Metamorphic evolution of Gondwana-derived fragment in Ograzhden and Belasitsa Mountains, Serbo-Macedonian Massif, SW Bulgaria

Метаморфна еволюция на откъснат от Гондвана фрагмент в Огражден и Беласица, Сърбо-Македонски масив, ЮЗ България

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The basement of the Ograzhden Unit of Serbo-Macedonian Massif (SMM) is composed of high-grade metamorphic rocks – mainly amphibolite-facies gneisses (K-feldspar metagranitoids and plagiogneisses) associated with gneisschists, schists and amphibolites, as well as boudins and large bodies of eclogitized metaophiolites. Till now petrological and geochemical peculiarities of orthogneisses and metaophiolites have been reported (Zidarov, Nenova, 1995; Zidarov et al., 2003; Macheva et al., 2006; Nenova, Zidarov, 2008). In this study we put emphasis on metamorphic evolution of different rock types based on microstructural criteria, thermobarometric calculations and geochronological data.

Petrological and geochronological data, including morphology, CL-patterns and *in-situ* chemistry of zircons, argue for an inhomogeneous succession of the primary rocks. Granitic orthogneisses show excellent macro- and microstructural evidence for melting and formation of leucosomes and neosomes by anatexis: coarse patch antiperthite exolutions, destabilization and consumption of micas with formation of serrated edges, partially myrmekitization at the contact with newly formed K-feldspar and appearance of fibrolite aggregates, mainly in the neighboring quartz grains; microgranophyric intergrowths of quartz and alkali feldspar in patches between primary grains; veinlets of inferred former melt consisting of quartz, K-feldspar, or sodic plagioclase along inferred former intragranular fractures. Euhedral crystal faces of feldspars, corrosion of plagioclase grains at the contact with newly formed K-feldspar and small rounded or atoll-shaped garnet grains in leucosome indicate the formation of melt as well as traces of hydration, resulting from back-reactions, especially in the plagioclase, which is strongly altered at the rim.

On the contrary, plagioclase-bearing schists and plagiogneisses contain only coarse grained subsolidus quartz-feldspar veins without traces of melting. Their zircon population and zircon textures, as well as distinct geochemical characteristics argue for sedimentary origin of the precursors.

The whole succession of rocks, including the ortho- and parametamorphic rocks of the Ograzden Unit in the Bulgarian part of SMM, has suffered high-grade metamorphism at the upper amphibolite facies at temperature conditions T_{max} of 675–710 °C for Ograzhden Mountain and slightly lower T_{max} of ~650 °C for Belasitsa Mountain. Microstructual peculiarities also give some inferences for the metamorphic conditions. The presence of antiperthites in the leucosomes of orthogneisses and plagiogneisses points to metamorphic conditions in the upper part of amphibolite or granulite facies (Büsch, Mehnert, 1991). Recrystallization via grain boundary migration as well as combined basal and prismatic sliding in quartz (chessboard textures) occur at temperatures ~600 °C. Ultrahigh and high pressures have been estimated for the eclogitic metabasites near Gega and Gorna Ribnitsa villages, respectively (Zidarov, Nenova, 1995; Nenova, Zidarov, 2008). Amphibolitized eclogites are also found as lenses, boudins and concordant elongated bodies intercalating with orthogneisses, plagiogneisses and plagioclase-bearing schists. Consequently, we can suppose that either the whole succession of mafic and felsic rocks has undergone ultra-high/high pressure metamorphism, or that they were merged together during the Variscan collision. Pressure estimates range from P_{min} 6–8 kbar to 12–13 kbar based on 3T phengite relics and application of different calibrations of phengite barometer. However, higher pressures cannot be excluded due to evidence from the eclogitic metabasites.

Ortho- and parametamorphic rocks are dated with a combination of LA-ICP-MS and ID-TIMS U/Pb zircon methods. The oldest orthogneisses (Kolarovo metagranites), cropping out in Belasitsa Mountain, define two clusters of age data at 554.8±3.3 Ma and 510.2±3.5 Ma. The main peak of magmatic ages of the Ograzhden Unit is in the range of 450–455 Ma, which are measured in many outcrops of equigranular and porphyritic orthogneisses. The magmatic succession ended with the intrusion of gabbroic to dioritic rocks between 435 and 440 Ma (amphibolite lenses, boudins and concordant elongated bodies intercalating with orthogneisses, plagiogneisses and plagioclase-bearing schists). Gneiss-schists and plagiogneisses reveal a wide range of primary zircon ages – main peak at around 600 Ma and minor zircon populations at 700–800 Ma, 1000–1100 and 2400 Ma. The high-grade metamorphism has been dated in zircon rims of metasediments, vein rocks and amphibolites, as well as in xenotime of newly formed leucosome at ~330 Ma. The wide range of primary rocks, their major and trace element chemistry and Sr-Nd isotope signatures, combined with the age data of zircon populations, give evidence for an old crustal fragment with Gondwana affinity that was rejuvenated during Ordovician–Silurian time, before the collision and metamorphic overprint during the Variscan orogeny.

Apart from the Variscan metamorphism, an Alpine low-grade retrograde metamorphism could be assumed from lower-intercept U/Pb ages of the non-abraded zircons in the Ordovician–Silurian orthogneisses along with weak deformation of Triassic granitoids (Zidarov et al., 2007) and Rb-Sr mineral regression lines of metamorphic and pre-Oligocene magmatic rocks (Zidarov et al., 2009). These age data are scattered between late Early Cretaceous and Early to Middle Eocene and could be related to Early Cretaceous collisional tectonics and nappe-stacking of the adjacent Morava and Struma units north of the studied region (Kounov et al., 2010), or are generally Cenozoic, eventually caused by post-collisional doming and crustal relaxation events (Kounov et al., 2004; Antić et al., 2016).

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