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COMPOSITION, STRUCTURE AND TECTONIC EVOLUTION OF THE PRE-URALIDES AND TIMANIDES

Abstract: The main features of structure and lithology of the Neoproterozoic – Middle Cambrian complexes at the eastern (Uralian) and north-eastern (Timan-Pechora) margins of the East-European Craton result from the juxtaposition of units derived from three paleo-continentals – Baltica (East-European craton), Arctida and Gondwana.

Keywords: Timan-Pechora region, Uralian fold-thrust belt, Pre-Uralides, Timanides, rock composition, tectonic zonation, tectonic evolution.

INTRODUCTION

The East European craton (EEC) is bounded in the north-east by the Timan-Pechora region (TP), and in the east by the Urals – a N-S-trending Variscan fold-thrust belt (Fig. 1A). The Timan Pechora region consists of the dislocated Neoproterozoic – Middle Cambrian complexes (folded basement) named as Timanides, which are predominantly overlain by the post-Upper-Cambrian cover. The Variscan Urals is characterized by a clear tectonic zonation. It is subdivided into the Eastern-Uralian and Western-Uralian megazones. Paleozoic ophiolites and volcanic island-arc complexes are widely distributed in the Eastern-Uralian megazone. On the contrary, the Upper Cambrian to Upper Paleozoic sedimentary complexes play the main role in the structure of the Western-Uralian megazone. The basement of these complexes is composed of the variously metamorphosed sedimentary, volcanic-sedimentary and volcanogenic formations, different intrusions (granitoids, gabbroids, ect.) and scarce ophiolites of the Neoproterozoic to Middle-Cambrian age that are collectively defined as the Pre-Uralides.

There are many models of the Neoproterozoic – Middle Cambrian tectonic evolution of the Western Urals and TP region (see a review in Kouznetsov 2005a,b). The characteristic features of previous interpretations are: (1) the Pre-Uralides represent a basement of the Paleozoic complexes of the Uralian margin of the EEC; (2) the Pre-Uralides and Timanides were formed on the margin of the EEC and presently occupy the autochthonous position. According to our new interpretation, the Pre-Uralides and Timanides comprise elements derived from the margins of three paleo-continentals: Baltica, Arctida and Gondwana.

TECTONIC POSITION AND ZONATION OF PRE-URALIDES AND TIMANIDES

The Pre-Uralides form a continuous chain of structures showing the variable width along the whole length of the Urals. The chain is named the Central-Uralian Uplift (CUU) and consists of the following tectonic units (Fig. 2B): (1) the Ebeta uplift composed of

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subduction-related rocks; (2) the Uraltau uplift comprising the subduction-related (south part) and variously metamorphosed sedimentary, volcano-sedimentary formations and rare granitoid intrusions (northern part), which are subdivided in 4 tectonic subunits; (3) the

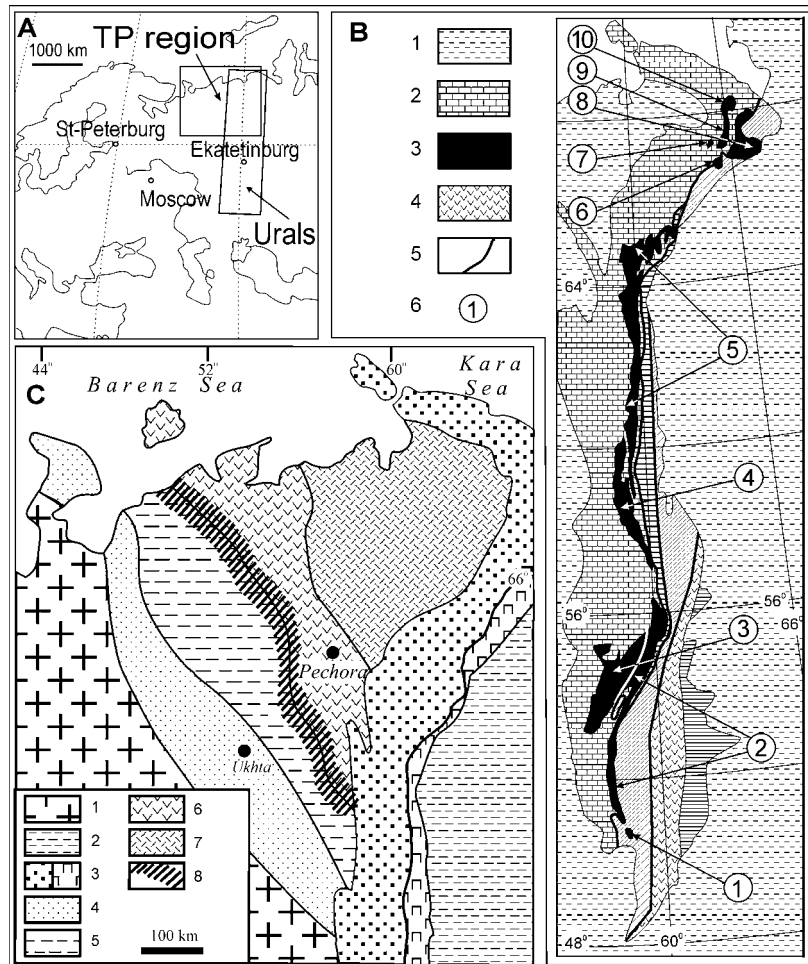


Fig. 1. Location (A) and tectonic zonation of the Pre-Uralides (B) and Timanides (C).
 (B): 1 – Mesozoic-Cenozoic cover; 2 - West Urals zone; 3 – Central Ural Uplifts (Pre-Uralides) ; 4 – East Urals zone; 5 – Main Uralian fault; 6 - tectonic units of the CUU: 1 – Ebeta uplift; 2 – Uraltau uplift; 3 – Bashkir uplift; 4 – Kvarkush anticlinorium; 5 –Lyapin anticlinorium; 6 – Kharamatalow uplift; 7-9 – Sobj uplift, including: 7 – Engane-Pe rises; 8 – Manitanyrd-Paipudyna rises; 9 – Kharbej rises; 10 – Ochenyrd uplift.
 (C): 1 – East-European craton; 2 – West-Siberian basin; 3 – West (a) and East (b) Urals; 4 – Timan block; 5 – Izhma block; 6 – Pechora block; 7 – Bolshezemel block; 8 – Pripechora-Ilych-Chiksha suture.

Bashkirian uplift composed of sedimentary and subordinate volcano-sedimentary rocks; (4) the Kvarkush anticlinorium built up of sedimentary formations; (5) the Lyapin anticlinorium comprising sedimentary formations (southern part) and variously

metamorphosed sedimentary, volcano-sedimentary successions, and granitoid intrusions (northern part); (6) the Kharamatalou uplift; Sobj uplift, including: (7) Engane-Pe, (8) Manitanyrd-Paipudyna, (9) Kharbej, and (10) Ochenyrd rises.

The main distinctive feature of the Pre-Uralides of the northern CUU is the widespread occurrence of granitoid intrusions and associated volcanic rocks. In contrast, the Pre-Uralian granitoids and volcanic rocks are absent in the southern parts of the CUU.

THE NEOPROTEROZOIC – MIDDLE CAMBRIAN TECTONIC EVOLUTION OF THE EASTERN AND NORTH-EASTERN BOUNDARIES OF EAST EUROPEAN CRATON

The Timanides of the TP region are composed of various rocks tectonized and metamorphosed under different P-T conditions. Sometimes they are intruded by granites. The Timanides are subdivided into two large domains: (1) the Timan domain including the Timan and Izhma blocks, and (2) the Bolshezemel domain including the Bolshezemel and Pechora blocks (Fig. 1C). Pripechora-Ilych-Chiksha fault zone (suture zone) clearly separates both the domains.

(1) Timanides of the Timan domain are composed of slightly deformed and weakly metamorphosed sedimentary formations formed at a passive continental margin. The north-west prolongation of the Timan domain is partly traced outside the Timan-Pechora region in the Kil'din Island and Rybachy, Sredny, and Varanger peninsulas, located at the northern margin of the Baltic shield. The south-east prolongation of the Timan domain is found in the CUU as the southern part of the Lyapin anticlinorium, and the Kvar Kush anticlinorium.

(2) Timanides of Bolshezemel domain are composed of intensely tectonized and metamorphosed volcanic, volcano-sedimentary complexes and granitoids. The Bolshezemel domain continues the south-east into the CUU as the northern part of the Lyapin anticlinorium, and within other structural elements of the CUU to the north. We investigated the granitoids from all these areas (Kouznetsov *et al.* 2005a,b; Soboleva *et al.* 2005) and our results testify their origin at an active continental margin and in a collision zone.

The Timanides of the Timan domain in the TP region, and the Pre-Uralides of the southern part of the Lyapin anticlinorium and Kvar Kush anticlinorium of the CUU are composed exclusively of the sedimentary complexes. Therefore, we believe that they were deposited on the passive margin of the Baltica, named as Timan margin. In contrast, the Timanides of the Bolshezemel domain of the TP region, and the Pre-Uralides of the northern part of the Lyapin anticlinorium, and all other structural units to the north of the CUU are composed of volcano-sedimentary rocks, granitoids and rare ophiolite complexes. We believe that they formed in an active continental margin setting at the rim of paleocontinent Arctida. This continent is reconstructed (Borisova *et al.* 2003; Kouznetsov *et al.* 2005 a,b; Soboleva *et al.* 2005) on the basis of the geological (Egorov *et al.* 2002), paleomagnetic (Metelkin *et al.* 2000), and other geophysical data (Magnetic anomalies ..., 1995).

The Bashkirian uplift of the CUU is located south of the Kvar Kush anticlinorium and consists of the sedimentary formations, subordinate lavas, and volcanic-clastic rocks formed in an incipient continental rift basin. These rocks are similar to the complexes of the Kvar Kush anticlinorium, of the southern part of the Lyapin anticlinorium, and the complexes of the Timan domain of the TP region. Consequently, the Pre-Uralides of the Bashkirian uplift of the CUU show the genetic relationship to the complexes of the Neoproterozoic Timan passive continental margin of the EEC.

The northern parts of the Uraltau uplift located east of the Bashkirian uplift are composed of the variously metamorphosed sedimentary and volcano-sedimentary complexes and rare granitoid intrusions. These granitoids are similar to the granitoids of the Bolshezemel domain of the TP region, and the granitoids from the northern part of the Lyapin anticlinorium of the CUU. Therefore, we suggest that the Pre-Uralides of the northern parts of the Uraltau uplift of the CUU represent fragments of the SE flank of the Vendian – Early Cambrian collision zone between the Timan passive continental margin of the Baltica (EEC) and the Bolshezemel active continental margin of Arctida. These fragments were emplaced in the present structural position by large-scale dextral movements along the eastern edge of the EEC during the Early-Middle Cambrian.

The Pre-Uralides of the southern part of the Uraltau uplift (Maxutovo unit) and the Ebeta uplift (Luzhnikovskaja and Alimbet units) are characterized by similar features. They consist of variously metamorphosed subduction-related volcano-sedimentary and sedimentary successions, accompanied by the tectonic slices of HP/UHP metamorphosed rocks. In some places, they are overlain by the rift-related volcanic-sedimentary and sedimentary rocks of the Late-Cambrian - Tremadocian age. During the recent field work new data were obtained providing evidence that these Lower Paleozoic rocks include sedimentary chaotic complexes containing irregular blocks, olistolites and olistopacks of the Lower Cambrian archaeocyatha limestones. The new findings show that this sedimentary sequence is exotic with respect to the eastern margin of the EEC. We believe that these clastic rocks were formed during the Early Paleozoic rifting of the northern Gondwana margin. The Pre-Uralides of the Luzhnikovskaja units (western part of the Ebeta uplift) represent relics of the Cadomian volcanic belt active in Neoproterozoic times along the northern margin of Gondwana. The Maxutovo unit (southern part of the Uraltau uplift) and the Alimbet units (eastern part of the Ebeta uplift) are relics of the Cadomian accretionary prism.

During break-up of the northern Gondwana margin and opening of a new ocean (Rheic Ocean) several terranes were splited up from Gondwana. During the Middle Ordovician – Late Devonian, these peri-Gondwanan terranes drifted northward. By the end of the Devonian, they were docked to the south-eastern edge of the Baltica. Later, during the Late Paleozoic collision of the Baltica and the Kyrgyz-Khazakhstan-Siberia continents the peri-Gondwanan terranes were accreted into a fold-thrust belt of the southern part of the Uralian frame of the EEC.

CONCLUSIONS

The Neoproterozoic – Middle Cambrian complexes of the eastern (Uralian) and north-eastern (Timan-Pechora) rims of the EEC formed at the margins of three paleocontinents.

1. The Pre-Uralides of the Bashkirian uplift, the Kvarkush anticlinorium and the southern part of the Lyapin anticlinorium, and the Timanides of the Timan domain were derived from the eastern and north-eastern passive margin of the Baltica (EEC).

2. The Pre-Uralides of the northern part of the Lyapin anticlinorium and the north part of the CUU, as well as the Bolshezemel domain of the TP region were derived from the Bolshezemel active margin of Arctida and from the collision zone between the Baltica (EEC) and Arctida. We believe that the Neoproterozoic – Middle Cambrian complexes of the northern part of the CUU are not the Pre-Uralides but they belong to the Timan orogen. They represent the eastern part of the TP region and were uplifted as a result of the Late Paleozoic (Variscan) tectonic activity. Some fragments of the SE flank of the collision zone between the Baltica (EEC) and Arctida were displaced by large-scale dextral movements

along the eastern edge of the EEC during the Early-Middle Cambrian and are now located in the northern part of the Uraltau uplift.

3. The Pre-Uralides of the southern part of the Uraltau uplift, and the Ebeta uplift comprise terranes exotic for the eastern edge of the EEC. These terranes were derived from the northern Gondwana margin belonging to the Cadomian orogenic belt. They were separated from Gondwana during the Early Ordovician and accreted into the Variscan fold-thrust belt. Thus, the Pre-Uralides of the most southern part of the CUU share the common Cadomian basement with other peri-Gondwanan terranes of Europe and America (e.g. Avalonia and Armorica) as well as Gondwana paleocontinent (NW Africa, Morocco).

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