Late-Jurassic granulite facies metamorphism of garnet-bearing metabasic rocks from the Chepelare area, Central Rhodope

Късноюрски метаморфизъм в гранулитов фациес на гранатсъдържащи метабазити от района на Чепеларе, Централни Родопи

Milena Georgieva[1], Valerie Bosse[2], Zlatka Cherneva[1], Pierre Gautier[3], Ianko Gerdjikov[1], Massimo Tiepolo[4]
Милена Георгиева[1], Валери Бос[2], Златка Чернева[1], Пиер Готие[3], Янко Герджиков[1], Масимо Тиеполо[4]

[1] Sofia University “St. Kliment Ohridski”, 15 Tsar Osvoboditel Blvd., 1504 Sofia, Bulgaria; E-mail: milena@gea.uni-sofia.bg; cherneva@gea.uni-sofia.bg; janko@gea.uni-sofia.bg
[2] Université Blaise Pascal, Laboratoire Magmas et Volcans, UMR 6524 CNRS, 5 rue Kessler, 63000 Clermont Ferrand, France; E-mail: V.Bosse@opgc.univ-bpclermont.fr
[3] Université Rennes 1, Géosciences Rennes, UMR 6118 CNRS, Campus de Beaulieu, 35042 Rennes, France; E-mail: pierre.gautier@univ-rennes1.fr
[4] CNR – Istituto di Geoscienze e Georisorse, University of Pavia, Italia; E-mail: tiepolo@crystal.unipv.it

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Introduction and geological setting

The Eo-Alpine evolution of the Rhodope region includes Late-Jurassic magmatic and metamorphic evens. The latter are documented in the Greek Rhodope by UHP relics and granulite facies overprints (Bauer et al., 2007, and references therein). Recently Bosse et al. (2010) reported Late-Jurassic metamorphic ages of granulite facies garnet-kyanite gneisses from the Chepelare area in the Bulgarian Rhodope. Garnet-bearing metabasic rocks that also keep record of granulite facies metamorphism (Georgieva et al., 2010) crop out in close spatial relations with garnet-kyanite gneisses. We present first results of in situ LA-ICP-MS dating of zircons in garnet-bearing metabasic rocks, whose protoliths suffered Late-Jurassic metamorphism.

The rocks of study belong to the variegated rock assemblage known as Chepelare Formation or Chepelare mélange. They crop out in the Arda tectonic unit and coincide with an ~1 km-thick zone of intense strain termed the Chepelare Shear Zone (Gerdjikov et al., 2010). The CSZ has previously been interpreted as a synmetamorphic thrust of presumed Mesozoic age, but recent data indicate that it was active during Late-Eocene. The garnet-bearing metabasic rocks crop out as elongated lenses of metric to decametric scale and alternate with marbles, garnet-kyanite gneisses and schists, biotite or two-mica gneisses and ultramific bodies.

Materials and methods

The sample represent a small body (1 × 0.5 m) situated between biotite gneisses and impure marbles along the road to the marble quarry to the East of town of Chepelare, above the thickest level of garnet-kyanite gneisses. The core of the metabasic body is nearly massive, with well visible garnet porphyroblasts. The rim is foliated, garnet-free and smaller grained. We used the core part samples for metamorphic conditions estimates and age determination. Microprobe of major minerals and U-Th-Pb analyses on zircon by LA-ICP-MS were carried out in thin sections.

Petrography and mineral chemistry

The peak metamorphic assemblage consists of garnet porphyroblasts, abundant clinopyroxene in the matrix and plagioclase. The texture is granoblastic with millimetric pockets of felsic minerals aggregates suggesting former presence of melt. Amphibole replaces clinopyroxene and forms intergrowths with plagioclase along garnet rims marking high-grade retrogression. Secondary biotite appears along the foliation planes. Rutile, titanite, opaque and zircon are abundant accessory phases. Garnet grains display weak prograde zonation (core-to-rim resp. Alm 60→56, Grs 23→25, Pyr 14→17, Sps 5→2) with thin resorbtion rim. Clinopyroxene is diopside with low Al_2O_3 and Na_2O content and XMg 0.63–0.68. Reaction rim plagioclase

is andesine ($An_{40–47}$). Amphibole situated close to the garnet as part of reaction rims is slightly enriched in alkalis edenite-hastingsite with XMg 0.47–50. The peak assemblage Grt-Cpx-Pl suggests HP granulite facies conditions. These characteristics correspond with the major petrologic features of Grt-Cpx-bearing metabasic rocks in the Chepelare variegated assemblage described in Georgieva et al. (2010). The latter gives an idea of a possible reaction of peak metamorphic assemblage production: Hbl + Pl + Qtz = Grt + Cpx + melt. Preliminary P–T estimates of the studied samples yield 800–850 °C at 1 GPa for Grt-Cpx pairs and 750–800 °C/0.7–1 GPa for the Grt-Amph-Pl reaction rim. These new mineral chemistry data and P–T estimates are close to or overlap the previous ones reported for garnet-bearing metabasics from the Chepelare mélange (750–850 °C/0.9–1.5 GPa – matrix assemblage; 700–800 °C/1.2–1.4 GPa – garnet inclusions; Georgieva et al., 2010), with pressure deviating towards lower values.

Zircon dating results

Zircons are very abundant in the metabasic body of study and occur as inclusion in garnet and in the matrix. Cathodoluminescence images show that most of the small grains (30 to 100 μm) have a dark rounded core surrounded by a large bright rim, whereas the larger grains (100 to 250 μm) display bigger patchy zoned cores and bright rims of different width. $^{206}Pb/^{238}U$ and $^{205}Pb/^{235}U$ ages have been obtained in thin sections by LA-ICP-MS at CNR Pavia, Italy. The spot size is 30 μm and in many cases it was impossible to analyze only rim of core of the zircons, thus some of results represent mixed ages. They are scattered between 161 ± 5 Ma and 131 ± 5 Ma. The cores of the large grains tend to slightly older ages (150–155 Ma, most frequent), whereas the rims of the small rounded grains are slightly younger (135–140 Ma, most frequent). LA-ICP-MS data of trace elements contents in dated zircon grains help for distinguishing between core and rim formation. The zircon cores are enriched in HREE and Y when compared with the zircon rims that is consistent with the presence of garnet during zircon rim growth. Thus we refer zircon cores to the protolith, and zircon rims growth contemporaneous with suggested garnet production reaction at granulite facies metamorphism.

Conclusions

Late-Jurassic granulite facies record is preserved both in metabasics and metapelite lithologies in the Chepelare variegated rock assemblage (Georgieva et al., 2007; Georgieva et al., 2010; Bosse et al., 2010). The preliminary geochronological results show that zircons in the studied metabasic rocks record Mesozoic ages only, between 161 ± 5 Ma and 131 ± 5 Ma. The group of old ages at around 150–155 Ma corresponds to the protolith ages probably whereas the younger ones at around 135–140 Ma correspond to the time of the granulite facies metamorphism. These new results are in the same Late-Jurassic range as the monazite ages obtained in the nearby Grt-Ky gneisses reported in Bosse et al. (2010). Our attempts to combine petrological and geochronological data for different rocks from the Chepelare variegated complex open new questions regarding regional scale importance of the Chepelare shear zone and Rhodope metamorphic evolution.

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