The exotic Volgo-Uralia: circular-and-linear structures of the crystalline crust defined by Palaeoproterozoic mantle upwelling

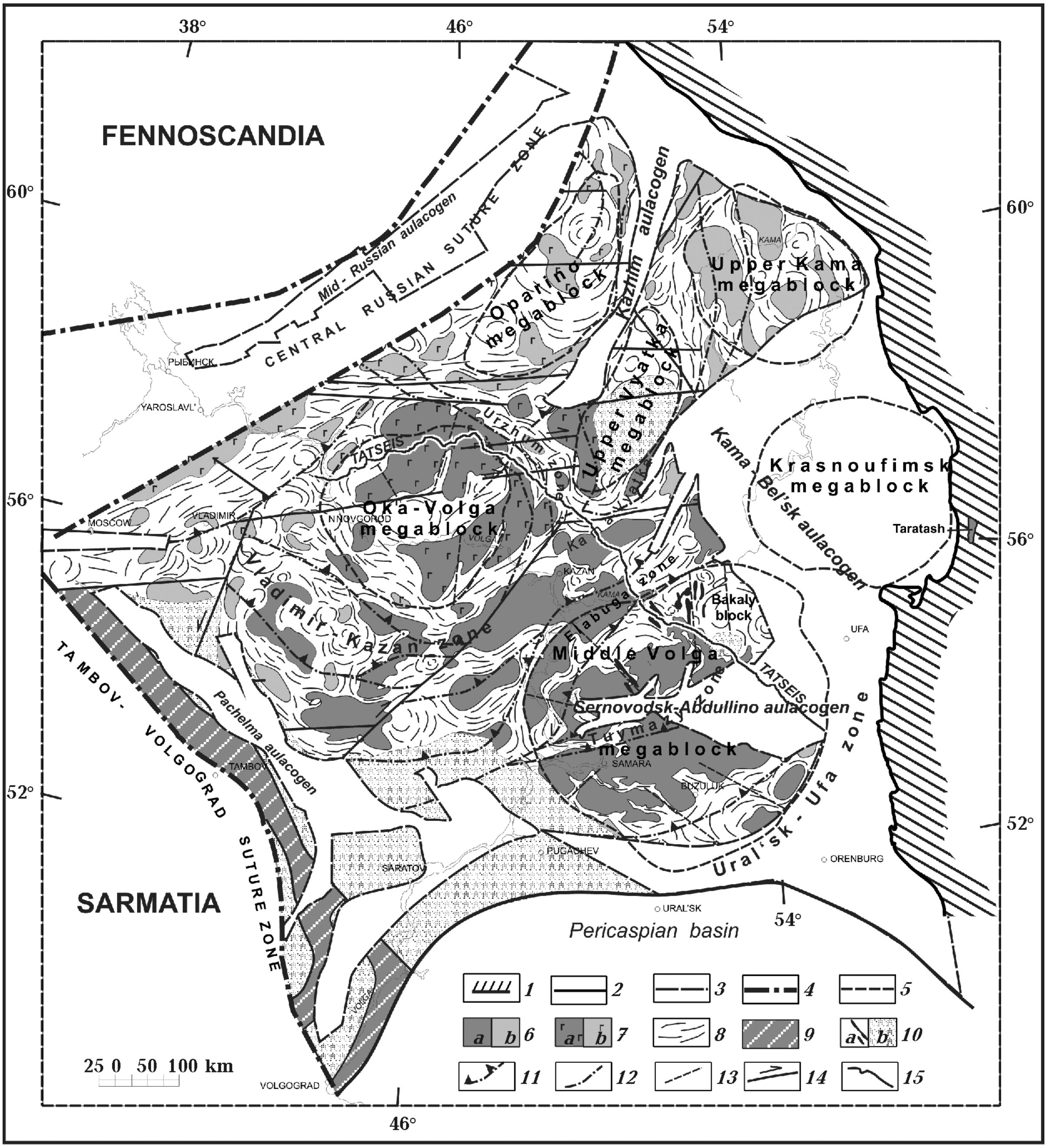
© ***S. Bogdanova[1], A. Postnikov[2], V. Trofimov[3], 2010***

[1]Department of Earth' and Ecosystems, Lund University, Sweden
Svetlana.Bogdanova@geol.lu.se
[2]Department of Lithology, Gubkin State University of Oil and Gas, Moscow, Russia
apostnikov@mtu-net.ru
[3]Insitute of Geology and Development of Fossil Fuels (IGIRGI), Moscow, Russia
vatgeo@yandex.ru

The crystalline crust of Volgo-Uralia, one of the major crustal segments of the East European Craton, is buried beneath a Phanerozoic, mostly Devonian to Triassic, sedimentary cover and underlying 2 to 10 km thick Meso- to Neoproterozoic sedimentary deposits intercalated with rare volcanics. The only exposed parts of the crystalline basement are isolated small blocks involved in the adjacent Paleozoic Uralides belt (Figure). Knowledge of the basement is therefore founded on geophysical data and drill cores alone. These are particularly numerous due to the high oil and gas potential of the region. Twenty drillings reach down into the crystalline crust for distances between 100 and 1000 m, some others even penetrating three kilometres and more. This provides valuable information on rock relationships and abundances [Bogdanova, 1986; The Crystalline …, 1996; Postnikov, 2002].

Essentially, Volgo-Uralia is a high-grade terrain composed of granulite- and amphibolite-facies supracrustal and plutonic rocks both Archean and Paleoproterozoic in age. It features several megablocks with more or less circular, "mosaic" patterns of magnetic and gravity anomalies, separated by belts of linear anomalies (see Figure). Previously, the megablocks were assumed to represent stable massifs of Archean crust, while the intervening zones of linear anomalies were interpreted as Paleoproterozoic ("Svecokarelian") fold belts [Goodwin, 1991; International …, 1979]. This view was challenged by the idea that the circular anomaly patterns of the megablocks had been caused by the doming of strongly stacked Archean crust during the Paleoproterozoic [Bogdanova, 1986]. That could explain why intense Paleoproterozoic structural and metamorphic reworking of the Archean crust follows the circular geophysical patterns of the megablocks and the distribution of Paleoproterozoic metasedimentary cover within these megablocks. In this model, the zones of linear anomalies, i.e. the former "Svecokarelian fold belts", are interdomal areas less affected by Paleoproterozoic reworking. Recently, such a picture has been corroborated by the "TATSEIS" seismic reflection profiling, which transected both megablocks and linear zones in central Volgo-Uralia [Trofimov, 2006]. This profiling revealed an up-doming mantle and the lower crust beneath the Oka-Volga megablock and the presence of an associated, up to 10 km thick highly metamorphosed volcano-sedimentary sequence atop its Neoarchean crust. As different from the Oka-Volga megablock, the Middle Volga megablock has Paleoproterozoic deposits within mostly troughs along the radial faults of the domal structure, and within small cover remains elsewhere. The deposition of the Paleoproterozoic cover must have taken place before 2,4—2,1 Ga, which is the age of the cutting granitoid intrusions and the metamorphism. Subsequently, both metamorphism of the cover rocks and granitoid magmatism continued episodically until 1,90—1,85 Ga. K-Ar ages of amphibole and biotite show several tectonothermal events by 1,65 Ga, when the Neoarchean fault zones were reactivated.

The Paleoproterozoic tectonics in Volgo-Uralia may suggest mantle-plume geodynamics, most probably related to the rifting of the Archean crust between 2,5 and 2,0 Ga, i. e. during a period of rifting well known from the Fennoscandian, Laurentian and other Precambrian cratons. However, the large sizes of the Volgo-Uralian "dome-and-basin" structures, reaching ca. 300 km across, and their good preservation are extraordinary features requiring additional study.



The main tectonic units of the crystalline basement structure of Volgo-Uralia (modified after S. V. Bogdanova, 1986 with additions by A. V. Postnikov): *1* — the Timan-Uralian boundary of the East European Craton; *2* — boundary of the Pericaspian basin; *3* — boundaries of the Meso-Neoproterozoic (Riphean) aulacogens; *4* — boundaries of the crustal segments; *5* — outlines of the circular cores of the megablocks; *6* — blocks of dominant granulites as defined by (*a* — drill core materials and geophysics, *b* — geophysical data); *7* — amphibolites, mafic granulites and various intrusions of the assumed Paleoproterozoic cover over the Oka-Volga megablock (*a* — by drill core materials and geophysics, *b* — by geophysical data); *8* — amphibolite facies rocks, granitoids and migmatites, undivided Archean and Paleoproterozoic; *9* — Tersa marginal magmatic belt; *10* — Palaeoproterozoic supracrustals (*a* — in troughs along the radial faults within the Middle Volga megablock; *b* — the Paleoproterozoic metasedimentary schists, migmatites and granitoids); *11* — thrust faults; *12* — faults unspecified; *13* — faults of the radial system within the circular cores of the megablocks; *14* — strike slips; *15* — TATSEIS transect.

It is remarkable that the Paleoproterozoic circular structural patterns are mirrored by the structure of the Proterozoic-Paleozoic sedimentary cover [Postnikov, 2002]. Particularly important are radial fault system of the basement structures controlling the position of Paleozoic cover swells and the distribution of the oil ore deposits [Trofimov et al., 2004]. Notably, large recent circular/ring structures recorded by satellite images coincide with some of the basement-cover structural features [The Crystalline ..., 1996].

References

Bogdanova S. V. The Earth's Crust of the Russian Platform in the Early Precambrian as exemplified by the Volgo-Uralian segment. — Moscow: Nauka, 1986. — 224 p (in Russian).

Goodwin A. Precambrian Geology. — New York: Academ. Press, 1991. — 666 p.

International Tectonic Map of Europe and Adjacent Areas / Eds. A. V. Peive, A. A. Bogdanov, V. E. Khain. — Scale 1:2 500 000. — IGC/CGMW, 1979. — 20 sheets.

Postnikov A. V. The basement of the eastern part of the East European platform and its influence upon the structure of oil-and-gas-bearing sedimentary cover. — Moscow: Geological Faculty, Gubkin State University of Oil and Gas, 2002. — 55 p. (in Russian).

The Crystalline Basement in Tatarstan and Problems of its Oil and Gas Deposits / Eds. R. K. Muslimov, T. A. Lapinskaya. — Kazan: Denta, 1996. — 488 p. (in Russian).

Trofimov V. A. Deep CMP Seismic Surveying along the Tatseis-2003 Geotraverse across the Volga-Ural Petroliferous Province Geotectonics // Geotektonika. — 2006. — **40**. — P. 249—262 (in Russian and English).

Trofimov V. A., Romanov Yu. A., Khromov V. T. Large radial-ring structures — potential objects for hydrocarbon prospecting in the Volga — Ural province / / Geology, Geophysics and Development of Oil and Gas Deposits. — 2004. — **4**. — P. 36—41 (in Russian).

The scenarios of repeatability of catastrophic climatic phenomena in Europe and Ukraine under the influence of climate changes (with use of historical records and manuscripts for the last millennium)

© *S. Boychenko, 2010*

Institute of Geophysics, National Academy of Sciences of Ukraine, Kiev, Ukraine
uaclimate@gmail.com

The climatic catastrophic phenomena, such as droughts, floods, extremely cold or warm winter, occurring at a large scale and great intensity are rather rare events. These phenomena, typically, occur only a few times per century. Because of this, statistically estimating the basic characteristics of the dynamics of repeatability of these events is very difficult. The instrumental observations are not helpful because of the short time-series. It is therefore necessary to use other proxy data as well. In our opinion, different historical records and manuscripts are most suiTable for this purpose. These records were very carefully compiled and described in the monasteries located in territory Europe [Borisenkov, Pasetsky, 1988].

The analysis is carried out on the basis of historical records and manuscripts for the last millennium (900—1800) [Borisenkov, Pasetsky, 1988]. The following phenomena were considered: droughts, rainy summers, floods, cold winters, late springs, colds at the beginning of a summer, catastrophic thunderstorms and catastrophic storms. It was used the names of these events, which are described in historical records and manuscripts.

The statistical analysis of these data shows that the long-term dynamics of repeatability of the climatic catastrophic phenomena in the territory Europe, Ukraine and Russian Plain was not similar to an ordinary stationary Poisson's flux of events [Boychenko, 2002]. It is supposed by our hypothesis