СПИСАНИЕ НА БЪЛГАРСКОТО ГЕОЛОГИЧЕСКО ДРУЖЕСТВО, год. 79, кн. 3, 2018, с. 49–50
REVIEW OF THE BULGARIAN GEOLOGICAL SOCIETY, vol. 79, part 3, 2018, p. 49–50
National Conference with international participation "GEOSCIENCES 2018"

Polymetamorphic evolution of Parvenets complex, Bulgaria – U-Th-Pb monazite geochronology and geochemistry

Полиметаморфна еволюция на Първенецкия комплекс, България – U-Th-Pb геохронология и геохимия на монацити

Milena Georgieva[1], Valerie Bosse[2], Zlatka Cherneva[1], Tzvetomila Vladinova[1]
Милена Георгиева[1], Валери Бос[2], Златка Чернева[1], Цветомила Владинова[1]

[1] Sofia University "St. Kliment Ohridski", Tsar Osvoboditel Blvd., 1504 Sofia, Bulgaria; E-mails: milena@gea.uni-sofia.bg; cherneva@gea.uni-sofia.bg; tsvetty@gmail.com
[2] Université Clermont Auvergne (UCA)-Clermont Ferrand, France, Campus universitaire des Cézeaux, 6 av. Blaise Pascal; E-mail: V.Bosse@opgc.univ-bpclermont.fr

Keywords: monazite, U-Th-Pb geochronology, polymetamorphism, Parvenets complex, Bulgaria.

Introduction and geological setting

Parvenets complex comprises the northernmost parts of the Central Rhodope Mountains and was attributed by different authors both to the Srednogorie Zone and the Rhodope Massif. According to Sarov (2012), the Parvenets complex is part of the Thracian Lithotectonic Unit, affected by the Maritsa Dextral Strike-Slip Shear Zone. New structural and geochronological studies suggest a polymetamorphic history for some parts of the Thracian Unit, with a high-grade metamorphism, followed by greenschist alpine metamorphic overprint (Naydenov et al., 2008). We present monazite geochronology data on kyanite-andalusite gneisses (in the vicinity of Hrabrino village) in order to reveal the polymetamorphic history of the Parvenets complex.

Analytical methods and samples description

Mineral chemistry and U-Th-Pb analyses of monazite were carried out by EMP and LA-ICP-MS (*in situ*, 9 µm spot size) at the Laboratoire Magmas & Volcans in Clermont-Ferrand, France. The studied samples are fine grained with quartz- and plagioclase-dominated matrix with intense final static recrystallization. Petrographic studies and Perple_x modeling recognized two metamorphic associations: relict (garnet-kyanite-biotite-white mica-plagioclase-quartz-rutile ±staurolite, at 620–685 °C and 1.25 to 0.7 GPa) and syn- to post-kinematic (andalusite-biotite-plagioclase-chlorite-white mica, at 600–480 °C and below 0.4 GPa). Large monazite and zircon grains are present as inclusions in plagioclase porphyroclasts and within the matrix. Xenothime, rutile and abundant opaque minerals are also present.

Monazite geochronology and geochemistry

Monazite inclusions in plagioclase porphyroclasts are rounded to subhedral grains (30 to 85 µm), slightly elongated sub-parallel to the inner foliation. One grain is strongly resorbed and surrounded by smaller rounded satellite grains (4 to 20 µm). Monazite inclusions yielded a concordant age of 303.7±3.3 Ma (2 σ level) and intercepts at 303.6±3.1 and 5526±460 Ma (MSWD = 0.24) on the Tera-Wasserburg concordia diagram (Fig. 1). Matrix monazites (40 to 70 µm) vary in shape, from euhedral to rounded single grains, or form clusters of rounded to resorbed grains. They associate with biotite bands and garnet fragments, but

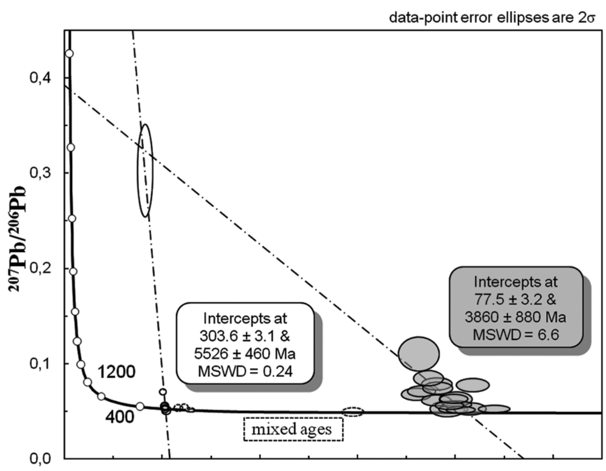

Fig. 1. Tera-Wasserburg concordia diagram for LA-ICP-MS data of all analyzed monazites

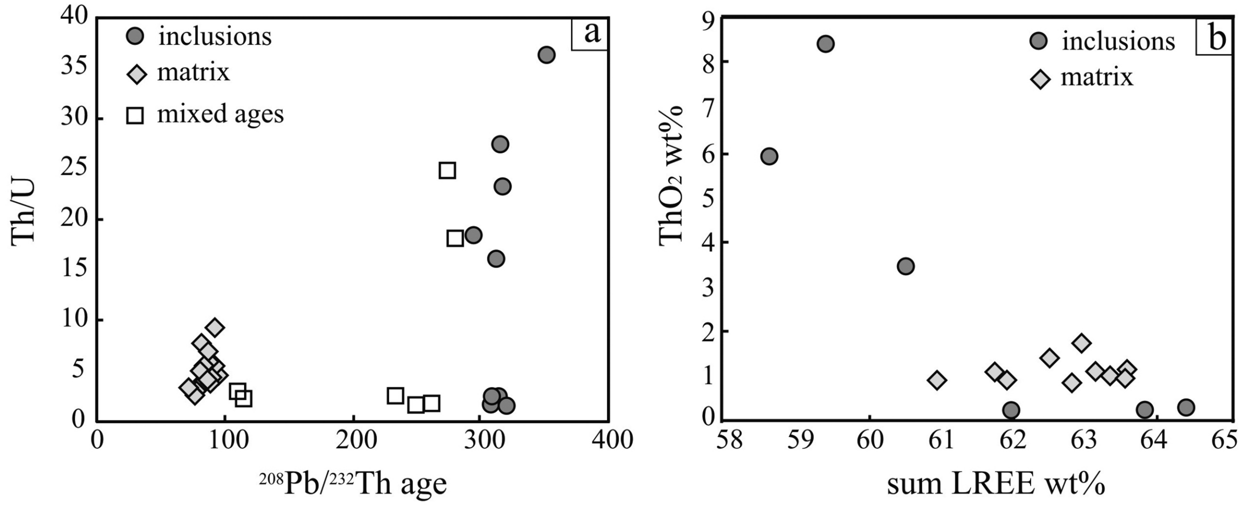

Fig. 2. *a*, Th/U vs. $^{208}Pb/^{232}Th$ ages of studied monazites, LA-ICP-MS data; *b*, ThO_2 vs. sum LREE (La-Sm, Gd), EMP data

are also present in the quartz-plagioclase matrix. The $^{208}Pb/^{232}Th$ ages range from 72.2±2.3 Ma to 89±3.1 Ma (2 σ level) and do not yield concordant age. On the Tera-Wasserburg diagram, most analyses plot close to the lower intercept age of 77.5±3.2 (MSWD = 6.6) (Fig. 1). Mixed ages scatter between these two distinct groups.

Monazite inclusions show high variation in Th/U ratio (from 1.6 to 36, av. 14.4) compared to the matrix grains (from 2.6 to 9.3, av. 5) (Fig. 2a). Higher Th/U ratio and ThO_2 content are typical for the magmatic or high-grade metamorphic monazites (Engi, 2017). Single resorbed monazite in plagioclase yielded the highest ThO_2 content, lowest LREE (Nd, Sm, Gd) and lowest Y_2O_3 content (Fig. 2b). The observed variations in the composition of monazite inclusions prevent the geochemical discrimination of the grains in terms of their textural position and age.

Discussion and conclusions

Monazite geochronology is a powerful tool in studying the complex history of metamorphic rocks. In our samples monazites record two different tectonothermal events: Variscan and Late Cretaceous. The Variscan event (303.7±3.3 Ma) could be related to high-grade metamorphism during the intrusion of Parvenets complex gneiss and amphibolite protoliths (330–340 Ma to 302–312 Ma; von Quadt et al., 2006). Monazite growth occurred again at lower pressure between 72 and 89 Ma and coincides with the Late Cretaceous magmatic activity along the Maritsa Strike-Slip Shear Zone (e.g., Kapitan Dimitrievo pluton 78.7±1.8 Ma; Kamenov et al., 2003). These new geochronological data together with petrography and thermodynamic modeling provide more evidence for complex polymetamorphic history of Parvenets complex.

Acknowledgements: This study was supported by National Scientific Fund, project DN 14/5 2017.

References

Engi, M. 2017. Petrochronology based on REE-minerals: monazite, allanite, xenotime, apatite. – In: Kohn, M. J., M. Engi, P. Lanari (Eds.). *Petrochronology*: *Methods and Applications. Reviews in Mineralogy and Geochemistry*, *83*, 365–418.

Kamenov, B., A. von Quadt, I. Peytcheva. 2003. Capitan Dimitrievo pluton in central Srednogorie, Bulgaria: Mineral chemistry, geochemistry and isotope evidence for magma-mixing origin. – *Geochem.*, *Mineral. and Petrol.*, *40*, 21–53.

Naydenov, K., K. Kolcheva, S. Sarov, E. Voynova, N. Petrov. 2008. Data on the structural and metamorphic evolution of the rocks from the Tracian unit between the towns of Asenovgrad and Kostenets. – *Rev. Bulg. Geol. Soc.*, *69*, 1–3, 27–37.

Sarov, S. 2012. Lithotectonic subdivision of the metamorphic rocks in the area of Rila and Rhodope Mountains – results from geological mapping at scale 1:50 000. – In: *Proceedings of the International Conference "The School of Prof. Zh. Ivanov"*, 43–47.

von Quadt, A., S. Sarov, I. Peytcheva, E. Voynova, N. Petrov, K. Nedkova, K. Naydenov. 2006. Metamorphic rocks from northern parts of Central Rhodopes – conventional and in situ U-Pb zircon dating, isotope tracing and correlations. – In: *Proceedings of the National Conference "GEOSCIENCES 2006"*. Sofia, Bulg. Geophys. Soc. and Bulg. Geol. Soc., 225–228.