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U-Pb zircon dating and zircon population analyses of the of the Paleogene magmatic rocks in Kyustendil area

U-Pb цирконово датиране и анализ на цирконовите популации на палеогенските магматични скали от района на Кюстендил

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Introduction

In this study we provide preliminary data for the Paleogene magmatic rocks concerning the new U-Pb zircon ages and analysis of the populations of the zircon crystals. For one of the characteristic igneous type in the studied region, the Kopriva trachyrhyodacites, trace elements and REE content of the zircon crystals are presented as well. Herein we provide newly obtained U-Pb zircon isotope ages for the of Gyueshevo rhyodacites (not dated with this method until now) and for the Kopriva trachyrhyodacites. Whit this research we can better understand the geological history and provide valuable information about the petrogenetic context: type and ages of the host-rocks, the magmatic conditions during zircon crystallization, contamination of the magma.

Analytical methods

Zircon crystals were separated from 63–250 μm sieved fractions using standard heavy liquid techniques, handpicked and mounted in epoxy resin, and polished to the middle of the grains. To reveal the internal textures of the crystals we made cathodoluminescence (CL) and backscattered (BSE) images of the zircon grains using SEM-EDS (JEOL JSM-6610 LV) scanning electron microscope (SEM) at University of Belgrade (Faculty of Mining and Geology) and CamScan CS 4 scanning electron microscope (SEM) at ETH–Zurich – equipped with an ellipsoidal mirror. Zircon LA-ICP-MS U-Th-Pb isotope dating and analysis of the trace and REE were made at the Geological Institute of BAS using NW excimer laser with DRC-e PE system and the ETH–Zurich system of Geolas 193 nm laser with Elan 6100 PE. The software programs used for data reduction are Glitter – for the U-Th-Pb dating of the zircons and SILLS (Signal Integration for Laboratory Laser Systems) for the zircons elements composition. Isotope age calculations and plots are constructed ISOPLOT–v3, a Microsoft EXCEL programs.

Geological setting

Four main Paleogene magmatic rocks can be distinguished in the Kyustendil region (Grozdev et al., 2010). On the basis of the terrain relationships and published geological data (Ivanov et al., 1971; Harkovska, 1974; Graf, 2001), they are present in the following order: Gyueshevo rhyodacites, Kopriva coarce porphyric by sanidine trachyrhyodacites, Osogovo granite, and the granite porphyry dykes (Garlyano type). These rocks are part of the Ruen magmatic zone (Milovanov et al., 2008, and references therein), which consists mainly of plutonic and subvolcanic rocks with acid composition and high-K calk-alkaline seriality. In general, the geochemical patterns for the trace elements and REE have been described in Grozdev et al. (2010 and references therein) and are typical for the continental crust magmatic rocks with granitoid composition.

Zircon data

Combined age dating and CL/BSE imaging of the zircons from the Paleogene magmatic rocks revealed (i) own zircon crystals with oscillatory magmatic zoning, (ii) inherited zircon cores overgrown by magmatic Paleogene rims, and (iii) zircon xenocrysts. The relative distribution and some characteristics of the grains are summarized in Table 1. The trace element composition of the zircons is studied only in the Kopriva trachyrhyodacites. For comparison we provide data for the magmatic Paleogene grains (32.8 Ma), the inherited zircon cores (282.6 Ma) and for the zircon xenocrysts (410.4 Ma). Main substitution elements in

Table 1. Zircon population in the studied rock types

Samples	Gyueshevo rhyodacites	Kopriva trachyrhyodacites	Osogovo granite	Granite porphyry dykes (Garlyano type)
Zircon size fraction	100–150 μm	100–300 μm	100–150 μm	100–150 μm
Zircon morphology	prismatic habit (100) < (110)			
Nuber of analyzed zircon	31	34	19	22
U-Pb isotope age	30.97±0.59 Ma (17 crystals)	32.56±0.87 Ma (19 zircon crystals)	31.0±1.2 Ma (13 zircons)	28.91±0.40 Ma (16 crystals)
Own magmatic zircon crystals	17	10	10	9
Inherited cores with Pg overgrowths	–	9 old cores with age 235.8–315.4 Ma	4 old cores with age 473.8–1803.8 Ma	7 old cores with age 200.2–241.4 Ma
Zircons xenocrysts	9 with age 280 Ma and 318–337 Ma	2 with age 410.4 Ma	2 with age 176.5 Ma	1 xenocryst not dated

zircon crystals are Hf, Y, U, Th. The measured Zr/Hf ratio for the 3 zircon varieties is ranging in a narrower range from 38 to 43. The Th/U ratio is clearly higher in the Paleogene magmatic zircons (0.918) than in the inherited cores (0.467) and for the zircon xenocrysts (0.52). The REE chondrite-normalized pattern for the 3 observed zircon varieties in the Kopriva sample have similar profile showing steeply-rising slope from the LREE to the HREE with a positive Ce and negative Eu anomalies. The Paleogene zircons and overgrowths shows more pronounced positive Ce anomaly and being generally richer in REE than the zircon old cores and xenocrysts.

Discussion and conclusions

The Gyueshevo rhyodacites and Kopriva trachyrhyodacites show contamination with Lower Triassic to Devonian (?) rocks (235–410.4 Ma). The Osogovo granite reveals no typical assimilation/contamination process, but take out older zircon grains from Lower Ordovician (474 Ma) and Paleoproterozoic rocks (1800 Ma). The rocks that contaminated the granite porphyry dykes have Triassic isotope age.

The trace elements and REE content of the old zircon cores/xenocrysts of the Kopriva trachyrhyodacites indicate igneous origin of the source rocks on the base of Th/U, which is ≥0.5 (Hoskin, Schaltegger, 2003). The Ce content in all studied zircon crystals is less than 50 ppm, which is evidence again for their magmatic origin (Griffin et al., 2002). The Zr/Hf ratio is typical for crustal zircons. On the Hf vs. Y diagram the Paleogene crystals fall in the field of the calc-alkaline felsic rocks, while the zircon cores/xenocrysts belong to the field of calc-alkaline basic rocks (Shnyukov in: Belousova et al., 1998). In summary, the analysis of the trace and rare-earth elements shows that the zircon old core crystals and xenocrysts belong to rocks with an igneous origin, which are from the continental crust (there are no mantle derivates), and probably with basic composition.

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