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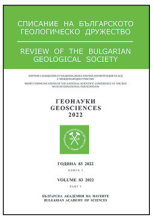

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Dating of Variscan magmatism in Kraishte and Balkan Mts

Датиране на вариски магматизъм от Краището и Стара планина

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Abstract. New age determinations by *in-situ* zircon and titanite LA-ICP-MS analysis for Variscan magmatic activity from Kraishte and Balkan Mts. are reported. The results confirm the presumed Variscan age of the magmatic rocks. For the Sedemte Prestola potassic granitoids, titanite dating reveal an age of 308.7±9.1 Ma. The zircon dating of potassic syenites, cropping out west of Shipka town gave less consistent results – 355±89 Ma. For potassic-alkaline syenite porphyries from the Lutskan pluton, Variscan $^{206}Pb/^{238}U$ ages cluster in 328–308 Ma interval. Zircons dating of potassic quartzdiorite porphyry from the Lutskan pluton display important inheritance with single $^{206}Pb/^{238}U$ age of 316 Ma, whereas results of titanite dating range between 350 and 315 Ma, defining poor isochrone of 301±91 Ma and MSWD of 5.6. Zircons from gabbro-diorite porphyries, cutting the Lutskan granitoids plotted on Terra-Wasserburg diagram yield Variscan age of 312±21 Ma and Concordia age of 296±4.6 Ma.

Keywords: potassic magmatism, Kraishte, Balkan Mts.

Introduction

The late Carboniferous orogeny has a significant influence on the geological evolution of Kraishte and Balkan Mts. in the Bulgarian part of the Variscan edifice in South-Eastern Europe. Voluminous calc-alkaline granitoids (Carrigan et al., 2005; Peytcheva et al., 2006; and references therein), and small potassic-alkaline intrusive bodies (Dyulgerov et al., 2018) are formed during the final stages of this orogeny. An outstanding feature of this Variscan edifice in Kraishte and Balkan Mts. is that magmatism is abundant, but the metamorphism is absent. The magmatic rocks intrudes dated sediments or metamorphics of Lower Paleozoic or Precambrian ages (*e.g.* Diabase-Phyllitoide Complex or Kraishte gneises and amphibolites).

The zircons from Buhovo-Seslavtsi, Svidnya and Shipka potassic plutons displayed very complex compositions with important inheritance and when they are analysed by CA-TIMS (chemical abrasion – thermal ionization mass spectroscopy) yielded mixed ages between the inherited cores and magmatic overgrowths (Dyulgerov et al., 2018). Hence, the *in-situ* LA-ICP-MS analyses proved to be most appropriate analytical technic for age determination and the results reveal that the Buhovo-Seslavtsi, Svidnya and Shipka plutons are formed in the time interval 320–303 Ma.

Considering the presence of inherited component in zircons from the studied potassic-alkaline plutons an approach based on *in-situ* LA-ICP-MS technic was applied for dating the Sedemte Prestola pluton, potassic syenites outcropping west of Shipka town (Balkan Mts.) and variable dykes from Lutskan pluton (Kraishte). Cathode luminescence (CL) and back scattered electron (BSE) images were performed for revealing the internal structure of the zircons and the analysis were performed on Perkin Elmer ELAN DRC with New Wave UP 193FX ablation system at Geological Institute, BAS.

Results

The Sedemte Prestola pluton is a small syenite-qurtzsyenite-granitic body with strong potassic affinity (Belev, 1979). It is composed of potassium feldspar, quartz, sodic-calcic amphibole and occa-

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sional biotite. Accessory phases are titanite, zircon, apatite and ilmenite. The back scattered electron images showed numerous bright phases evenly distributed in the zircons and the CL images revealed that they are structureless with no growing patters. I*n-situ* LA-ICP-MS isotope analyses gave no consistent results, attesting that there was significant radiogenic lead loss due to the metamictisation of the zircons. *In-situ* titanite U-Pb dating yields Concordia age of 308.7±9.1 Ma, confirming the late Carboniferous age of the Sedemte Prestola potassic rocks (Fig. 1). This age also limits the time of introduction of the intermediate fine-grained dykes from the Rzhana pluton (microdiorite/basaltic andesites), which cut the granitoids and are posterior to the Sedemte Prestola plutonic rocks.

The potassic melasyenites cropping out west of Shipka town (Dyulgerov, 2011) show two contrasting zircon populations. The first one display prolonged crystallization history with distinct growth patterns – inherited cores and oscillating magmatic rims. The age determinations obtained from this zircon type plot in the time spans: 560–434 Ma and 329–327 Ma. The second zircon type is presented by relatively homogenous crystals without cores, rims and oscillating patterns. An outstanding fea-

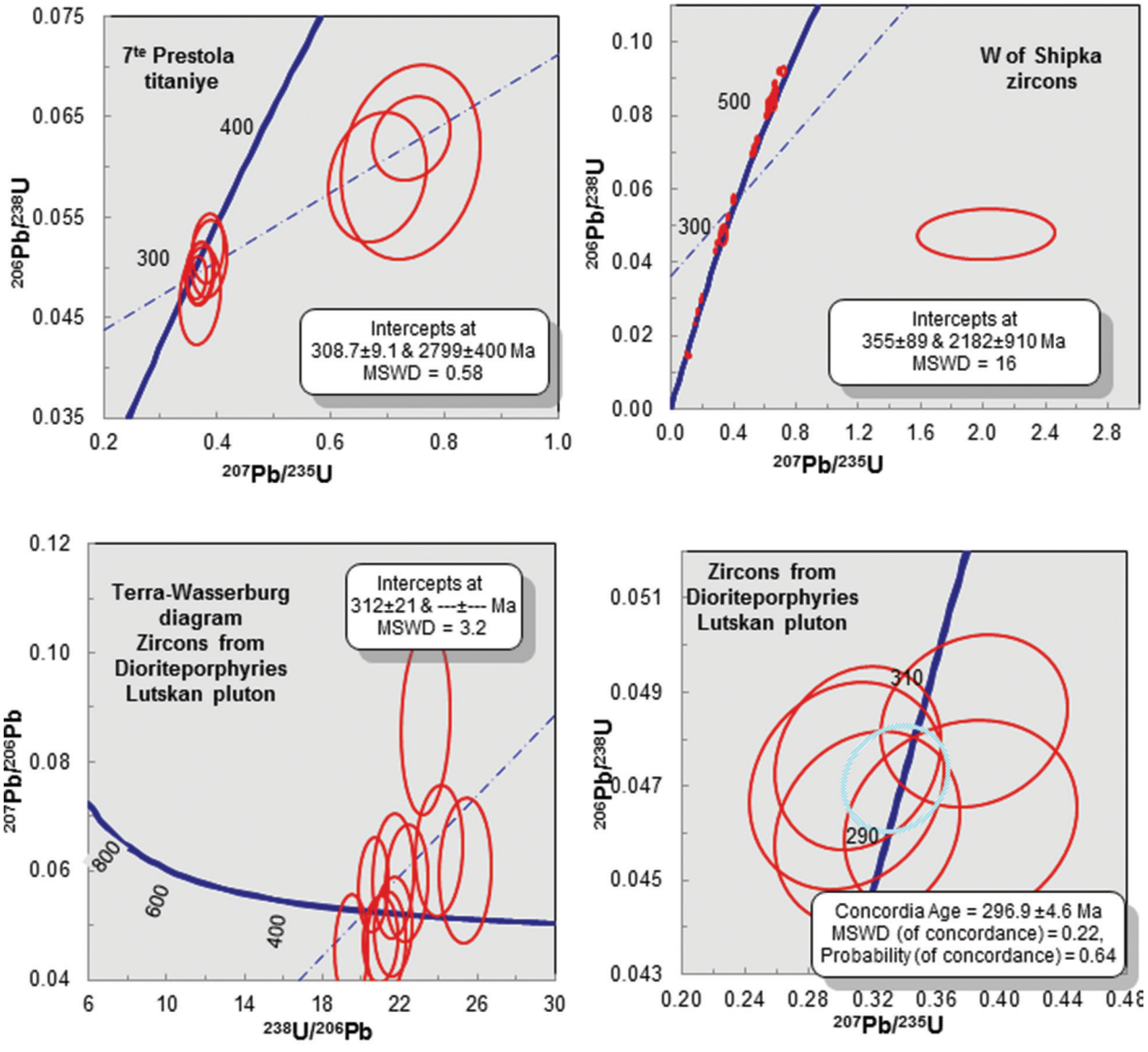

Fig. 1. Selected Concordia plots and Terra-Waserburg diagram for zircons and titanite from the studied Sedemte Prestola, Lutskan and syenites W of Shipka town

ture is the presence of numerous bright microinclusions of Th-U phases visible in BSE image, and radial fractures. The obtained ages are in the time frame 298–293 Ma, but with an important scattering in the lower limit 166–92 Ma. The upper ages in both zircon types are interpreted as magmatic, whereas 166–92 Ma are result of radioactive damage of crystal structure and subsequent radiogenic Pb loss. Considering the abovementioned data, it can be assumed 329–293 time interval (late Carboniferous and post-Visean) as likely for the crystallization of potassic melasyenite west of Shipka town. Plotting the data on Concordia diagram we obtain poor isochrone with 355±89 Ma age and MSWD = 16 (Fig. 1).

The granitoids from the Lutskan pluton are dated as 325±23 Ma (Peytcheva et al., 2011), whereas for peralkaline syenite porphyries such data do not exist. The recent investigations on the Lutskan pluton established the presence of more primitive dykes intruding the granitoids. These dykes differ in composition: gabbro to gabbro-diorite, and transitional alkaline quartzdiorite. In order to elucidate the time of formation of the dyke series and their possible genetic links to the granitoids, a comprehensive study on dykes' series was performed. The BSE and CL image of zircons from syenite porphyries revealed that they are two main types: the first one is with numerous bright microinclusions (probably Th-U phases), lack of internal structure, and radial fractures. The second type presents automorphic, platy to prismatic crystals with oscillatory growth patterns. The results for the first type show very large scattering in the range 267–57 Ma, which we interpret as a result of significant radiogenic lead loss due to the very strong metamictization of the structure. The results of the second zircon type are more consistent and age determinations plot in three time intervals: 464–390; 328–308 and 275–107 Ma. The first time interval represent inherited cores in analysed zircons, as these ages correspond to the age of country rocks (Precambrian metamorphics and Devonian sediments), whereas 328–308 Ma is the likely time of syenite porphyries crystallization and this correlates with the data of Peytcheva et al (2011). The dating of more primitive dykes from Lutskan pluton reveals that the dykes are contemporaneous to the granitoid intrusion. The zircon age determination of transitional alkaline quartzdiorite does not get consistent results, but titanite dating plot in a relatively narrow time interval with Variscan ages: 360–316 Ma, defining a poor isochrone of 301±91 Ma with MSWD of 5.4. The zircons from diorite porphyries display growth patterns with inherited cores and oscillating crystallization rims. The results of age determination show several time interval: the inherited cores display Precambrian to Silurian ages (571–439 Ma), whereas oscillating rims reveal Variscan ages (322–291 Ma). Plotting the results on Terra-Wasserburg diagram we obtain 312±21 Ma with MSWD 3.2, and on Concordia diagram 296±4.6 with MSWD 0.22 (Fig. 1).

Conclusions

The obtained data confirmed the presumed Variscan age of studied potassic-alkaline plutons and place the Sedemte Prestola pluton, the potassic syenites west of Shipka and the dyke series of Lutskan amid the other potassic-alkaline magmatic bodies in Balkan Mts. and Kraishte region (Dyulgerov et al., 2018). The results reveal that 328–300 Ma is the time interval of occurrence of the potassic magmatism and that it is contemporaneous to the calk-alkaline granitoids in the in the Bulgarian part of the Variscan orogen.

The systematic study of the zircons from the potassic rocks showed two outstanding features: the significant inheritance and development of the core–rims structure, and the presence of numerous Th-U phases as micro inclusions in the zircons in peralkaline varieties. This led to the very strong metamictization of the crystal structure, a significant Pb loss, and thus impossible to use the zircons for age determinations. A viable alternative as a suitable phases for dating was proven to be the titanite.

Unlike the Svidnya, Buhovo-Seslavtzi, Shipka, Sedemte Prestola pluton, and the potassic syenites west of Shipka, the Lutskan pluton shows more complex history. In this magmatic body, there is a close association of variable magmatic rocks with different geochemical signature, which are either formed in a narrow time span or are synchronous. Elucidating the genesis of this variable rock types will shed a light on the tectono-magmatic evolution of the eastern part of the Variscan orogenic edifice.

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