New data on mid-Mesozoic migmatization in the Central Rhodope

Нови данни за мезозойска мигматизация в Централните Родопи

Zlatka Cherneva[1], Milena Georgieva[1], Ianko Gerdjikov[1], Valentin Grozdev[2], Elena Stancheva[2]
Златка Чернева[1], Милена Георгиева[1], Янко Герджиков[1], Валентин Гроздев[2], Елена Станчева[2]

[1] Sofia University "St. Kliment Ohridski", 15 Tzar Osvoboditel Blvd., 1504 Sofia; E-mail: cherneva@gea.uni-sofia.bg
[2] Geological Institute of the Bulgarian Academy of Sciences, "Acad. G. Bonchev" str., bl. 24, 1113 Sofia

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Introduction

Recent studies provide evidence of mid-Mesozoic metamorphic event in the Rhodope metamorphic complex. Data available support an interpretation of HP granulite facies conditions that favoured dehydration partial melting (Bosse et al., 2010; Georgieva et al., 2010, 2011; Didier et al., 2014) after an earlier UHP event. The granulite facies record is preserved in different types of rocks in the Chepelare Shear Zone (Bulgaria) and in the Nestos Shear Zone (Greece). Among the rocks studied, garnet-bearing migmatites, in particular garnet-bearing leucosomes, indicate fluid-absent melting in contrast to the widespread garnet-free Cenozoic migmatites in the Rhodope, which resulted from fluid-assisted melting (Cherneva, Georgieva, 2005). In maintenance of this opinion we present new geochronological and geochemical data on garnet-bearing migmatite from the area of Mechi Chal peak SW of Chepelare. It is well known (Kostov et al., 1962) that the rocks from this locality are part of the Chepelare Shear zone (Formation).

Samples and methods

Zircon separates of garnet-bearing migmatite (sample HP36; E 24.666, N 41.692) were studied by LAICP-MS at the Geological Institute, Bulgarian Academy of Sciences. The petrological characteristics of the sample are given in Cherneva et al. (2008). The rock comprises quartz, K-feldspar ($Ab_{25}Or_{75}$), plagioclase ($An_{15–17}$), garnet ($Alm_{46–58}Prp_{12–15}Grs_{22–27}Sps_{3–4}$), minor biotite (XFe 0.45–0.48) and magnetite. The accessory minerals assemblage includes allanite, apatite, zircon and rutile. The approximate conditions of melting are in the range 1.6–1.9 GPa/800–850 °C according to conventional thermobarometric estimates. The whole-rock Zr-content (296 ppm) exceeds melt saturation at 800–850 °C (147–251 ppm after Watson, Harrison, 1983) thus indicating inheritance of precursor's zircon.

Results

Zircon grains are short-prismatic to prismatic, transparent, and pale yellowish to colourless. The internal structures imaged by BSE and CL give directions of two zircon populations. Larger (125–200 µm) short-prismatic grains are weakly planar and sector zoned with scarce chaotic zoned cores, like metamorphic zircon of granulite facies (Corfu et al., 2003). Smaller (63–125 µm) prismatic grains display magmatic oscillatory zonation. Some of them contain homogeneous or weakly zoned interiors and/or narrow (<30 µm) outermost bright and featureless in CL rims that cut discordantly into mantles, often filling embayments.

The results of dating distinguish two groups of zircons, namely: mid-Mesozoic 139–148 Ma, and late-Paleozoic 271–308 Ma. The Mesozoic age (average 144.1±1.8 Ma) is characteristic of larger short-prismatic grains. The only analyzed core (chaotic zoned) yields 166.9±2.2 Ma. The late-Paleozoic ages are typical for smaller prismatic grains, whose interiors tend towards a bit older age (average 297±10 Ma), when compared to the oscillatory bands (average 285±11 Ma). An outer rim of growth after resorption, wide enough to be analyzed, yields 147.1±9.88 Ma. Summarized results suggest mid-Mesozoic growth of zircon that occurs as whole grains or as overgrowth rim around inherited late-Paleozoic magmatic zircons.

Trace elements data complete mid-Mesozoic and late-Paleozoic zircons characteristics. The strongest distinguishing features refer to REE, U, and Th. The normalized REE patterns display HREE enrichment, positive Ce- and negative Eu-anomaly. The Mesozoic zircons differ with lower REE sum (94–384 ppm) and lower Lu/Gd ratio (0.24–0.49) when compared to more variable late-Paleozoic ones (174–1655 ppm and 0.16– 0.13 respectively). It is known that zircon in apparent equilibrium with metamorphic garnet has distinctive flat HREE patterns and overall reduced REE abundances compared to pre-metamorphic magmatic grain (Schaltegger et al., 1999; Rubatto, 2002). Negative Eu-anomalies indicate partitioning between zircon and coexisting feldspars in both zircon populations. The mid-Mesozoic zircons have low Th/U ratios (<0.1) typical for metamorphic origin (Williams et al., 1996; Rubatto et al., 2001) and reflect a competition for Th between zircon and allanite in our sample. Higher Th/U ratio values of late-Paleozoic zircons (0.3–1.7) correspond to their magmatic origin.

Ti-in-zircon thermometer (Ferry, Watson, 2007) provides estimates of zircon crystallization temperature. The contents of Ti are strongly variable with average values of 7.4±5.3 ppm for the Mesozoic zircons and 8.3±5.5 ppm for the late-Paleozoic ones. The average thermometric results are 727±48 °C and 752±50 °C respectively. The discrepancy between conventional and Ti-in-zircon thermometry is not surprising since the later records growth or re-equilibration of zircon after cooling from peak temperatures (Ewing et al., 2013).

Discussion and conclusions

The new data support an interpretation of mid-Mesozoic fluid-absent melting in a upper-Paleozoic orthometamorphic protolith. Similar results report Georgieva et al. (2011) from rocks situated 5 km eastward in the Chepelate Shear Zone, where garnet-bearing migmatitic gneisses have similar petrology, and ranges of monazite and zircon ages (137–144 Ma and 123–144 Ma respectively). Likewise, zircon cores and their oscillatory zoned envelopes yield Paleozoic ages (250–320 Ma), while the rims are Mesozoic. The later display geochemical features like reported above with low Th/U ratio and flat HREE patterns reflecting similar condition of HREE and Th distribution between zircon, garnet and monazite in this instance.

Evidence of fluid-absent granulite facies melting in the Rhodope Mesozoic evolution emphasize the importance of garnet-bearing quartz-feldspar leucosome segregations in different rocks as a distinctive feature of the process in the field.

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