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# THE KLISSURA GRANITE IN THE WESTERN BALKAN – QUESTIONS AND ANSWERS FROM NEW FIELD AND ISOTOPE STUDIES

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In the core of the Berkovitsa anticline, E-SE of the Berkovitsa town a sequence of igneous rocks crop out, which belong to the "Stara Planina Calc-Alkaline Formation (Dimitrov, 1958). We report new field, structural and isotope-geochronological data for one body, known as the Klissura leucogranite (Klissura is the former name of the village of Burzya) (Fig. 1).

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The "Ceramica Aspida" Ltd performed this work in connection with the exploration license for an area E-NE of the village of Burzya. The new field geological mapping shows, that the Klissura granite covers a much larger area up to the Srechanska bara river to the NE. The position of the body is defined by a system of faults striking NE 50-55° and NW 320-340°, which were reactivated several times

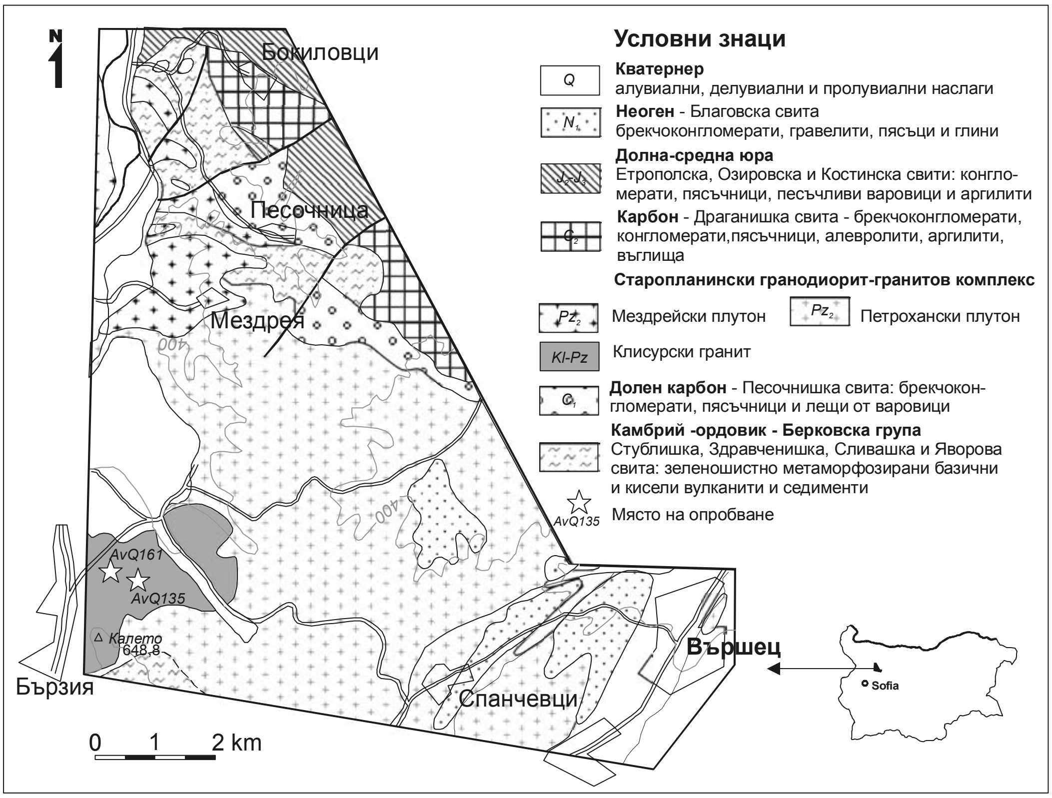


Fig. 1. Geological map of the region of the villages Burzya-Vurshets-Bokilovtsi (modified after Haydoutov et al., 1992) with the new field data and sample localities.

The Klissura granite crosscuts the granodiorites of Petrochan pluton. We consider the porphyritic granodiorites in the area NE of Burzya as a possible variety of the Petrochan pluton (Fig. 1); these porphyritic granodiorites were described earlier as diatectites of the Burzya migmatitic complex of Berkovitsa group (Haydoutov et al., 1979, 1992). We never have seen a direct contact of the Klissura granite with the metamorphosed phyllites and diabases of Berkovitsa group. The porphyritic granodiorites of the Petrochan pluton in the vicinity of pick Kaleto have intrusive contacts with rocks of the Berkovitsa group and within these parts the latter suffered a contact metamorphism with formation of hornfelses and cordierite-bearing schists.

The Klissura granite is fine-, medium- and coarse-grained, often pegmatite-like. White aplitic veins cross cut the body in some places. The structure of the granite is hypidiomorphic to granoblastic. The fresh granites are meso- and leucocratic rocks. The main rock-forming minerals are plagioclase (albite-oligoclase), K-feldspar, quartz, hornblende, biotite and muscovite, and the accessories – zircon, monazite and magnetite. Dimitrova and Arnaudova (1977) described accessory pyrite and molybdenite, too. Despite the granite looks leucocratic and free of mafic minerals on the surface, in the boreholes we can find more then 5% of green hornblende, the latter usually recrystallised in structurally controlled fissures/fractures. The weathering of the rock lead to limonitisation of most mafic minerals and this could be the reason, why the Klissura granite have been considered as an amphibole-free rock in the geological literature (Dimitrov, 1932; Vutov, 1967-1968; Mircheva and Veznev, 1969; Dimitrova and Arnaudova, 1977). Using the classification diagram of Peccerillo and Taylor (1976) the fresh rocks of Klissura pluton belong to the high-K granites.

Both plutons – the Klissura and Petrochan are intruded by basic dark dykes, striking NW and N to NE. The intrusion of the first group of dykes (diorites to gabbro-diorites) is related to strike-slip shear zones with formation of lens-like bodies (3-10 m tick and 60-70 m long). The second group of dykes (microdiorites) is related to normal shear zones; these dykes can be traced over 100 m with a thickness of ≤ 2 m. In the published literature these dykes are considered as vein type rocks of the Petrochan pluton (Haydoutov et al., 1992); the geological relationships, as well as their chemical characteristics (enrichment in hydrothermal-related elements like Cu, Pb, Zn, As, Ba etc.) give evidence for a possible formation in Alpine time.

Published data about the age of Klissura granite and the surrounding rocks are: Carrigan et al. (2003) suppose an age of about 500 Ma for the Klissura granite, because one group of the studied zircons (in situ SIMS analyses) reveals ages around this value; Carrigan et al. (in print) suggest an age of 304 ± 4 Ma for the granodiorites of Petrochan pluton; finally a Lower Paleozoic age for some protoliths of Berkovitsa group was assumed by Carrigan et al. (2003) and Peytcheva and von Quadt (2004).

During the present isotope-geochronological and geochemical studies we used fresh samples: sample AvQ135-C1 (from a borehole) represents the Klissura granite, and sample AvQ161 is taken from a microdiorite dyke (striking NE). The isotope analyses are carried out at the Institute of Isotope Geology and Mineral Resources, ETH-Zurich, whereas a precise conventional U-Pb-zircon and monazite method and ID-TIMS (Isotope Dilution – Thermal Ionisation Mass Spectrometry) techniques were used, combined with in-situ LA-ICP-MS analyses of both accessories.

Three types of zircons were observed in the sample AvQ135-C1: (i) brownish, transparent, prismatic (60-65%); (ii) colorless, sparkle, prismatic to almost isometric, some of them with rounded edges (30-35%); (iii) colorless prismatic (rare and uncommon). The monazites are transparent, yellow-green or orange-yellowish. Both minerals show magmatic oscillatory zonality in CL (cathode luminescent) (Fig. 3) and BSE (back scattered electron) images, whereas the short prismatic and isometric zircons reveal usually a complex internal morphology with inherited cores and recrystallised parts. Two single zircon grains from the first type zircons (long prismatic, brownish) and two single monazite grains determine a discordia line with an upper intercept age 329.7 ± 7.6 Ma (ID-TIMS analyses, Fig. 2). One zircon grain of the same type reveals a higher apparent age and gives evidence for negligible lead inheritance (Fig. 2). The lower intercept with the concordia marks a Late Alpine event at 62 ± 17 Ma.

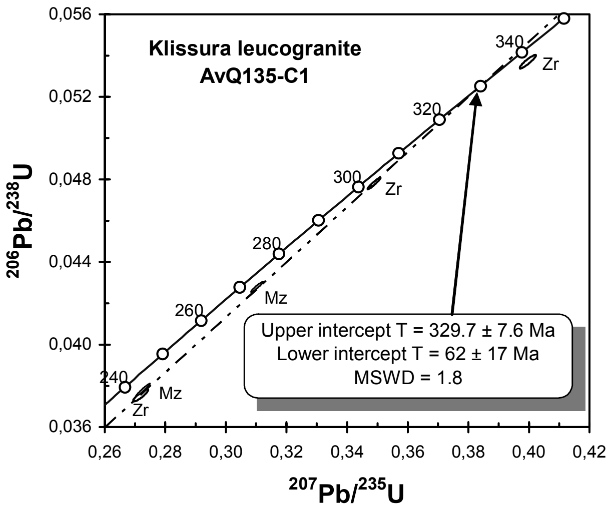


Fig. 2. U-Pb concordia diagram for zircons and monazites of sample AvQ135-C1, Klissura leucogranite

From the second type zircons one prismatic grain was measured, which was concordant at 450 Ma.

The microdiorite dyke (sample AvQ161) contains zircons with different morphology. Our preliminary data show that the zircons are discordant and could be inherited from the hosting rocks.

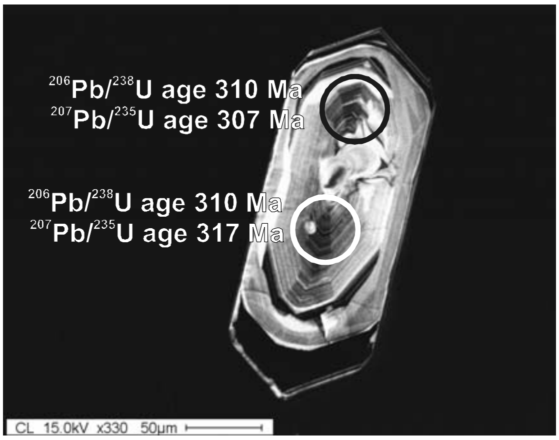


Fig. 3. CL image of zircon from samples AvQ135-C1. The circles show the location of the LA-spots with the corresponding U/Pb age.

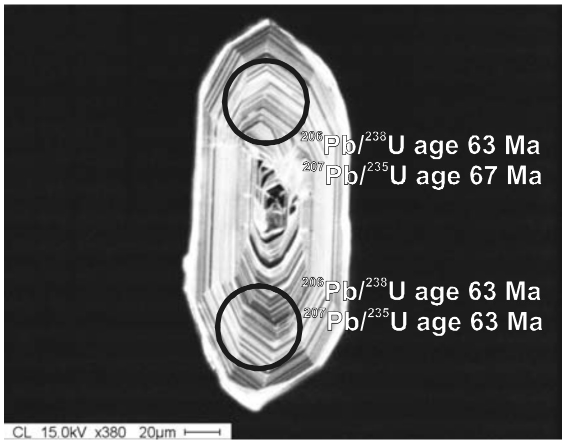


Fig. 4. CL image of zircon from sample AvQ161. The circles show the location of the LA-spots with the corresponding U/Pb age.

The "conventional" U-Pb data are compared with LA-ICP-MS analyses of the same type zircons and monazites. The method is local and despite the error uncertainties are usually higher (3-10%, Kosler and Sylvester, 2003) it provides additional information about the different parts in the inhomogeneous grains. A spot of 20 and 40 µm diameter and 5 to 30 µm depth was used for current analyses. In sample AvQ135 the first type of zircons (brownish) reveals ages in the range 310-330 Ma (Fig. 3), and three monazite grains give ages of 43-65 Ma. In sample AvQ161 two zircon grains are Paleozoic (one of them entirely Variscan in age, and the second one – with a Variscan rim), whereas one grain was concordant at 63 Ma (Fig. 4).

The same monazite grains, which are studied by LA-ICP-MS were measured using Th-U-Pb electron microprobe method (Tarassov et al, 2004, this volume), applied for the first time in Bulgaria for dating of accessory minerals. Two monazite grains point to a Variscan age, and in additional three grains an Alpine age was obtained.

Our preliminary field and isotope data give evidence for a mainly Variscan formation of the Klissura granite with an Alpine tectonic and hydrothermal (metasomatic) overprint. There is some evidence for a possible Late Cretaceous age of cross-cutting diorite-gabbro-diorite dykes. The new knowledge about the geology in the region of Burzya let some open question: a) in which environment was the Klissura granite formed, b) what is the relation to the Petrochan gabbro to granites, c) condition of the tectonic overprinting and d) time of the hydrothermal event. In the region of the Western Balkan these open points require further detailed structural, petrologic-geochemical and isotope-geochronological investigations.

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