Analogs of the Sinian complex in the central and northern Tien Shan. Geologiya i Geofizika, 42, 10, 1453–1463 (in Russian).

Kiselev, V.V., Zhukov, Yu.V., Israileva, R.M., Komarevtsev, V.T., Tsyganok, E.N., 1982. Radiological evidence for the Grenville tectono-magmatic stage in the Northern Tianshan. Izvestiya Academy of Sciences of the Kyrgyz SSR, 6, 26–30 (in Russian).

Kiselev, V.V., Apayarov, F.Kh., Komartsev, V.T., Tsyganok, E.N., Lukashova, E.M., 1993. Isotopic ages of zircons from crystalline complexes of the Tianshan. In: Kozakov, I.K. (Ed.), Early Precambrian of the Central Asia Folded Belt. Nauka, St. Peterburg, pp. 99–115 (in Russian).

Kiselev, V.V., Maksumova, R.A., 2001. Geology of the Northern and Middle Tien-Shan: principal outlines. In: Seltmann, R., Jenchuraeva, R.J. (Eds.). In: Paleozoic geodynamics and gold deposits in the Kyrgyz Tien-Shan. Excursion guidebook. Natural History Museum, London; Institute of Geology, National Academy of Science, Bishkek, 21–38.

Klishevich, V.L., Semiletkin, S.A., 1995. Terrigenous-carbonate lower Paleozoic of the western part of Northern and Middle Tian-Shan. Bulletin of Moscow Society of Naturalists, Geol. Branch 70, 2, 5–75 (in Russian).

Kojima, S., 1989. Mesozoic terrane accretion in Northeast China, Sikhote-Alin and Japan regions. Palaeogeography, Palaeoclimatology, Palaeoecology 69, 213–232.

Konopelko, D., Biske, G., Seltmann, R., Eklund, O., Belyatsky, B., 2007. Hercynian post-collisional A-type granites of the Kokshaal range, southern Tien-Shan, Kyrgyzstan. Lithos 97, 140–160.

Konopelko, D., Biske, G., Seltmann, R., Kiseleva, M., Matukov, D., Sergeev, S., 2008. Deciphering Caledonian events: timing and geochemistry of the Caledonian magmatic arc in the Kyrgyz Tien Shan, Journal of Asian Earth Sciences 32, 131–141.

Konopelko, D., Seltmann, R., Biske, G., Lepekhina, E., Sergeev, S., 2009. Possible source dichotomy of contemporaneous post-collisional barren I-type versus tin-bearing A-type granites, lying on opposite sides of the South Tien Shan suture. Ore Geology Review, 35, 206–216.

Konopelko, D., Kullerud, K., Apayarov, F., Sakiev, K., Baruleva, O., Ravna, Lepekhina, E., 2012. SHRIMP zircon chronology of HP-UHP rocks of the Makbal metamorphic complex in the Northern Tien Shan, Kyrgyzstan. Gondwana Research 22, 300–309.

Konopelko, D., Seltmann, R., Apayarov, F., Belousova, E., Izokh, A., Lepekhina, E., 2013. U-Pb-Hf zircon study of two mylonitic granite complexes in the Talas-Fergana fault zone, Kyrgyzstan, and Ar-Ar age of deformations along the fault. Journal of Asian Earth Sciences, 73, 334–346.

Korobkin, V.V., Smirnov, A.V., 2006. Paleozoic tectonics and geodynamics of volcanic arcs in northern Kazakhstan. Geologiya i Geofizika 47, 462–474.

Kotov, A.B., Salnikova, E.B., Reznitskii, L.Z., Vasilev, E.P., Kozakov, I.K., Yakovleva, S.Z., Kovach, V.P., Berezhnaya, N.G., 1997. Age of metamorphism of the Slyudyanka crystalline complex, southern Baikal area: U-Pb geochronology of granitoids. Petrology 5, 338–349.

Kotov, A.B., Sorokin, A.A., Sal'nikova. E.B. Sorokin, A.P., Velikoslavinskii, S.D., Anisimov, I.V., Yakovleva., S.Z., 2009a. Early Paleozoic age of gabbroids of the Amur Complex (Bureya-Jiamusi Superterrane of the Central Asian Fold Belt). Doklady Earth Sciences 425, 185–188.

Kotov, A.B., Sorokin, A.A., Sal'nikova. E.B. Sorokin, A.P., Larin, A.M. Velikoslavinskii, S.D., Belyakov, T.V., Anisimova, I.V., Yakovleva, S.Z., 2009b. Mesozoic Age of Granitoids from the Beket Complex (Gonzha Block within the Argun Terrane of the Central–Asian Fold Belt). Doklady Earth Sciences 429, 1457–1461.

Kotov, A.B., Velikoslavinskii, S.D., Sorokin, A.A., Kotov, L.N., Sorokin A.P., Larin, A.M., Kovach, V.P., Zagornaya, N.Yu. , Kurguzova, A.V., 2009c. Age of the Amur Group of the Bureya–Jiamusi Superterrane in the Central Asian Fold Belt: Sm–Nd Isotope Evidence. Doklady Earth Sciences 429, 125–1248.

Kovach, V.P., Jian, P., Yarmolyuk, V.V., Kozakov, I.K., Liu, D., Terent'eva, L.B., Lebedev, V.I., Kovalenko, V.I., 2005. Magmatism and geodynamics of Early Stages of the Paleoasian ocean formation: geochronological and geochemical data on ophiolites of the Bayan-Khongor zone. Doklady Earth Sci. 404, 229–234.

Kovach, V.P., Yarmolyuk, V.I., Kovalenko, V.I., Kozlovskyi, A.B., Kotov, A.B., Terent'eva, L.B., 2011. Composition, sources, and mechanisms of formation of the continental crust of the Lake zone of the Central Asian Caledonides. II. Geochemical and Nd isotope data. Petrology 19, 399–425.

Kovach, V.P., Sal'nikova, E.B., Rytsk, E.Yu., Yarmolyuk, V.V., Kotov, A.B., Anisimova, I.V., Yakovleva, S.Z., Fedoseenko, A.M., Plotkina, Yu.V., 2012. The time length of formation of the Angara-Vitim batholite: Results of U-Pb geochronological studies. Doklady Earth Sciences 444, 553–558.

Kovach, V.P., Salnikova, E.B, Wang, K-L., Jahn, B-M., Chiu, H-Y., Reznitskiy, L.Z., Kotov, A.B, Iizuka, Y., Chung, S-L., 2013. Zircon ages and Hf isotopic constraints on sources of clastic metasediments of the Slyudyansky high-grade complex, southeastern Siberia: Implication for continental growth and evolution of the Central Asian Orogenic Belt. Journal of Asian Earth Sciences 62, 18–36.

Koval, P.V., 1998. Regional geochemical analysis of granitoids. Siberian Branch of Russian Academy of Sciences, Novosibirsk, 492 p. (in Russian).

Kovalenko, V.I., Yarmolyuk, V.V., 1990. Evolution of magmatism in the structures of Mongolia. In: Evolution of geologic processes and metallogeny of Mongolia. Moscow, p. 23–54 (in Russian).

Kovalenko, V.I., Mossakovskiy, A.A., Yarmolyuk, V.V., 1983. The problems of reconstruction of geodynamic settings, and petrochemical zoning (as exemplified by the Late Paleozoic volcanic belt of Mongolia). Geotektonika 6, 13–29 (in Russian).

Kovalenko, V.I., Pukhtel, I.S., Yarmolyuk, V.V., Zhuravlev, D.Z., Stosch, H., Jagoutz, E., 1996a. The Sm-Nd isotopic systematics of ophiolites in the Ozernaya zone (Mongolia). Stratig. Geol. Correl. 4, 107–113.

Kovalenko, V.I., Yarmolyuk, V.V., Pukhtel, I.S., Stosh, K., Yagutts, E., Korikovskiy, S.P., 1996b. Igneous rocks and magma sources of the Ozernaya zone ophiolites, Mongolia. Petrology 4, 453–495.

Kovalenko, V.I., Yarmolyuk, V.V., Salnikova, E.B., Budnikov, S.V., Kovach, V.P., Kotov, A.B., Ponomarchuk, V.A., Kozlov, V.D., Vladykin, H.B., 2003. Sources of igneous rocks and origin of Early

Mesozoic tectonic and magmatic area of the Mongol-Transbaikal magmatic areas: 1. Geological characteristics and isotope geochronology. Petrology 11 (2), 164–178 (in Russian).

Kovalenko, V.I., Yarmolyuk, V.V., Kovach, V.P., Kotov, A.B., Kozakov, I.K., Salnikova, E.B., Larin, A.M., 2004. Isotope provinces, mechanisms of generation and sources of the continental crust in the Central Asian mobile belt: geological and isotopic evidence. Journal of Asian Earth Sciences 23, 605–627.

Kozakov, I., Sal'nikova, E.B., Khain, E.V., Kovach, V.P., Berezhnaya, N.G., Yakovleva, S.Z., Plotkina, Y.V., 2002. Early Caledonian crystalline rocks of the Lake Zone of Mongolia; formation history and tectonic settings as deduced from U-Pb and Sm-Nd datings. Geotectonics 36, 156–166.

Kozakov, I., Sal'nikova, E., Nutman, A.P., Kovach, V., Kotov, A., Podkovyrov, V., Plotkina, Y., 2005. Metasedimentary complexes of the Tuva-Mongolian Massif: age, provenances and tectonic position. Stratigraphy and Geological Correlation 13, 3–25.

Kozakov, I., Kovach, V., Bibikova, E., Kirnozova, T., Zagornaya, N., Plotkina, Y., Podkovyrov, V., 2007. Age and sources of granitoids in the junction zone of the Caledonides and Hercynides in southwestern Mongolia: Geodynamic implications. Petrology 15, 126–150.

Kozakov, I.K., Kotov, A.B., Kovach, V.P., Sal'nikova, E.B., 1997. Crustal growth in the geologic evolution of the Baidarik block, central Mongolia: Evidence from Sm-Nd isotopic systematics. Petrology 5, 201–207.

Kozakov, I.K., Kotov, A.B., Salnikova, E.B., Bibikova, E.V., Kovach, V.P., Kirnozova, T.I., Berezhnaya, N.G., Lykhin, D.A., 1999. Metamorphic age of crystalline complexes of the Tuva-Mongolia Massif: The U-Pb geochronology of granitoids. Petrology 7, 177–191.

Kozakov, I.K., Salnikova, Ye.B., Didenko, A.N., Kovach, V.P., Fedoseenko, A.M., Yakovleva, C.Z., 2004. The age and geodynamic setting of formation of high-temperature metamorphic complexes of the South Mongol belt. Geologiya i Geofizika 45, 519–524 (in Russian).

Kozakov, I.K., Salnikova, Ye.B., Kotov, A.B., 2005. Age boundaries and geodynamic settings of formation of crystalline complexes of the Central Asian fold belt eastern segment. – The problems of tectonics of Central Asia. Moscow, GEOS, 112 pp.

Kozakov, I.K., Sal'nikova, E.B., Wang, T., Didenko, A.N., Plotkina, Yu.V., Podkovyrov, V.N., 2007. Early Precambrian crystalline complexes of the Central Asian microcontinent: Age, sources, tectonic position. Stratigraphy and Geological Correlation 15, 121–140.

Kozakov, I.K., Kirnozova, T.I., Kovach, V.P., Plotkina, Yu.V., Fugzan, M.M., 2009a. Crystalline complexes in the Tarbagatai uplift of the early Caledonian superterrane in Central Asia: geodynamic implications. In: Isotope systems and the time of geologic processes. Proceedings of the Fourth Russian Conference on Isotope Geochronology. Institute of Precambrian Geology and Geochronology, Russian Academy of Sciences, St. Petersburg, 1, pp. 246–249 (in Russian).

Kozakov, I.K., Anisimova, I.V., Sal'nikova, E.B., Kovach, V.P., Plotkina, Yu.V., Fedoseenko, A.M., Yakovleva, S.Z., 2009b. A Riphean metamorphic complex in the Songa uplift of the Early Caledonian superterrane in Central Asia. In: Isotope systems and the time of geologic processes. Proceedings of the Fourth Russian Conference on Isotope Geochronology. Institute of Precambrian Geology and Geochronology, Russian Academy of Sciences, St. Petersburg 1, 249–251 (in Russian).

Kozakov, I.K., Kozlovsky, A.M., Yarmolyuk, V.V., Kovach, V.P., Bibikova, E.V., Kirnozova, T.I., Plotkina, Yu.V., Zagornaya, N.Yu., Fugzan, M.M., Erdenejargal, Ch., Lebedev, V.I., Eenjin, G., 2011. Crystalline complexes of the Tarbagatai block of the early Caledonian superterrane of Central Asia. Petrology 19, 426–444.

Kozakov, I.K., Yarmolyuk, V.V., Kovach, V.P., Bibikova, E.V., Kirnozova, T.I., Kozlovskii, A.M., Plotkina, Yu.V., Fugzan, M.M., Lebedev, V.I., Erdenezhargal Ch., 2012. The early Baikalian crystalline complex in the basement of the Dzabkhan microcontinent of the early Caledonian orogenic area, Central Asia. Stratigraphy and Geological Correlation 20, 231–239

Kozlovskiy, Ye.A. (ed.), 1988. Geology of the BAM zone. Geologic structure. Leningrad, Nedra. 1, 443 pp. (in Russian).

Kozubova, L.A., Mirkina, S.L., Rublev, A.G., Chukhonin, A.P., 1980. Radiological age and specificities of the Chivirkuisky pluton composition (Baikal Mountain region). Doklady Akademii Nauk SSSR 251, 948–951.

Kozubova, L.A., Abramovich, I.I., Klushin, I.G., 1982. Magmatism and plate tectonics of the Mongol-Transbaikal fold system and its margins. In: Correlation of endogenic processes of the Siberian platform and its margins. Novosibirsk, 120–127 (in Russian).

Kravchinsky, V.A., Cogné, J.P., Harbert, W.P., Kuzmin, M.I., 2002a. Evolution of the Mongol-Okhotsk Ocean as constrained by new palaeomagnetic data from the Mongol-Okhotsk suture zone, Siberia. Geophysical Journal International 148, 34–57.

Kravchinsky, V.A., Konstantinov, K.M., Courtillot, V., Valet, J.-P., Savrasov, J.I., Cherniy, S.D., Mishenin, S.G., Parasotka, B.S., 2002b. Palaeomagnetism of East Siberian traps and kimberlites: two new poles and palaeogeographic reconstructions at about 360 and 250 Ma. Geophysical Journal International 148, 1–33.

Kravchinsky, V.A., Sklyarov, E.V., Gladkochub, D.P., Harbert, W.P., 2010. Paleomagnetism of the Precambrian eastern Sayan rocks: Implications for the Ediacaran–Early Cambrian paleogeography of the Tuva-Mongolian composite terrane. Tectonophysics 486, 65–80.

Krawczynski, V.A., 1995. Paleomagnetism of the Mongol-Okhotsk fold belt. Diss., Irkutsk State Technical University, 181 pp. (in Russian).

Kröner, A., 1991. Tectonic evolution in the Archean and Proterozoic. Tectonophysics 187, 393–410.

Kröner, A., Rojas-Agramonte, Y., 2014. The Altaids as seen by Eduard Suess, and present thinking on the Late Mesoproterozoic to Palaeozoic evolution of Central Asia. Austrian Journal of Earth Sciences 107/1, 156–168.

Kröner, A., Windley, B.F., Badarch, G., Tomurtogoo, O., Hegner, E., Jahn, B.M., Gruschka, S., Khain, E.V., Demoux, A., Wingate, M.T.D., 2007. Accretionary grouth and crust formation in the Central Asian orogenic belt and comparison with the Arabian-Nubian shield. Geological Society of America, Memoir 200, 1–29; 181–209.

Kröner, A., Hegner, E., Lehmann, B., Heinhorst, J., Wingate, M.T.D., Liu, D.Y., Ermelov, P., 2008. Palaeozoic arc magmatism in the Central Asian Orogenic Belt of Kazakhstan: SHRIMP zircon ages and whole-rock Nd isotopic systematics. J. Asian Earth Sci. 32, 118–130.

Kröner, A., Lehmann, J., Schulmann, K., Demoux, A., Lexa, O., Tomurhuu, D., Štípská, P., Liu, D., Wingate, M.T.D., 2010. Lithostratigraphic and geochronological constraints on the evolution of the Central Asian Orogenic Belt in SW Mongolia: Early Paleozoic rifting followed by late Paleozoic accretion. American Journal of Science 310, 523–574.

Kröner, A., Alexeiev, D.V., Hegner, E., Rojas-Agramonte, Y., Corsini, M., Chao, Y., Wong, J., Windley, B.F., Liu, D., Tretyakov, A.A., 2012. Zircon and muscovite ages, geochemistry, and Nd–Hf isotopes for the Aktyuz metamorphic terrane: Evidence for an Early Ordovician collisional belt in the northern Tianshan of Kyrgyzstan. Gondwana Research, 21, 901–927.

Kröner, A., Alexeiev, D.V., Rojas-Agramonte, Y., Hegner, E.,Wong, J., Xia, X., Belousova, E., Mikolaichuk, A., Seltmann, R., Liu, D., Kisilev, V., 2013. Mesoproterozoic (Grenville-age) terranes in the Kyrgyz North Tianshan: Zircon ages and Nd-Hf isotopic constraints on the origin and evolution of basement blocks in the southern Central Asian Orogen. Gondwana Research 23, 272–295.

Kröner, A., Kovach, V., Belousova, E., Hegner, E., Armstrong, R., Dolgopolova, A., Seltmann, R., Alexeiev, D.V., Hoffmann, J.E., Wong, J., Sun, M., Cai, K., Wang, T., Tong, Y., Wilde, S.A., Degtyarev, K.E., Rytsk, E., 2014. Reassessment of continental growth during the accretionary history of the Central Asian Orogenic Belt. Gondwana Research, 25, 103–125.

Kruk, N.N., Vladimirov, A.G., Babin, G.A., Shokalsky, S.P., Sennikov, N.V., Rudnev, S.N., Volkova, N.I., Kovach, V.P., Serov, P.A., 2010. Continental crust in Gorny Altai: nature and composition of protoliths. Russian Geology and Geophysics 51, 431–446.

Kurchavov, A.M., Shatagin, A.M., 2001. The age, origin and material source of ignimbrites in Aksoran and Korgantas massives, Tokrau basin, Central Kazakhstan, by results of Rb-Sr and Sm-Nd isotopic investigation. Geology and prospecting of Kazakhstan, 2, 38–42 (in Russian).

Kurenkov, S.A., 1983. Tectonics of ophiolite complexes in the Southern Tien-Shan. Nauka, Moscow, 96 p. (in Russian).

Kurenkov, S.A., Aristov, V.A., 1995. On the age of Turkestan paleo-ocean crust. Geotectonics 6, 22–31 (in Russian).

Kurihara, T., Tsukada, K., Otoh, S., Kashiwagi, K., Chuluun, M., Byambadash, D., Boijir, B., Gonchigdorj, S., Nuramkhan, M., Niwa, M., Tokiwa, T., Hikichi, G.y., Kozuka, T., 2009. Upper Silurian and Devonian pelagic deep-water radiolarian chert from the Khangai-Khentei belt of Central Mongolia: Evidence for Middle Paleozoic subduction-accretion activity in the Central Asian Orogenic Belt. J. Asian Earth Sci. 34, 209–225.

Kurushin, R.A., Bayasgalan, A., Ölziybat, M., Enhtuvshin, B., Molnar, P., Bayarsayhan, Ch., Hudnut, K.W., Lin, J., 1999. The surface rupture of the 1957 Gobi-Altay, Mongolia, earthquake. Geological Society America, Special Paper 32, 1–144.

Kuzmichev, A.B., 2004. The tectonic history of the Tuva–MongolianMassif: Early Baikalian, late Baikalian, and early Caledonian stages. Probel Publishing House, Moscow, 192 p. (in Russian).

Kuzmichev, A.B., Bibikova, E.V., Zhuravlev, D.Z., 2001. Neoproterozoic (~800 Ma) orogeny in the Tuva–Mongolia Massif (Siberia): island arc–continent collision at the northeast Rodinia margin. Precambrian Research 110, 109–126.

Kuzmichev, A., Kröner, A., Hegner, E., Liu, D.Y., Wan Y.S., 2005. The Shishkhid ophiolite, northern Mongolia: A key to the reconstruction of a Neoproterozoic island-arc system in central Asia. Precambrian Research 138, 125–150.

Kuzmichev, A., Sklyarov, E., Postnikov, A., Bibikova, E., 2007. The Oka Belt (Southern Siberia and Northern Mongolia): a Neoproterozoic analog of the Japanese Shimanto Belt? The Island Arc 16, 224–242.

Kuzmichev, A.B., Larionov, A.N., 2011. The Sarkhoi Group in East Sayan: Neoproterozoic (~770–800 Ma) volcanic belt of the Andean type. Russian Geology and and Geophysics 52, 685–700.

Kuzmichev, A.B., Larionov, A.N., 2013. Neoproterozoic island arcs of East Sayan: duration of magmatism (from U-Pb zircon dating of volcanic clastics). Russian Geology and Geophysics 54, 34–43.

Kuzmin, M.I., Gordienko, I.V., Al'mukhamedov, A.I., Antipin, V.S., Bayanov, V.D., Filimonov, A.V., 1995. Paleooceanic complexes Dzhida zone of Caledonides (Southwestern Transbaikalia). Geology and Geophysics 36 (1), 3–18 (in Russian).

Kuzmin, M.I., Krawczynski, V.A., 1996. First paleomagnetic data on the Mongol-Okhotsk belt. Geology and Geophysics 37 (1), 54–62. (in Russian).

Kuzmin, M.I., Yarmolyuk, V.V., Kravchinsky, V.A., 2010. Phanerozoic hot spot traces and paleogeographic reconstructions of the Siberian continent based on interaction with the African large low shear velocity province. Earth-Science Reviews 102, 29–59.

Lamb, M.A., Badarch, G., 1997. Paleozoic sedimentary basins and volcanic-arc systems of southern Mongolia: New stratigraphic and sedimentologic constraints. International Geology Review 39, 542–576.

Lamb, M.A., Badarch, G., 2001. Paleozoic sedimentary basins and volcanic arc systems of southern Mongolia; new geochemical and petrographic constraints. In: Hendrix, M.S., Davis, G.A. (Eds.), Paleozoic and Mesozoic Tectonic Evolution of Central and Eastern Asia: From Continental Assembly to Intracontinental Deformation. Geol. Soc. Am. Mem. 194, pp. 117–149.

Larin, A.M., Velikoslavinskiy, S.D., Kotov, A.B. Salnikova, E.B., Glebovitskiy, V.A., Kovach, V.P., 2010. Tectono-magmatic evolution of the Dzhugdzhur-Stanovoy and the Selenga-Stanovoy superterrane of the Central Asian fold belt. In: Problems of geology and comprehensive development of natural resources of East Asia. Collected papers of the All-Russian scientific conference, June 16-18, 2010, Blagoveshchensk. Blagoveshchensk, Institute of Geology and Nature Management, DVO RAN, 25–26 (in Russian).

Larin, A.M., Kotov, A.B., Sal'nikova, E.B., Sorokin, A.A., Sorokin, A.P., Korshunov, A.M., Velikoslavinskii, S.D., Yakovleva, S.Z., Plotkina, Yu.V., 2011. Age and tectonic position of granites and volcanics in the eastern margin of the Selenga–Vitim volcano-plutonic belt. Doklady Earth Sciences 441, 1502–1507.

Laurent-Charvet, S., Charvet, J., Monie, P., Shu, Liangshu, 2003. Late Paleozoic strike-slip shear zones in eastern central Asia (NW China): New structural and geochronological data. Tectonics, 22, doi: 10.1029/2001TC901047.

Lee, C.-T.A., Morton, D.M., Kistler, R.W., Baird, A.K., 2007. Petrology and tectonics of Phanerozoic continent formation: from island arcs to accretion and continental arc magmatism. Earth Planet. Sci. Lett. 263, 370–387.

Lehmann, J., Schulmann, K., Lexa, O., Corsini, M., Kröner, A., Štípská, P., Tomurhuu, D., Otgonbator, D., 2010. Structural constraints on the evolution of the Central Asian Orogenic Belt in SW Mongolia. American Journal of Science 310, 575–628.

Lennon, R.G., Wilde S.A., Yang,T. 1997. The Mashan Group: a 500 Ma granulite facies terrain within the Jiamusi Massif, Heilongjiang Province, North-eastern China. In: Cox, R., Ashwal, L.D. (eds.), Proterozoic Geology of Madagascar. Proceedings of UNESCO-IUGS-IGCP 348/368 International Field Workshop, Antananarivo, Madagascar, 1997. Gondwana Research Group, Publication 5, pp. 45–46.

Letnikov, F.A., Kotov, A.B., Sal'nikova, E.B., Shershakova, M.M., Shershakov, A.V., Rizhanova, N.G., Makeev, A.F., 2007. Granodiorites of the Grenville phase in the Kokchetav Block, northern Kazakhstan. Doklady Earth Sciences 417, 1195–1197.

Letnikov, F.A., Kotov, A.B., Degtyarev, K.E., Levchenkov, O.A., Shershakova, M.M., Shershakov, A.V., Rizhanova, N.G., Makeev, A.F., Tolkachev, M.D., 2009. Late Ordovician granitoids of northern Kazakhstan: U-Pb age and tectonic setting. Doklady Earth Sciences 424, 24–28.

Letnikova, E.F., Geletii, N.K., 2005. Vendian-Cambrian carbonate sequences in sedimentary cover of the Tuva-Mongol microcontinent. Lithol. Mineral Res. 40, 167–177.

Letnikova, E.F., Geletii, N.K., 2005. Vendian-Cambrian carbonate sequences in the sedimentary cover of the Tuva-Mongolian microcontinent. Litologiya i Poleznye Iskopaemye No. 2, 192–204 (in Russian).

Levashova, N.M., Degtyarev, K.E., Bazhenov, M.L., Collins, A.Q., Van der Voo, R., 2003. Middle Paleozoic paleomagnetism of east Kazakhstan: post-Middle Devonian rotations in a large-scale orocline in the central Ural–Mongol belt. Tectonophysics 377, 249–268.

Levashova, N.M., Mikolaichuk, A.V., McCausland, P.J.A., Bazhenov, M.L., Van der Voo, R., 2007. Devonian paleomagnetism of the North Tien Shan: implications for the middle–late Paleozoic paleogeography of Eurasia. Earth and Planetary Science Letters 257, 104–120.

Levashova, N.M., Van der Voo, R., Abrajevitch, A.V., Bazhenov, M.L., 2009. Paleomagnetism of mid-Paleozoic subduction-related volcanics from the Chingiz Range in NE Kazakhstan: The evolving paleogeography of the amalgamating Eurasian composite continent. Geol. Soc. Am. Bull. 121, 555–573.

Levashova, N.M., Kalygin, V.M., Gibsher, A.S., Yff, J., Ryabinin, A.B., Meert, J.G., Malone, S.J., 2010. The origin of the Baydaric microcontinent, Mongolia: constraints from paleomagnetism and geochronology. Tectonophysics 485, 306–320.

Levashova, N.M., Meert, J.G., Gibsher, A.S., Grice, W.C., Bazhenov, M.L., 2011a. The origin of microcontinents in the Central Asian Orogenic Belt: Constraints from paleomagnetism and geochronology. Precambrian Research 185, 37–54.

Levashova, N.M., Gibsher, A.S., Meert J.G., 2011b. Precambrian microcontinents of the Ural–Mongolian belt: New paleomagnetic and geochronological data. Geotectonics 45, 51–70.

Li, C.Y., Wang, Q., 1983. The Paleoplate tectonics of North China and adjacent region and the origin of Eurasia. In: Li, C.Y (ed.), Contributions for the Project of Plate Tectonics in Northern China, Chinese Academy of Geological Sciences, Beijing, 1, pp. 3–16. (in Chinese with English abstract).

Li, H.Q., Chen, F.W., Hong, D.W., 1998. Gold mineralization and continental accretion of Western Junggar massif during Paleozoic era. In: Continental growth in the Phanerozoic: evidence from East-Central Asia, IGCP 420 First Workshop (July 27–August 3, 1998, Urumqi, Xinjiang, China), Schedule and Abstracts, p. 23.

Li, J.Y., 2006. Permian geodynamic setting of Northeast China and adjacent regions: Closure of the Paleo-Asian Ocean and subduction of the Paleo-Pacific Plate. Journal of Asian Earth Sciences 26, 207–224.

Li, J.Y., Niu, B.G., Song, B., Xu, W.X., Zhang, Y.H., Zhao, Z.R., 1999. Crustal formation and evolution of northern Changbai Mountains, northeast China. Geological Publishing House, Beijing, 137 pp. (in Chinese with English abstract).

Li, R.S., 1991. Xinlin ophiolite. Heilongjiang Geology 2, 19–32 (in Chinese with English abstract).

Li, Y., Zhou, H., Brouwer, F.M., Wijbrans, J.R., Zhong, Z., Liu, H., 2011. Tectonic significance of the Xilin Gol Complex, Inner Mongolia, China: Petrological, geochemical and U–Pb zircon age constraints. J. Asian Earth Sci. 42, 1018–1029.

Li, Z.T., Zhao, C.J., 1987. On the characteristics and origin of Singkainian granodiorite body in Chushan Mountain, east Heilongjiang province. Acta Petrologica Sinica 1, 3–16 (in Chinese with English abstract).

Li, Z.X., Bogdanova, S.V., Collins, F.S., Davidson, A, DeWaele, B., Ernst, R.E., Fitzsimons, I.C.W., Gladkochub, D.P. Jacobs, J., Karlstrom, K.E., Lu, S, Natapov, L.M., Pease, V., Pisarevsky, S.A., Thrane, K., Vernikovsky, V, 2008. Assembly, configuration, and break-up history of Rodinia: a synthesis. Precambrian Research 160, 179–210.

Lin, W., Faure, M., Shi, Y., Wang, Q., Li, Z., 2009. Palaeozoic tectonics of the south-western Chinese Tianshan: new insights from a structural study of the high-pressure/low-temperature metamorphic belt. Intern. J. Earth Sci. 98, 1259–1274.

Liou, J.G., Graham, S.A., Maruyama, S., Wang, X., Xiao, X., Carroll, A.R., Chu, J., Feng, Y., Hendrix, M. S., Liang, Y.H., McKnight, C.L., Tang, Y., Wang, Z.X., Zhao, M., Zhu, B., 1989a. Proterozoic blueschist belt in western China: best documented Precambrian blueschists in the word. Geology 17, 1127–1131.

Liou, J.G., Wang, X., Coleman, R.G., Zhang, Z.M., Maruyama, S., 1989b. Blueschists in major suture zones of China. Tectonics 8, 609–619.

Litvinovsky, B.A., Zanvilevich, A.N., Alakshin, A.M., Podladchikov, Y.Y., 1993. The Angara-Vitim batholiths, the largest granitoid pluton. Izd. SO RAN, OIGGM, Novosibirsk, 141 p. (in Russian).
Litvinovsky, B.A., Posokhov, V.F., Zanvilevich, A.N., 1995. Unusual Rb–Sr data on the age of two typical peralkaline granitoid plutons in Western Transbaikalia. Geologia i Geofizika 36, 65–72.
Litvinovsky, B.A., Posokhov, V.E., Zanvilevich, A. N., 1999. New Rb-Sr data on the age of Late Paleozoic granitoids in Western Transbaikalia. Geologya i Geophizika 40, 694–702.
Litvinovsky, B.A., Yarmolyuk, V.V., Vorontsov, A.A., Zhuravlev, D.Z., Posokhov, B.F., Sandimirova, G.P., Kuzmin, D.V., 2001. Late Triassic stage of formation of the Mongolian–Transbaikalian alkaline-granitoid province: data of isotope-geochemical studies. Geologia i Geofizika 42, 445–455.
Litvinovsky, B.A., Jahn, B.M., Zanvilevich, A.N., Saunders, A., Poulain, S., Kuzmin, D.V., Reichow, M.K., Titov, A.V., 2002. Petrogenesis of syenite-granite suites from the Bryansky Complex (Transbaikalia, Russia): implications for the origin of A-type granitoid magmas. Chemical Geology 189, 105–133.
Litvinovsky, B.A., Tsygankov, A.A., Jahn, B.M., Be'eri-Shlevin, Y., 2011. Origin and evolution of overlapping calc-alkaline and alkaline magmas: The Late Paleozoic post-collisional igneous province Transbaikalia. Lithos 125, 845–874.
Liu, J., 1988. Precambrian Geology of the Jiamusi Massif. Heilongjiang Geology 1, 148–156 (in Chinese with English abstract).
Liu, J.F., Chi, X.G., Dong, C.Y., Zhao, Z., Li, G.R., Zhao, Y.D., 2008. Discovery of Early Paleozoic granites in the eastern Xiao Hinggan Mountains, northeastern China and their tectonic significance. Geological Bulletin of China 27, 534–544.
Liu, M., Yang, Y., Shen, Z., Wang, S., Wang, M., Wan, Y., 2007. Active tectonics and intracontinental earthquakes in China: The kinematics and geodynamics. Geological Society of America, Special Paper 425, 299–318.
Liu, M., Stein, S., Wang, H., 2011. 2000 years of migrating earthquakes in north China: How earthquakes in midcontinents differ from those at plate boundaries. Lithosphere 3, 128–132.
Lomize, M.G., Demina, L.I., Zarshchikov, A.A. 1997. The Kyrgyz–Terskey paleoceanic basin, Tien Shan. Geotectonics 6, 463–482.
Long, L.L., Gao, Klemd, R., Beier, C., Qian, Q., Zhang, X., Wang, J.B., Jiang, T., 2011. Geochemical and geochronological studies of granitoid rocks from the Western Tianshan Orogen: Implications for continental growth in the southwestern Central Asian Orogenic Belt. Lithos, 126, 321–340.
Long, X., Yuan, C., Sun, M., Xiao, W., Zhao, G., Wang, Y., Cai, K., Xia, X., Xie, L., 2010. Detrital zircon ages and Hf isotopes of the early Paleozoic flysch sequence in the Chinese Altai, NW China: New constraints on depositional age, provenance and tectonic evolution. Tectonophysics 480, 213–231.
Lu, S., Li, H., Zhang, C., Niu, G., 2008. Geological and geochronological evidence for the Precambrian evolution of the Tarim Craton and surrounding continental fragments. Precambrian Research 160, 94–107.
Lutts, B.G., 1980. Geochemistry of oceanic and continental magmatism. Moscow, Nedra, 247 pp. (in Russian).
Lykhin, D.A., Kostitsyn, Y.A., Kovalenko, V.I., Yarmolyuk, V.V., Sal'nikova, E.B., Kotov, A.B., Kovach, V.P., Ripp, G.S., 2001. Ore-bearing magmatism at the Ermakov beryllium deposit in the western Transbaikal Region: Age, magma sources, and relationships to ore mineralization. Geology of Ore Deposits 43, 46–63.
Lykhin, D.A., Kovalenko, V.I., Yarmolyuk, V.V., 2002. Rb-Sr age and magma sources of the Early Mesozoic beryllium province of Central Asia: Evidence from the Orot deposit. Doklady Earth Sciences 385, 676–679.
Lykhin, D.A., Kovalenko, V.I., Yarmolyuk, V.V., Kotov, A.B., Kovach, V.P., Sal'nikova, E.B., 2004. Age, composition, and sources of ore-bearing magmatism of the Orot beryllium deposit in Western Transbaikalia. Geology of Ore Deposits 46, 108–124.
Lykhin, D.A., Kovalenko, V.I., Yarmolyuk, V.V., Sal'nikova, E.B., Kotov, A.B., Anisimova, I.V., Plotkina, Yu.V., 2010. The Yermakovsky beryllium deposit, Western Transbaikal region, Russia: Geochronology of igneous rocks. Geology of Ore Deposits 52, 114–137.
Makarov, V.I., Alekseev, D.V., Batalev, V.Yu., Bataleva, E.A., Belyaev, I.V., Bragin, V.D., Dergunov, N.T., Efimova, N.N., Leonov, M.G., Munirova, L.M.,. Pavlenkin, A.D., Roecker, S., Roslov, Yu.V., Rybin, A.K., Shchelochkov, G.G., 2010. Underthrusting of Tarim beneath the Tien Shan and Deep Structure of Their Junction Zone: Main Results of Seismic Experiment along MANAS Profile Kashgar–Song-Kul. Geotectonics 44, 102–126.

Makrygina, V.A., Belichenko, V.G., Reznitsky, L.Z., 2007. Types of paleoisland arcs and back-arc basins in the northeast of the Paleoasian Ocean (from geochemical data). Russian Geology and Geophysics 48, 107–119.

Maksumova, R.A., Zakharov, I.L., Zima, M.B., Khristov, M.P., Chernyshuk, V.P., 1988. The thrust-sheeted structure of the Early Caledonides in Tien-Shan under the light of new data on stratigraphy of the Lower Paleozoic units. In: Pre-Paleozoic and Lower Paleozoic of Tien-Shan. Frunze, "Ilim", p.144–152 (in Russian).

Maksumova, R.A., Bakirov, A.B., Sakiev, K.S., 2009. Tectonic zoning of Tien Shan Caledonides. International excursion and workshop "Tectonic evolution and crustal structure of the Tian Shan belt and related terrains in the Central Asian orogenic belt". Abstract-volume, Bishkek, 33–35.

Mamani, M, Wörner, G., Sempere, T., 2010. Geochemical variations in igneous rocks of the Central Andean orocline (13 °S to 18 °S): tracing crustal thickening and magma generation through time and space. Geological Society of America Bulletin 122, 162–182.

Mandl, G., 1987. Tectonic deformation by rotating parallel faults: the 'bookshelf' mechanism. Tectonophysics 141, 277–316.

Mao, Q., Xiao, W., Fang, T., Wang, J., Han, C., Sun, M., Yuan, C., 2012. Late Ordovician to early Devonian adakites and Nb-enriched basalts in the Liuyuan area, Beishan, NW China: Implications for early Paleozoic slab-melting and crustal growth in the southern Altaids. Gond. Res. 22, 534–553.

Maruyama, S., 1997. Pacific-type orogeny revisited: Miyashiro-type orogeny proposed. The Island Arc 6, 91–120.

Maruyama, S., Sakai, H., 1986. Tectonics of Asia as a composite continent. Mon. Assoc. Geol. Coll. Japan 31, 487–518.

Maruyama, S., Parkinson, C.D., 2000. Overview of the geology, petrology and tectonic framework of the high-pressure–ultrahigh-pressure metamorphic belt of the Kokchetav Massif, Kazakhstan. The Island Arc 9, 439–455.

Maruyama, S, Isozak, Y, Kimura, G., Terabayashi, M., 1997. Paleogeographic maps of the Japanese islands: plate tectonics synthesis.

Matsumoto, I., Tomurtogoo, O., 2003. Petrological characteristics of the Hantaishir ophiolite complex, Altai region, Mongolia: coexistence of podiform chromitite and boninite. Gond. Res. 6, 161–169.

Mattaner, M., Matle, Ph., Malavieille, J., Tapponier, P., Maluski, H., Xu Zhi Shin, Lu Yr Lun, Tang Yao Qin., 1985. Tectonics of the Qinling Belt: build-up and evolution of eastern Asia. Nature 317 (6037), 496–500.

Mazarovich, 1938. Elements of geology. Obiedinennoe Nauchno-Tekhnicheskoye Izdatelstvo (NKTP) SSSR, Moscow. Leningrad, 544 pp. (in Russian).

Mazukabzov, A.M., Donskaya, T.V., Gladkochub, D.P., Sklyarov, E.V., Ponomarchuk, V.A., Sal'nikova, E.B., 2006. Structure and age of the metamorphic core complex of the Burgutui ridge (Southwestern Transbaikal region). Doklady Earth Sciences 407, 179–183.

Mazukabzov, A.M., Donskaya, T.V., Gladkochub, D.P., Paderin, I.P., 2010. The Late Paleozoic geodynamics of the West Transbaikalian segment of the Central Asian fold belt. Russian Geology and Geophysics 51, 482–491.

McKenzie, D.P., 1969. Speculations on the consequences and causes of plate motions. Geophysical Journal of the Royal Astronomical Society 18, 1–32.

Mekhonoshin, A.S., Vladimirov, A.G., Fedorovsky, V.S., Volkova, N.I., Travin, A.V., Kolotilina, T.B., Khromykh, S.V., Yudin, D.S., 2004. Mafic-ultramafic magmatism of the Ol'khon collision system of West Transbaikalia: composition, ^{40}Ar-^{39}Ar age, Structural position, in: Geodynamic evolution of the lithosphere of the Central Asian mobile belt (from ocean to continent). Institute of Geography Publisher, Irkutsk, vol. 2, 40–43 (in Russian).

Melnikov, A., Delvaux, D., Travin, A., Buslov, M., Vladimirov, A., Smirnova, L., Theunissen, K., 1997. Late Paleozoic–Early Mesozoic sinistral movement along the Irtysh shear zone, NE Kazakhstan. Abstract, Tectonic Studies Group Annual General Meeting, Durhan (UK), 17–19 December, 1997, p. 93.

Melnikov, A., Travin, A., Plotnikov, A., Smirnova, L., Theunissen, K., 1998. Kinematics and Ar/Ar geochronology of the Irtysh shear zone in NE Kazakhstan. In: Continental growth in the Phanerozoic: Evidence from East-Central Asia, IGCP 420 First Workshop (July 27–August 3, 1998, Urumqi, Xinjiang, China), Schedule and Abstracts, p. 30.

Meng, Q.R., 2003. What drove late Mesozoic extension of the northern China-Mongolia tract? Tectonophysics 369, 155–174.

Meng, Q.R., Hu, J.M., Jin, J.Q., Zhang, Y., Xu, D.F., 2003. Tectonics of the late Mesozoic wide extensional basin system in the China-Mongolia border region. Basin Research 15, 397–416.

Meng, X., Ge, M., Tucker, M.E., 1997. Sequence stratigraphy, sea-level changes and depositional systems in the Cambro-Ordovician of the North China carbonate platform. Sed. Geol. 114, 189–222.

Metcalfe, I., 2006. Palaeozoic and Mesozoic tectonic evolution and palaeogeography of East Asian crustal fragments: The Korean Peninsula in context. Gond. Res. 9, 24–46.

Metelkin, D.V., Gordienko, I.V., Klimuk, V.S., 2007. Paleomagnetism of Upper Jurassic basalts from Transbaikalia: new data on the time of closure of the Mongol-Okhotsk ocean and Mesozoic intraplate tectonics of Central Asia. Geology and Geophysics 48 (10), 1061–1073 (in Russian).

Miao, L., Fan, W., Liu, D., Zhang, F., Shi, Y., Guo, F., 2007a. Geochronology and geochemistry of the Hegenshan ophiolitic complex: implications for late-stage tectonic evolution of the Inner Mongolia-Daxinganling orogenic belt, China. J. Asian Earth Sci. 32, 348–370.

Miao, L., Zhang, F., Fan, W.M., Liu, D., 2007b. Phanerozoic evolution of the Inner Mongolia Daxinganling orogenic belt in North China: constraints from geochronology of ophiolites and associated formations. In: Zhai, M.G., Windley, B.F., Kusky, T.M., Meng, Q.R. (eds.), Mesozoic Sub-Continental Lithospheric Thinning Under Eastern Asia. Geol. Soc. Lond., Spec. Publ. 280, pp. 223–237.

Miao, L.C., Fan, W.M., Zhang, F.Q., Liu, D.Y., Jian, P., Shi, G.H., Tao, H., Shi, Y.R., 2004. Zircon SHRIMP geochronology of the Xinkailing-Kele complex in the northwestern Lesser Xing'an Range, and its geological implications. Chinese Science Bulletin 49, 2201–2209.

Miao, L.C., Liu, D.Y., Zhang, F.Q., Fan, W.M., Shi, Y.R., Xie, H.Q., 2007. Zircon SHRIMP U-Pb ages of the "Xinghuadukou Group" in Hanjiayuanzi and Xinlin areas and the "Zhalantun Group" in Inner Mongolia, Da Hinggan mountains. Chinese Science Bulletin 52, 1112–1134.

Mikhailov, N.P. (ed.), 1989. Geological structure and mineral resources of the USSR: 6, Kazakhstan and Middle Asia: 1, Kazakhstan folded region. Nedra Publisher, Leningrad, 285 p. (in Russian).

Mikolaichuk, A.V., 2000. The structural position of thrusts in the recent orogen of the Central Tien Shan. Geology and Geophysics 41, 961–970 (in Russian).

Mikolaichuk, A.V., Apayarov, F.Kh., 2009. Pre-caradocian obduction as the main structure-forming factor in formation of the Northern Tien Shan Caledonides. International Excursion and workshop "Tectonic evolution and crustal structure of the Tian Shan belt and related terrains in the Central Asian orogenic belt". Abstract volume, Bishkek, 39–42.

Mikolaichuk, A.V., Kurenkov, S.A., Degtyarev, K.E., Rubtsov, V.I., 1997. Northern Tien-Shan, main stages of geodynamic evolution in the late Precambrian and early Palaeozoic. Geotectonics 31, 445–462 (in Russian with English abstract).

Milanovskiy, Ye.Ye., 1989: Geology of the USSR. Part 2. Moscow State University, Moscow, 271 pp. (in Russian).

Miller, E.L., Geiman, M., Parfenov, L., Hourigan, J., 2002. Tectonic settings of Mesozoic magmatism: A comparison between northeastern Russia and the North American Cordillera. In: Miller, E.L., Grantz, A., Klemperer S.L. (eds.): Tectonic Evolution of the Bering Shelf-Chukchi Sea-Arctic Margin and Adjacent Landmasses, Geological Society of America Special Paper 360, 313–332.

Minayev, V.Ye., Fedorov, G.V., 1984. Petrochemistry of basites of the Gorif formation (Southern Tien-Shan). Proceedings of the Academy of Sciences of Tajic SSR, XXYII, 9, 524–527 (in Russian).

Mirkamalov, R.H., Chirikin, V.V., Khan, R.S., Kharin, V.G., Sergeyev, S.A., 2012. Results of the U-Pb (SHRIMP) dating of granitoid and metamomorphic complexes of the Tien-Shan fold belt (Uzbekistan). Proceedings of St.-Petersburg University, ser. 7, 1, 3–25.

Mitrofanov, F.P., Bibikova, Y.V., Gracheva, Y., Kozakov, I.K., Sumin, L.V., Shuleshko, I.K., 1985. Isotope age of 'grey' tonalities and gneisses of the Archean in Caledonian structures of central Mongolia. Doklady Akademii Nauk SSSR 284, 670–675.

Mokhov, V.A., 1988. Dynamo-metamorphism zones in the Leninogorsk mining region (Rudny Altai), in: Lineament Zone Structure of Dynamo-Metamorphism. Institute of Geology and Geophysics, Siberian Branch, Russian Academy of Sciences, Novosibirsk, 100–108 (in Russian).

Molnar, P., Dayem, K.E., 2010. Major intracontinental strike-slip faults and contrasts in lithospheric strength. Geosphere 6, 444–467.

Molnar, P., Tapponnier, P., 1975. Cenozoic tectonics of Asia: Effects of a continental collision. Science 189, 419–426.

Moskvin, M.M. (Ed.), 1986. Cretaceous system. Stratigraphy of the USSR. Moscow, Nedra, 1, 338 pp., 2, 443 pp. (in Russian)

Mossakovskiy, A.A., 1975. Orogenic structures and volcanism of Eurasia Paleozoids. Moscow, Nauka, 319 pp. (in Russian).
Mossakovskiy, A.A., Ruzhentsev, S.V., Samygin, S.G., Kheraskova, T.N., 1993. Geodynamic evolution of the Central-Asian folded belt, and history of its development. Geotectonics 6, 3–32.
Mukhin, P.A., Abdullayev, Kh.A., Minayev, V.Ye., Khristov, S.Ye., Egamberdiev, S.A., 1989. Geodynamic of Middle Asia in the Paleozoic. Soviet Geology 10, 47–58 (in Russian).
Mukhin, P.A., Karimov, Kh.K., Savchuk, Yu.S., 1991. Paleozoic geodynamics of the Kyzyl-Kum. Fan Publisher, Tashkent, 148 p. (in Russian).
Muratov, M.V., 1965. Geosynclinal fold belts of Eurasia. Geotektonika 6, 4–19 (in Russian).
Mushkin, A., 2011. New constraints on Late Quaternary slip rates along the Gobi-Altay Fault in SW Mongolia, 2011. GSA Annual Meeting, Abstract 49–8.
Naletov, P.I., 1961. Stratigraphy of the central area of the Buryat Republic. Gosgeoltechizdat Publishing House, Moscow, 280 p. (in Russian).
Nalivkin, D.V., 1926. The sketch of the Turkestan geology. Turkpechat, Tashkent – Moscow. 184 pp. (in Russian).
Natal'in, B.A., 1991. Mesozoic accretion and collision tectonics of the USSR southern Far East. Tikhookeanskaya Geologiya 5, 3–23 (in Russian).
Natal'in, B.A., 1991. Mesozoic accretion and collision tectonics of southern USSR Far East. Pacific Geology 10, 3–23.
Natal'in, B.A., 1993. History and modes of Mesozoic accretion in southeastern Russia. The Island Arc 2, 15–34.
Natal'in, B.A., Borukayev, C.B., 1991. Mesozoic sutures in the southern Far East of USSR. Geotectonics 25, 64–74.
Natal'in, B.A., Popeko, L.I., 1991. The Paleozoic of the Galam segment, Mongol-Okhotsk fold system. Tikhookeanskaya Geologiya 2, 81–89 (in Russian).
Natal'in, B.A., Şengör, A.M.C., 2005. Late Palaeozoic to Triassic evolution of the Turan and Scythian platforms: The pre-history of the Palaeo-Tethyan closure. Tectonophysics 404, 175–202.
Natal'in, B.A., Popeko, L.I., Chebotov, S.A., 1985. Tectonics of the West Dzhagdy zone, Mongol-Okhotsk fold belt. Tikhookeanskaya Geologiya 2, 49–64 (in Russian).
Naumova, V.V., Miller, R.J., Patuk, M.I., Kapitanchuk, M.Y., Nokleberg, W.J., Khanchuk, A.I., Parfenov, L.M., Rodionov, S.M., 2006. Geographic information systems (GIS) spatial data compilation of geodynamic, tectonic, metallogenic, mineral deposits, geophysical maps and associated descriptive data for northeast Asia. Open-File Report, U. S. Geol. Surv., Denver, CO.
Nekrasov, G.E., Rodionov, N.V., Berezhnaya, N.G., Sergeev, S.A., Ruzhentsev, S.V., Minina, O.R., Golionko, B.G., 2007. U-Pb age of zircons from plagiogranite veins in migmatized amphibolites of the Shaman Range (Ikat-Bagdarin zone, Vitim highland, Transbaikal region). Doklady Earth Sciences 413, 160–163
Nelson, M., Jones, C., 1987. Palaeomagnetism and crustal rotations along a shear zone, Las Vegas Range, southern Nevada. Tectonics 6, 13–33.
Nenakhov, V.M., Belov, S.I., 1996. Main features of the intrusive magmatism in the Turkestan-Alai Range. Proceedings of Voronezh University, Ser. Geology, 1, 84–89. (in Russian).
Nenakhov, V.M., Nikitin, A.V., 2007. Structure, magmatism, and Paleozoic tectonic evolution of the Uakit Zone in the context of the formation of the Angara-Vitim batholith in the western Transbaikal region. Geotectonics 41, 114–129.
Nenakhov, V.M., Ivanikov, V.V., Kuznetsov, L.V., Strik, Yu.N., 1992. Special aspects of the investigation and mapping of collisional granitoids. Roscomnedra, Moscow, 101 p. (in Russian).
Nenakhov, V.M., Nikitin, A.V., Doronina, N.A., Matukov, D.I., Lepekhina, E.N., Berezhnaya, N.G., 2007. Polychronous origin of the Angara-Vitim Batholith. Doklady Earth Sciences 414, 538–541.
Neyevin, A.V., Biske, Yu.S., Neyevin, I.A., 2011. Lower Paleozoic stratigraphy of the eastern Middle Tien-Shan part of the Syr-Daria continental block, with paleogeography and geodynamic connections. Proceedings of St.-Petersburg University, ser. 7, 2, 21–36.
Neymark, V.P., Ritsk, E.Y., Rizvanova, N.G., 1993. Hercinian age and Precembrian crustal protolith for Barguzun granitoids of the Angaro-Vitimskii batholiths: U-Pb and Sm-Nd evidence. Doklady Academii Nauk 331, 726–729 (in Russian).
Nie, S.Y., Rowley, D.B., Ziegler, A.M., 1990. Constraints on the locations of Asian microcontinents in Paleo-Tethys during the Late Paleozoic. Palaeogeography and Biogeography. Geological Society of America, Memoir 12, 397–409.

Nikitin, I.F., 1972. The Ordovician of Kazakhstan. Part 1. Stratigraphy. Nauka Publisher, Alma-Ata, 244 p. (in Russian).
Nikitin, I.F., 2002. Ordovician siliceous and siliceous-basalt formations of Kazakhstan. Geology and Geophysics 43, 512–527 (in Russian).
Nokleberg, W.J., ed., 1994. Circum-North Pacific tectono-stratigraphic terrane map. U.S. Geologic Survey, Open File Report 94. 433 p., 2 sheets scale 1:5, 000,000; 2 sheets scale 1: 10,000,000.
Nokleberg, W.J., ed., 2003. Preliminary Northeast Asia geodynamics map. U.S. Geological Survey Open-File Report 03-205, 2 sheets, scale 1 : 5,000,000.
Obruchev, S.V. (Ed.), 1964. Precambrian of East Sayan. Nauka Publishing House, Moscow, Leningrad (in Russian).
Obruchev, V.A., 1900. The Central Asia, Northern China and Nan Shan – Report on the travel with the mission of Russian Emperor's Geographical Society, 1892–94. 1. Russian Emperor's Geographical Society, St.-Petersburg (in Russian).
Oh, C.W., 2006. A new concept on tectonic correlation between Korea, China and Japan: Histories from the late Proterozoic to Cretaceous. Gondwana Research 9, 47–61.
Osmonbetov, K.O. (ed.), 1982. Stratificated (suprarcrustal) and intrusive formations of Kyrgyzstan. Ilim Publisher, Frunze. Part 1, pp. 357. Part 2, pp. 254. (in Russian).
Osozawa, S., Tsolmon, G., Majigsuren, U., Sereenen, J., Niitsuma, S., Iwata, N., Pavlis, T., Jahn, B.M., 2008. Structural evolution of the Bayanhongor region, west-central Mongolia. J. Asian Earth Sci. 33, 337–352.
Ota, T., Buslov, M.M., Watanabe, T., 2002. Metamorphic evolution of the late Precambrian eclogite and associated metabasites, Gorny Altai, southern Russia. International Geology Review, 837–858.
Ota, T., Utsunomiya, A., Uchio, Y., Isozaki, Y., Buslov, M.M., Ishikawa, A., Maruyama, S., Kitajima, K., Kaneko, Y., Yamamoto, H., Katayama, I., 2007. Geology of the Gorny Altai subduction–accretion complex, southern Siberia: Tectonic evolution of an Ediacaran–Cambrian intra-oceanic arc-trench system. Journal of Asian Earth Sciences 30, 666–695.
Owen, L.A., Windley, B.F., Cunningham, W.D., Badamgarov, J., Dorjnamjaa, D., 1997. Quaternary alluvial fans in the Gobi Desert, southern Mongolia: Evidence for neotectonics and climate change. Journal of Quaternary Science 12 (3), 239–252.
Owen, L.A., Cunningham, W.D., Windley, B.F., Badamgarov, J. & Dorjnamjaa, D., 1999. The landscape evolution of Nemegt Uul: A late Cenozoic transpressional uplift in the Gobi Altai, southern Mongolia. In: Smith, B.J., Whalley, W.B., Warke, P.A. (eds.), Uplift, Erosion and Stability: Perspectives on long-term landscape development. Geological Society London Special Publications 162, 201–218.
Pan, G., Xiao, Q., Lu, S., Den, J., Feng, Y., Zhang, K., Zhang, Z., Wang, F., Xing, G., Hao, G., Feng, Y., 2009. Subdivision of tectonic units in China. Geology in China 36, 1–28.
Parfenov, L.M., 1984. Continental margins and island arcs of Mesozoids of Asia's north-eastern part. Novosibirsk. Nauka, 192 pp. (in Russian).
Parfenov, L.M., Natal'in, B.A., 1977. Tectonic evolution of Asia's north-eastern part in the Mesozoic and Cenozoic. Doklady AN SSSR 235, 1132–1135 (in Russian).
Parfenov, L.M., Bulgatov, A.N., Gordienko, I.V., 1996. Terranes and the formation of orogenic belts of the Transbaikal region. Tikhookeanskaya Geologiya 22, 3–15 (in Russian).
Parfenov, L.M., Nokleberg, W., Khanchuk, A.I., 1998. The principles of composing the legend to the geodynamic map of North and Central Asia, Russian southern Far East, Korea and Japan, and its main divisions. Tikhookeanskaya Geologiya 3, 3–13 (in Russian).
Parfenov, L.M., Popeko, L.I., Tomurtogoo, O., 2001. Problems of tectonics of the Mongol-Okhotsk orogenic belt. Geology of the Pacific Ocean 16, 797–830.
Parfenov, L.M., Berzin, N.A., Khanchuk, A.I., Badarch, G., Belichenko, V.G., Bulgatov, A.N., Dril, S.I., Kirillova, G.L., Kuzmin, M.I., Nokleberg, W.J., Prokopiev, A.V., Timofeev, V.F., Tomurtogoo, O., Yang, H., 2003. A model of orogenic belt formation in Central and Northeast Asia. Tikhookeanskaya Geologiya 22, 7–41.
Peacock, D.C.P., Anderson, M.W., Morris, A., Randall, D.E., 1998. Evidence for the importance of small faults on block rotation. Earth 299, 1–13.
Pecherskii, D.M., Didenko, A.N., 1995. Palaeoasian ocean: Petromagnetic and paleomagnetic information on its lithosphere. Institute of Physics of the Earth, Russian Academy of Sciences, Moscow, 298 p. (in Russian).
Pei, F.P., Xu, W.L., Yang, D.B., Zhao, Q.G., Liu, X.M., Hu, Z.C., 2007. Zircon U–Pb geochronology of basement metamorphic rocks in the Songliao basin. Chinese Science Bulletin 52, 942–948.

Pei, F.P., Xu, W.L., Yang, D.B., Ji, W.Q., Yu,Y., Zhang, X.Z., 2008. Mesozoic volcanic rocks in the southern Songliao Basin: Zircon U-Pb ages and their constraints on the nature of basin basement. Earth Science (Journal of China University of Geosciences) 32, 603–617 (in Chinese with English abstract).

Peive, A.V., Mossakovsky, A.A. (eds.), 1982. Tectonics of Kazakhstan. Moscow, Nauka Publisher, 139 p. (in Russian).

Petrov, O., Leonov, Yu., Tingdong, L., Tomurtogoo, O., Hwang, J. H. (eds.), 2008. Tectonic map of Central Asia and adjacent areas. Scale 1:2500000., CCGM/CGMW

Petrova, Z.I., Reznitskii, L.Z., Makrygina, V.A., 2002. Geochemical Parameters of Metaterrigenous Rocks of the Slyudyanka Group, Southwestern Baikal Area, as Indicators of Their Source and Protolith Genesis. Geochemistry International 40, 355–365.

Petrova, Z.I., Makrygina, V.A., Reznitskii, L.Z., 2005. Geochemistry of Metagraywackes in the Structures Surrounding the Southern Part of the Siberian Platform and Their Significance for Paleogeodynamic Reconstructions. Geochemistry International 43, 758–768.

Pfänder, J.A., Jochum, K.P., Kröner, A., Kozakov, I., Oidup, C., Todt, W., 1998. Age and geochemical evolution of an Early Cambrian ophiolite-island arc system in Tuva, south central Asia. Geol. Survey Finland, Spec. Pap. 26, 42.

Pfänder, J.A., Jochurn, K.P., Kozakov, I., Kröner, A., Todt, W., 2002. Coupled evolution of back-arc and island arc-like mafic crust in the late-Neoproterozoic Agardagh Tes-Chem ophiolite, Central Asia: evidence from trace element and Sr-Nd-Pb isotope data. Contrib. Mineral. Petrol. 143, 154–174.

Pfänder, J.A., Kröner, A., Timothy, M.K., 2004. Tectono-magmatic evolution, age and emplacement of the Agardagh Tes-Chem ophiolite in Tuva, Central Asia: Crustal growth by island arc accretion. In: Kusky, T.M. (ed.): Precambrian Ophiolites and Related Rocks, Elsevier, Amsterdam, pp. 207–221.

Pickering, K.T., Koren, T.N., Lytochkin, V.N., Siveter, D.J., 2008. Silurian–Devonian active-margin deep-marine systems and paleogeography, Alai Range, southernTien Shan, Central Tien Shan, Central Asia. Journal of Geological Society, London 165, 189–210.

Pirajno, F., 2010. Intracontinental strike-slip faults, associated magmatism, mineral systems and mantle dynamics :examples from NW China and Altay-Sayan(Siberia). Journal of Geodynamics 50, 325–346.

Pisarevsky, S.A., 2005. New edition of the Global Paleomagnetic Database. EOS Transactions 86, 170 pp.

Plotnikov, A.V., Titov, A.V., Kruk, N.N., Ota, T., Kabashima, T., Hirata, T., 2001. Middle Paleozoic age of metamorphism in the South-Chuya complex in Gorny Altai (results of Ar–Ar, Rb–Sr, and U–Pb isotope dating). Russian Geology and Geophysics 42, 1333–1347.

Pokrovskii, B.G., Zhidkov, A.Ya., 1993. Sources of Material for High-K Alkaline Rocks from the Synnyr and South Sakum Massifs in Transbaikalia from Isotopic Data. Petrology 1, 195–204.

Pollitz, F., Vergnolle, M., Calais, E., 2003. Fault interaction and stress triggering of twentieth century earthquakes in Mongolia. Journal of Geophysical Research B: Solid Earth 108, ETG 16-1 - ETG 16-14.

Polyanskii, N.V., Dobretsov, N.L., Ermolov, P.V., Kuzebnyi, V.S., 1979. The structure and history of the Char ophiolite belt. Soviet Geology and Geophysics 20, 52–62.

Popeko, L.I., Natal'in, B.A., Belyaeva, G.V., Kotlyar, G.V., Shishkina, G.R., 1993. Paleobiogeographic zoning and geodynamics of the Russian southern Far East. Tikhookeanskaya Geologiya 5, 19–30 (in Russian).

Popov, L., Ebbestad, J., Mambetov, A., Apayarov, F., 2007. A low diversity shallow water lingulid brachiopod-gastropod association from the Upper Ordovician of North Kyrgyzstan. Acta Palaeontologica Polonica 52, 27–40.

Popov, L.E., Bassett, M.G., Zhemchuzhnikov, V.G., Lars, E., Holmer, L.E., Klishevich, I.A. 2009. Gondwanan faunal signatures from early Palaeozoic terranes of Kazakhstan and Central Asia: evidence and tectonic implications. In: Bassett, M.G. (ed.), Early Palaeozoic Peri-Gondwanan terranes: New insights from tectonics and biogeography. Geological Society, London, Special Publications 325, 23–64.

Popov, V.I., 1938. The history of depressions and elevations in the Western Tien-Shan. Science Commission of the Uzbek SSR, Tashkent, 415 p. (in Russian).

Popov, V.S., 1996. Some problems of tectonics, magmatism, and metallogeny of Central Kazakhstan. In: Seltmann, R., Shatov, V., Kremenetsky, A., Lehmann, B., Popov, V., Ermolov, P. (eds.), Granite–related ore deposits of central Kazakhstan and adjacent areas. Glagol Publishing House, St. Petersburg, pp. 109–118.

Porshniakov, 1973. The Hercynides of Alai and adjacent Southern Tien-Shan. Leningrad University, Leningrad. 216 pp. (in Russian).

Posokhov, V.F., Shadaev, M.G., Litvinovsky, B.A., Zanvilevich, A.N., Khubanov, V.B., 2005. Rb-Sr age and sequence of formation of granitoids of the Khorinka volcanoplutonic structure in the Mongolo-Transbaikalian belt. Russian Geology and Geophysics 46, 612–619.

Prentice, C.S., Kendrick, K., Berryman, K., Bayasgalan, A., Ritz, J.F., Spencer, J.Q., 2002. Prehistoric ruptures of the Gurvan Bulag fault, Gobi Altay, Mongolia. Journal of Geophysical Research B: Solid Earth 107, ESE 1-1 - 1-18.

Puchkov, V.N., 1997. Structure and geodynamics of the Uralian orogen. In: Burg, J.P., Ford, M. (eds.): Orogeny through Time. Geol. Soc. Lond., Spec. Publ. 121, pp. 201–236.

Puchkov, V.N., 2000. Paleogeodynamics of Southern and Middle Urals. Dauria Publisher, Ufa, 146 p. (in Russian).

Puchkov, V.N., 2003. Uralides and Timanides: Their structural relationship and position in the geologic history of the Ural-Mongolian fold belt. Geologiya i Geofizika 44, 28–39.

Puchkov, V.N., Khristov, Ye.V., Ivanov, K.S., Mikolaychuk, A.V., 1987. New data on the age of greenstone formations in the Southern Tien-Shan. Doklady Academy of Sciences of the USSR 294, 435–438.

Pysklywec, R.N., Beaumont, C., 2004. Intraplate tectonics: Feedback between radioactive thermal weakening and crustal deformation driven by mantle lithosphere instabilities. Earth and Planetary Science Letters 221, 275–292.

Reichow, M.K., Litvinovsky, B.A., Parrish, R.R., Saunders, A.D., 2010. Multi-stage emplacement of alkaline and peralkaline syenite-granite suites in the Mongolian–Transbaikalian Belt, Russia: Evidence from U-Pb geochronology and whole-rock geochemistry. Chemical Geology 273, 120–135.

Ren, J., Jiang, C., Zhang, Z., Qin, D., 1987. Geotectonic evolution of China. Science Press Beijing and Springer-Verlag, Hong Kong.

Repina, L.N., Romanenko, E.V., 1978. Trilobites and the Lower Cambrian Stratigraphy of the Altai (Nauka, Moscow). 303 p. [in Russian].

Reznitskii, L.Z., Sal'nikova, E.B., Barash, I.G., Belichenko, V.G., Glebovitskii, V.A., Kotov, A.B., Kovach, V.P., Yakovleva, S.Z., Fedoseenko, A.M., 2007. Upper Age Boundary of the Accretion of Terranes in the Northwestern Part of the Eastern Segment of the Central Asian Foldbelt. Doklady Earth Sciences 414, 548–551.

Reznitskii, L.Z., Makrygina, V.A., Kovach, V.P., Belichenko, V.G., Kotov, A.B., 2008. Lower limits of the protolith age of the Khamar-Daban, Tunka and Dzhida terranes: Sm-Nd data of metamorphosed terrigenous rocks. In: Sklyarov, E.V. (Ed.), Geodynamic evolution of lithosphere in the Central Asian mobile belt (from ocean to continent). Izd. Instituta Zemnoi Kory, Irkutsk, Issure 6, vol. 2, pp. 62–64 (in Russian).

Rippington, S., Cunningham, D., England, R., 2008. Structure and petrology of the Altan Uul ophiolite: New evidence for a late Carboniferous suture in the Gobi Altai, southern Mongolia. Journal of the Geological Society 165, 711–723.

Ritz, J.F., Brown, E.T., Bourles, D.L., Philip, H., Schlupp, A., Raisbeck, G.M., Yiou, F., Enkhtuvshin, B., 1995. Slip rates along active faults estimated with cosmic-ray-exposure dates: application to the Bogd fault, Gobi-Altai, Mongolia. Geology 23, 1019–1022.

Ritz, J.F., Bourles, D., Brown, E.T., Carretier, S., Chevry, J., Enhtuvshin, B., Galsan, P., Finkel, R. C., Hanks, T.C., Kendrick, K.J., Philip, H., Raisbeck, G., Schlupp, A., Schwartz, D.P., Yiou, F., 2003. Late Pleistocene to Holocene slip rates for the Gurvan Bulag thrust fault (Gobi-Altay, Mongolia) estimated with 10Be dates. Journal of Geophysical Research B: Solid Earth 108, ETG 8-1 - 8-16.

Roberts, N., Cunningham, D., 2008. Automated alluvial fan discrimination, Quaternary fault identification, and the distribution of tectonically reactivated crust in the Gobi Altai region, southern Mongolia. International Journal of Remote Sensing 29, 6957–6969.

Roganov, G.V., 1976. Tectonics of the eastern part of the Mongol-Okhotsk fold geosynclinal region. Unpublished doctoral dissertation, University of Khabarovsk, 23 pp. (in Russian).

Rogers, J.J.W., Santosh, M., 2003. Supercontinents in Earth history, Gondwana Research 6, 357–368.

Rojas-Agramonte, Y., Kröner, A., Demoux, A., Xia, X., Wang, W., Donskaya, T., Liu, D., Sun, M., 2011. Detrital and xenocrystic zircon ages from Neoproterozoic to Paleozoic arc terranes of Mongolia: Significance for the origin of crustal fragments in the Central Asian Orogenic Belt. Gondwana Research 19, 751–763.

Rojas-Agramonte, Y., Kröner, A., Alexeiev, D.V., Jeffreys, T., Khudoley, A.K., Wong, J., Geng, H., Shu, L., Semiletkin, S.A., Mikolaichuk, A.V., Kiselev, V.V., Yang, J., Seltmann, R., 2014. Detrital and ig-

neous zircon ages for supracrustal rocks of the Kyrgyz Tianshan and palaeogeographic implications, Gondwana Research, in press, doi.org/10.1016/j.gr.2013.09.005.
Rolland, Y., Alexeiev, D.V., Kröner, A., Corsini, M., Loury, C., Moni, P., 2013. Late Palaeozoic to Mesozoic kinematic history of the Talas–Ferghana strike-slip fault (Kyrgyz West Tianshan) as revealed by $^{40}Ar/^{39}Ar$ dating of syn-kinematic white mica. Journal of Asian Earth Sciences, 67–68, 76–92.
Rosen, O.M., Fedorovsky, V.S. 2001. Collisional granitoids and earth crust layering (exemplified by Cenozoic, Paleozoic and Proterozoic systems). Nauchny Mir Publisher, Moscow, pages? (in Russian).
Rotarash, L.A., Gredyushko, E.A., 1974, Formation, history and strutcure of the serpentinitic melange in the Zaisan folded area. Geotektonika, no. 4, 73–79. (in Russian with English abstract).
Rowley, D.B., Raymond, A., Parris, J.T., 1985. Carboniferous paleogeography, phytogeography, and paleoclimate reconstractions. International Coal Geology 5, 7–42.
Rozen, O.M., 2003. Siberian craton: tectonic zonation, the stages of evolution. Geotectonics 3, 3–21 (in Russian).
Rozen, O.M., Fedorovsky, V.S., 2001. Collision Granitoids and Crustal Layering. Nauka Publ. House Mir, Moscow, 188 p. (in Russian).
Rudnev, S.N., Borisov, S.M., Babin, G.A., Levchenkov, O.A., Makeev, A.F., Serov, P.A., Matukov, D.I., Plotkina, Y.V., 2008. Early Paleozoic batholiths in the northern part of the Kuznetsk Alatau: Composition, age, and sources. Petrology 16, 395–419.
Ruzhentsev, C.V., Pospelov, I.I., 1992. The South Mongolian Variscan fold system. Geotektonika 5, 45–62 (in Russian).
Ruzhentsev, C.V., Pospelov, I.I., Badarch, G., 1989. Tectonics of Mongolian Indosinides. Geotektonika 6, 13–27 (in Russian).
Ruzhentsev, S.V., Mossakovskiy, A.A., 1996. Geodynamics and tectonic evolution of the Central Asian Paleozoic structures as the result of the interaction between the Pacific and Indo-Atlantic segments of the Earth. Geotectonics, 29, 294–311.
Ruzhentsev, S.V., Nekrasov, G.E., 2009. Tectonics of the Aga zone, Mongolia-Okhotsk belt. Geotectonics 43, 34–50.
Ruzhentsev, S.V., Nekrasov, G.Ye., 2009. Tectonics of the Aginskiy zone (Transbaikal region). Geotektonika 1, 39–58 (in Russian).
Ruzhentsev, S.V., Badarch, G., Voznesenskaya, T.A., 1985. Tectonics of the Trans-Altai zone of Mongolia (Gurvansaykhan and Dzolen ranges). Geotectonics 19, 276–284.
Ruzhentsev, S.V., Aristov, V.A., Minina, O.R., Katyukha, Yu.P., Golionko, B.G., 2005. Tectonics of the Ikat–Bagdara and Dzhida zones of Western Transbaikalia. In: Aspects of Central Asian Tectonics. Geos Publisher, Moscow, pp. 171–198 (in Russian).
Ruzhentsev, S.V., Aristov, V.A., Minina, O.R., Golionko, B.G., Nekrasov, G.E., 2007. Hercynides of the Ikat-Bagdarin zone in Transbaikalia. Doklady Earth Sciences 417, 1198–1201.
Ruzhentsev, S.V., Minina, O.R., Aristov, V.A., Golionko, B.G., Larionov, A.N., Lykhin, D.A., Nekrasov, G.E., 2010. Geodynamics of the Eravna zone (Uda-Vitim fold system of the Transbaikal region): Geological and geochronological data. Doklady Earth Sciences 434, 1168–1171.
Ruzhentsev, S.V., Minina, O.R., Nekrasov, G.E., Aristov, V.A., Golionko, B.G., Doronina, N.A., Lykhin, D.A., 2012. The Baikal-Vitim Fold System: Structure and geodynamic evolution. Geotectonics 46, 87–110.
Ryabinin, A.B., Buslov, M.M., Zhimulev, F.I., Travin, A.V., 2011. The late Paleozoic fold-thrust structure of the Tunka Goltsy. East Sayan, Russian Geology and Geophysics 52, 1605–1623.
Ryazantsev, A.V., Degtyarev, K.E., Kotov, A.B., Sal'nikova, E.B., Anisimova, I.V., Yakovleva, S.Z., 2009. Ophiolite sections of the Dzhalair-Nayman zone, South Kazakhstan: Their structure and age substantiation. Doklady Earth Sciences, 427A, 902–906.
Rybin, A.K., 2011. Deep structure and the modern geodynamics of the Central Tien-Shan, after results of magneto-telluric investigations. Nauchniy mir, Moscow, 232 pp. (in Russian).
Rytsk, E.Y., Neimark, L.A., Amelin, Yu.V., 1998. Paleozoic Granitoids in the Northern Part of the Baikalian Orogenic Area: Age and Past Geodynamic Settings. Geotectonics 32, 379–393.
Rytsk, E.Y., Sal'nikova, E.B., Kovach, V.P., Glebovitskii, V.A., Skopintsev, V.G., Kotov, A.B., Gusev, Yu.P., Yakovleva, S.Z., Fedoseenko, A.M., Plotkina, Yu.V., 2000. Upper age boundary of the Oka Group (Eastern Sayan). Doklady Earth Sciences 374, 1080–1083.

Rytsk, E.Y., Amelin, Y.V., Rizvanov, N.G., Krymski, R.S., Shalaev, V.S., Mitrofanov, G.L., Mitrofanova, N.N., Perelyaev, V.I., Shalaev ,V.S., 2001. Age of rocks in the Baikal-Muya foldbelt. Stratigraphy and Geological Correlation 9, 315–326.

Rytsk, E.Y., Kovach, V.P., Kovalenko,V.I., 2007a. Structure and evolution of the continental crust in the Baikal Fold Region. Geotectonics 41, 440–464.

Rytsk, E.Y., Kovach, V.P., Yarmolyuk, V.V., Kovalenko,V.I., 2007b. Isotopic provinces and formation stages of the continental crust in the Baikal-Muya Belt: Sm-Nd isotopic evidence for granitic and silicic volcanic rocks. Doklady Earth Sciences 416, 1100–1104.

Rytsk, E.Y., Kovach, V.P., Yarmoluyk, V.V., Kovalenko, V.I., Bogomolov, E.S., 2008. Sources of rocks and evolution of continental crust in Barguzin-Vitim superterrane structures. In: Sklyarov, E.V. (Ed.), Geodynamic evolution of lithosphere in the Central Asian mobile belt (from ocean to continent). Izd. Instituta Zemnoi Kory, Irkutsk, Issure 6, vol. 2, pp. 74–77 (in Russian).

Rytsk, E.Y., Kovach, V.P., Makeev, A.F., Bogomolov, E.S., Rizvanova, N.G., 2009. The eastern boundary of the Baikal collisional belt: Geological, geochronological, and Nd isotopic evidence. Geotectonics 43, 264–273.

Rytsk, E.Y., Kovach, V.P., Yarmolyuk, V.V., Kovalenko, V.I., Bogomolov, E.S., Kotov, A.B., 2011. Isotopic Structure and Evolution of the Continental Crust in the East Transbaikalian Segment of the Central Asian Foldbelt. Geotectonics 45, 349–377.

Sabitova, T.M., Lesik, O.M., Adamova, A.A., 1998. Velocity and density heterogenesis of the Tien-Shan lithosphere. Pure and Applied Geophysics 151, 539–548.

Safonova, I., Seltman, R., Gladkochub, D., Kim, J., Komiya, T., Kroener, A., Schulmann, K., Sun, M., Xiao, W., 2011. A new concept of continental construction in the Central Asian orogenic belt (compared to actualistic examples from the Western Pacific). Episodes, 34, 186–196.

Safonova, I.Y., 2009. Intraplate magmatism and oceanic plate stratigraphy of the Paleo-Asian and Paleo-Pacific Oceans from 600 to 140 Ma. Ore Geology Reviews 35, 137–154.

Safonova, I.Y., Buslov, M.M., Kokh, D.A., 2004a. Paleoasian oceanic crust fragments in Gorny Altai and Eastern Kazakhstan: geochemistry and structural position. Liosfera 3, 84–96.

Safonova, I.Y., Buslov, M.M., Iwata, K., Kokh, D.A., 2004b. Fragments of Vendian–Early Carboniferous oceanic crust of the Paleo-Asian Ocean in foldbelts of the Altai–Sayan region of Central Asia: Geochemistry, biostratigraphy and structural setting. Gondwana Research 7, 771–790.

Safonova, I.Y., Simonov, V.A., Buslov, M.M., Ota, T., Maruyama, S., 2008. Neoproterozoic basalts of the Paleo-Asian Ocean (Kurai accretionary zone, Gorny Altai, Russia): Geochemistry, petrogenesis, and geodynamics. Russian Geology and Geophysics 49, 254–271.

Safonova, I.Y., Utsunomiya, A., Kojima, S., Nakae, S., Tomurtogoo, O., Filippov, A.N., Koizumi, K., 2009. Pacific superplume-related oceanic basalts hosted by accretionary complexes of Central Asia, Russian Far East and Japan. Gondwana Research 16, 587–608.

Safonova, I.Y., Buslov, M.M., Simonov, V.A., Izokh, A.E., Komiya, T., Kurganskaya, E.V., Ohno, T., 2011. Geochemistry, petrogenesis and geodynamic origin of basalts from the Katun' accretionary complex of Gorny Altai (southwestern Siberia). Russ. Geol. Geophys. 52, 421–442.

Salnikova, E.B., Sergeev, S.A., Kotov, A.B., Yakovleva, S.Z., Steiger, R.H., Reznitskiy, L.Z., Vasil'ev, E.P., 1998. U-Pb zircon dating of granulite metamorphism in the Sludyanskiy complex, eastern Siberia. Gondwana Research 1, 195–205.

Salnikova, E.B., Kozakov, I.K., Kotov, A.B., Kroner, A., Todt, W., Bibikova, E.V., Nutman, A., Yakovleva, S.Z., Kovach, V.P., 2001. Age of Palaeozoic granites and metamorphism in the Tuvino-Mongolian Massif of the Central Asian Mobile Belt: loss of a Precambrian microcontinent. Precambrian Research 110, 143–164.

Samygin, S., Burtman, V., 2009. Tectonics of the Ural Palaeozoides in comparison with the Tien Shan. Geotectonics 43, 133–151.

Samygin, S.G., 1974. The Chingiz strike-slip fault and its role in the structure of the central Kazakhstan. Nauka Publisher, Moscow. 204 p. (in Russian).

Samygin, S.G., Kheraskova, T.N., 1994. Formations and sedimentary environments of the early Paleozoic active margin (Chingiz range, Central Kazakhstan). Lithology and Mineral Resources 3, 86–102 (in Russian).

Sandiford, M., Hand, M., 1998. Controls on the locus of intraplate deformation in central Australia. Earth and Planetary Science Letters 162, 97–110.

Sano, H., Kanmera, K., 1991. Collapse of ancient oceanic reef complex – what happened during collision of Akiyoshi reef complex? – Sequence of collisional collapse and generation of collapse products. Journal of the Geological Society of Japan 97, 631–644.

Savel'ev, A.A., Astrakhantsev, O.V., Knipper, A.L., Sharas'kin, G.N., Savel'eva, G.N., 1998. Structure and deformation stages of the northern termination of the Magnitogorsk zone of the Urals. Geotektonika 3, 38–50.

Savel'eva, V.B., Travin, A.V., Zyryanov, A.S., 2003. The ^{40}Ar–^{39}Ar dating of metasomatic rocks in deep fault zones of the marginal suture of the Siberian Platform. Doklady Earth Sciences 391, 862–865.

Savel'eva, V.B., Kostitsyn, Yu.A., Travin, A.V., Ponomarchuk, V.A., Moshchenko,A.S., 2006. Geochemistry and Rb–Sr age of graphite-bearing granitoids in the southeast of the Main Sayan Fault. Russian Geology and Geophysics 47, 218–236.

Savel'eva, V.B., Larionov, A.N., Travin, A.V., 2010. Age and geodynamic setting of granitoids in the southeastern Main Sayan Fault. In: Geodynamic evolution of the lithosphere of the Central Asian Mobile Belt (from ocean to continent). Institute of the Earth's Crust, Siberian Branch, Russian Academy of Sciences, Irkutsk, vol. 2, pp. 64–66 (in Russian).

Schwartz, S.Y., Van der Voo, R., 1983. Palaeomagnetic evaluation of the orocline hypothesis in the central and southern Appalachians. Geophysical Research Letters 10, 505–508.

Scrynnik, L.I., 2003. The post-Silurian tectonic history of the South-Eastern Kazakhstan. Geotectonics 3, 65–78 (in Russian).

Seliverstov, K.V., Ghes', M.D., 2001. Petrochemistry of igneous rocks and main parameters of the Middle Carboniferous – Early Permian subduction of the Turkestan ocean. Geology and Geophysics 42, 1471–1475 (in Russian).

Seltmann, R., Konopelko, D., Biske, G., Divaev, F., Sergeev, S., 2011. Hercynian post-collisional magmatism in the context of Paleozoic magmatic evolution of the Tien Shan orogenic belt. Journal of Asian Earth Sciences 42, 821–838.

Şengör, A.M.C., Natal'in, B.A., 1996. Palaeotectonics of Asia: Fragments of a synthesis. In: Yin, A., Harrison, T.M. (Eds.), The tectonic evolution of Asia. Cambridge University Press, Cambridge, pp. 486–640.

Şengör, A.M.C., Natal'in, B.A., 2007. Eduard Suess and the Altaids: What is in a name? In: Seltmann, R., Borisenko, A., Fedoseev, G. (eds.) Magmatism and metallogeny of the Altai and adjacent large igneous provinces with an introductory essay on the Altaids. IAGOD Guidebook Series, 16. CERCAMS/NHM, London, 187–294.

Şengör, A.M.C., Natal'In, B.A., Burtman, V.S., 1993. Evolution of the Altaid tectonic collage and Palaeozoic crustal growth in Eurasia. Nature 364, 299–307.

Şengör, A.M.C., Natal'in, B.A., Burtman, V.S., 1994. Tectonic evolution of the Altaids. Russian Geology and Geophysics 35, 33–47.

Şengör, A., Natal'in, B., Sunal, G., Van der Voo, R., 2014. A new look at the Altaids: A superorogenic complex in Northern and Central Asia as a factory of continental crust. Part I: Geological data compilation (exclusive of palaeomagnetic observations). Austrian Journal of Earth Sciences 107/1, 168–232.

Serykh, 1996. Granitic rocks of central Kazakhstan. In: Shatov, V.V., Seltmann, R., Kremenetsky, A., Lehmann, B., Popov, V., Ermolov, P. (eds.), Granite-related ore deposits of central Kazakhstan and adjacent areas. Glagol Publishing House, St. Petersburg, pp. 25–54.

Shadaev, M.G., Posokhov, V.F., Drubetskoi, E.R., 1992. New data on age of the Ichetui suite in Western Transbaikalia: Rb-Sr and K-Ar data. Geologia i Geofizika 33, 41–44.

Shadaev, M.G., Khubanov, V.B., Posokhov, V.F., 2005. New data on the Rb-Sr age of dike belts in western Transbaikalia. Russian Geology and Geophysics 46, 707–715.

Shao, J., 1989. Continental crust accretion and tectono-magmatic activity at the northern margin of the Sino-Korean Plate. J. Southeast Asian Earth Sci. 3, 57–62.

Shao, J.A., Tang, K.D., 1995. Terranes in northeast China and evolution of northeast Asia continental margin (in Chinese). Seismic Press, Beijing, 185 pp.

Shao, J.A., Tang, K.D., Zhan, L.P., 1995. Reconstruction of an ancient continental margin and its implication: new progress on the study of geology of Yanbian region, northeast China. Science in China (Series B) 25, 548–555.

Shatagin, K.N., Degtyarev, K.Ye., Golubev, V.N., Astrakhantsev, O.V., Kuznetsov, N.B., 2001. Vertical and lateral heterogeneity of the crust beneath North Kazakhstan from geochronological and isotope-geochemical data on Paleozoic granitoids. Geotectonica 5, 26–44 (in Russian).

Shatov, V.V., Seltmann, R., Kremenetsky, A., Lehmann, B., Popov, V., Ermolov, P. (eds.), 1996. Granite-related ore deposits of Central Kazakhstan and adjacent areas. Glagol Publishing House, St. Petersburg, 396 p.

Shatsky, N.S., 1938. On the tectonics of Central Kazakhstan. Proceedings of the Academy of Sciences of the USSR, ser. Geology, 5–6, 737–769 (in Russian).

Shatsky, V.S., Jagoutz, E., Sobolev, N.V., Kozmenko, O.A., Parkhomenko, V.S., Troesch, M., 1999. Geochemistry and age of ultrahigh pressure metamorphic rocks from the Kokchetav massif (northern Kazakhstan). Contributions to Mineralogy and Petrology 137, 185–205.

Shayakubov, T.Sh. (ed.), 1998. Geological map of Uzbekistan at scale 1:500000. Institute of Mineral Resources, Tashkent.

Shayakubov, T.Sh., Dalimov, T.N. (eds.), 1998. Geology and minerals of the Republic of Uzbekistan. University of Usbekistan, Tashkent, 723 p. (in Russian).

Shergina, Yu.P., Murina, G.A., Kozubova, L.A., Lebedev, P.B., 1979. Age and some genetic features of the Kunaley complex rocks of Western Transbaikalia based on Rb-Sr method. Doklady Akademii Nauk SSSR 246, 1199–1202 (in Russian).

Shervais, J.W., 2001. Birth, death and resurrection: the life cycle of suprasubduction zone ophiolites. Geochemistry, Geophysics, Geosystems 2, paper number 2000GC000080, 45 p.

Shevchenko, B.F., Kaplyn, V.B., 2007. The deep geodynamic model of the Euroasian and Amur lithosperic plates junction area. Litosphera 4, 3–20 (in Russian).

Shi, G.R., Zhan L.P., 1996. A mixed mid-Permian marine fauna from the Yanji area, northeastern China: a paleobiogeographical reinterpretation. The Island Arc 5, 385–395.

Shi, G., Liu, D., Zhang, F., Jian, P., Miao, L., Shi, Y., Tao, H., 2003. SHRIMP U-Pb zircon geochronology and its implications on the Xilin Gol Complex, Inner Mongolia, China. Chinese Sci.Bull. 48, 2742–2748.

Shkol'nik, S.I., Reznitskii, L.Z., Belichenko, V.G., Barash, I.G., 2009. Geochemistry, petrogenesis, and geodynamic typification of metavolcanics of the Tunka terrane (Baikal-Hovsgol region). Russian Geology and Geophysics 50, 779–788.

Shkol'nik, S.I., Reznitsky, L.Z., Barash, I.G., 2011. Possibility of Identification of Back-Arc Paleobasins from High-Grade Orthometamorphite Rocks: Evidence from Basic Crystalline Schists of the Slyudyanka Crystalline Complex, South Baikal Region. Geochemistry International 49, 1177–1194.

Shu, L., Charvet, J., Lu, H., Laurent, C.S., 2002. Paleozoic accretion-collision events and kinematics of ductile deformation in the eastern part of the southern Central Tianshan belt, China. Acta Geologica Sinica 76, 308–323.

Shvanov, V.N., 1983. Lithology and formation correlation of clastic and metamorphic rocks of Southern Tien-Shan. Leningrad University, Leningrad, 216 pp. (in Russian).

Simonov, V.A., Dobretsov, N.L., Buslov, M.M., 1994. Boninite series in structures of the Paleo-Asian ocean. Russian Geology and Geophysics 35, 182–199.

Sisson, V.B., Pavlis, T.L., Roeske, S.M., Thorkelson, D.J., 2003. Introduction: an overview of ridge-trench interactions in modern and ancient settings. In: Sisson, V.B., Roeske, S.M., Pavlis, T.L. (eds.), Geology of a transpressional orogen developed during ridge-trench interaction along the North Pacific Margin. Geological Society of America, Special Papers 371, 1–18.

Sklyarov, E.V., 1990. Ophiolites and blueschists of southeast Sayan. First international symposium on geodynamic evolution and main sutures of Central Asia. IGCP Project 283. Guidebook for excursion. Ulan-Ude, 57 p.

Sklyarov, E.V., Postnikov, A.A., 1990. The Khugein high-pressure belt of northern Mongolia. Transactions (Doklady) of the Russian Academy of Sciences 315, 950–954 (in Russian).

Sklyarov, E.V., Mazukabzov, A.M., Donskaya, T.V., Doronina, N.A., Shafeev, A.A., 1994. Metamorphic core complexes of the Zagan Range (Transbaikalia). Doklady Earth Sciences 339, 83–86.

Sklyarov, E.V., Postnikov, A.A., Posokhov, V.F., 1996. Structural setting, metamorphism and petrology of the Hugein Group (northern Mongolia). Russian Geology and Geophysics 37, 69–78.

Sklyarov, E.V., Mazukabzov, A.M., Mel'nikov, A.I., 1997. Metamorphic core complexes of the Cordilleran type. Izd. SO RAN, NITs OIGGM, Novosibirsk, 182 p. (in Russian).

Sklyarov, E.V., Fedorovskii, V.S., Gladkochub, D.P., Vladimirov, A.G., 2001. Synmetamorphic Basic Dikes As Indicators of Collision Structure Collapse in the Western Baikal Region. Dokl. Earth Sci. 381, 1028–1033.

Sklyarov, E.V., Fedorovsky, V.S., Kotov, A.B., Lavrenchuk, A.V., Mazukabzov, A.M., Levitsky, V.I., Sal'nikova, E.B., Starikova, A.E., Yakovleva, S.Z., Anisimova, I.V., Fedoseenko, A.M., 2009. Carbonatites in collisional settings and pseudo-carbonatites of the Early Paleozoic Ol'khon collisional system. Russian Geology and Geophysics 50, 1091–1106.

Slautsitais, I.P., 1971. Palaeomagnetic directions and pole positions. Data for the USSR – Issue 1, Soviet Geophysical Committee: World Data Center-B (Moscow), (in Russian).
Smelov, A.P., Timofeev, V.F., 2003. Terreynovy analysis and geodynamic model of the North Asian craton in the Early Precambrian. Pacific Geology 22 (6), 42–54 (in Russian).
Smethurst, M.A., Khramov, A.N., Torsvik, T.H., 1998. The Neoproterozoic and Palaeozoic paleomagnetic data for the Siberian platform: from Rodinia to Pangea. Earth-Science Reviews 43 (1), 1–24.
Smirnova, L.V., Theunissen, K., Buslov, M.M., 2002. Formation of the late Paleozoic structure of the Teletsk region: kinematics and dynamics (Gorny Altai–West Sayan junction). Russian Geology and Geophysics 43, 100–113.
Solomovich, L.L., Trifonov, B.A., 2002. Postcollisional granites in the South Tien Shan Variscan collisional belt, Kyrgyzstan. Journal of Asian Earth Sciences 21, 7–21.
Song, B., Niu, B.G., Li, J.Y., Xu, W.X. 1994. Isotope geochronology of granitoids in Mudanjiang-Jixi area. Acta Petrologica et Mineralogica 13, 204–213 (in Chinese with English abstract).
Song, T.G., 1997. Inversion styles in the Songliao Basin (northeast China) and estimation of the degree of inversion. Tectonophysics 283, 173–188.
Sorokin, A.A., 2001. Paleozoic accretionary complexes of the Mongol-Okhotsk fold belt eastern segment. Tikhookeanskaya Geologiya 20, 31–36 (in Russian).
Sorokin, A.A., Kudryashov, N.M., Sorokin, A.P., 2002. Fragments of Paleozoic active margins at the Southern periphery of the Mongolia–Okhotsk Fold belt: Evidence from the Northeastern Argun terrane, Amur River Region. Doklady Earth Sciences 387, 1038–1042.
Sorokin, A.A., Kudryashov, N.M., Li, J.Y., Zhuravlev, D.Z., Pin, Y., Sun, G.H., Gao, L.M., 2004. Early Paleozoic granitoids in the eastern margin of the Argun' terrane, Amur area: first geochemical and geochronologic data. Petrology 12, 367–376.
Sorokin, A.A., Kotov, A.B., Kudryashov, N.M., Salnikova, Ye.B., 2004a. Geochronology of granitoid and gabbro-tonalite complexes of the eastern segment, Mongol-Okhotsk fold belt and its framing as boundary conditions for geodynamic reconstructions. In: Geodynamic evolution of the lithosphere of the Central Asian mobile belt (from ocean to continent). Materials of the meeting. Irkutsk. 2, 106–110 (in Russian).
Sorokin, A.A., Yarmolyuk, V.V., Kotov, A.B., Sorokin, A.P., Kudryashov, M.N., Li, J., 2004b. Geochronology of Triassic-Jurassic granitoids of the Mongol-Okhotsk fold belt southern framing, and the problem of Early Mesozoic granite formation of Central and East Asia. Doklady AN 399, 227–231 (in Russian).
Sorokin, A.A., Kotov, A.B., Salnikova, Ye.B., Kudryashov, N.M., 2005. Alien blocks in the structure of the Mongol-Okhotsk fold belt eastern segment. In: Geodynamic evolution of the lithosphere of the Central Asian mobile belt (from ocean to continent). Materials of the meeting Irkutsk 2, 107–110 (in Russian).
Sorokin, A.A., Kotov, A.B., Sal'nikova, E.B., Kudryashov, N.M., Kovach, V.P., 2007. Early Paleozoic gabbro-granitoid associations in Eastern segment of the Mongolian–Okhotsk fold belt (Amur river basin): age and tectonic position. Stratigraphy and Geological Correlation 15, 241–257.
Sorokin, A.A., Kotov, A.B., Sal'nikova, E.B., Kudryashov, N.M., Anisimova, I.V., Yakovleva, S.Z., Fedoseenko, A.M., 2010a. Granitoids of the Tyrma–Bureya complex in the northern Bureya–Jiamusi superterrane of the Central Asian fold belt: age and geodynamic setting. Russian Geology and Geophysics 51, 429–437.
Sorokin, A.A., Kotov, A.B., Sal'nikova, E.B., Sorokin, A.P., Yakovleva, S.Z., Fedoseenko, A.M., Plotkina, Yu.V., 2010b. First Data on the Age of Early Paleozoic Granitoids from the Malyi Khingan Terrane of the Central Asian Fold Belt. Doklady Earth Sciences 431, 299–303.
Sorokin, A.A., Kotov, A.B., Sal'nikova, E.B., Kudryashov, N.M., Velikoslavinskii, S.D., Yakovleva, S.Z., Fedoseenko, A.M., Plotkina, Y.V., 2011a. Early Paleozoic granitids in the Lesser Khingan Terrane, Central Asian Foldbelt: age, geochemistry, and geodynamic interpretations. Petrology 19, 601–617.
Sorokin, A.A., Smirnov, Yu.V., Smirnova, Yu.N., Kudryashov, N.M., 2011b. First Data on Age of Metarhyolites from the Turan Group of the Bureya Terrane, Eastern Part of the Central Asian Foldbelt. Doklady Earth Sciences 439, 370–375.
Sovetov, J.K., Kulikova, A.E., Medvedev, M.N., 2007. Sedimentary basins in the southwestern Siberian craton: Late Neoproterozoic-Early Cambrian rifting and collisional events. In: Linnemann, U., Nance, R.D., Kraft, P., Zulauf, G. (eds.), The Evolution of the Rheic Ocean: From Avalonian-Cadomian Active Margin to Alleghenian-Variscan Collision. Geol. Soc. Am., Spec. Pap. 423, pp. 549–578.

Stampfli, G.M., Borel, G.D., 2002: A plate tectonic model for the Paleozoic and Mesozoic constrained by dynamic plate boundaries and restored synthetic oceanic isochrons. Earth Planet. Sci. Lett. 196, 17–33.
Stampfli, G.M., Borel, G.D., Machant, R., Mosar, J., 2002. Western Alps geological constraints on western Tethyan reconstructions, Journal of the Virtual Explorer 8, 77–106.
State Geologic map of the Russian Federation, scale 1:1,000,000, 3rd ed., 2007. Aldan-Stanovoy series. Sheet M-50 (Borzya). Explanatory Note. VSEGEI Publishing House (in Russian).
Stepanets, V.G., Yermolov, P.Ye, 2008. Isotopic age and genesis of zyrcons in mafic-ultramafic of the ophiolites (example of Tolpak Mountains, Central Kazakhstan). In: Problems of Mineralogy, Petrography and Mineral Resources 11, Permian University, Perm, Russia, 170–176.
Stipska, P., Schulmann, K., Lehmann, J., Corsini, M., Lexa, O., Tomurhuu, D., 2010. Early Cambrian eclogites in SW Mongolia: evidence that the Palaeo-Asian Ocean suture extends further east than expected. J. Metam. Geol. 28, 915–933.
Stix, J., 1991. Subaqueous, intermediate to silicic-composition explosive volcanism: a review. Earth-Science Reviews 31, 21–53.
Stupak, F.M., 1999. New data on the geology, age and tectonics of Early Mesozoic volcanogenic formations, Northern Transbaikal region. Doklady Earth Sciences 369A, 1240–1243.
Stupakov, S.I., Volkova, N.I., Travin, A.V., Simonov, V.A., Sakiyev, K.S., Novgorodtsev, O.S., 2004. Eclogites of the Atbashi range as indicators of the Early Carboniferous collision in the Southern Tian-Shan. Petrology of magmatic and metamorphic formations 4, 272–277, Tomsk (in Russian).
Suess, E., 1901. Das Antlitz der Erde. Dritter Band, erste Hälfte. F. Tempsky, Prag und Wien, and G. Freitag, Leipzig, IY + 508 pp.
Suess, E., 1908. The Face of the Earth, vol. III. Clarendon Press, Oxford, viii + 400 p.
Sui, Z.M., Ge, W.C., Wu, F.Y., Zhang, J.H., Xu, X.C., Cheng, R.Y., 2007. Zircon U–Pb ages, geochemistry and its petrogenesis of Jurassic granites in northwestern part of the Da Hinggan Mts. Acta Petrologica Sinica 23, 461–480 (in Chinese with English abstract).
Sukhorukov, V.P., Travin, A.V., Fedorovsky, V.S., Yudin, D.S., 2005. The age of shear deformations in the Ol'khon region, western Cisbaikalia (from results of Ar-40/Ar-39 dating). Russian Geology and Geophysics 46, 567–571.
Sun, M., Yuan, C., Xiao, W., Long, X., Xia, X., Zhao, G., Lin, S.,Wu, F., Kröner, A., 2008. Zircon U–Pb and Hf isotopic study of gneissic rocks from the Chinese Altai: Progressive accretionary history in the early to middle Palaeozoic. Chemical Geology 247, 352–383.
Svyazhina, I.A., 1971. Palaeomagnetic directions and pole positions. Data for the USSR – Issue 7, Soviet Geophysical Committee: World Data Center-B (Moscow) (in Russian).
Tagiri, M., Yang, T., Bakirov, A., Nakajima, T., Uchiumi, S. 1995. Mineral paragenesis and metamorphic P-T paths of ultrahigh-pressure eclogites from Kyrgyzstan Tien Shan. Island Arc 4, 280–292.
Taira, A., Byrne, T., Ashi, J.,1992. Photographic atlas of an accretionary prism. Geologic structures of the Shimanto belt, Japan. University of Tokyo Press, 124 p.
Tang, K.D., 1990. Tectonic development of Palaeozoic fold belts at the north margin of the Sino-Korean craton. Tectonics 9, 249–260.
Tang, K.D., Wang, Y., He, G.Q., Shao, J.A., 1995. Continental-margin structure of Northeast China and its adjacent areas. Acta Geologica Sinica 69, 16–30.
Tapponnier, P., Molnar, P., 1979. Active faulting and Cenozoic tectonics of the Tien Shan, Mongolia, and Baykal regions. Journal of Geophysical Research 84, 3425–3459.
Tapponnier, P., Peltzer, G., Le Dain, A.Y., Armijo, R., Cobbold, P., 1982. Propagating extrusion tectonics in Asia: new insights from simple experiments with plasticine. Geology 10, 611–616.
Taylor, T.R., Dewey, J.F., Monastero, F.C., 2008. Transtensional deformation of the brittle crust: Field observations and theoretical applications in the Coso-China Lake region, eastern margin of the Sierra Nevada microplate, southeastern California. International Geology Review 50, 218–244.
Terleev, A.A., 1991. Stratigraphy of Vendian-Cambrian sediments of the Katun' anticline (Gorny Altai). In: Khomentovsky, V.V. (ed.), Late Precambrian and early Paleozoic of Siberia. United Institute of Geology, Geophysics and Mineralogy, Siberian Branch, Russian Academy of Sciences, Novosibirsk, p. 82–106 (in Russian).
Thatcher, W., 2009. How the continents deform: The evidence from tectonic geodesy. Annual Reviews of Earth and Planetary Sciences 37, 237–262.
The Paleogeographic Atlas of Northern Eurasia, 1988. Institute of Tectonics of Lithosphere Plates Russian Academy of Natural Sciences, Moscow (on CD).

Tolmacheva, T.J., Degtyarev, K.E., Samuelsson, J., Holmer, L.E., 2008. Middle Cambrian to Lower Ordovician faunas from the Chingiz Mountain Range, central Kazakhstan. Alcheringa 32, 443–463.

Tomurtogoo, O., 1997. Ophiolites and the formation of fold areas of Mongolia. Unpublished D.Sc. thesis, Geological Institute, Russian Academy of Sciences, Moscow, 59 pp. (in Russian).

Tomurtogoo, O., 1999. Geological Map of Mongolia, 1: 1,000,000. Mongolian Academy of Sciences, Institute of Geology and Mineral Resources.

Tomurtogoo, O., Windley, B.F., Kröner, A., Badarch, G., Liu, D.Y., 2005. Zircon age and occurrence of the Adaatsag ophiolite and Muron shear zone, Central Mongolia: constraints on the evolution of the Mongol-Okhotsk ocean, suture and orogen. Journal of the Geological Society of London 162, 125–134.

Torsvik, T.H., Cocks, L.R.M., 2004. Earth geography from 400 to 250 Ma: a palaeomagnetic, faunal and facies review. J. Geol. Soc. Lond. 161, 555–572.

Torsvik, T.H., Smethurst, M.A., 1999. Plate Tectonic modeling: Virtual Reality with GMAP. Computer & Geosciences 25, 395–402.

Torsvik, T.H., Van der Voo, R., Preeden, U., Mac Niocaill, C., Steinberger, B., Doubrovine, P.V., van Hinsbergen, D.J.J., Domeier, M., Gaina, C., Tohver, E., Meert, J.G., McCausland, P.J.A., Cocks, L.R.M., 2012. Phanerozoic polar wander, palaeogeography and dynamics. Earth-Science Reviews 114, 325–368.

Travin, A.V., Boven, A., Plotnikov, A.V., Vladimirov, V.G., Theunissen, K., Vladimirov, A.G., Melnikov, A.I., Titov, A.V., 2001. $^{40}Ar/^{39}Ar$ dating of ductile deformations in the Irtysh Shear Zone, Eastern Kazakhstan. Geochemistry International 12, 1237–1241.

Travin, A.V., Yudin, D.S., Vladimirov, A.G., Khromykh, S.V., Volkova, N.I., Mekhonoshin, A.S., Kolotilina, T.B., 2009. Thermochronology of the Chernorud granulite zone, Ol'khon Region, Western Baikal area. Geochemistry International 47, 1107–1124.

Traynor, J.J., Sladen, C., 1995. Tectonic and stratigraphic evolution of the Mongolian People's Republic and its influence on hydrocarbon geology and potential. Marine and Petroleum Geology 12, 35–52.

Tsygankov, A.A., Matukov, D.I., Berezhnaya, N.G., Larionov, A.N., Posokhov, V.F., Tsyrenov, B.Ts., Khromov, A.A., Sergeev, S.A., 2007. Late Paleozoic granitoids of western Transbaikalia: magma sources and stages of formation. Russian Geology and Geophysics 48, 120–140.

Tsygankov, A.A. Litvinovskiy, B.A., Jahn, B.M., Reikov, M., Liu, D.I., Larionov, A.N., Presniakov, S.L., Lepekhina, E.N., Sergeev, S.A., 2010. Sequence of magmatic events at the Late Paleozoic stage of magmatism in the Transbaikal region (results of U-Pb isotope dating). Geologiya i Geofizika 51, 1249–1276 (in Russian).

Tsygankov, A.A., Litvinovsky, B.A., Jahn, B.M., Reichow, M.K., Liu, D.Y., Larionov, A.N., Presnyakov, S.L., Lepekhina, Ye.N., Sergeev, S.A., 2010. Sequence of magmatic events in the Late Paleozoic of Transbaikalia, Russia (U-Pb isotope data). Russian Geology and Geophysics 51, 972–994.

Turkina, O.M., Nozhkin, A.D., Bayanova, T.B., Dmitrieva, N.V., Travin, A.V., 2007. Precambrian terranes in the southwestern framing of the Siberian craton: isotopic provinces, stages of crustal evolution and accretion–collision events. Russian Geology and Geophysics 48, 61–70.

Tursungaziev, B.T., Petrov, O.V., 2008. Geological Map of Kyrgyz Republic at 1: 500 000 scale. National Academy of Sciences of Kyrgyz Republic, Bishkek (in Russian).

Types of magmas and their sources in the history of the Earth, 2006. Rare metal magmatism: rock associations, magma composition and sources, and geodynamic settings of formation. Moscow: IGEM RAN, 2, 280 pp. (in Russian).

Uchio, Y., Isozaki, Y., Ota, T., Utsunomiya, A., Buslov, M.M., Maruyama, S., 2004. The oldest mid-oceanic carbonate buildup complex: Setting and lithofacies of the Vendian (Late Neoproterozoic) Baratal limestone in the Gorny Altai Mountains, Siberia. Proceedings of the Japan Academy, Series B (9), 422–428.

Uchio, Y., Isozaki, Y., Buslov, M.M., Maruyama, S., 2008. Occurrence of phosphatic microfossils in an Ediacaran–Cambrian mid-oceanic paleo-atoll limestone of southern Siberia. Gondwana Research 14, 183–192.

Utsunomiya, A., Jahn, B.M., Ota, T., Safonova, I.Y., 2009. A geochemical and Sr–Nd isotopic study of the Vendian greenstones from Gorny Altai, southern Siberia: Implications for the tectonic setting of the formation of greenstones and the role of oceanic plateaus in accretionary orogen. Lithos 113, 437–453.

Van der Voo, R., 1990. The reliability of paleomagnetic data. Tectonophysics, 184, 1–9.

Van der Voo, R., 2004. Presidential Address: Palaeomagnetism, oroclines, and growth of the continental crust. GSA Today 14, 4.

Van Der Voo, R., Spakman, W., Bijwaard, H., 1999. Mesozoic subducted slabs under Siberia. Nature 397, 246–249.

Van der Voo, R., Levashova, N., Skrinnik, L., Kara, T., Bazhenov, M., 2006. Late orogenic, large-scale rotations in the Tien Shan and adjacent mobile belts in Kyrgyzstan and Kazakhstan. Tectonophysics 426, 335–360.

Vasiliev, E.P., Mazukabzov, A.M., 1977. The paragenesis of shear-related folds in southern surrounding of the Siberian platform. In: The forming of tectonic structures of Eastern Siberia. Nauka Publ. House, Novosibirsk, pp. 30–40 (in Russian).

Vasiliev, E.P., Reznitskii, L.Z., 1988. Tectonic-metamorphic zoning and building of the continental crust of the southern Baikal area and the Khamar-Daban Ridge. In: Evolution of Earth's crust in Precambrian and Paleozoic (Sayan-Baikal folded belt). Nauka Publ. House, Novosibirsk, pp. 71–87 (in Russian).

Vasiliev, E.P., Reznitskii, L.Z., Vishniakov, V.N., Nekrasova, E.I., 1981. The Slyudianka crystalline complex. Nauka Publ. House, Novosibirsk, 196 p. (in Russian).

Vassallo, R., Jolivet, M., Ritz, J.F., Braucher, R., Larroque, C., Sue, C., Todbileg, M., Javkhlanbold, D., 2007a. Uplift age and rates of the Gurvan Bogd system (Gobi-Altay) by apatite fission track analysis. Earth and Planetary Science Letters 259, 333–346.

Vassallo, R., Ritz, J.F., Braucher, R., Jolivet, M., Carretier, S., Larroque, C., Chauvet, A., Sue, C., Todbileg, M., Bourles, D., Arzhannikova, A., Arzhannikov, S., 2007b. Transpressional tectonics and stream terraces of the Gobi-Altay, Mongolia. Tectonics 26, DOI: 10.1029/2006TC002081.

Vaughan, A.P.M., Leat, P.T., Pankhurst, R.J., 2005. Terrane processes at the margins of Gondwana. Geological Society, London, Special Publication 246, 445 p.

Veimarn, A.B., Kuzmin, A.V., Kononova, L.I., Baryshev, V.N., Vorontzova, T.N., 2005. Geological events at the Frasnian/Famennian boundary on the territory of Kazakhstan, Urals and adjacent regions of the Russian plate. CFS Courier Forschungsinstitut Senckenberg 199, 37–50.

Vernikovsky, V.A., Vernikovskaya, A.E., Pease, V.L., 2004. Neoproterozoic orogeny along the margins of Siberia. In: Gee, D.G. (ed.): The Neoproterozoic Timanide Orogen of Eastern Baltica. Geol. Soc. Lond., Mem. 30, pp. 233–247.

Vernikovsky, V.A., Kazansky, A.Y., Matushkin, N.Y., Metelkin, D.V., Sovetov, J.K., 2009. The geodynamic evolution of the folded framing and the western margin of the Siberian craton in the Neoproterozoic: geological, structural, sedimentological, geochronological, and paleomagnetic data. Russ. Geol. Geophys. 50, 380–393.

Vescheva, S.V., Turkina, O.M., Letnikova, E.F., Ronkin, Yu.L., 2008. Geochemical and Sm–Nd isotopic characteristics of the Neoproterozoic terrigenous rocks of the Tuva–Mongolian Massif. Doklady Earth Sciences 418, 155–160.

Vladimirov, A.G., Ponomareva, A.P., Shokalskii, S.P., Khalilov, V.A., Kostitsyn, Yu.A., Ponomarchuk, V.A., Rudnev, S.N., Vystavnoi, S.A., Kruk, N.N., Titov, A.V., 1997. Late Paleozoic–early Mesozoic granitoid magmatism in Altai. Russian Geology and Geophysics 38, 755–770.

Vladimirov, A.G., Kozlov, M.S., Shokal'skii, S.P., Khalilov, V.A., Rudnev, S.N., Kruk, N.N., Vystavnoi, S.A., Borisov, S.M., Berezikov, Y.K., Metsner, A.N., Babin, G.A., Mamlin, A.N., Murzin, O.M., Nazarov, G.V., Makarov, V.A., 2001. Major epochs of intrusive magmatism of Kuznetsk Alatau, Altai, and Kalba (from U–Pb isotope dates). Russian Geology and Geophysics 42, 1157–1178.

Vladimirov, A.G., Khromykh, S.V., Mekhonoshin, A.S., Volkova, N.I., Travin, A.V., Yudin, D.S., Kruk, N.N. 2008. U-Pb dating and Sm-Nd systematics of igneous rocks in the Ol'khon region (Western Baikal Coast). Doklady Earth Sciences 423, 1372–1375.

Vladimirov, V., Melnikov, A., Plotnikov, A., Travin, A., Smirnova, L., Theunissen, K., 1998. The Irtysh shear zone in NE-Kazakhstan: Kinematics and preliminary data on metamorphic conditions and Ar–Ar geochronology. Abstract-volume, Active Tectonic Continental Basin International Conference, Ghent University, 1998, p. 105.

Volkov, V.I., Goltsman, V.I., Arakeliants, M.M. 1997. The age of ultra-acid volcanism in late orogenic depressions of the Chatkal-Kurama zone (Middle Tien-Shan) by isotope dating. Stratigraphy. Geologic correlation, 5, 86–104.

Volkova, N.I., Stupakov, S.I., Simonov, V.A., Tikunov, Yu.V., 2004. Petrology of metabasites from the Terekta Complex as a constituent of ancient accretionary prism of Gorny Altai. J. Asian Earth Sci. 23, 705–713.

Volkova, N.I., Stupakov, S.I., Tret'yakov, G.A., Simonov, V.A., Travin, A.V., Yudin, D.S., 2005. Blueschists from the Uimon Zone as evidence for Ordovician accretionary-collisional events in Gorny Altai. Russian Geology and Geophysics 46, 361–378.

Volkova, N.I., Sklyarov, E.V., 2007. High-pressure complexes of Central Asian Fold Belt: Geologic setting, geochemistry, and geodynamic implications. Russian Geology and Geophysics 48, 83–90.

Volkova, N.I., Tarasova, E.N., Polyanskii, N.V., Vladimirov, A.G., Khomyakov, V.D., 2008. High-pressure rocks in the serpentinite melange of the Chara Zone, Eastern Kazakhstan: Geochemistry, petrology, and age. Geochemistry International 46, 422–437.

Volkova, N.I., Vladimirov, A.G., Travin, A.V., Mekhonoshin, A.S., Khromykh, S.V., Yudin, D.S., Rudnev, S.N., 2010. U-Pb isotopic dating of zircons (SHRIMP-II) from granulites of the Ol'khon region of Western Baikal area. Doklady Earth Sciences 432, 821–824.

Vorontsov, A.A., Ivanov, V.G., Yarmolyuk, V.V., Kuz'min, M.I., Sandimirova, G.P., Smirnov, V.N., 1999. Late Mesozoic bimodal alkaline volcanic association of the Western Transbaikal region and the age of its formation: Geological and geochronological (Rb-Sr and K-Ar) data. Doklady Earth Sciences 369, 1097–1101.

Vorontsov, A.A., Yarmolyuk, V.V., Ivanov, V.G., Nikiforov, A.V., 2002. Late Mesozoic magmatism in the Dzhida sector of the western Transbaikalia rift zone: Evolutionary stages, associations, and sources. Petrology 10, 448–468.

Vorontsov, A.A., Yarmolyuk, V.V., Lukhin, D.A., Dril, S.I., Sandmirova, G.P., 2007. Magmatic sources and geodynamics of the Early Mesozoic Northern Mongolia-Western Transbaikalia rift zone. Petrology 15, 35–57.

Wang, B., Faure, M., Shu, L.S., Cluzel, D., Charvet, J., de Jong, K., Chen, Y., 2008. Paleozoic tectonic evolution of the Yili Block, Western Chinese Tianshan. Bull. de la Soc. Géol. de France 179, 483–490.

Wang, B., Cluzel, D., Shu, L.S., Faure, M., Charvet, J., Chen, Y., Meffre, S., de Jong, K., 2009. Evolution of calc-alkaline to alkaline magmatism through Carboniferous convergence to Permian transcurrent tectonics, western Chinese Tianshan. International Journal of Earth Sciences 98, 1275–1298.

Wang, B., Jahn, B.M., Lo, C.H., Shu, L.S., Wu, C.Y., Li, K.S., Wang, F., 2011. Structural analysis and $^{40}Ar/^{39}Ar$ thermochronology of Proterozoic rocks in Sailimu area (NW China): Implication to polyphase tectonics of the North Chinese Tianshan. Journal of Asian Earth Sciences 42, 839–853.

Wang, C.S., Feng, Z.Q., Zhang, L.M., Huang, Y.J., Cao, K., Wang, P.J., Zhao, B., 2013. Cretaceous paleogeography and paleoclimate and the setting of SKI borehole sites in Songliao Basin, northeast China. Palaeogeography, Palaeoclimatology, Palaeoecology 385, 17–30.

Wang, Q., Liu, X., 1986. Paleoplate tectonics between Cathaysia and Angaraland in Inner Mongolia of China. Tectonics 5, 1073–1088.

Wang, Q., Zhang, P.-Z., Freymueller, J.T., Bilham, R., Larson, K.M., Lai, X., You, X., Niu, Z., Wu, J., Li, Y., Liu, J., Yang, Z., Chen, Q., 2001. Present-day crustal deformation in China constrained by global positioning system measurements. Science 294, 574–577.

Wang, Q., Shu, L., Charvet, J., Faure, M., Ma, H., Natal'in, B.A., Gao, J., Kroener, A., Xiao, W., Li, J., Windley B.F., Yan, C., Glen, R., Jian, P., Zhang, W., Seltmann, R., Wilde, P., Choulet, F., Wan, B., Quinn, C.D., Rojas-Agramonte, Y., Shang, Q.H., Zhang, W., Lin, W., 2010. Understanding and study perspectives on tectonic evolution and crustal structure of the Paleozoic Chinese Tianshan. Episodes 33, 242–266.

Wang, T., Hong, D.W., Jahn, B.M., Tong, Y., Wang, Y.B., Han, B.F., Wang, X.X., 2006. Timing, petrogenesis, and setting of Paleozoic synorogenic intrusions from the Altai Mountains, northwest China: implications for the tectonic evolution of an accretionary orogen. Journal of Geology 114, 735–751.

Wang, T., Zheng, Y., Zhang, J., Zeng, L., Donskaya, T., Guo, L., Li, J., 2011. Pattern and kinematic polarity of late Mesozoic extension in continental NE Asia: perspectives from metamorphic core complexes. Tectonics 30, TC6007, doi: 10.1029/2011TC002896.

Wang, T., Guo, L., Zheng, Y., Donskaya, T., Gladkochub, D., Zeng, L., Li, J., Wang, Y., Mazukabzov, A., 2012. Timing and processes of late Mesozoic mid-lower-crustal extension in continental NE Asia and implications for the tectonic setting of the destruction of the North China Craton: Mainly constrained by zircon U–Pb ages from metamorphic core complexes. Lithos 154, 315–345.

Wang, Y., Zhang, F.Q., Zhang, D.W., Miao, L.C., Li, T.S., Xie, H.Q., Meng, Q.R., Liu, D.Y., 2006. Zircon SHRIMP U–Pb dating of meta-diorite from the basement of the Songliao basin and its geological significance. Chinese Science Bulletin 51, 1877–1883.

Wang, Y., Yuan, C., Long, X., Sun, M., Xiao, W., Zhao, G., Cai, K., Jiang, Y., 2011. Geochemistry, zircon U-Pb ages and Hf isotopes of the Paleozoic volcanic rocks in the northwestern Chinese Altai: Petrogenesis and tectonic implications. J. Asian Earth Sci. 42, 969–985.

Wang, Y.Q. 1996. Pre-Cambrian stratigraphy of Northeastern China. Jilin Geology 15, 1–14.

Watanabe, T., Buslov, M.M., Koitabashi, S., 1994. Comparisons of arc-trench systems in the early Paleozoic Gorny Altai and the Mesozoic-Cenozoic of Japan. Proc. 29th International Geological Congress, Kyoto, Japan, 24 Aug. - 3 Sept., 1992. Part B. Reconstruction of the Paleoasian Ocean. Utrecht, The Netherlands, VSP International Science Publishers, p. 169–186.

Webb, L.E., Graham, S.A., Johnson, C.L., Badarch, G., Hendrix, M.S., 1999. Occurrence, age, and implications of the Yagan-Onch Hayrhan metamorphic core complex, southern Mongolia. Geology 27, 143–146.

Wessel, P., Smith, W., 1998. New, improved version of the Generic Mapping Tools released. EOS Trans. AGU, 79(579).

Wilde, S.A., Dorsett-Bain, H.L., Liu, J.L., 1997. The identification of a Late Pan-African granulite facies event in Northeastern China: SHRIMP U–Pb zircon dating of the Mashan Group at Liu Mao, Heilongjiang Province, China. Proceedings of the 30th IGC: Precambrian Geol. Metamorphic Petrol., VSP International Science Publishers, Amsterdam, 17, pp. 59–74.

Wilde, S.A., Dorsett-Bain, H.L., Lennon R.G., 1999. Geological setting and controls on the development of graphite, sillimanite and phosphate mineralisation within the Jiamusi Massif: An exotic fragment of Gondwanaland located in North-Eastern China? Gondwana Research 2, 21–46.

Wilde, S.A., Zhang, X.Z., Wu, F.Y., 2000. Extension of a newly-identified 500 Ma metamorphic terrain in Northeast China: further U–Pb SHRIMP dating of the Mashan Complex, Heilongjiang Province, China. Tectonophysics 328, 115–130.

Wilde, S.A., Wu, F.Y., Zhang, X.Z., 2001. The Mashan Complex: SHRIMP U–Pb zircon evidence for a Late Pan-African metamorphic event in NE China and its implications for global continental reconstructions. Geochimica 30, 35–50 (in Chinese, with English abstract).

Wilde, S.A., Wu, F.Y., Zhang, X.Z., 2003. Late Pan-African magmatism in Northeastern China: SHRIMP U–Pb zircon evidence for igneous ages from the Mashan Complex. Precambrian Research 122, 311–327.

Wilde, S.A., Wu, F.Y., Zhao, G.C., Sklyarov, E., 2008. The Jiamusi, Khanka and Bureya blocks; a contiguous crustal entity accreted to the Central Asian Orogenic Belt in the Early Jurassic? In: 33rd International Geological Congress, Oslo. Pre-Mesozoic Accretionary Tectonics in Central Asia, Abstracts CD-ROM, ASI-06.

Wilde, S.A., Wu, F.Y., Zhao, G.C., 2010. The Khanka Block, NE China, and its significance to the evolution of the Central Asian Orogenic Belt and continental accretion. In: Kusky, T.M., Zhai, M.G., Xiao, W.J. (eds.), The Evolved Continents: Understanding Processes of Continental Growth. Geological Society of London, Special Publication 338, pp. 117–137.

Wilde, S.A., Zhou J.-B., Wu F.-Y., 2015. Development of the North-Eastern Segment of the Central Asian Orogenic Belt. This volume.

Wilhem, C., Windley, B.F., Stampfli, G.M., 2012. The Altaids of Central Asia: A tectonic and evolutionary innovative review. Earth-Science Reviews 113, 303–341.

Williams, H., Hatcher, R.D., 1982. Suspect terranes and accretionary history of the Appalachian orogen. Geology 10, 530–536.

Windley, B.F., Allen, M.B., Zhang, C., Zhao, Z.Y., Wang, G.R., 1990. Paleozoic accretion and Cenozoic redeformation of the Chinese Tianshan Range, Central Asia. Geology 18, 128–131.

Windley, B.F., Kröner, A., Guo, J., Qu, G., Li, Y., Zhang, C., 2002. Neoproterozoic to Paleozoic geology of the Altai orogen, NW China: new zircon age data and tectonic evolution. J. Geol. 110, 719–737.

Windley, B.F., Alexeiev, D., Xiao, W., Kroener, A., Badarch, G., 2007. Tectonic models for accretion of the Central Asian Orogenic Belt. Journal of the Geological Society 164, 31–47.

Wu, F.Y., Jahn, B.M., Wilde, S.A., Sun, D.Y., 2000. Phanerozoic crustal growth: U-Pb and Sr-Nd isotopic evidence from the granites in northeastern China. Tectonophysics 328, 89–113.

Wu, F.Y., Wilde, S.A., Sun, D.Y., 2001. Zircon SHRIMP ages of gneissic granites in Jiamusi Massif, northeastern China (in Chinese with English abstract). Acta Petrologica Sinica 17, 443–452.

Wu, F.Y., Sun, D.Y., Li, H.M., Jahn, B.M., Wilde, S.A., 2002. A-type granites in Northeastern China: Age and geochemical constraints on their petrogenesis. Chemical Geology 187, 143–173.

Wu, F.Y., Jahn, B.M., Wilde, S.A., Lo, C.H., Yui, T.F., Lin, Q., Ge, W.C., Sun, D.Y., 2003a. Highly fractionated I-type granites in NE China (I): Geochronology and petrogenesis. Lithos 66, 241–273.

Wu, F.Y., Jahn, B.M., Wilde, S.A., Lo, C.H., Yui, T.F., Lin, Q., Ge, W.C., Sun, D.Y., 2003b. Highly fractionated I-type granites in NE China (II): isotopic geochemistry and implications for crustal growth in the Phanerozoic. Lithos 67, 191–204.

Wu, F.Y., Wilde, S.A., Sun, D.Y., Zhang, G.L., 2004. Geochronology and petrogenesis of post-orogenic Cu, Ni-bearing mafic-ultramafic intrusions in Jilin, NE China. Journal of Asian Earth Sciences 23, 781–797.

Wu, F.Y., Lin, J.Q., Wilde, S.A., Sun, D.Y., Yang, J.H., 2005. Nature and significance of the Early Cretaceous giant igneous event in eastern China. Earth and Planetary Science Letters 233, 103–119.

Wu, F.Y., Yang, J.H., Lo, C.H., Wilde, S.A., Sun, D.Y., Jahn, B.M., 2007a. The Heilongjiang Group: a Jurassic accretionary complex in the Jiamusi Massif at the western Pacific margin of northeastern China. The Island Arc 16, 156–172.

Wu, F.Y., Zhao, G.C., Sun, D.Y., Wilde, S.A., Zhang, G.L., 2007b. The Hulan Group: its role in the evolution of the Central Asian Orogenic Belt of NE China. Journal Asian Earth Sciences 30, 542–556.

Wu, F.Y., Sun, D.Y., Ge, W.C., Zhang, Y.B., Grant, M.L., Wilde, S.A., Jahn, B.M., 2011. Geochronology of the Phanerozoic granitoids in northeastern China. Journal of Asian Earth Sciences 41, 1–30.

Xiao, W., Windley, B.F., Hao, J., Zhai, M., 2003. Accretion leading to collision and the Permian Solonker suture, Inner Mongolia, China: Termination of the central Asian orogenic belt. Tectonics 22, 8–1; 1069; doi:10.1029/2002TC001484.

Xiao, W., Windley, B.F., Badarch, G., Sun, S., Li, J., Qin, K., Wang, Z., 2004a. Palaeozoic accretionary and convergent tectonics of the southern Altaids; implications for the growth of Central Asia. Journal of the Geological Society London 161, 339–342.

Xiao, W., Zhang, L., Qin, K., Sun, S., Li, J., 2004b. Paleozoic accretionary and collisional tectonics of the eastern Tianshan (China); implications for the continental growth of Central Asia. Am. J. Sci. 304, 370–395.

Xiao, W., Han, C., Yuan, C., Sun, M., Lin, S., Chen, H., Li, Z., Li, J., Sun, S., 2008. Middle Cambrian to Permian subduction-related accretionary orogenesis of Northern Xinjiang, NW China: Implications for the tectonic evolution of Central Asia. J. Asian Earth Sci. 32. 102–117.

Xiao, W., Windley, B.F., Huang, B.C., Han, C.M., Yuan, C., Chen, H.L., Sun, M., Sun, S., Li, L., 2009a. End-Permian to mid-Triassic termination of the accretionary processes of the southern Altaids: implications for the geodynamic evolution, Phanerozoic continental growth, and metallogeny of Central Asia. International Journal of Earth Sciences 98, 1189–1217; 1219–1220.

Xiao, W., Windley, B.F., Yuan, C., Sun, M., Han, C.M., Lin, S.F., Chen, H.L., Yan, Q.R., Liu, D.Y., Qin, K.Z., Li, J.L., Sun, S., 2009b. Paleozoic multiple subduction-accretion processes of the southern Altaids. Am. J. Sci. 309, 221–270.

Xiao, W., Huang, B., Han, C., Sun, S., Li, J., 2010a. A review of the western part of the Altaids: A key to understanding the architecture of accretionary orogens. Gondwana Research 18, 253–273.

Xiao, W., Mao, Q.G., Windley, B.F., Han, C.M., Qu, J.F., Zhang, J.E., Ao, S.J., Guo, Q.Q., Cleven, N.R., Lin, S.F., Shan, Y.H., Li, J.L., 2010b. Paleozoic multiple accretionary and collisional processes of the Beishan orogenic collage. American Journal of Science 310, 1553–1594.

Xiao, W., Windley, B.F., Allen, M.B., Han, C., 2013. Late Paleozoic multiple accretionary tectonics of the Tianshan Orogenic collage. Gond. Res. 23, 1316–1341.

Xiao, W.J., Windley, B., Hao, J., Zhai, M.G., 2003. Accretion leading to collision and the Permian Solonker suture, Inner Mongolia, China: termination of the Central Asian Orogenic Belt. Tectonics, 2002TC001484.

Xiao, W.J., Zhang, L.-C., Qin, K.-Z., Sun, S., Li, J.-L., 2004. Paleozoic accretionary and collisional tectonics of the eastern Tianshan (China): Implications for the continental growth of Central Asia. American Journal of Science 304, 370–395.

Xiao, X., Gao, J., Tang, Y., Jun, W., Min, Z., 1994. Blueschist belts and their tectonic significance in the orogenic belts, northwestern China. Russian Geology and Geophysics 35, 172–189.

Xu, J., Zhu, G., Tong, W., Cui, K., Liu, Q., 1987. Formation and evolution of the Tancheng-Lujiang wrench fault system: a major shear system to the northwest of the Pacific ocean. Tectonophysics 134, 273–310.

Xu, J.F., Castillo, P.R., Chen, F.R., Niu, H.C., Yu, X.Y., Zhen, Z.P., 2003. Geochemistry of late Paleozoic mafic igneous rocks from the Kuerti area, Xinjiang, northwest China: implications for back-arc mantle evolution. Chem. Geol. 193, 137–154.

Xu, X., Harbert, W., Dril, S., Kravchinksy, V. 1997. New paleomagnetic data from the Mongol–Okhotsk collision zone, Chita region, south–central Russia: implications for Palaeozoic paleogeography of the Mongol–Okhotsk Ocean. Tectonophysics, 269, 113–129.

Yakubchuk, A.S., 1990. Tectonic setting of ophiolite zones in the structure of the central Kazakhstan Paleozoides. Geotectonics 24, 415–425.

Yakubchuk, A.S., 2004. Architecture and mineral deposit settings of the Altaid orogenic collage: a revised model. Journal of Asian Earth Sciences 23, 761–779.
Yakubchuk, A.S., 2008. Re-deciphering the tectonic jigsaw puzzle of nothern Eurasia. Journal of Asian Earth Sciences 32, 82–101.
Yakubchuk, A.S., Degtyarev, K.E., 1994. The remnants of the Paleo-Asian Ocean within Central Kazakhstan. In: Coleman, R.G. (ed.): Reconstruction of the Paleo-Asian Ocean, 29th Intern. Geol. Congr., Kyoto, Japan, part B, pp. 7–24.
Yakubchuk, A.S., Edwards, A.C., 1999. Auriferous Palaeozoic accretionary terranes within the Mongol-Okhotsk suture zone, Russsian Far East. In: Weber, G. (Ed.), Proceedings Pacrim '99. Australasian Institute of Mining and Metallurgy, Publications Series, 347–358.
Yakubchuk, A.S., Cole, A., Seltmann, R., Shatov, V., 2002. Tectonic setting, characteristic, and regional exploration criteria for gold mineralization in tha Altaid orogenic collage: the Tien Shan province as a key example. Society of Economic Geologists, Special Publication 9, 177–201.
Yan, J.Y., Tang, K.D., Bai, J.W., Mo, Y.C., 1989. High pressure metamorphiic rocks and their tectonic environment in northeastern China. Journal of Southeast Asian Earth Sciences 3, 303–313.
Yang, J.H., Wu, F.Y., Wilde, S.A., Belousova, E., Griffin, W.L., 2008. Mesozoic decratonization of the North China block. Geology 36, 467–470.
Yang, T.N., Li, J.Y., Zhang, J., Hou, K.J., 2011. The Altai-Mongolia terrane in the Central Asian Orogenic Belt (CAOB): A peri-Gondwana one? Evidence from zircon U–Pb, Hf isotopes and REE abundances. Precamb. Res. 187, 79–98.
Yang, Z., Cheng, Y., Wang, H., 1986. The geology of China. Oxford University Press, Great Britain.
Yanshin, A., 1965. Tectonic structure of Eurasia. Geotektonika 5, 7–35 (in Russian).
Yarmolyuk, V.V., 1983. Late Paleozoic volcanism of continental riftogenic structures of Central Asia. Moscow, Nauka, 193 pp. (in Russian).
Yarmolyuk, V.V., Kovalenko, V.I., 1991. Rift-originated magmatism of active continental margins and its ore potential. Nauka Publ. House, Moscow, 263 p. (in Russian).
Yarmolyuk, V.V., Kovalenko, V.I., Kotov, A.B., Sal'nikova, E.B., 1997. The Angara–Vitim Batholith: On the Problem of Batholith Geodynamics in the Central Asia Foldbelt. Geotectonics 31, 359–373.
Yarmolyuk, V.V., Ivanov, V.G., Kovalenko, V.L., 1998. Sources of intraplate magmatism of western Transbaikalia in the late Mesozoic-Cenozoic: Trace-element and isotope data. Petrology 6, 101–123.
Yarmolyuk, V.V., Kovalenko, V.I., Kuz'min, M.I., 2000. North Asian Superplume Activity in the Phanerozoic: Magmatism and Geodynamics. Geotectonics 34, 343–366.
Yarmolyuk, V.V., Litvinovsky, B.A., Kovalenko, V.I., Jahn, B.-M., Zanvilevich, A.N., Vorontsov, A.A., Zhuravlev, D.Z., Posokhov, V.F., Kuz'min, D.V., Sandimirova, G.P., 2001. Formation Stages and Sources of the Peralkaline Granitoid Magmatism of the Northern Mongolia–Transbaikalia Rift Belt during the Permian and Triassic. Petrology 9, 302–328.
Yarmolyuk, V.V., Kovalenko, V.I., Sal'nikova, E.B., Budnikov, S.V., Kovach, V.P., Kotov, A.B., Ponomarchuk, V.A., 2002. Tectono-magmatic zoning, magma sources, and geodynamics of the early Mesozoic Mongolia–Transbaikal province. Geotectonics, 36, 293–311.
Yarmolyuk, V.V., Kovalenko, V.I., Kovach, V.P., Rytsk, E.Yu., Kozakov, I.K., Kotov, A.B., Sal'nikova, E.B., 2006. Early stages of the Paleoasian Ocean formation: Results of geochronological, isotopic, and geochemical investigations of Late Riphean and Vendian-Cambrian complexes in the Central Asian Foldbelt. Doklady Earth Sciences 411, 1184–1189.
Yarmolyuk, V.V., Kozakov, I.K., Anisimova, I.V., Sal'nikova, E.B., Kovach, V.P., Kozlovskii, A.M., Plotkina, Yu.V., Yakovleva, S.Z., 2009. Estimation of the age of the ophiolite complex in the Songa uplift of the early Caledonian superterrane in Central Asia. In: Isotope systems and the time of geologic processes. Proceedings of the Fourth Russian Conference on Isotope Geochronology. Institute of Precambrian Geology and Geochronology, Russian Academy of Sciences, St. Petersburg 2, pp. 294–296 (in Russian).
Yarmolyuk, V.V., Kovach, V.P., Kovalenko, V.I., Salnikova, E.B., Kozlovskii, A.M., Kotov, A.B., Yakovleva, S.Z., Fedoseenko, A.M., 2011. Composition, sources, and mechanism of continental crust growth in the Lake Zone of the Central Asian Caledonides: I. Geological and geochronological data. Petrology 19, 55–78.
Ye, H.W., Zhang, X., 1994. The ^{40}Ar–^{39}Ar age of the vein crossite in blueschist in Mudanjiang area NE China and its geological implication. Journal of Changchun University (Earth Science) 24, 369–372 (in Chinese with English abstract).

Ye, H.W., Zhang, X.Z., Zhou, Y.W., 1994. The texture and evolution of Manzhouli-Suifenhe lithosphere-study based on features of blueschist and ophiolites. In: M-SGT geological project group (ed.), Geological study on the texture and evolution of the Manzhouli-Suifenhe geological section in China. Seismic Publishing House, pp. 73–83.

Yefremov, S.V., Kozlov, V.D., Dril, S.I., Sandimirova, G.P., 1998. Geochemical features, genesis and age of Paleozoic granitoids of the Eastern Transbaikal region. In: Metallogeny, oil and gas potential, and geodynamics of the North Asian craton and orogenic belts of its framing. Materials of the II All-Russian metallogenic meeting. Irkutsk, 245–246 (in Russian).

Yermolov, V.P., 2005. The age and composition of Proterozoic and Paleozoic continental crust of the Eastern Kazakhstan and adjacent territories. Proceeding of National Academy of Sciences, Resp. Kazakhstan, Geology ser. 6, 3–14 (in Russian).

Yermolov, V.P., Malchenko, Ye.G., 2003. The age and composition of the Phenerozoic in the continental crust of Kazakhstan. Proceeding of the National Academy of Sciences, Resp. Kazakhstan, Geology ser. 4, 3–15 (in Russian).

Yin, A., 2010. Cenozoic tectonic evolution of Asia: A preliminary synthesis. Tectonophysics 488, 293–325.

Yin, A., Harrison, T.M., 2000. Geologic evolution of the Himalayan-Tibetan orogen. Annual Review of Earth and Planetary Sciences 28, 211–280.

Yin, A., Nie, S., 1993. An indentation model for the North and South China collision and the development of the Tan-Lu and Nonam fault systems, eastern Asia. Tectonics 12, 801–813.

Yolkin, E.A., Sennikov, N.V., Buslov, M.M., Yazikov, A.Y., Gratsianova, R.T., Bakharev, N.K., 1994. Paleogeographic reconstruction of the western Altai-Sayan area in the Ordovician, Silurian and Devonian and their geodynamic interpretation. Russian Geology and Geophysics 35, 100–124.

Yolkin, E.A., Kontorovich, A.E., Bakharev, N.K., Belyaev, S.Yu., Varlamov, A.I., Izokh, N.G., Kanygin, A.V., Kashtanov, V.A., Kirda N.P., Klets, A.G., Kontorovich, V.A., Krasnov, V.I., Krinin, V.A., Moiseev, S.A., Obut, O.T., Saraev, S.V., Sennikov, N.V., Tishchenko, V.M., Filippov, Yu.F., Khomenko, A.V., Khromykh, V.G., 2007. Paleozoic facies megazones in the basement of the West Siberian geosyncline. Russian Geology and Geophysics 48, 491–504.

Yuan, C., Sun, M., Xiao, W., Li, X., Chen, H., Lin, S., Xia, X., Long, X., 2007. Accretionary orogenesis of the Chinese Altai: insights from Paleozoic granitoids. Chemical Geology 242, 22–39.

Yuan, C., Sun, M., Wilde, S.,Xiao, W.J., Xu, Y.G., Long, X.P., Zhao, G.C., 2010. Post-collisional plutons in the Balikun area, East Chinese Tianshan: evolving magmatism in response to extension and slab break-off. Lithos 119, 269–288.

Yudin, D.S., Khromykh, S.V., Mekhonoshin, A.S., Vladimirov, A.G., Travin, A.V., Kolotilina, T.B., Volkova, N.I., 2005. 40Ar/39Ar Age and Geochemical Features of Syncollisional Gabbroids and Granites from the Western Baikal Region: Evidence from the Birkhin Massif and Its Folded Framing. Dokl. Earth Sci. 405, 1261–1266.

Yue, Y., Liou, J.G., Graham, S.A., 2001. Tectonic correlation of Beishan and Inner Mongolia orogens and its implications for the palinspastic reconstruction of North China; Paleozoic and Mesozoic tectonic evolution of central Asia; from continental assembly to intracontinental deformation. Geol. Soc Am. Mem. 194, 101–116.

Zaytsev, Yu. A., 1984. Evolution of geosynclines (oval, concentric type). Nedra Publishers, Moscow, 208 p.

Zhang, C.-L., Li, Z.-X., Li, X.-H., Xu, Y.-G., Zhou, G., Ye, H.-M., 2010. A Permian large igneous province in Tarim and Central Asian orogenic belt, NW China: results of a ca. 275 Ma mantle plume? Geological Society of America Bulletin 122, 2020–2040.

Zhang, C.Y., Zhang, X.Z., Qiu, D.M., 2007. Zircon U–Pb isotopic ages of amphibolite of the Qinglongcun Group in Yanbian area and its geological significance. Journal of Jilin University (Earth Sciences) 37, 672–677 (in Chinese with English abstract).

Zhang, F.Q., Chen, H.L., Yu, X., Dong, C.W., Yang, S.F., Pang, Y.M., Batt, G.E., 2011. Early Cretaceous volcanism in the northern Songliao Basin, NE China and it geodynamic implication. Gondwana Research 19, 163–176.

Zhang, H., Niu, H., Terada, K., Yu, X., Sato, H., Ito, J.I., 2003. Zircon SHRIMP U-Pb dating on plagiogranite from Kuerti Ophiolite in Altay, north Xinjiang. Chinese Sci. Bul. 48, 2231–2235.

Zhang, J.H., Ge, W.C., Wu, F.Y., Wilde, S.A., Yang, J.H., Liu, X.M., 2008. Large-scale Early Cretaceous volcanic events in the northern Great Xing'an Range, Northeastern China. Lithos 102, 138–157.

Zhang, J.H., Gao, S., Ge, W.C., Wu, F.Y., Yang, J.H., Wilde, S.A., Li, M., 2010. Geochronology of the Mesozoic volcanic rocks in the Great Xing'an Range, northeastern China: implications for subduction-induced delamination. Chemical Geology 276, 144–165.

Zhang, K.J., 1997. North and South China collision along the eastern and southern North China margins. Tectonophysics 270, 145–156.

Zhang, K.J., 2004. Granulite xenoliths from Cenozoic basalts in SE China provide geochemical fingerprints to distinguish lower crust terranes from the North and South China tectonic blocks: comment. Lithos 73, 127–134.

Zhang, X.H., Zhang, H.F., Tang, Y.J., Wilde, S.A., 2008. Geochemistry of Permian bimodal volcanic rocks from central Inner Mongolia, North China: Implication for Tectonic setting and Phanerozoic continental growth in Central Asian Orogenic belt. Chemical Geology 249, 262–281.

Zhang, X.Z., 1991. Coexistence of blueschists and greenschists: a new evidence for the tectonic evolution of the Heilongjiang rock series. Journal of Changchun University (Earth Science) 21, 277–282 (in Chinese with English abstract).

Zhang, X.Z., 1992. Heilongjiang mélange: The evidence of Caledonian suture zone of the Jiamusi massif. Journal of Changchun University (Earth Sciences, Special Issue, Doctoral thesis) 22, 94–101 (in Chinese with English abstract).

Zhang, Y.B., Wu, F.Y., Wilde, S.A., Zhai, M.G., Lu, X.P., Sun, D.Y., 2004. Zircon U–Pb ages and tectonic implications of "Early Paleozoic" granitoids at Yanbian, Jilin province, NE China. The Island Arc 13, 484–505.

Zhang, Y.B., Wu, F.Y., Zhai, M.G., Lu, X.P., Zhang, H.F., 2008. Geochronology and Tectonic Implications of the Seluohe Group in the Northern Margin of the North China Craton. International Geology Review 50, 135–153.

Zhang, Y.P., Tang, K.D., 1989. Pre-Jurassic tectonic evolution of intercontinental region and the suture zone between the North China and Siberian platforms. Journal of Southeast Asian Earth Sciences 3, 47–55.

Zhao, C.J., Peng, Y.J., Dang, Z.X., 1996. The Formation and Evolution of Crust in Eastern Jilin and Heilongjiang Provinces. Liaoning University Press, Shenyang, pp. 1–226 (in Chinese with English abstract).

Zhao, G., Wilde, S.A., Cawood, P.A., Sun, M., 2001. Archean blocks and their boundaries in the North China Craton: lithological, geochemical, structural and P–T path constraints and tectonic evolution. Precambrian Research 107, 45–73.

Zhao, G.C., Cawood, P.A., Wilde, S.A., Sun, M., 2002. Review of global 2.1–1.8 Ga orogens: Implications for a pre-Rodinia supercontinent. Earth-Science Reviews 59, 125–162.

Zhao, G.C., Sun, M., Wilde, S.A., Li, S.Z., 2005. Late Archean to Paleoproterozoic evolution of the North China Craton: key issues revisited. Precambrian Research 136, 177–202.

Zhao, G.C., Sun, M., Wilde, S.A., Li, S.Z., Zhang, J., 2006. Some key issues in reconstructions of Proterozoic supercontinents. Journal of Asian Earth Sciences 28, 3–19.

Zhao, W., Kumar, P., Mechie, J., Kind, R., Meissner, R., Wu, Z., Shi, D., Su, H., Xue, G., Karplus, M., Tilmann, F., 2011. Tibetan plate overriding the Asian plate in central and northern Tibet. Nature Geosci. 4(12), 870–873.

Zhao, X., Coe, R., Zhou, Y., Hu, S., Wu, H., Kuang, G., Dong, Z., Wang, J., 1994. Tertiary paleomagnetism of North and South China and a reappraisal of late Mesozoic paleomagnetic data from Eurasia: implications for the Cenozoic tectonic history of Asia. Tectonophysics 235, 181–203.

Zhao, X., Coe, R.S., Gilder, S.A., Frost, G.M., 1996. Paleomagnetic constraints on the palaeogeography of China: implications for Gondwanaland. Australian Journal of Earth Sciences 43, 643–672.

Zhao, X.X., Coe, R.S., Zhou, Y.X., Wu, H.R., Wang, J., 1990. New paleomagnetic results from northern China. Collision and suturing with Siberia and Kazakhstan. Tectonophysics 181, 43–81.

Zheng, Y., Zhang, Q., Wang, Y., Liu, R., Wang, S.G., Zuo, G., Wang, S.Z., Lkaasuren, B., Badarch, G., Badamgarav, Z., 1996. Great Jurassic thrust sheets in Beishan (North Mountains) – Gobi areas of China and southern Mongolia. Journal of Structural Geology 18, 1111–1126.

Zhou, C.Y., Wu, F.Y., Ge, W.C., Sun, D.Y., Abdel Rahman, A.A., Zhang, J.H., Cheng, R.Y., 2005. Age, geochemistry and petrogenesis of the cumulate gabbro in Tahe, northern Great Xing'an Range. Acta Petrologica Sinica 21, 763–775 (in Chinese with English abstract).

Zhou, D., Graham, S.A., Chang, E.Z., Wang, B., Hacker, B.R., 2001. Paleozoic tectonic amalgamation of the Chinese Tian Shan; evidence from a transect along the Dushanzi-Kuqa Highway. In: Hendrix, M.S., Davis, G.A. (eds.), Paleozoic and Mesozoic Tectonic Evolution of Central Asia: From Continental Assembly to Intracontinental Deformation. Geol. Soc Am. Mem. 194, pp. 23–46.

Zhou, J.B., Wilde, S.A., 2013. The crustal history and tectonic evolution of NE China. Gondwana Research 23, 1365–1377.

Zhou, J.B., Wilde, S.A., Zhang, X.Z., Zhao, G.C., Zheng, C.Q., Wang, Y.J., Zhang, X.H., 2009. The onset of Pacific margin accretion in NE China: Evidence from the Heilongjiang high-pressure metamorphic belt. Tectonophysics 478, 230–246.

Zhou, J.B., Wilde, S.A., Zhao, G.C., Zhang, X.Z., Zheng, C.Q., Wang. H., 2010a. Pan-African metamorphic and magmatic rocks of the Khanka Massif, NE China: further evidence regarding their affinity. Geological Magazine 147, 737–749.

Zhou, J.B., Wilde, S.A., Zhao, G.C., Zhang, X.Z., Wang, H., Zeng, W.S., 2010b. Was the easternmost segment of the Central Asian Orogenic Belt derived from Gondwana or Siberia: an intriguing dilemma? Journal of Geodynamics 50, 300–317.

Zhou, J.B., Wilde, S.A., Zhao, G.C., Zhang, X.Z., Zheng, C.Q., Wang, H., 2010c. New SHRIMP U-Pb Zircon ages from the Heilongjiang complex in NE China: constraints on the Mesozoic evolution of NE China. American Journal of Science 310, 1024–1053.

Zhou, J.B., Wilde, S.A., Zhang, X.Z., Ren, S.M., Zheng, C.Q., 2011a. Pan-African metamorphic rocks of the Erguna block in the Great Xing'an Range, NE China: evidence for the timing of magmatic and metamorphic events and their tectonic implications. Tectonophysics 499, 105–177.

Zhou, J.B., Wilde, S.A., Zhang, X.Z., Zhao, G.C., Liu, F.L., Qiao, D.W., Ren, S.M., Liu, J.H., 2011b. A >1300 m late Pan-African metamorphic belt in NE China: New evidence from the Xing'an Block and its tectonic implications. Tectonophysics 509, 280–292.

Zhou, J.B., Wilde, S.A., Zhang, X.Z., Liu, F.L., Liu, J.H., 2012. Detrital zircons from Phanerozoic rocks of the Songliao Block, NE China: Evidence and tectonic implications. Journal of Asian Earth Sciences 47, 21–34.

Zhuravlev, B.Ya., Uryvayeva, A.P., Fedorov, T.S., 1977. The Kazakhstanian marginal volcanic belt of Devonian. In: Geology and mineral resources of central Kazakhstan. Nauka Publishers, Moscow, pp. 167–183 (in Russian).

Zhuravlev, Ye.G., 1986. Tectonics of the basement of the Western Siberia. Geotectonics 5, 107–115 (in Russian).

Ziegler, A.M., Rees, P.M., Rowley, D.B. et al., 1996. Mesozoic assembly of Asia: constraints from fossil floras, tectonics, and paleomagnetism. The tectonic evolution of Asia. Cambridge University Press, 371–400.

Ziegler, P.A., 1986. Geodynamic model for the Palaeozoic crustal consolidation of Western and Central Europe. Tectonophysics 126, 303–328.

Zinov'ev, S.V., 1992. Stress-metamorphic complexes of the Bukhtarma segment of the Irtysh Shear Zone. United Institute of Geology, Geophysics and Mineralogy, Siberian Branch, Russian Academy of Sciences, Novosibirsk, 128 p. (in Russian).

Zinov'ev, S.V., Travin, A.V., Chikov, B.M., 2009. On the age of the Tishinka deposit, Rudnyi Altai. Doklady Earth Sciences 428, 1088–1092.

Zmievskiy, Yu.P., Petukhov, A.D., Kiryanov, V.V., 1990. New evidence of the structure and age of the Dzhelonskiy Formation. In: Stratigraphy of the Precambrian and Phanerozoic of the Transbaikal region and southern Far East. Khabarovsk, 79–180 (in Russian).

Zonenshain, L.P., Kuzmin, M.I., Moralev, V.M., 1976. Global tectonics, magmatism and metallogeny. Moscow, Nedra, 231 pp. (in Russian).

Zonenshain, L.P., Kuzmin, M.I., Kononov, M.V., 1985. Absolute reconstructions of the Paleozoic oceans. Earth and Planetary Science Letters 74, 103–116.

Zonenshain, L.P., Kuz'min, M.I., Natapov, L.M., 1990a. Geology of the USSR: A Plate tectonic synthesis. Geodynamic Monograph. American Geophysical Union, Washington, Geodynamics Series 21, 242 p.

Zonenshain, L.P., Kuz'min, M.I., Natapov, L.M., 1990b. Tectonics of lithospheric plates of the territory of the USSR. Nedra Publishers, Moscow, vol. 1, 327 p., vol. 2, 324 p. (in Russian).

Zorin, Y.A., Belichenko, V.G., Turutanov, U.Kh., Mordvinova, V.V., Kozhevnikov, V.M., Khozboyar, P., Tomurtogoo, O., Arviasbaatar, N., Gao, Sh., Devis, P., 1994. The Baikal-Mongol transect. Geologiya i Geofizika 7-8, 94–110 (in Russian).

Zorin, Y.A., Sklyarov, E.V., Mazukabzov, A.M., Belichenko, V.G., 1997. Metamorphic core complexes and Early Cretaceous rifting in the Trans-Baikal region. Russian Geology and Geophysics 38, 1574–1584.

Zorin, Y.A., Belichenko, V.G., Turutanov, U.Kh., Kozhevnikov, V.M., Skliarov, E.V., Tomurtogoo, O., Khosbaiar, P., Arvisbaatar, Kh., Biambaa, Ch., 1998. Terranes of East Mongolia and Central Transbaikal region, and development of the Mongol-Okhotsk fold belt. Geologiya i Geofizika 1, 1–25 (in Russian).
Zorin, Y.A., 1999. Geodynamics of the western part of the Mongolia-Okhotsk collisional belt, Trans-Baikal region (Russia) and Mongolia. Tectonophysics 306, 33–56.
Zorin, Y.A., Mazukabzov, A.M., Gladkochub, D.P., Donskaya, T.V., Presnyakov, S.L., Sergeev, S.A., 2008. Silurian age of major folding in Riphean deposits of the Baikal-Patom zone. Doklady Earth Sciences 423, 1235–1239.
Zorin, Y.A., Sklyarov, E.V., Belichenko, V.G., Mazukabzov, A.M., 2009. Island arc–back-arc basin evolution: implications for Late Riphean–Early Paleozoic geodynamic history of the Sayan–Baikal folded area. Russian Geology and Geophysics 50, 149–161.
Zubovich, A.V., Makarov, V.I., Kuzikov, S.I., Mosienko, O.I., Shchelochkov, G.G., 2007. Intracontinental mountain building in Central Asia as inferred from satellite geodetic data. Geotectonics 41, 13–25.
Zubtsov, Ye.I., Porshniakov, G.S., Yagovkin, A.V., 1974. A new sketch of the pre-Mesozoic tectonics of the Tien-Shan. Doklady Academy of Science of the USSR 217, 1153-1156 (in Russian).
Zuo, G., Zhang, S., He, G., Zhang, Y., 1991. Plate tectonic characteristics during the early Paleozoic in Beishan near the Sino-Mongolian border region, China. Tectonophysics 188, 385–392.