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LA-ICP-MS U-Pb zircon dating of granites in the area of Vishteritsa pegmatites: implication for timing of fertile magmatism in the Western Rhodopes, Bulgaria

LA-ICP-MS U-Pb цирконово датиране на гранити от пегматитовия район Вищерица: значение за определяне на времето на рудоносния магматизъм в Западните Родопи, България

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Introduction

The Rhodopes are a main tectonic unit on the Balkan Peninsula and are referred as Rhodope Zone, Rhodope Massif or Rhodope Metamorphic Complex. Tectonic interpretations agree on its complex Alpine (Late Jurassic to late Oligocene) tectono-metamorphic history comprising earlier compressional and later extensional periods. The Alpine evolution in the western parts of this tectonic unit is related with intensive granitoid magmatism. The main pluton there is the Rila-West Rhodopes batholith (RWRB). It is a composite pluton comprising granitoids of different age (Valkov et al., 1989; Kamenov et al., 1999; Stavrev et al., 2020a). Isotope-geochronological studies distinguished two major magmatic stages: Late Cretaceous (71–68 Ma) represented by hornblend-biotite and biotite granodiorites, and Paleogene (~40 Ma) with biotite- and two-mica, leucocratic and aplitoid granites.

In this study, we present new data on the age of the RWRB granitoids that are outcropped south of the Babyak-Grashevo shear zone (BGSZ) and host the Vishteritsa rare-metal pegmatites, the latter recently dated at 47.59±0.38 Ma by U-Pb method on columbite (Peytcheva et al., 2020, this volume). LA-ICP-MS U-Pb technique is used for age dating of the zircons of the granites with the aim to bracket the time period of fertile granitic magmatism in the Western Rhodopes. The study is also motivated by the early Eocene Re-Os age of molybdenite (Stavrev et al., 2020, this volume) from the Babyak Mo-Ag-Au-W-Bi-base metal deposit, although the deposit is hosted by Upper Cretaceous granitoids dated at ~71 Ma (Stavrev et al., 2020).

Geological setting, materials and analytical techniques

The granitoids of the RWRB south of the BGSZ are coarse-grained and porphyritic biotite and two-mica granites with presumable Paleogene age (~40 Ma?), and the Upper Cretaceous biotite to Amf-Bi granites and granodiorites of the Grancharitsa body. Characteristic, especially for the Paleogene granites is the presence of pegmatite veins and fields. Three of them are well known, namely Vishteritsa, Malak Beslet and Studene (Arnaudov, Petrusenko, 1967) while being exploited for K-feldspar and muscovite until 1961. In the western and southern parts of the RWR batholith the granites and their pegmatites intrude metamorphic rocks that corresponds to the Middle and Upper Allochthones of the Rhodope Metamorphic Complex (Georgiev et al., 2010). These host rocks are mainly gneisses, gneiss-shists, amphibolites and marbles that are affiliated to various lithotectonic units: the Sarnitsa, Mesta, Slashten, Malyovitsa (Middle Allochthon) and Obidim, Ograzhden (Upper Allochthon; Sarov et al., 2008).

The sample Os7b was taken from the western part of the RWRB and has the following coor-

dinates: E 731 358, N 4 632 795 (UTM Zone 34, Northern Hemisphere (WGS 84). It is a two-mica coarse-grained granite and outcrops around 10 km east of Osenovo village, close to the Vishteritsa pegmatite field. Similar granites were followed in the field south to Kanina River and the contact with the gneisses and gneiss-schists of the Middle Allochthon on the way to Kovachevitsa village (Sarnitsa lithotectonic unit; Sarov et. al., 2008) and north of the sampled outcrop, at least to the village of Palatik.

The zircons were separated at the Geological Institute of the Bulgarian Academy of Sciences (GIBAS) using a standard procedure and heavy liquids. The zircon population consists of middle to long prismatic well-shaped zircons with beige to orange-beige color. LA-ICP-MS method was applied for in situ U-Pb dating of the zircons. Analytical work was performed employing the equipment at the Geological Institute (BAS) – a NWR UP193 FX laser ablation system combined with PerkinElmer ELAN DRC-e ICP-mass spectrometer. During the analyses LA-crater 35 μm, repetition rate 8 and fluency of ~7 J/cm^2 was applied, using GJ1 as primary and Plešovice as secondary standard reference material (SRM). The results of the U-Pb geochronology were calculated using Iolite combined with Visual Age program to obtain ages and ratios corrected for instrumental drift and down-hole fractionation. The plots were processed using ISOPLOT 4.15.

Results and concluding remarks

The 26 analyzed zircons are dated mainly in the range 49–53 Ma, two grains showing some lead loss (apparent age 46–47 Ma) and two revealing negligible inheritance (54–56 Ma). Two zircons are older and show concordant ages at 143 and 71 Ma, respectively. Excluding the outlier, twenty zircons define a Concordia age 51.94±0.61 Ma (2 σ uncertainties, decay-const. errs included, MSWD of concordance 1.4; Fig. 1).

The obtained age is clearly younger than the 68–71 Ma Upper Cretaceous granites of RWRB (Peytcheva et al., 2007; Stavrev et al., 2020) but also are older than the 39–40 Ma upper Paleogene granites of the batholith (Peytcheva et al., 2007). It infers a more complex character of the RWRB and a possibility of incremental growth over a long period (71–39 Ma), as it was observed in collisional to post collisional plutons in the Alpine-Himalayan belt (e.g., Rezeau et al., 2016). Although it is not easy to distinguish the granites of different age in the field, the compositional characteristics of the Eocene granites allow us to assume their wide distribution south of the Babyk-Grashevo shear zone.

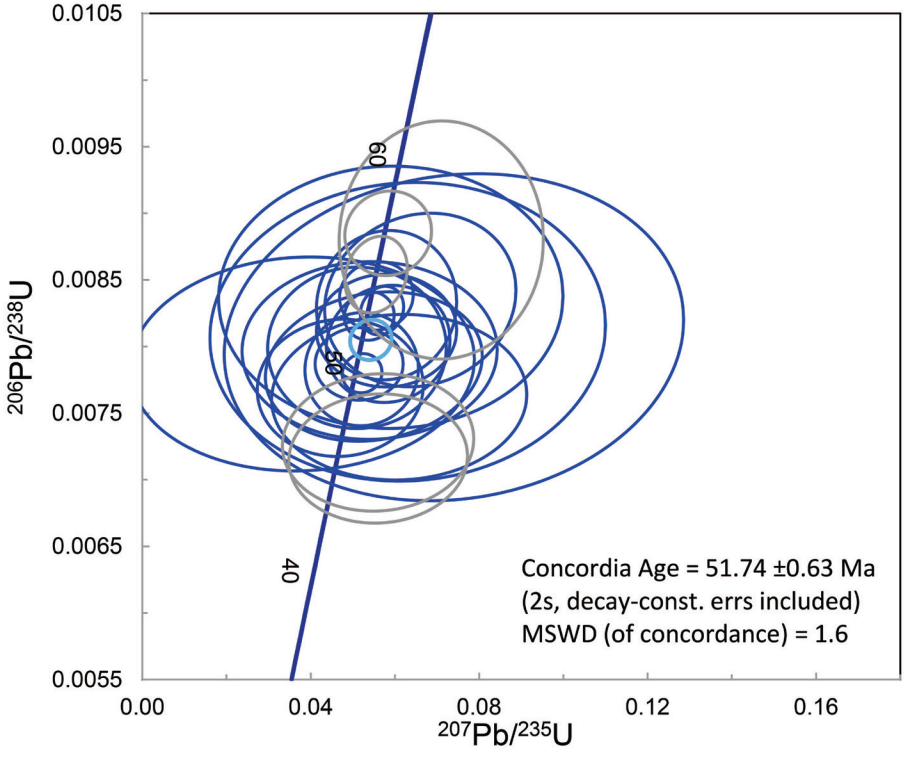

Fig. 1. Concordia diagram for LA-ICP-MS U-Pb zircon isotope data of sample Os7b. The Concordia age is calculated excluding the outlier analyses that are shown in grey.

Cenozoic granitoid magmatism accompanied with pegmatites in the Rhodopes cover a wider age range from ~58–56 to 42 Ma (Marchev et al., 2013). In the Middle Allochthone of the Rhodopes, which is the metamorphic frame of RWRB the closest pegmatites and granitoids are dated 48–52 Ma (Gorinova et al., 2019) NNE of the batholith (in Rila Mountain), 56 Ma (Kapatnik pluton, Rila, Milovanov et al., 2010; Dolno Dryanovo, Western Rhodopes and Spanchevtsi, Pirin Mountain, Jahn-Awe et al., 2010). Additional dating in the western and southern parts of the RWRB are needed to better constrain the contacts to older and younger granites.

Many of the early–middle Eocene granitoid intrusives reveal adakite-like signatures resulting from high-pressure amphibole fractionation accompanied by trace-element rich accessory minerals and water suppressed plagioclase fractionation (Marchev et al., 2013). Mantle underplating and interaction with the mid- to lower part of collision- and underplating-induced thickened crust in the Rhodopes are suggested to explain the favorable conditions for their formation. Adakitic magmas are considered potentially fertile for ore-deposits (e.g., Chiaradia, 2009; Chiaradia et al., 2009) mainly because of their high water saturation (Richards, 2013). The affiliation of the southern part of RWRB to the same group of plutons may be used as possible tool to estimate its economic potential as source of conventional and strategic rare metals.

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