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The Archean formation of the Sarmatian continental crust

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Abstract

Based on our new U–Pb isotope data (SHRIMP-II) for the Voronezh Crystalline Massif (VCM) and on published U–Pb data for the Archean rocks of the Ukrainian Shield (USh), we have substantiated the main stages of the Archean evolution of the Sarmatian crust, a fragment of the basement of the East European Platform. New data have been obtained for 20 indicative rocks of the Kursk block (KB) of the VCM. We compared the Eoarchean and Paleoarchean KB rocks (mafic rocks and tonalites of the Oboyan' complex), orthogneisses of the USh Dniester–Bug province (Bug granulite complex), and tonalites and mafic rocks of the USh Azov Province and have established the existence of ancient continental crust (3.75–3.60 Ga) in Sarmatia. The presence of Paleoarchean xenogenic zircons in younger intrusions indicates a wide spread of Paleoarchean rocks in the deep VCM crust section. In the Mesoarchean (3.2–3.0 Ga), eastern Sarmatia (KB and Azov and Middle Dnieper provinces) was a single granite–greenstone terrain. Two stages of felsic magmatic activity have been dated: 3.15–3.10 Ga (volcanics in the greenstone belts and tonalite–trondhjemite granites in the VCM and USh) and 3.05–3.00 Ga (volcanics and tonalite–trondhjemite granites in the USh and granites in the VCM KB). Magmatic and tectono-metamorphic processes (2.95–2.85 Ga) have been established throughout the eastern part of Sarmatia. The latest Mesoarchean endogenic activity (2.85–2.80 Ga) testifies to the tectonic differentiation of the area. Mafic and felsic magmatism, deformations, metamorphism, and ultrametamorphism under amphibolite and granulite facies conditions took place in the most part of the KB and in the Azov and Bug areas. It is shown that ultrametamorphic granites formed from an ancient (3.0–3.5 Ga) protolith. The USh Middle Dnieper province had a different tectonic position. Here, intrusion of post-tectonic granites and formation of mature sediments proceeded at 2.81–2.86 Ga. Our geochronological data show that most of the Sarmatian continental crust formed in the Mesoarchean as a result of both the intrusion of juvenile material and the reworking of the older protolith rocks. Neoarchean events (2.8–2.5 Ga) are weakly expressed in Sarmatia in contrast to Baltia, another large fragment of the East European Platform basement, where endogenic processes at 2.65–2.75 Ga were the major crust-forming geologic events.

Keywords: Archean; U–Pb SIMS SHRIMP-II method; continental crust; Sarmatia; Ukrainian Shield; Voronezh Crystalline Massif

Introduction

Sarmatia is one of the three segments of the basement of the East European Platform (Bogdanova, 1991) that was divided into the Voronezh Crystalline Massif (VCM) and the Ukrainian Shield (USh) during the formation of the Dnieper–Donets Basin (Fig. 1*a*). The VCM consists of the Bryansk, Kursk, and Khoper blocks; the Kursk block (KB) is partly made up of Archean rocks (Fig. 1*b*) (Chernyshov et al., 1997). Within the USh, there are a few provinces (except for the Volyn' and Middle Dnieper ones) where both Archean and Proterozoic rocks are developed. The Volyn' province is composed mainly of Proterozoic complexes, and the Middle Dnieper province (MDP), predominantly of Archean ones (Fig. 2).

The geologic structure of the VCM is inferred from borehole study and geophysical data, and that of the USh, from scarce outcrops and results of geophysical research. Therefore, geochronological data are of special significance.

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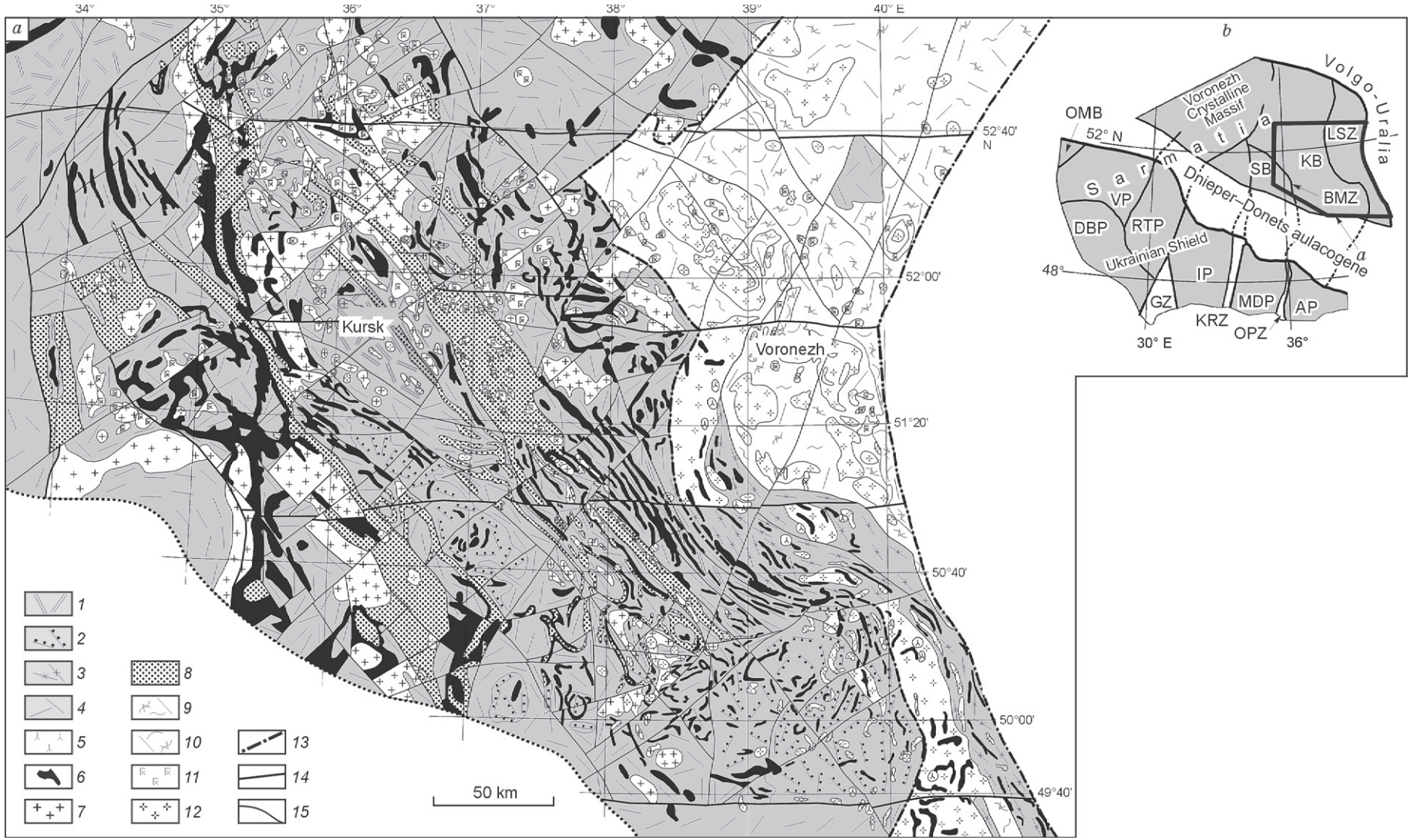

Fig. 1. Schematic geological map of the Kursk block of the Voronezh Crystalline Massif, after Chernyshov et al. (1998) and Ryborak (2011), simplified and modified (*a*), and tectonic-regionalization map of Sarmatia (Lobach-Zhuchenko et al., 2014b) (*b*). *a*: 1–7, Archean: *1–4*, Oboyan' complex: *1*, Bryansk association, *2*, Rossosh' association, *3*, Don association, *4*, undivided Oboyan' complex; *5*, ultramafic and mafic rocks (Besedino and Belogor'e complexes); *6*, greenstone association (Mikhailovka and Sergeevka complexes); *7*, granitoids of the Saltykovka complex, granites and migmatites of the Ataman complex; *8–12*, Proterozoic: *8*, Kursk and Oskol Groups; *9*, Losevo Group; *10*, Voronezh Formation; *11*, ultramafic and mafic rocks and diorites (Zolotukhino, Stoilo–Nikolaevka, Smorodino, Rozhdestvenka, and Ol'khovka complexes); *12*, granitoids (Malinovka, Shebekino, Dubrava, Pavlovka, Liski, Usman', and Ol'khovka complexes); *13–15*, faults: *13*, structural sutures of rank I bounding structure–facies zones, *14*, deep faults of rank II bounding macroblocks, *15*, regional fault zones revealed from geological and geophysical data; *b:* suture zones separating the Sarmatian provinces: GZ = Golovanevsk, KRZ = Krivoi Rog, OPZ = Orekhov–Pavlograd (Ukrainian Shield), OMB = Osnitsa–Mikhashevichi belt, BMZ = Belgorod–Mikhailovka (Kursk Magnetic Anomaly (KMA)); tectonic provinces: VP = Volyn', DBP = Dniester–Bug, RTP = Ros'–Tikich, IP = Ingulets, MDP = Middle Dnieper, AP = Azov (Ukrainian Shield); tectonic blocks: SB = Sumy, KB = Kursk; LSZ = Losevo suture zone (KMA).