Ordovician protoliths of metamorphic rocks in Eastern Pirin–Western Rhodopes: Are they part of the Ograzhden Unit?

Ордовишки протолити на метаморфити в Източен Пирин–Западни Родопи: части ли са те от Огражденската единица?

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Key words: Ograzhden Unit, Pirin–Rhodopes, metagranitoids, metagabbro, U-Pb dating.

Introduction

The southern parts of Western Rhodopes consist mainly of metamorphic rocks, recently subdivided in four tectonic units (Sarov et al., 2008): 1) Mesta, 2) Slashten, 3) Sarnitsa and 4) Obidim Unit. The uppermost Obidim Unit (4) comprises migmatitic para- and orthogneisses, garnet-bearing two-mica schists (metapelites), amphibolites and eclogites (?). Field observations, the range from gabbroic to granitoid metamorphic rocks, the presence of coarse-grained porphyroclastic metagranites with huge 4.8 cm K-feldspar megacrysts and the high grade of metamorphism prompt to some similarities with the migmatites of the Ograzden complex W of Struma river (Sarov et al., 2008) and in Western Pirin (Machev, 1990).

To verify the geological correlation of Obidim Unit with the Ograzden unit we carried out isotope geochronological and geochemical studies of the rock varieties in the region of Obidim and Mesta villages in Eastern Pirin-Western Rhodopes. The selected samples represent a diorite (AvQ297), a strongly mylonitized gneiss (AvQ299) and a leucosome vein (AvQ299) from an outcrop SE of Obidim. Two more samples - metagabbro (AvQ300) and the coarse-grained porphyroclastic metagranites (AvQ301) – crop out close to Mesta village. Conventional U-Pb-zircon ID-TIMS (Isotope Dilution – Thermal Ionization Mass Spectrometry) method is applied for the precise dating of the metamorphic protoliths, using the double uranium and lead spike of the Earth-Time 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 (2s 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. After this step we can distinguish the inherited zircon grains/cores (if they are present) in magmatic and/or recrystallized zones, which help unraveling the magmatic and metamorphic history. Hf-zircon isotope data provide the most promising 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 Southern Bulgaria.

U-Pb isotope geochronology and isotope tracing

Zircons of sample AvQ300 (metagabbro, N 41°46'53"; E 23°39'34") are mostly long prismatic, transparent, pale beige-violet, with rounded edges. ID-TIMS U-Pb isotope age data of chemically abraded grains lie in the range 430–460 Ma (Fig. 1), whereas the youngest zircons are slightly discordant. A discordia line through all data is calculated, which yields an upper intercept age of 454.1 ± 8.3 Ma (magmatic protolithic age, Fig. 1). The lower intercept is poorly defined and points to a Variscan metamorphic overprint. We cannot exclude a slightly younger age for the protoliths 445.9 ± 9.8 Ma, as defined by a three-point Discordia. LA-ICP-MS ages are usually slightly younger but discordant with an upper intercept age around 440 Ma. Similar age 446 ± 7) is measured by the LA-ICP-MS method for the zircons of the metadiorite AvQ297.

The coarse-grained metagranite AvQ301 contains long to rarely short prismatic, transparent, violet-beige zircons with rounded edges. Chemically abraded zir-

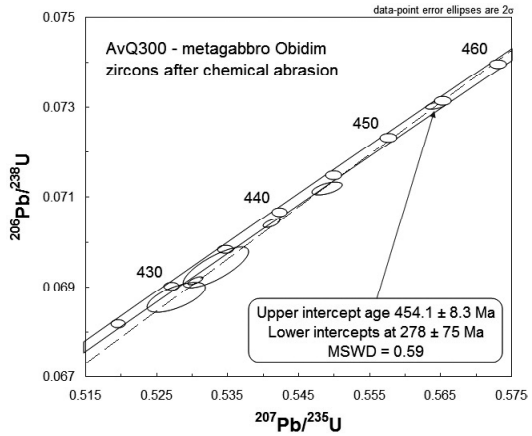

Fig. 1. Concordia diagram for zircons of sample AvQ300 – metagabbro from the Obidim (Ograzhden) Unit in Eastern Pirin

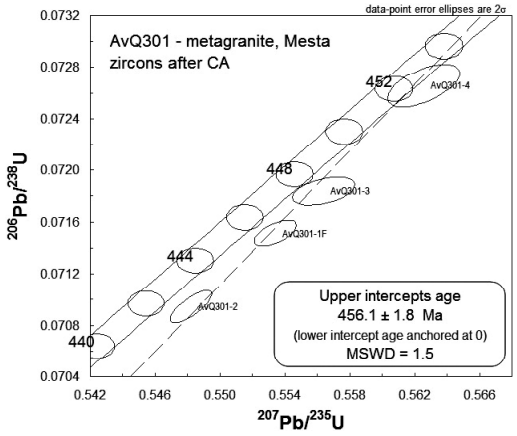

Fig. 2. Concordia diagram for zircons of sample AvQ301 – metagranite from the Obidim (Ograzhden) Unit in Western Rhodopes

cons retain slightly discordant and determine an upper intercept TIMS-age of 456.1 ± 1.8 Ma (Fig. 2). The weighted mean $^{206}Pb/^{238}U$ LA-ICP-MS zircon age is about 20 Ma lower, which is probably due to the weak discordance of some grains. Zircons of the strongly mylonitized gneiss AvQ299 resemble the above zircons in morphology and age, showing a mean $^{206}Pb/^{238}U$ age of 452 ± 14 Ma (LA-dating). Few rim analyses gave discordant younger ages of 380–420 Ma.

High-grade metamorphism and migmatization of the Obidim Unit can be defined by the U-Pb dating of zircon rims from the leucosome vein AvQ299. Their LA-ICP-MS ages of 321 ± 19 give evidence for a Variscan high-grade overprint. Zircons without rims and the zircon cores are Ordovician – 461 ± 14, as the hosting gneisses. The cores and the metamorphic rims are distinguished in the CL-images; oscillatory zoning of the cores is linked to the magmatic stage and its absence in the rims can be interpreted as a metamorphic overprint. Studied monazites of the same sample are discordant. Although their $^{206}Pb/^{238}U$ ages range between 220 and 260 Ma it is likely that this ages are geologically meaningless. We suppose, that the monazites lie on a discordia with Variscan upper intercept and an Alpine lower intercept.

εHf-zircon isotope data for the Ordovician gabbros and granitoids range between Hf +1.6 and –6.4, but the majority of them are between –0.5 and –2.5. These values mark a similar crust-mantle source for the magma and a possible magma mixing.

Conclusions

Obtained precise ID-TIMS and in-situ LA-ICP-MS U-Pb zircon data, combined with mainly magmatic origin of the gneisses (oscillatory zoning of the zircons) give evidence for Ordovician (445–460 Ma) magmatic protoliths of the metamorphic rocks between Obidim and Mesta. They were overprinted by high-grade metamorphism at Variscan time (320–330 Ma). Both, the metagabbros and the metagranites reveal mixed crust-mantle eHf-zircon characteristics. These data infer a time similarity with the magmatism and metamorphism in the Ograzhden and Belassitsa Mountain (Zidarov et al., 2003; Macheva et al., 2007). Consequently, the isotope geochronological and geochemical data for the rocks of the Obidim Unit in Western Rhodopes support the field data and can be interpreted as part of the Ograzden unit (Sarov et al., 2008). Recent field studies show a distribution of the Ograzhden Unit further in the Western Rhodopes and in NW Rila (Sarov, this volume).

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