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New data on the westernmost part of the Sakar unit metamorphic basement, SE Bulgaria

Нови данни за метаморфния фундамент в западната част на Сакарската единица, ЮИ България

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Introduction and geological setting

The metamorphic basement of the Sakar unit, Sakar-Strandzha zone (Ivanov, 2017) consists of metagranites, paragneisses, amphibolites, mica gneisses and schists, unconformably overlained by fossil-bearing Sakar type Triassic metasediments (Chatalov, 1990) with revealed late Permian maximum depositional age of 259 Ma (Bonev et al. 2019a). Previously, the basement was considered as an old Archean block, affected by two metamorphic events and correlated with the metamorphic rocks of the Eastern Rhodope massif (Kozhoukharova, Kozhoukharov, 1973). Nowadays, most of the authors consider the basement as Precambrian intruded by Paleozoic and rarely Neoproterozoic (meta) granitoids (Bonev et al., 2019b and reference therein). Both basement and metasedimentary cover undergone post-Triassic greenschist-epidote-amphibolite-facies metamorphism (Tzankova, Pristavova, 2007; Chavdarova, Machev, 2017).

We studied a metaplagiogranite and adjacent rocks using zircon U-Pb geochronology and geochemistry to determine the age of magmatic and metamorphic events in the basement of the westernmost part of the Sakar. The metaplagiogranite crops out in small area near to the Klokotnitsa quarry (N 41°59'48.92, S 25°34'25.00), emplaced in muscovite-chlorite-quartz gneiss. Both rocks are distinguished by uniform foliation. We studied also a nearly located quartz-muscovite schist with unclear relations, due to the younger sedimentary cover.

Petrographic observations

The metaplagiogranite has a porphyroclastic texture. The major minerals are plagioclase, K-feldspar, quartz, muscovite and epidote, while the accessory phases are zircon, garnet and magnetite. The euhedral plagioclases show intensive sericitization and twinning. The subhedral K-feldspar exhibits undulose extinction. Rare euhedral garnets are observed among the polygonized quartz and thin muscovite bands. Muscovite-sericite bands trace the foliation and involve prismatic epidotes. The zircons are included in phyllosilicate bands and in plagioclase.

The muscovite-chlorite-quartz gneiss shows granolepidoblastic texture. The prominent minerals are muscovite, chlorite, and quartz, with minor presence of zircon, rutile and Ti-magnetite. The phyllosilicate bands form the foliation, with single transverse muscovite or chlorite flakes. The quartz has undulose extinction. The euherdral plagioclase is subparallel to the foliation. The zircon, rutile and Ti-magnetite are bound to the phyllosilicate bands.

The quartz-muscovite schist has granolepidoblastic texture. The major minerals (muscovite and quartz) form alternating bands and trace the foliation. The presence of coarse-grained muscovite flakes, obliquely to the foliation, are abundant. The polygonized quartz forms triple junction and monomineral bands or lenses. The zircon and Ti-magnetite are common in the phyllosilicate bands.

U-Pb zircon geochronology and geochemistry

The metagranite zircons have homogenous, oscillatory, rarely patchy cores (mean Th/U=0.42) and thin dark metamorphic envelopes (mean Th/U=0.05) (Fig. 1a). The ages range from 287 Ma to 618 Ma with major cluster at 520–550 Ma refer to the magmatic cores (Concordia age of 530.4±6.3 Ma)

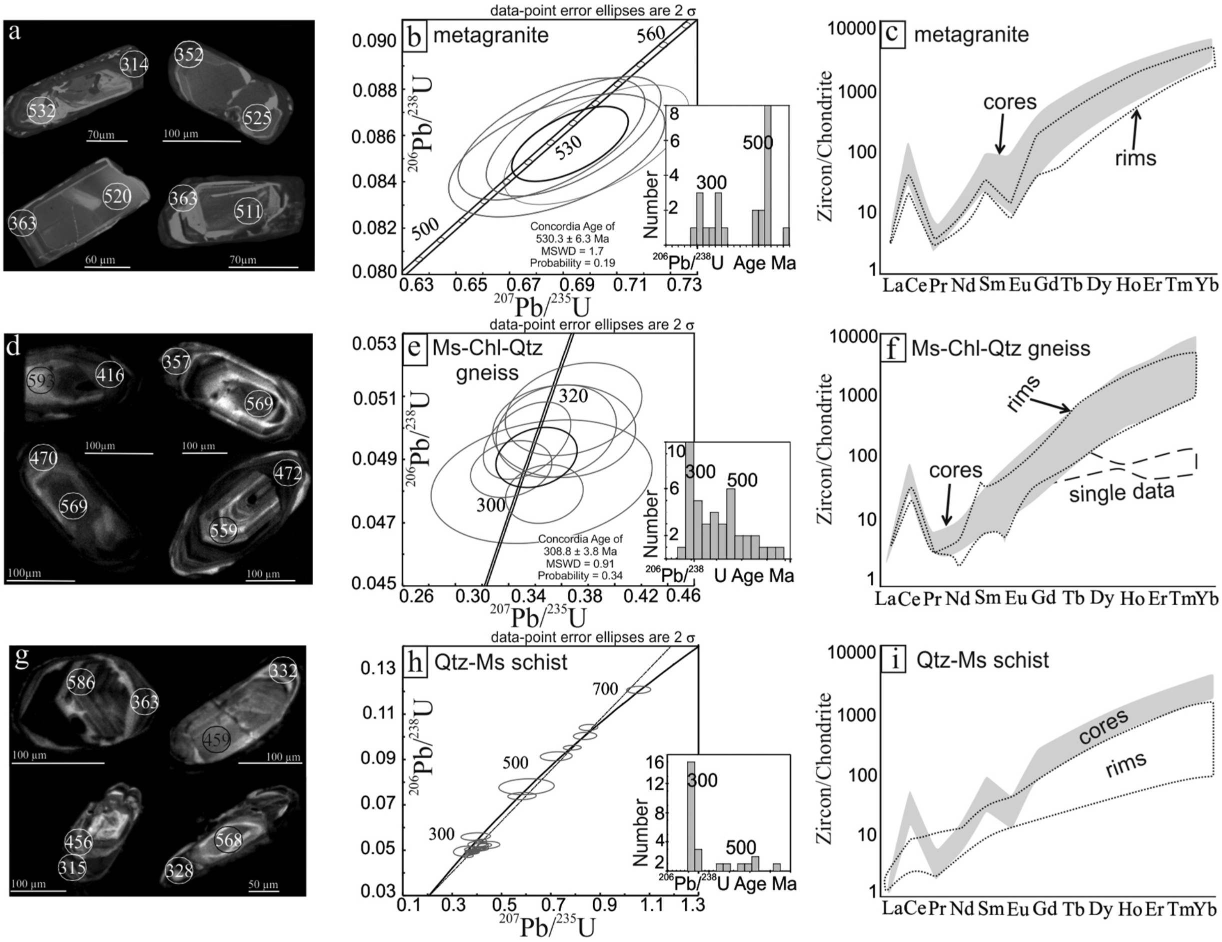

Fig. 1. *a–c,* metagranite*: a,* CL zircon images of euhedral cores with dark rims; *b*, Concordia diagram of 530.4±6.3 Ma MSWD=1.7 with inset histogram plot of all analyses; *c*, zircon chondrite-normalized REE diagram; *d–f,* muscovite-chlorite-quartz gneiss: *d*, CL zircon images with homogeneous cores and oscillatory rims; *e*, U-Pb Concordia diagram of 308.8±3.8 Ma, MSWD=0.91 with inset histogram plot of all analyses; *f*, zircon chondrite-normalized REE diagram; g–*I,* quartz-muscovite schist: *g,* CL zircon images of oscillatory and homogeneous cores with dark or patchy rims; *h*, U-Pb Concordia diagram with inset histogram plot for all analyses; *i*, zircon chondrite-normalized REE diagram. The circles point on the CL zircon images correspond to $^{206}Pb/^{238}U$ age. Chondritic values are from McDonough and Sun (1995).

(Fig. 1b). The younger ages from 302 to 364 Ma are related to the metamorphic rims (mean 334 ±27 Ma). The REE chondrite-normalized patterns show positive Ce anomaly (Ce/Ce*=4.95–28.82 for cores and 1.37–21.43 for rims), Eu negative anomaly (Eu/Eu*=0.12–1 for the cores and 0.15–0.58 for the rims) and HREE enrichment (Lu_N/Gd_N=6.70–69.27 for cores and 28.43–67.35 for rims) (Fig. 1c).

Zircons with oscillatory cores and oscillatory or homogeneous rims are typical for the muscovite-chlorite-quartz gneiss (Fig. 1d). The magmatic zircon data define two age populations. The first one clusters around 300 Ma and determines Concordia age of 308.8±3.8 Ma (Fig. 1e). The presence of Neoproterozoic core and Silurian oscillatory zones is determined by secondary age group 405–662 Ma. The REE patterns for the second group corresponds to typical igneous distribution with flat LREE portion, indications for positive Ce anomaly, negative Eu anomaly (Eu/Eu*=0.38–0.65) and steep HREE pattern (Lu_N/Gd_N=13–73) (Fig. 1f). The younger rims from the first group demonstrate similar REE distribution pattern: positive Ce anomaly (Ce/Ce* =3.49–32.32), negative to negligible Eu anomaly (Eu/Eu*=0.23–1.06) and steep HREE pattern (Lu_N/Gd_N=8.49–73) (Fig. 1f). The exceptions are several depleted in HREE zircon rims from both groups.

On CL images the zircon grains from the quartz-muscovite schist show homogenous and oscillatory magmatic cores (mean Th/U=0.49) with darker metamorphic overgrowth (mean Th/U=0.02) (Fig. 1g). The zircon ages vary from 298 Ma to 1054 Ma with major cluster at 309–332 Ma (Fig. 1h) for the metamorphic rims (mean 316±5.2 Ma). The magmatic ages range from 459 to 1054 Ma. The magmatic cores have positive Ce anomaly (Ce/Ce*=15–17) and pronounced negative Eu anomaly (Eu/Eu*=0.21–0.27) and HREE enrichment (Lu_N/Gd_N=10–46) (Fig. 1i). The younger rims differ from cores with weak negative Eu anomaly (Eu/Eu*=0.75–0.88), weak positive Ce anomaly (Ce/Ce*=1.14–2) and flat HREE pattern (Lu_N/Gd_N=4–28) (Fig. 1i).

Conclusions

We applied U-Pb zircon geochronology and geochemistry and report the first finding of remnants of crystalline basement with late Neoproterozoic–Cambrian age and Gondwana affinity in Sakar unit (Bulgaria). The Neoproterozoic–Cambrian age is better preserved in zircon population of the metaplagiogranite, but also in inherited cores of zircons grains in adjacent rocks. Cadomian metagranites related to orogeny in the northern Gondwana margin are present in the SE part of the Sakar-Strandzha zone (534–546 Ma, Şahin et al., 2014), Pontides and Anatolide-Tauride block in Turkey (e.g., Okay, Nikishin, 2015 and reference therein). Magmatism and significant crust recycling during continuous amalgamation of Gondwana blocks to Laurasia in Late Ordovician–early Silurian (Okay, Nikishin, 2015) is recorded as oscillatory zircon zones of adjacent gneiss and schist. The extensive Carboniferous plutonism and high-temperature metamorphism provoke a new zircon growth in all three samples, resulting in outermost homogeneous rims with low Th/U ratio. The lower Carboniferous–lower Permian detrital zircons in metasediments and metagranitoids are abundant in the eastern part Sakar unit (Vladinova et al., 2018; Bonev et al., 2019b). The Late Jurassic–Early Cretaceous deformation and metamorphism is visible in the Triassic metasediment cover, but did not provoke a zircon resetting in the basement rocks and metasediments.

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References

Bonev N., P. Filipov, R. Raicheva, R. Moritz. 2019a. Detrital zircon age constraints on the deposition of the Topolovgrad Group, Sakar-Strandzha Zone, SE Bulgaria. – *Geophys. Res. Abstr.*, *EGU*, 21, 1921-1.

Bonev, N., P., Filipov, R. Raicheva, R. Moritz. 2019b. Timing and tectonic significance of Paleozoic magmatism in the Sakar unit of the Sakar-Strandzha Zone, SE Bulgaria. – *Intern. Geol. Rev.*, *61*, 16, 1957–1979.

Chatalov, G. 1990. *Geology of the Strandza Zone in Bulgaria*. Geologica Balc., Series Operum Singulorum 4. Sofia, BAS, Publishing House, 263 p. (in Bulgarian with English abstract).

Chavdarova, S., Ph. Machev. 2017. Amphibolites from Sakar Mountain – geological position and petrological features. – In: *Proceedings of the National Conference "GEOSCIENCES 2017"*. Sofia, Bulg. Geol. Soc., 49–50.

Ivanov, Zh. 2017. *Tectonics of Bulgaria*. Sofia, "St. Kliment Ohridski" Publishing House, 331 p. (in Bulgarian with English abstract).

Kozhoukharova, E., D., Kozhoukharov. 1973. Stratigraphy and petrology of the Precambrian metamorphic rocks in the Sakar Mountain. – *Bull. Geol. Inst., Ser. Geochem., Mineral., Petrogr.*, *12*, 193–213 (in Bulgarian with English abstract).

McDonough, W., S. Sun. 1995. The composition of the Earth. – *Chem. Geol.*, *120*, 223–253.

Okay, I., A., M., A. Nikishin. 2015. Tectonic evolution of the southern margin of Laurasia in Black Sea region. – *Intern. Geol. Rev.*, *57*, 1051–1076.

Şahin, S. Y., N. Aysal, Y. Güngör, I. Peytcheva, F. Neubauer. 2014. Geochemistry and U-Pb zircon geochronology of metagranites in Istranca (Strandja) Zone, NW Pontides, Turkey: Implication for the geodynamic evolution of Cadomian orogeny. – *Gondwana Res*., *26*, 755–771.

Tzankova, N., P. Pristavova. 2007. Metamorphic evolution of garnet-bearing schists from Sakar Mountain, Southeastern Bulgaria. – *C. R. Acad. Bulg. Sci.*, *60*, 3, 271–278.

Vladinova, Tz., M. Georgieva, V. Bosse, Z. Cherneva. 2018. U-Pb detrital zircons geochronology from metasedimentary rocks of the Sakar Unit, Sakar-Strandzha zone, SE Bulgaria. – *Rev. Bulg. Geol. Soc., "Geosciences 2018"*, *79*, 3, 67–68.