Upper Cambrian orthogneiss protoliths within the Variscan Central Sredna Gora high-grade metamorphic basement, Bulgaria

Горнокамбрийски ортогнайси в херцинския високостепенен метаморфен фундамент на Централна Средна гора, България

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The Variscan high-grade metamorphic rocks are well-exposed in the Central Sredna Gora Mountain. Commonly they are regarded in the light of the Alpine tectonic framework, but with respect to their origin, age and metamorphic evolution only a few data exist. Initially, these rocks were divided into several metamorphic units (Zagorchev, 2008 and references therein), recently included into a single Central Sredna Gora high-grade metamorphic complex (Gerdjikov et al., 2013). Nevertheless, in the context of the Variscan and pre-Variscan tectonic history its characteristics are still poorly studied and not well understood.

Considerable part of the Central Sredna Gora high-grade metamorphic complex is dominated by migmatitic paragneisses, but locally unmigmatized or weakly migmatized domains have been distinguished. In the northern part of the complex, such domain is separated as the Koprivshtitsa unit (for details see Zagorchev, 2008 and references therein), which has a tectonic contact (see Fig. 1 in Lazarova et al., this volume) with the migmatitic Pirdop unit and intrusive relationships with the Late Variscan Koprivshtitsa Granite.

In this study we focus on a brief characterization of the unmigmatized Koprivshtitsa unit. It is exposed as a thin E-W trending and ~ 30 km long strip, located north of Koprivshtitsa town. Up to now the unit was described as variegated in rock composition, dominated by amphibolites and biotite gneisses, and subordinate biotite and two-mica schists, quartz-feldspar gneisses, sillimanite-biotite and garnet-sillimanite-biotite schists, quartzites, quartzitic schists, a single layer of marble, garnet-pyroxene calciphyres and garnet amphibolites (Zagorchev, 2008 and references therein). Parts of the unit consist of varying in size orthogneiss bodies, as the larger one is the Bobevitsa orthogneiss (Zagorchev at al., 1973), dated at 616.9 ± 9.5 and 595 ± 23 Ma (Carrigan et al., 2006). A protolith age of 502.8 ± 3.2 Ma was obtained from hornblenede-biotite gneiss near Koprivshtitsa town (Peytcheva, von Quadt, 2004).

In spite of the previous descriptions of the Koprivshtitsa unit, our field observations show that it has more simple rock composition. The most abundant lithology is fine- to medium-grained metagranites, but intermediate and mafic protoliths are also presented. The metagranites (or two-mica orthogneisses) form relatively thin sheet-like bodies hosted within a section of mafic composition. Generally, the contacts of the sheets are parallel to the foliation fabric in- and outside the bodies, but locally slightly oblique contacts have been preserved as well. The foliation and lineation fabrics are defined by the preferred orientation of micas, quartz and feldspars. Main rock-forming minerals are quartz, plagioclase, K-feldspar, white mica, biotite and accessory titanite, zircon and apatite. The melanocratic part of the Koprivshtitsa unit comprises mainly biotite-amphibole and amphibole-biotite gneisses and rarely amphibolites. The gneisses are well-foliated rocks composed mainly of hornblende and biotite in varying proportions, and subordinate plagioclase, quartz, ± K-feldspar and accessories. The foliation is defined by the preferred orientation of hornblende and biotite, both composing more than 80% of the rock. Quartz and feldspars are presented as isolated elongated along the foliation grains or lens-shaped aggregates. Within the unit, bodies of porphyroclastic in K-feldspar biotite metagranites, metagranodiorites and metadiorites are locally presented. The relationships of these rocks with the metagranite sheets and their metamafic host still remain unclear. It is quite possible, that some of the metaigneous rocks are cogenetic with the Cadomian Bobevitsa orthogneisses.

Common feature of the Koprivshtitsa unit is a distinct E-W striking and generally steep dipping (60–80°) to the south metamorphic foliation. The lineation is moderately (20–40°) plunging to the south and southwest. Similar foliation and lineation trends are

common within the pile of the migmatitic gneisses of the Pirdop unit.

One sample of fine-grained leucogranite has been taken for a purpose of a U-Pb geochronology. The zircon population is of igneous origin with well preserved magmatic oscillatory zoning and morphologies. The cathodoluminescence images show that a number of grains preserved fine recrystallized rims, most probably related with the high-grade overprint. The isotope ages range between 400 and 560 Ma. The probability density plot shows an age data cluster between 470 and 525 Ma with a mean age of 497 ± 12 Ma, which is considered as the best approximation to the crystallisation age of the granite protolith. A group of analyses yielded ages ranging between 400 and 470 Ma. We are interpreting these results as an evidence of a certain Pb-loss and some rejuvenation related to the metamorphic overprint. Few single zircons and some cores have slightly older ages with peaks at ~600 and 750 Ma.

The detail characteristics of the Koprivshtitsa unit and the obtained ages show that certain parts of the Variscan high-grade metamorphic basement of the Central Sredna Gora Mountain represent fragments from a metamorphosed Upper Cambrian igneous complex. The newly obtained crystallization age of 497 ± 12 Ma of the metagranite corresponds well with the 502.8 ± 3.2 Ma age of the hornblende-biotite gneisses (Peytcheva, von Quadt, 2004) thus suggesting a nearly contemporaneous emplacement of both mafic and felsic igneous phases.

Additionally, the obtained Late Cambrian ages may have an important impact on the regional tectonic interpretations as up to date only the Cadomian ages have been considered to represent the age of this part of the Central Sredna Gora high-grade metamorphic pile (Zagorchev, 2008; Antonov et al., 2010). In the context of the last published geodynamic models for the neighbouring areas (Kounov et al., 2012; Antić et al., 2014 and references therein), we can assume that the formation of the Cadomian igneous fragments is linked to the Late Ediacaran–Early Cambrian subduction and related arc magmatism. Similarly, it appears that the Late Cambrian magmatism can be interpreted as a result of the Late Cambrian–Early Ordovician rifting event related to the initial opening of the Rheic Ocean.

In summary, the detail characteristic of the Koprivshtitsa unit is the first step into the restoration of the poorly studied pre-Variscan history of the Central Sredna Gora high-grade basement.

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Reference

Antić, M., I. Peytcheva, A. von Quadt, A. Kounov, B. Trivić, T. Serafimovski, G. Tasev, I. Gerdjikov. 2014. Geochronological and geochemical studies on crystalline rocks from the central Serbo-Macedonian massif with implications on its pre-Alpine evolution. – In: *Proceedings of XX CBGA Congress, Bull. Shk. Gjeol., Special Issue 1*., p. 195.

Antonov, M., S. Gerdjikov, L. Metodiev, Ch. Kiselinov, V. Sirakov, V. Valev. 2010. *Explanatory Note to the Geological Map of the Republic of Bulgaria in Scale 1:50 000. Map Sheet K-35-37-B (Pirdop)*. Sofia, Geocomplex, 99 p.

Carrigan, C., S. Mukasa, I. Haydoutov, K. Kolcheva. 2006. Neoproterozoic magmatism and Carboniferous high-grade metamorphism in the Sredna Gora Zone, Bulgaria: An extension of the Gondwana-derived Avalonian-Cadomian belt? – *Precam. Resurch*, *147*, 3–4, 404–416.

Gerdjikov, I., A. Lazarova, A. Kounov, D. Vangelov. 2013. High-grade metamorphic complexes in Bulgaria. – *Ann. Univ. Mining and Geol. "St. Ivan Rilski"*, *56*, I–Geol. and Geophis., 47–52.

Kounov, A., J. Graf, A. von Quadt, D. Bernoulli, J.-P. Burg, D. Seward, Z. Ivanov, M. Fanning. 2012. Evidence for a "Cadomian" ophiolite and magmatic-arc complex in SW Bulgaria. – *Precam. Res.*, *212–213*, 275–295.

Peytcheva, I., A. von Quadt. 2004. The Palaeozoic protoliths of Central Srednogorie, Bulgaria: records in zircons from basement rocks and Cretaceous magmatites. – In: *Extended Abstracts of 5-th International Symposium on Eastern Mediterranean Geology*, *Conf. Vol.* Thessaloniki, Greece, T11-9.

Zagorchev, I. 2008. Amphibolite-facies metamorphic complexes in Bulgaria and Precambrian geodynamics: controversies and "state of the art". – *Geologica Balc*., *37*, 1–2, 33–46.

Zagorchev, I., Ch. Dabovski, D. Tchunev. 1973. Tectonics of western part of the Sredna Gora metamorphic block (Sashtinska Sredna Gora). – *Rev. Bul. Geol. Sci.*, *37*, 1, 1–10 (in Bulgarian).