U-Pb LA-ICP/MS zircon geochronology of metamorphic basement and Oligocene volcanic rocks from the SE Rhodopes: inferences for the geological history of the Eastern Rhodope crystalline basement

U-Pb LA-ICP/MS цирконова геохронология на метаморфния фундамент и олигоценски вулкански скали от ЮИ Родопи: изводи за геоложката история на кристалинния фундамент на Източни Родопи

Nikolay Bonev[1], Peter Marchev[2], Maria Ovtcharova[3], Robert Moritz[3], Alexey Ulianov[4]
Николай Бонев[1], Петър Марчев[2], Мария Овчарова[3], Роберт Мориц[3], Алексей Улянов[4]

[1] Department of Geology, Paleontology and Fossil Fuels, Sofia University “St. Kliment Ohridski”, 1504 Sofia, Bulgaria;
E-mail: niki@gea.uni-sofia.bg
[2] Department of Geochemistry and Petrology, Geological Institute, Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria
[3] Department of Mineralogy, University of Geneva, CH-1205 Geneva, Switzerland
[4] Institute of Mineralogy and Petrology, University of Lausanne, CH-1015 Lausanne, Switzerland

Key words: high-grade basement, U-Pb LA-ICP-MS geochronology, geochemistry, Eastern Rhodopes, Bulgaria.

The high-grade metamorphic basement of the Rhodope massif (RM) was considered traditionally as Precambrian in age. In the eastern RM Carboniferous granitoid protoliths were indentified in the lower high-grade basement unit, together with Carboniferous and Late Jurassic granitoid protoliths in the upper high-grade basement unit (Cornelius, 2008). However, an important part of the upper basement unit in the eastern RM is composed of metaophiolite association, whose age remains largely unknown. It consists of metaperidotites and metabasalts (Bonev, 2006 and references therein), including also metagabbros intruded by metaplagiogranites (Ovtcharova, Sarov, 1995). This contribution provides the first U-Pb zircon LA-ICP/MS ages on a suite of these rocks, along with zircon ages obtained from the dykes of alkaline basalts (Marchev et al., 1998) and overlying Paleogene volcanic rocks from the Iran tepe volcano (Marchev et al., 2010). Our goal is to compare the ages of metamorphic rocks with the ages of inherited zircons in the magmas, sampled from the entire metamorphic section, in order to constrain the geological history of the region and neighboring terranes.

Samples of a metagabbro and intruding metaplagiogranite and a sample of garnet-bearing amphibolite in the southern flank of the Kesebir-Kardamos dome (Bonev et al., 2006) were analyzed for whole-rock geochemistry and zircons were dated by U-Pb LA-ICP/MS technique in the University of Lausanne, Switzerland. In addition, a sample of Oligocene alkaline basalt dyke, intruding nearby metagabbro occurrence, and an andesite and dacite samples of the latest Late Eocene-Oligocene lavas of the Iran tepe volcano were dated by the same technique. All metamorphic rocks display amphibolite facies overprint on igneous mineral phases, being transformed into amphibolites and two-mica gneiss. Geochemistry of the metamafic rocks defines low-Ti tholeiitic gabbro-diorite protolith and granodioritic composition of the metaplagiogranite. N-MORB normalized trace element profiles of the metamafic rocks display high LILE/HFSE ratio, a negative Nb anomaly and HFSE-HREE enriched, close to slightly depleted relative to N-MORB. The metaplagiogranite sample exhibits similar to the metamafic rocks trace element patterns. Trace element geochemistry indicates MOR to SSZ signatures of the metamorphic rocks.

Cathodoluminescence of zircons from different metamorphic rocks revealed inherited cores within the zircon grains that show well-developed continuous oscillatory zoning from core to rim, which supports their magmatic character. The ***garnet amphibolite*** sample yielded a major zircon population that shows variation in $^{206}Pb/^{238}U$ ages from core to rim from 459 ± 4 Ma to 434 ± 4 Ma (with one exception down to 412 ± 3 Ma, which may be attributed to unresolved Pb loss, since the spot was taken close to the periphery of the grain). In the ***metagabbro*** sample, a zircon grain yielded a core age at 474 ± 6 Ma with a rim age at 456 ± 4 Ma and a rim age at 319 ± 4 Ma in another grain. Two zircon grains in the same sample yielded significantly younger ages: first grain revealed similar within the analytical uncertainty core and rim $^{206}Pb/^{238}U$ ages of 49.1 ± 1.3 and 47.8 ± 0.8 Ma. These dates are older than the latest metamorphic overprint in amphibolite facies, since the hornblende of this sample yielded a $^{40}Ar/^{39}Ar$ date of 39.21 ± 4.13 Ma (Bonev et al., this volume). The second young zircon from the same sample yielded rim $^{206}Pb/^{238}U$ ages of 31.5 ± 0.6 Ma and 32.6 ± 0.8 Ma. In the ***metaplagiogranite*** sample a single zircon shows indistinguishable within the analytical uncertainty core and rim ages and yields a mean $^{206}Pb/^{238}U$ date of 511 ± 5 Ma. Another zircon population revealed core to rim age variation between 468 ± 8 and 442 ± 4 Ma respectively. The two populations established in the ***alkaline basalts*** (303 ± 5 Ma and 460 ± 5 Ma) coincide with the ages of most distributed metamorphic lithologies in the region. The Iran tepe ***andesite*** shows inherited Variscan zircons of 306 ± 3 Ma. The ***dacite*** lava exhibits the largest variability of zircons with a single core of Neoproterozoic (641 ± 5 Ma) and Ordovician (457 ± 4 Ma) rim. Other 3 zircons show one narrower age interval with Variscan age (291 ± 6 Ma) and larger scatter from 267 ± 4 to 168 ± 1 Ma, which can be attributed to a combination of different growth zones, recrystallization and Pb loss effect in a singe spot analyses.

The obtained results reveal an important understanding in the pre-Alpine evolution of the Eastern Rhodopes. For the first time, they document the existence of a major phase of Ordovician arc magmatism with inherited Pan-African crustal components, which have experienced Carboniferous, and likely Jurassic and Tertiary metamorphic overprint. The Permo-Carboniferous ages, obtained from zircons in the alkaline basalts and Iran tepe lavas, most probably come from the lower high-grade unit, underlying the metamafic rocks. Recent zircon dating within RM and adjacent zones (terranes) revealed limited Neoproterozoic and regionally present Ordovician, Silurian, Permo-Carboniferous, Triassic and Jurassic magmatic components that had participated in the crustal build-up of the high-grade basement (Peytcheva, Quadt, 1995; Carrigan et al., 2003; Liati, 2005; Himmerkus et al., 2009; Peytcheva et al., 2009). Occurrences of similar lithologies with similar ages in a range of "terranes" suggest that, most probably, they have originated as a single terrane of Gondwana margin origin affected by later tectonic events.

Acknowledgements: The study was supported by SNSF SCOPES grant IB7320-111046/1 and NSF grant VU-NZ 02/06.

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