Metamorphic rocks from northern parts of Central Rhodopes – conventional and *in situ* U-Pb zircon dating, isotope tracing and correlations

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Introduction

The new 1:50 000 scale geological mapping of the Rhodopes is based on Geological Units. Upon the characteristic shistosity, mineral lineation, sense of shear and clear boundaries they reveal protoliths that are generated and metamorphosed in specific metamorphic grade at curtain time. This approach makes the timing and isotope tracing of the metamorphic rocks in the Rhodopes extremely important and was the reason for the collaborative work of mapping geologists and isotope scientist in the field and in the isotope laboratories. Here we present new precise geochronological and isotope-geochemical data for some metamorphic rocks from the northern parts of Central Rhodopes mostly on the boundary zone to Srednogorie tectonic zone.

Geological setting and sampling

The northern parts of Central Rhodopes between the villages of Brestovitsa, Parvenets and Assenovgrad are characterized by variegated lithological composition and complicated tectonic relationships, which result from the prolonged activity of the Maritsa fault zone (fig. 1). The latter leaded to the accretion of rock successions that differ in origin and composition, metamorphic grade, age and tectonic evolution. Ivanov et al. (1984) distinguish in this area two main tectonic units: the Northern Rhodopean one and the Parvenets complex. They occupy the highest levels of a synmetamorphic napped complex. The rocks of the Northern Rhodopean unit are considered by Ivanov et al. (2000) as analogs of the Narechenska group of the Assenitsa tectonic unit. The boundary between the main units is marked by the Northern Rhodopean detachment (the Northern Rhodopean trust, Bonchev et al., 1951).

Low metamorphic marbles, calc shists and disintegrated bodies of serpentinized ultrabasic rocks prevail in the secession of the described area. They are considered as part of the Thracian unit (Sarov et al., 2006, this volume). The low metamorphic rocks have a tectonic contact to two mica gneisses with boudines of amphibolites, which are trusted (?) from NW over the low metamorphic rocks. The southern boundary of Thracian unit to the high metamorphic rocks of the Rhodopes is a steep N and NE dipping dextral fault zone. On many places this strike-slip fault zone leaded to the formation of Paleogene volcanic-sedimentary basins. The new mapping of the northernmost unit of the Rhodopes, the Assenitsa unit (Ivanov et al., 2000) resulted in the distinguishing of two sub-units – the Assenitsa, which is build up mostly by parametamorphic rocks, and the Bachkovo-Dobralak unit, consisting of orthogneisses (Naydenov et al., 2006, this volume).

Here we present data for the gneisses and amphibolites of the Tracian unit from the outcrop W of Parvenets (samples 5672 and 5672a) and from Bachkovo leucocratic orthogneisses (AvQ-090) of Bachkovo-Dobralak unit (fig. 1). Conventional U-Pb-zircon method and ID-TIMS (Isotope Dilution – Thermal Ionisation Mass Spectrometry) techniques are used for precise dating of the metamorphic protoliths. They are combined with *in-situ* LA-ICP-MS analyses of zircons, which were first polished to the half and imaged in CL and BSE. So we can distinguish and date roughly the inherited zircon grains/cores, magmatic and/or recrystallized zones, which help unraveling the metamorphic history. Hf-zircon isotope data provide additional source information about studied zircons.

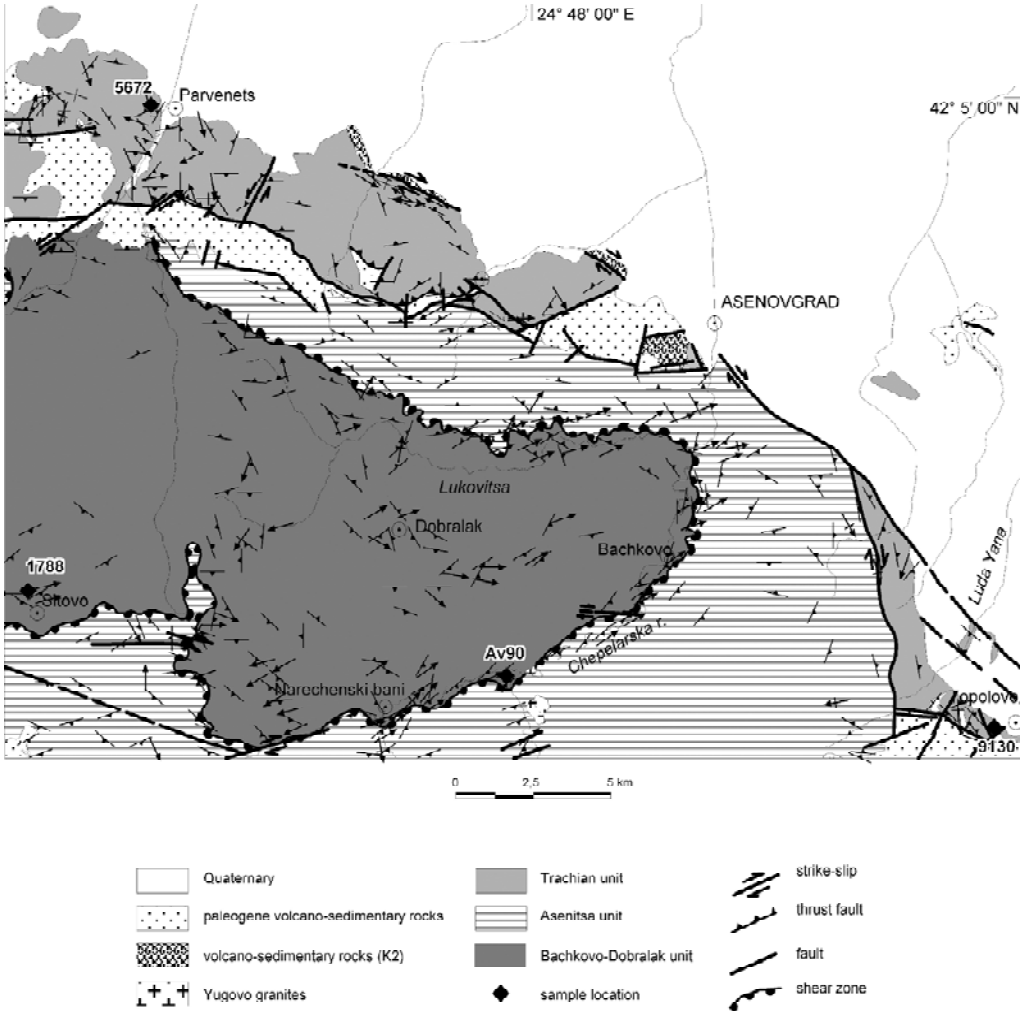

Fig. 1. Geological map of the northern parts of Central Rhodopes, after Sarov et al., 2006, with sample localities

U-Pb isotope geochronology and isotope tracing

Zircons of sample AvQ-90 (Bachkovo leptitic orthogneisses) are mainly semitransparent, beige-brownish, rarely clear and colorless. Brownish zircons define a discordia with an upper intercept age 153.5±4.1 Ma, whereas 2 chemical abraded (Mattinson, 2005) grains are concordant at 151.17±1.1 Ma (fig. 2). The lower intercept of the discordia give evidence for Late Alpine metamorphic overprint 55.9±7.2 Ma. CL and BSE images show magmatic oscillatory zonality and high U-content (dark areas on CL or light/white in BSE images), leading to partly disturbed (metamict) structure (fig. 3). In the latter measured ages are discordant and with lead loss (122 Ma $^{206}Pb/^{238}U$ age), whereas in the crystalline zones it coincides with the conventional determined age of 153.5±4.1 Ma. The colorless zircons reveal inheritance with Early and Late Paleozoic age. The e-Hf isotope data (sample AvQ090) at 150 Ma are scattering between +0.24

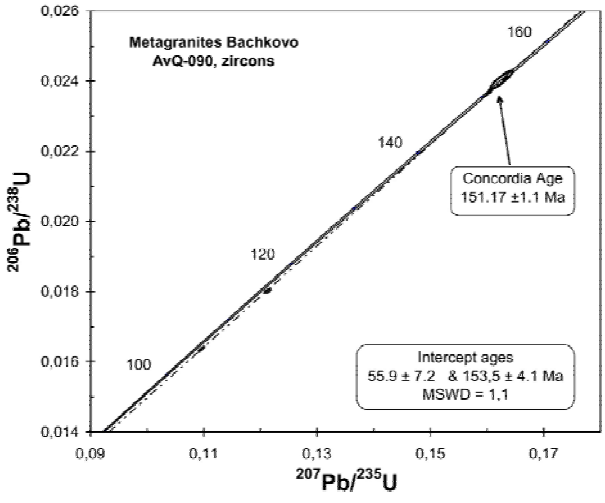

Fig. 2. Concordia diagram for zircons of Bachkovo metagranite (sample AvQ-090)

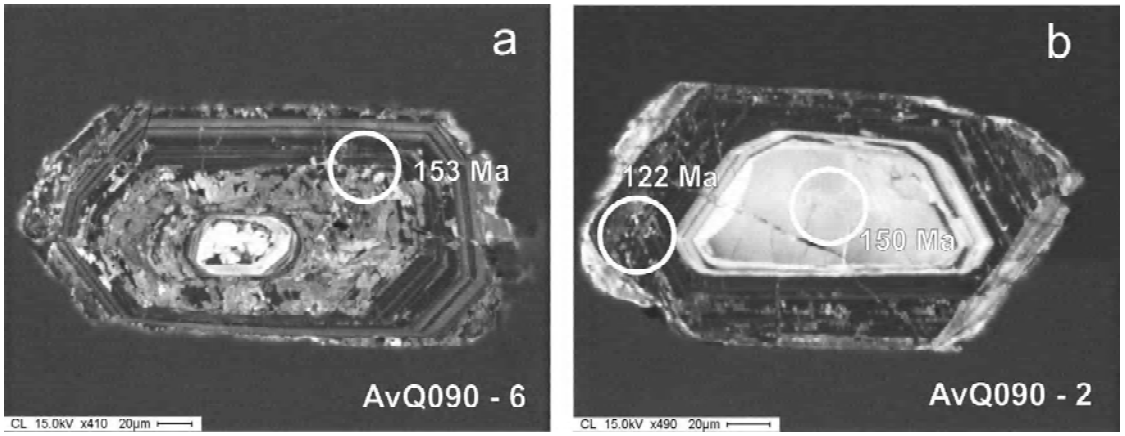

Fig. 3. CL images of zircons from sample AvQ-090 (Bachkovo metagranite). The circles show the location of the LA-spots with the corresponding $^{238}U/^{206}Pb$ age data.

and +4.55, zircons with an older lead component show more negative e-Hf values up to —9.0. The positive ε-Hf values at 150 Ma demonstrate that young crust material and/or lithospheric mantle material play an important role during the magma genesis.

In the Parvenets gneisses (sample 5672a) we distinguish 2 main types of zircons: (i) beige-brownish, transparent to semitransparent, and (ii) almost colorless, transparent. Prismatic grains prevail, whereas in the small size fractions they are mostly long prismatic, and in the bigger fractions increase the content of the shorter crystals. All zircons all slightly rounded. Conventional U-Pb analyses show lead inheritance, as well as lead loss in the measured grains. They define discordias, which in both cases cross the Concordia at ~330—340 Ma. Lead loss is observed mainly in the brownish zircons and is obviously connected to the Alpine overprint. CL and BSE images of the zircons show inherited cores with Early Paleozoic and older age (in situ LA-ICP-MS data), and outer parts with oscillatory magmatic zonation. These peculiarities are interpreted as formation of crustal peraluminous synmetamorphic (?) granites in the Carboniferous, which were metamorphic overprinted in Late Alpine time. All ε-Hf values at 330 Ma define a small range between —4.3 and —6.7, some part of zircons with an old lead component show a decrease of the ε-Hf data to —8.9.

From the same outcrop W of Parvenets village is the amphibolite (sample 5672). There the sparse zircons reveal ages ~302—312 Ma.

Discussion and correlation of the results

Obtained precise U-Pb zircon data and the oscillatory zoning of the zircons give evidence for magmatic protoliths of Bachkovo gneisses with a Jurassic age of 153.5±4.1 Ma. Preliminary data for the Dobralak metagranites are in the same range of 150 Ma. Both orthogneisses are overprinted during the Late Alpine metamorphism at 55.9±7.2 Ma. Consequently isotope-geochronological data support the working hypothesis that they define a new geological unit — the Bachkovo-Dobralak unit, which has similar protolithic ages (Jurassic) and metamorphic overprint (Late Alpine) upon the similar structural characteristics (Naydenov et al., this volume).

Gneisses of the Parvenets complex reveal an age of 330—340 Ma, which is consistent with the age of high-grade metamorphism in the Central Srednogorie (Carrigan et al., 2006). This fact allows a correlation with the basement of the Srednogorie zone and suggests a synmetamorphic generation of these granitic melts. After the accretion to the Rhodopes the metagranites suffered together with the cross-cutting gabbroic bodies (amphibolites of sample 5672) the Late Alpine metamorphic overprint.

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Метаморфни скали от северните части на Централните Родопи – конвенционално и *in situ* U-Pb цирконово датиране, изотопни характеристики и корелации

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Резюме. Новото геоложко картиране на северните части от Родопите доведе до отделянето на нови единици или подединици. В настоящото изследване се представят U-Pb цирконови изотопно-геохроноложки и Hf изотопни данни за метаморфни скали от Тракийската и Бачково-Добралъшката единици (Саров и др. и Найденов и др., този том). Осцилаторната магматична зоналност на цирконите и получените точни датировки свидетелстват за магматични протолити на Бачковските левкократни гнайси (проба AvQ-090, фиг. 1) с юрска възраст 153,5±4,1 Ma. Предварителните данни за Добралъшките метагранити са със сходна възраст. И двата типа скали са с наложен късноалпийски метаморфизъм при 55,9±7,2 Ma. Следователно изотопно-геохроноложките данни подкрепят идеята, че двата вида скали принадлежат на една геоложка единица, обхващаща протолити със сходна възраст на образуване и метаморфизъм, редом със сходните структурни особености (Найденов и др., този том).

Ортогнайсите (обр. 5672а) и секущите амфиболити (обр. 5672) от района на Първенец, отнесени към Тракийската единица показват възраст 330—340 Ma, която съвпада с времето на високостепенния метаморфизъм в Централното Средногорие (Carrigan et al., 2006). Този факт позволява корелирането им с фундамента на Централното Средногорие и предполага синметаморфно генериране на гранитните топилки. След приляпването към Родопите метагранитите, заедно със секущите ги метагабра с възраст 302—312 Ma, са претърпели късноалпийски метаморфизъм.