Pirin tectonometamorphic evolution: isotopic data and partial revision

Тектонометаморфна еволюция на Пирин: изотопни данни и частична ревизия

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The Pirin-Pangaion tectonic unit has been introduced (Zagorčev, 1994) as the lowermost tectonic unit within the Rhodopes tectonic edifice. Recently published U-Pb isotopic data on zircons (Machev, Ovtcharova, 2008; Jahn-Awe et al., 2010; Zagorchev et al., 2012, 2014; Filipov, Marchev, 2012) and additional new information by LA-ICP-MS U-Pb studies on zircons from the metamorphic and igneous rocks of Pirin Mountain enable a partial revision of the older concepts about its tectonometamorphic history.

The Pirin-Pangaion unit consists of 3 subunits, only the northernmost one (Pirin subunit) cropping out on Bulgarian territory. The Pirin subunit has a heterogeneous structure due to the polymetamorphic and polydeformational history, and the intrusion of the Northern Pirin (Dautov, Kresna), Central Pirin and Southern Pirin (Teshovo) plutons in Early Oligocene times. The following areas are recognized within the subunit: (1) NW (Krupnik) area to the NW of the North Pirin pluton; (2) Sinanitsa area between the North Pirin and the Central Pirin pluton; (3) Southern Pirin area; (4) western (Lilyanovo-Petrovo) area that corresponds to the sigmoidal Petrovo anticline; (5) eastern area (crops out as a discontinuous strip between Bansko and Gotse Delchev, and represents the southwest-vergent thrusted rim of the West-Rhodope unit). Whereas the ages of the granitoid bodies are relatively well constrained, the isotopic studies within the 5 areas of metamorphic outcrops are restricted mostly to area (1), with only two determinations from area (3) distinguished above.

The NW (Krupnik) area is built up by rocks of the amphibolite facies Rupchos Group of the Rhodopian Supergroup. Their polymetamorphic evolution has been proven (Zagorchev et al., 2012) by LA-ICP-MS U-Pb isotopic studies on zircons. The following metamorphic and igneous events have been recognized: (i) Cadomian (528–517.5±1.3 Ma) for an amphibolite-facies metamorphic event with quartz-feldspar veins; (ii) Late Hercynian (Permo–Triassic) Krupnik porphyric granite and quartz-feldspathic foliation-conformable veins (237.7±1.9 Ma, 240.45±0.43 Ma); (iii) intrusion of the Early Oligocene North-Pirin (Dautov, Kresna) granite pluton (31.71±0.15 Ma). No data about a Hercynian (ca. 300 Ma) metamorphic event has been established at that time although such event is widespread in the other parts of the Rhodopes, and in the Southern Pirin area. During our new studies, we concentrated on the very important metamorphic septum (Zagorchev, 1995; Zagorchev et al., 2012) that had been preserved as a thin (tens to few hundred meters) rim between the Kresna and the Krupnik pluton, a phenomenon that has been found during the geological mapping in 1966/67, and confirmed during all consequent geological studies (see Zagorčev, 1994). The septum is built up of an alternation of all major rock varieties of the Rupchos Group: biotite and two-mica gneisses and schists, amphibolites and marbles. Biotite and two-mica gneisses and amphibolites have been subject of intense granitization (quartz-feldspar metasomatosis, and anatexis), and transformed into nebulites with ghost structures of former foliation and metamorphic banding; granitized former boudins initially built up of amphibolites have been transformed into hornblende-biotite gneisses. The anatexites are cross-cut by Krupnik granite dykes. The analysis of the U-Pb zircon data from the nebulites of the septum indicates a concordant zircon age of ca. 305.5±2.8 Ma, and a Discordia of zircon figurative points with upper intercept with the Concordia at 333±22 Ma. Most of the individual data points vary between ca. 339 Ma and 238 Ma (age of the Krupnik pluton), with a few Mesozoic ages and 3 data points between 49.5 and 37 Ma obviously influenced

by the youngest nearby intrusion of the Kresna granite. It is of utmost importance that the isotopic data confirm the existence within the septum of a major Hercynian (at ca. 300 Ma) metamorphic and anatectic event; its resultant diatexites and nebulites have been insignificantly influenced by the later granitoid intrusions, a fact already inferred on purely geological grounds and observations (Zagorchev, 1995).

The southern Pirin area has been previously subject of a single U-Pb determination (Machev, Ovtcharova, 2008) on the so-called Kriva Reka metagranites (Bachkovo Formation) of ca. 300.1±2.3 Ma interpreted by them as intrusion age. We obtained a concordant zircon age of 289.6±1.8 Ma from the same rocks at the same place (near the fountain at the monument of Sandanski). A similar age of 300.8±1.8 Ma has been obtained by us on a sample from gneisses of the Lukovitsa Varied Formation at several hundred meters from the monument, and near the boundary with the Dobrostan Marble Formation. Therefore, we interpret these dates as the age of the Hercynian amphibolite-facies metamorphism. Massonne (2016) reported a high-pressure event (garnet-phengite association) recorded within an andalusite-bearing garnet micaschist from the Lukovitsa Formation sampled close to our Hercynian zircon sample. The culmination of this event is estimated by him at ca. 16 kbar and 500 °C. He is pretending to date this event by monazite at a mean age of 45.8±5.8 Ma (garnet core) to 42.1±5.2 Ma (outer garnet mantle). As far as the single monazite grains dated cover continuously the range between ca. 82 and 25 Ma (Massonne, 2016, Figs. 8 and 9), we interpret the monazite apparent ages as the result of the thermal influence of the Palaeogene (Palaeocene–Ypresian and Late Eocene–Early Oligocene) igneous events responsible also for the late andalusite crystallization; this LP-HT event has been known since a long time (e.g., Boyadjiev, 1959), and has always been related to the nearby granite intrusions.

The complex fold structure of the Pirin subunit (Zagorčev, 1994) has been disrupted and intruded by the Spanchevo pluton (55.05±0.59–57.23±0.58 Ma, Jahn-Awe et al., 2010; Zagorchev et al., 2014) and the Late Eocene–Early Oligocene (37–32 Ma) North-Pirin, Central-Pirin and Teshovo granite plutons (Filipov, Marchev, 2012; Zagorchev et al., 2014). We wish also to emphasize again on the presence of a Mid-Palaeogene compressive event of thrusting along the Strymon Thrust after the intrusion of the Spanchevo pluton, and before the new intrusions in conditions of extension in Late Eocene to Early Oligocene times that were also responsible for the formation of the Mesta volcanic complex.

Conclusions

The U-Pb zircon data obtained within the Rhodopian Supergroup in the Pirin subunit of the Pirin-Pangaion tectonic unit confirm their polymetamorphic and polyphase geodynamic evolution, with the main events of (i) Cadomian amphibolite-facies metamorphism; (ii) Hercynian amphibolite-facies metamorphism; (iii) Permo–Triassic granite intrusion; (iv) Palaeogene igneous episodes in at least two single extensional events separated by compression and thrusting; (v) final exhumation by normal faulting and uplift in Neogene times.

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