likely either Cretaceous (~100–120 Ma) or Variscan (~300 Ma). Protolith ages are almost totally unknown in the Rhodope Terrane, as most dating techniques that have been applied utilized systems known to be easily reset during metamorphism (i.e., Rb-Sr, $^{40}Ar/^{39}Ar$). The Bubino gabbro, a component of the Variegated Fms., yields an age of 572 ± 5 Ma, and initial geochemical and petrological studies suggest this rock has bonninite-like chemistry and was formed in a subduction zone setting. Data for another gabbroic unit from the north central Rhodope are not definitive, but clearly indicate an age >500 Ma. Zircons from both of these rocks also contain homogeneous exterior zones that are interpreted as metamorphic, and yield Variscan ages ~300–350 Ma. These are the first Neoproterozoic protolith and Variscan metamorphic ages so far reported for the Rhodope Terrane. A granite from the Bela Reka antiform also yields a Variscan age of 301 ± 4 Ma, and contains a few inherited cores with ages of ~660 and ~2500 Ma. Although recently interpreted as a product of Cretaceous subduction, the lack of well-established metamorphic and protolith ages urges caution in making tectonic reconstructions. Our preliminary data indicate a significant Pre-Alpine tectonic history in the Rhodope Terrane.

Metamorphosed Hercynian granites in the Alpine structures of the Central Rhodopes, Bulgaria: Position and geochemistry

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Modern views on the Rhodopes massif evolution distinguish two successive compressional and extensional stages completed in the Alpine time. Both stages resulted from the collision between Eurasian and African plates in early Cretaceous time. During the compressional stage, the rocks have been subjected to regional metamorphism and a system of large-scale south verging thrusts emerged. The extensional stage began with tectonic erosion of the anomalous thickened crust and continued with the formation of detachment fault system. The latter has been connected with a development of granitic and migmatitic domes and imposed graben depressions filled with sediments of Palaeogene age. The Late Cretaceous-Tertiary extensional system in the Central Rhodopes area consists of two plates: an upper plate (Asenitsa unit) that has been affected by amphibolite facies metamorphism (550 °C / 13 kbar); and a lower plate (Arda unit) that has been affected by migmatization (620–680 °C / 4–8 kbar). The Arda unit migmatites was exhumed during the Oligocene (35–34 Ma) and formed the core of the Central Rhodopian Dome.

The core of the Central Rhodopian Dome consists of migmatitic orthogeneisses. U-Pb dating shows the Eocene age of migmatization 37–38 Ma (monazite and zircon from anatectic melts) and Hercynian age 308–310 Ma (zircon from gneiss and anatectic melts) of migmatite precursor. Geochemical data and zircon with magmatic oscillatory zoning indicate that the precursor was a granitoid rock of calc-alkaline affinity, which was emplaced ca. in a frame, represented at present by garnet-kyanite schists, marbles and metaeclogites.

Alpine migmatization ranged from subsolidus mobilization to low-temperature water-saturated melting in biotite stability field. Migmatite geochemistry corroborates a conclusion of low mobility of HFS elements and preservation of protolithic zircon during melting thus allowing an interpretation of orthogneisses protolith origin. In situ leucosome LREE and Zr concentrations coincide with those calculated for low temperature felsic peraluminous melts. The low total REE concentrations and distribution patterns without Eu-anomaly are dominant. LIL elements (Rb, Ba, Sr) occurring as trace constituents in major phases show larger variations compared to mesosome. Average Rb/Sr and Ba/Rb values of K-feldspar mineral separates show systematic changes in the sequence: in situ leucosome – mesosome – evolved melt (respectively Rb/Sr 0.49–0.65–0.93 and Ba/Rb 10.1 – 8.2–5.5) marking fractionation of crystallizing phases during incomplete melt extraction.

Protolith lithologies include hornblende-biotite granodiorite, biotite, and two-mica granites, and aplitic veins. Major and trace element signatures show magmatic differentiation trends, which are consistent with hornblende and plagioclase fractionation. REE data support such an interpretation. Granodiorite and biotite granite have similar total REE content (200–300 ppm), distribution patterns and negative Eu-anomaly (0.5–0.6). Aplitic granites (total REE <100 ppm) differ in higher HREE fractionation and pronounced negative Eu-anomaly (0.1–0.4). A/CNK ratio values in the suit range from 0.9 to 1.2. The oxygen isotopic composition of isolated samples $\delta^{18}O$ 6.2–8.3 and calculated initial $^{87}Sr/^{86}Sr$ ratio (0.705–0.707) corroborate an assumption of predominant I-type granitoid protolith. Trace element discrimination plots based on Zr, Ta, Nb, and Hf distribution show close similarities with volcanic-arc granites and late or post-collision calc-alkaline intrusions, which may be derived from a mantle source but underwent extensive crustal contamination.