Jurassic metagranitoids south of the West-Rhodope batholith – conventional and *in situ* U-Pb zircon analyses, Sr-Nd-Hf isotope tracing and geodynamic constraints

Юрски метагранитоиди южно от Западнородопския батолит – конвенционални и *in situ* U-Pb цирконови анализи, Sr-Nd-Hf изотопни характеристики и геодинамично значение

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Introduction

The region south of the West-Rhodope batholith (Bulgaria) consist mainly of metamorphic rocks, subdivided recently in four lithotectonic units (Sarov et al., 2008): 1) Mesta, 2) Slashten, 3) Sarnitsa and 4) Ograzhden (Obidim) unit. The Mesta unit (1) comprises the lowermost part of the metamorphic section and consists of strongly sheared biotite, two-mica orthogneisses and/or aplitic orthogneisses of equigranular to porphyroclastic structure. The Slashten (2) and Sarnitsa lithotectonic units (3) are composed mainly by rocks probably of parametamorphic origin (schists, marbles, calcschists, paragneisses); this unit include abundant meter to decameter scale mafic to ultramafic bodies and sill-like orthogneiss bodies. An increasing of the metamorphic conditions is leading to a local migmatization or metatexites for the rocks of Surnitsa unit. The metagranitoids of the three Units reveal Jurassic protolith age (Von Quadt et al., 2008). The uppermost Ograzhden Unit (4) is recently defined as the Variscan basement with Ordovician (440–460 Ma) magmatic protoliths and a Carboniferous high-grade metamorphism (Peytcheva et al., this volume).

We present here isotope data for metagranitoids of Sarnitsa unit from outcrops N of Pletena (AvQ-292), from Kovatchevitsa (AvQ295 and AvQ295a) and N of the same village (AvQ296). Some preliminary data for metagabbros (AvQ293, AvQ294 and AvQ294a) from the region S of the West-Rhodope batholith will be also discussed. Conventional U-Pb-zircon ID-TIMS (Isotope Dilution – Thermal Ionisation Mass Spectrometry) method is applied for the precise dating of the metamorphic protoliths, using the double uranium and lead spike of the EarthTime project (ET2535). In order to minimize the effects of secondary lead loss, zircons were pretreated by "chemical abrasion" techniques (Mattinson, 2005). The data are combined with the less precise (2σ errors of 2–5%) *in situ* LA-ICP-MS analyses of zircons, which were first imaged in cathodoluminescent (CL) and back-scattered electron (BSE) regime. At least we can distinguish and date the inherited zircon grains/cores of the magmatic and/or recrystallized zones, which help to unravel the metamorphic history. Sr-Nd-whole-rock and Hf-zircon isotope data provide additional source information for the hosting magma. The analyses are completed at IGMR, ETH-Zurich as part of a collaborative work with the Research Institute "Geology and Geophysics" Corporation during the new 1:50 000 scale geological mapping of the Rhodopes.

U-Pb isotope geochronology and isotope tracing

Zircons of sample AvQ-292 (two-mica metagranite with garnet, N 41°42'36"; E 23°58'03") are mainly prismatic to long prismatic, beige-brownish and semitransparent, slightly rounded. Their CL-images show oscillatory magmatic zoning. LA-ICP-MS analyses of the zircons yield a weighed mean $^{206}Pb/^{238}U$ age of 157.6 ± 5.0 Ma interpreted as crystallization age of the granites. To define the time of the metamorphism we analyzed also monazites of the same sample. Although few of them are spreading to higher ages (60–280 Ma) a mean $^{206}Pb/^{238}U$ age of 54.8 ± 3.1 Ma was calculated for the main population of studied grains.

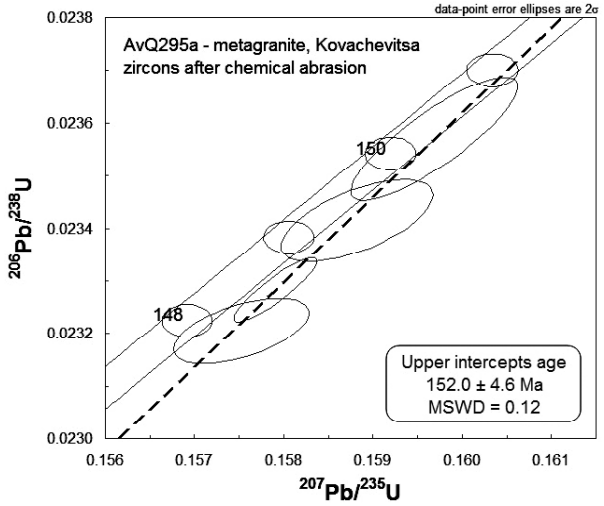

Fig. 1. Concordia diagram for chemically abraded (CA) zircons of sample AvQ295a

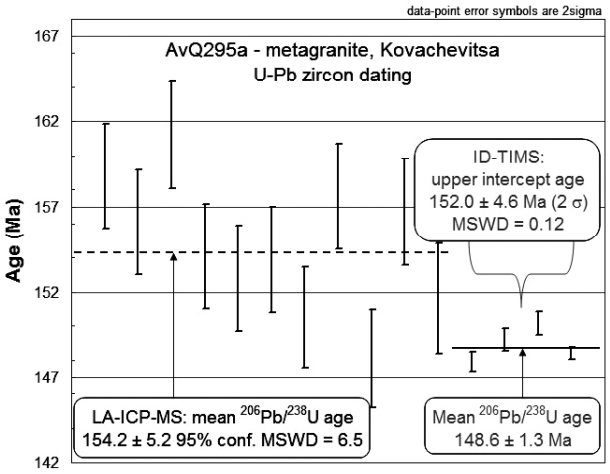

Fig. 2. *In situ* LA-ICP-MS $^{206}Pb/^{238}U$ ages for zircons of sample AvQ295a. The TIMS data are shown for comparison.

Zircons of sample AvQ295 (equigranular two-mica metagranite, N 41°41'15"; E 23°49'38") are middle to short prismatic, muddy-brownish. CL-images show oscillatory magmatic zoning. The latter is poorly preserved in dark (rich in uranium) parts of the grains which transferred partly to amorphous (metamict) based on the uranium decay. For the *in-situ* LA-ICP-MS U-Pb analyses we chose the crystalline parts of the zircons to avoid lead lose in the U-decay-damaged zones. We determine a mean $^{206}Pb/^{238}U$ age of 154.5 ± 3.1 Ma.

Metagranites of sample AvQ295a (100 m NE from AvQ295) are distinguished from the AvQ295 by their higher content of biotite and courser grain-size. Their zircon grains are middle prismatic, muddy-brownish to beige, semitransparent. They are dated conventionally (ID-TIMS) at 152.0 ± 4.6 Ma (2 sigma error uncertainties; Fig. 1) and at 154.2 ± 5.2 (95% conf., Fig. 2) by in-situ LA-ICP-MS analyses.

The Amf-Bi metagranodiorite AvQ296 (N 41°42'29"; E 23°49'52") was chosen for analyses, as it is weakly deformed, porphyroclastic and crops out very close to the West-Rhodope batholiths. Consequently, a possibility was considered that this sample represents the Cretaceous granitoids of the batholiths instead of the Jurassic basement. The zircon population of sample AvQ296 was very similar to that of the AvQ295 and zircons were only longer prismatic and less muddy-brownish. CL-images do not show inherited cores, only magmatic oscillatory zoning. The *in-situ* LA-ICP-MS U-Pb analyses yield mean $^{206}Pb/^{238}U$ age of 155.4 ± 3.3 Ma.

The age data for the zircons of metagabbros are not equivocal. The sample AvQ293 (road to Pletena) contained only a few grains with different characteristics. LA-ICP-MS U-Pb isotope data for zircons of a boudine (AvQ294) and sheet-shaped body (AvQ294a) from outcrop NW of Gorno Dryanovo (N 41°39'33"; E 23°49'35") point to ages of ~440 and 158.5 ± 2.6 Ma, respectively.

Sr-Nd-whole-rock and Hf-zircon isotope data of the granitoids give evidence for mixed mantle-crustal sources of the magma.

Discussion of the results

The obtained precise U-Pb zircon data confirm the Jurassic age of the orthogneisses of Surnitsa Unit in the Western Rhodopes, whereas the granitoid protoliths are dated in a narrow interval 157.6 ± 5.0 and 152.0 ± 4.6 Ma. Studied zircons show oscillatory zoning that are evidence for the magmatic origin of the protoliths. Monazites are dated at 54.8 ± 3.1 Ma. This age defines the time of metamorphism of the Surnitsa Unit and is correlated with compressional stage of tectonic evolution. The complicated present position of the rocks results from the subsequent Late Alpine extensional tectonic events in the Western Rhodopes.

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