Paleozoic granitoid magmatism in NW Stara planina, Bulgaria

Палеозойски гранитоиден магматизъм в СЗ Стара планина, България

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The magmatic associations (complexes) in NW Stara Planina were grouped in Precambrian (Neoproterozoic) ophiolites, Cambrian island arc magmatic association (established only in W Carpathians segment of the same orogenic belt) and Variscan post-collisional, mainly acid magmatic (plutonic and volcanic to subvolcanic) rocks (Haydoutov, 1989; Haydoutov et al., 2010). The U-Pb zircon dating of a metagabbro from the Tcherni Vrah massif determine the Neoproterozoic age (563±5 Ma) of the ophiolite complex (Von Quadt et al., 1989). Rocks with volcanic arc affinities in NW Bulgaria are volcanics intercalated with Paleozoic terrigenous sediments (Haydoutov, 1989). Cambrian plutonic rocks with VA characteristics are established in the Tran region (Dyulgerov et al., 2006) and in the Kraishte zone (Kounov et al., 2012). The Variscan granitoid magmatism in Western Stara planina is characterized by many publications, but zircon U-Pb ages are presented by Carrigan et al. (2005) and Peytcheva et al. (2006). The Variscan volcanic and subvolcanic magmatism in NW Stara Planina occur at the end of the orogenic cycle. Based on stratigraphic data it is determined as Late Carboniferous to Early Permian (Čunev et al., 1965; Cortesogno et al., 2004). It is controlled by graben structures and it has calc-alkaline composition. Despite the volcanic-arc geochemical signature of the rocks, their geologic and tectonic evolution defines the magmatism as post-collisional (Cortesogno et al., 2004).

Results and interpretation

The studied area is situated in W Stara Planina, between Kopilovtsi village and Kopren summit, W and SW of the village. The Diabase-phyllitoid complex (DPC) in the studied area comprises rocks of the ophiolite complex (metagabbros, metagabbrodiorites and metadorites and chlorite-amphibole schists) and metasedimentary foliated sericite and chlorite-sericite schists. The metagabbro and metadiorites are foliated also at their periphery, but have preserved magmatic textures in their central parts. The Kopren granitoid pluton (considered as Variscan – Čunev, 1968) is intruded in DPC in the SW part of the study area. It is elongated in southern direction (~4 km) covering ~3 km^2. The pluton has partly deformed periphery, where the superimposed foliation is parallel to the main metamorphic foliation within the host schists. In central parts the rocks have well preserved medium to coarse grained granitic and porphyroide magmatic textures. The pluton is composed mainly by tonalites and less by granodiorites. Tonalites have euhedral, partly albitized or sericitized plagioclase ($An_{27–63}Or_{2–7}$, but mainly andesine) and euhedral to subhedral Mg-hornblende. Quartz (18 to 25%) is anhedral. Biotite (small amounts) is chloritized. The granodiorite differs mainly by plagioclase that varies from $An_{12}Or_1$ to $An_{37}Or_3$ and the accessory phase is zircon. The temperature of crystallization is 760 to 850 °C, H_2O=2.3–4.5 wt%, fO_2=NNO+1.4 – NNO+2 (according to Ridolfi et al., 2010).

Two morphologic types of subvolcanic bodies are established in the central and eastern parts of the area. One relatively big body elongated in SSE direction (~160°) with length ~2.2 km, 200–600 m wide and outcrop about 0.8 km^2. The others subvolcanic bodies are mainly dikes with thickness up to 8 m and SE direction (120–150°). The big subvolcanic body crosscut the Kopren pluton and it is formed in 2 impulses (granodiorite porphyries and granite porphyries). Brecciated domains are also established. The dikes demonstrate more variegated composition (porphyritic quartz diorites, porphyritic quartz monzodiorites, granodiorite porphyries and granite porphyries) with fine to coarse porphyritic texture. The ground mass is holocrystalline, fine to micrograined. In most of the subvolcanic rocks the plagioclase are albitized and mafic minerals are chloritized, carbonatized, and sericitized. Alkaline feldspars are Na-K feldspar. Accessory minerals are apatite, ore minerals and zircon. At the western part

of the studied area the magmatic rocks are covered by transgressive Lower Permian terrigenous sediments.

The Kopren rocks have calc-alkaline composition with slightly raised potassic alkalinity due to the sericitisation. The primordial mantle normalized pattern show clearly pronounced negative anomalies of Nb and Ti. The ORG normalized values for the more incompatible elements (Sr, K, Rb and Ba) are low (1–10) and Nb show again a negative anomaly. The chondrite normalized pattern is flat with $La_n/Yb_n = 2$ with slight negative Eu anomaly (Eu/Eu* = 0.75). All the subvolcanic rocks are calc-alkaline and nearly the half are corundum normative (mainly the more acid). The ORG normalized patterns for the subvolcanic rocks are similar to the patterns of volcanic arc granitoids in Pearce et al. (1984). The granodiorite porphyries are with Ba negative anomaly analogous to the pattern of the Chilean granites. Those of the granite porphyries are similar to the pattern of the Jamaica granite. The REE chondrite normalized patterns of all the subvolcanic rocks are enriched in LREE with La_n/Yb_n ratio between 6 and 14 and do not have Eu anomaly. Those of the big subvolcanic body are slightly higher (8–14). On the Rb–Yb+Nb and Y–Nb diagrams of Pearce et al. (1984) all studied granitoids plot in the field of the volcanic arc.

The U-Pb zircon dating of the rocks of the Kopren granodiorite yield an Early Cambrian concordia age of 533±1.5 Ma (MSWD = 0.9). A granodiorite porphyry subvolcanic dike gives an Early Permian concordia age of 291.9±3.1 Ma (MSWD = 12). This age is approximately 7 Ma older than the U-Pb zircon dating for the 2 phases of the big subvolcanic body that yield concordia ages respectively 285.1±3.5 Ma (MSWD = 1.2) and 285±2.8 Ma (MSWD = 17). The time interval between the MOR rocks from the ophiolite complex (563±5 Ma) and the intra oceanic volcanic-arc rocks of the Kopren pluton is about 30 Ma that means that the subduction zone has to be close to the oceanic ridge and the subducting slab is hot.

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References

Carrigan, C., S. Mukasa, I. Haydoutov, K. Kolcheva. 2005. Age of Variscan magmatism from the Balkan sector of the orogene, Central Bulgaria. – *Lithos*, *82*, 125–147.

Cortesogno, L., L. Gaggero, A. Ronchi, S. Yanev. 2004. Late orogenic magmatism and sedimentation with Late Carboniferous to Early Permian basins in the Balkan terrane (Bulgaria): geodynamic implications. – *Int. J. Earth Sci. (Geol. Rundsch.)*, *93*, 500–520.

Čunev, D. 1968. Staroplaninska calc-alkaline plutonic formation. – In: *Stratigraphy of Bulgaria*, 135–151 (in Bulgarian).

Čunev, D., K. Kolčeva, K. Yankulova. 1965. Sur certaines modalités du développement du magmatisme Paléozoïque supérieur en Bulgarie du Nord-Ouest. – *Rev. Bulg. Geol. Soc*., *26*, 3, 349–354 (in Bulgarian with a French abstract).

Dyulgerov, M., I. Peytcheva, A. von Quadt, R. Nedialkov. 2006. Source and age heterogeneities between the rocks of Lutzkan pluton. – In: *Proceedings of National Conference* "*GEOCSIENCES 2006*", 177–180.

Haydoutov, I. 1989. Precambrian ophiolites, Cambrian island arc, and Variscan suture in the South Carpathian–Balkan region. – *Geology*, *17*, 905–908.

Haydoutov, I., S. Pristavova, L.-A. Daieva. 2010. Some features of the Neoproterozoic–Cambrian geodynamics in southeastern Europe. – *Compt. rend. Acad. bulg. Sci.*, *63*, 11, 1597–1608.

Kounov, A., J. Graf, A. von Quadt, D. Bernoulli, J.-P. Burg, D. Seward, Z. Ivanov, M. Fanning. 2012. Evidence for a "Cadomian" ophiolite and magmatic-arc complex in SW Bulgaria. – *Precambrian Research*, *212–213*, 275–295.

Pearce, J., N. Harris, A. Tindle. 1984. Trace element discrimination diagrams for the tectonic interpretation of granitic rocks. – *J. Petrol.*, *25*, 956–983.

Peytcheva, I., A. von Quadt, O. Malinov, E. Tacheva, R. Nedialkov. 2006. Petrochan and Klissura plutons in Western Balkan: relationships, in situ and single grain U-Pb zircon/monazite dating and isotope tracing. – In: *Proceedings of National Conference* "*GEOCSIENCES 2006*", 221–224.

Ridolfi, F., A. Renzulli, M. Puerini. 2010. Stability and chemical equilibrium of amphibole in calc-alkaline magmas: an overview, new thermobarometric formulations and application to subduction-related volcanoes. – *Contr. Mineral. and Petrol*., *160*, 45–66.

Von Quadt, A., I. Peytcheva, I. Haydoutov. 1989. U-Zr dating of Tcerni Vrah metagabbro, West Balkan, Bulgaria. – *Compt. rend. Acad. bulg. Sci.*, *51*, 1–2, 86–89.