# U/Pb ID-TIMS dating of zircons from Sakar-Strandzha Zone: new data and old questions about the Variscan orogeny in SE Europe

# U/Pb ID-TIMS датиране на циркони от Сакар-Странджанската зона: нови данни и стари въпроси за Вариския ороген в ЮИ Европа

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The Sakar-Strandzha Zone (SSZ; Ivanov, 1998), also known as Strandzha and Sakar subunits of the Srednogorie (Dabovski, Zagorchev, 2009) or as Strandzha Massif (SM; Okay et al., 2001; Natal’in et al., 2016 and references therein), is a crucial region for reconstructing the link between the Balkanides in Bulgaria and Serbia and the Pontides in Turkey. The Balkanides are considered part of the European Variscan orogeny that formed during the collision between Laurasia and Gondwana in the Devonian–Carboniferous (e.g. Haydoutov, Yanev, 1997). The prominent Cimmerian structures of broadly Triassic–Jurassic age in the Western Pontides and the SM as one of its main subunits refer to the Tethyan orogeny (e.g. Şengör et al., 1984). Recent publications about SSZ and SM (Gerjikov, 2005; Machev et al., 2015) and correlation of the terranes in Bulgaria and NW Turkey (e.g. Yanev et al., 2006; Natal’in et al., 2016) revealed many similarities between the pre-Alpine and especially the Variscan evolution of the Balkanides and the Western Pontides. The present study contributes to the understanding of the Variscan orogeny of the area by providing new age data for a gabbro and granite from the Bulgarian part of Strandzha and Sakar mountains.

**Samples and analytical methods.** We present geochronological data for two rock samples: a weakly deformed gabbro SG059 sampled near Zhelyazkovo village in Strandzha Mountain (Strandzha subunit of SSZ) and a porphyritic granite AvQ042 sampled near Hlyabovo village (the Hlyabovo quarry; Sakar subunit of SSZ). Zircon crystals were separated by heavy liquids and pre-selected under binocular. Several grains were mechanically abraded to remove their outer zones, which are often rich in U and Th that cause extensive radiation damage and associated loss of Pb isotopes. Mechanical abrasion of these outermost zones is known to improve concordance of analytical results. After digestion of individual zircon grains, U and Pb were chemically extracted and their isotopic composition measured by conventional ID-TIMS (isotope dilution – thermal-ionization mass-spectrometry). Full details of the analytical techniques and data reduction are given in Georgiev et al. (2012).

**Results and discussion.** Dated zircons from the Sakar granite define a discordia line with an upper intercept age of 305±5.5 Ma (Fig. 1a), interpreted as the crystallization age of the granite. Abraded zircons are positioned notably closer to the Concordia line, one of them being almost concordant at 300.4 Ma. Zircons from Zhelyazkovo gabbro in Strandzha (Fig. 1b) are largely concordant and define a Concordia age of 302.1±1.5 Ma, interpreted as the crystallization age of the gabbro. This age is slightly younger than the age of the Sakar granite, but both ages overlap within their uncertainties.

The dated granite and gabbro from Sakar and Strandzha Mountains (SSZ) were emplaced close to the Carboniferous–Permian boundary. Similar but less precise LA-ICPMS U-Pb zircon ages of 293.8±7.6 Ma and 274.10±4.50 Ma were obtained for rocks form the Oman-Fakya and the Monastery Heights plutons in the Bulgarian portion of SM (Georgiev et al., 2012). Basement granitoids from the Turkish part of SM also have similar zircon Pb evaporation ages in the 271–309 Ma range (Okay et al., 2001). Further, age distribution of inherited zircons from the Cretaceous plutonic and volcanic rocks confirms significant presence of Carboniferous–Permian plutomic rocks in the basement of the whole Eastern Srednogorie zone including the SM (Georgiev et al., 2012). Recent dating of a number of granitoids from the Turkish part of SM (Natal’in et al., 2016) revealed similar to older Carboniferous ages (299–312 Ma), with subordinate magmatic activity in the Late Permian–Early Triassic.

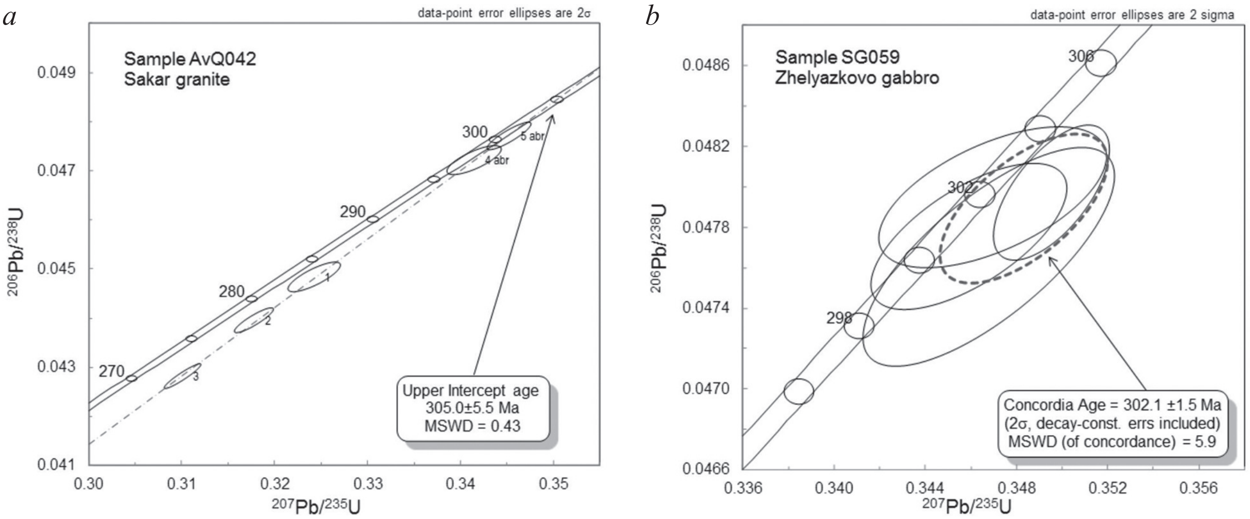


**Fig. 1.** U-Pb ID-TIMS zircon data for: *a*, sample AvQ042 – Sakar granite (mechanically abraded zircons are labeled with "abr"); *b*, sample SG059 – Zhelyazkovo gabbro (all analyzed zircons are mechanically abraded)

The 302–305 Ma ages from this study and other published data from SM correlate very well with those of the Petrochan pluton (302–307 Ma) and the Vezhen pluton (refined age of 302–307 Ma) from the Balkan Mountain, as well as with the Smilovene (304.1±5.5 Ma) and Hisara plutons (303.5±3.3 Ma; Carrigan et al., 2005) and Medet gabbro (305.5±5 Ma) in Sredna Gora. The 300–307 Ma old plutons in the Balkan and Srednogorie zones are considered postcollisional (e.g. Haydoutov, Yanev, 1997). This is supported by petrological and geochemical data for the composite granite-to-gabbro Petrochan, Vezhen and Smilyane plutons. The similar ages and geochemical characteristics of many plutons from the Balkanides and SM, including the reported gabbro from Strandzha (SG059) and granite from Sakar (AvQ 042), suggest that the 299–310 Ma old magmatism in the Balkanides and Strandzha are coeval. Therefore, our results in conjunction with published ages suggest a common geological evolution of the Balkanides and SSZ at least until the end of Carboniferous, most likely genetically related to the Variscan orogeny. Subsequently, the Variscan basement of the SM has been affected by the Cimmerian orogeny that caused Jurassic deformation and low- to intermediate metamorphic overprint.

On the other side, geological studies for the Turkish part of SM suggest that the Carboniferous–Permian and the Early Triassic granitoids are subduction related. Consequently, they are interpreted as either related to the Cimmerian orogeny, or to the long-lived Cambrian–Triassic Silk Road magmatic arc, which evolved on the northern side of Paleo-Tethys (Natal'in et al., 2016 and references therein). The correct tectonic reconstruction is generally hindered by extensive Cimmerian to Alpine tectonics and Jurassic metamorphism. Further international collaborations with an interdisciplinary approach, particularly regional geochemical and geochronological syntheses, and a broader view on the geology on the Balkan Peninsula and adjacent areas have the potential improve the accuracy of the tectonic reconstructions.

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