Amphibolites from Sakar Mountain – geological position and petrological features

Амфиболити от Сакар – геоложко положение и петроложки особености

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Keywords: orthoamphibolites, paraamphibolites, Sakar Mountain.

Introduction

The metamorphic rocks of the Sakar mountain region have traditionally been referred to two metamorphic complexes – archaic (correlated with the rocks from Eastern Rodops) and Topolovgrad Group (Kozhoukharov et al., 1993 a, b). Among the rocks of the Topolovgrad Group (TG) for the first time in our country were found fossil remains, which in general determine their Triassic age. According to Gerdjikov (1999) there is a concordant stratigraphic and structural agreement between the two complexes and the author note the Archaic complex as a Volcanic-Terrigenous Complex (VTC) with an supposed late Paleozoic–Triassic age, and the two complexes are considered by Sarov et al. (2012) as part of the Thracian lithotectonic unit. The subject of the present study is the amphibolites from VTC and TG. The aim is to establish the character (ortho- or para-) of the amphibolites of two complexes, to define criteria for their differentiation and to determine the P-T conditions of the metamorphism.

Petrology

Orthoamphibolites are revealed as “layered” bodies and lenses only in the rocks of the VTC or as xenoliths in the Sakar Pluton. They are melanocratic, often with a massive structure. As a result of the primary heterogeneity of the protolith, there is also an irregular alternation of melanocratic and leucocratic bands. They contain amphibole, quartz, plagioclase, epidope, biotite, chlorite, hematite, and ilmenite. Their texture is nematoblastic, granonematoblastic, porphyroblastic.

Amphibole is in the largest amount and forms elongateed, idioblastic crystals. (100) deformation tweens are rarely observed. Amphiboles belong to the calcium group and they are classified as tschermakites.

The quartz forms lense-like, porphyry-like aggregates, alone or together with plagioclase.

Biotite is relatively rare and is found only in orthoamphibolites north from Dervishka Mogila peak.

Plagioclase is observed as several morphological types: large xenoblastic porphyroblasts with inclusions of small-grain amphibole; relatively large crystals with a strongly altered core and a “clear” rims and clear crystals, twined after albite law. Plagioclase is oligoclase–andesine ($An_{18–40}$), with no pronounced zonation.

The epidote is irregularity distributed in the rock – isolated grains in the matrix or as inclusions in the amphiboles. The crystals are inhomogeneous – presence of lighter and darker areas. The lighter ones are richer in Fe, respectively in pistacide and epidotic components.

Chlorite is irregularity distributed and is observed as separate, large flakes or as smaller ones in amphibole rich bands. The composition is repidolite with X_{Fe} = 0.38–0.39.

The ilmenite forms xenoblastic crystals, most often elongated along the foliation. In some cases, ilmenite also exhibit exolutions (intergrowths?) of hematite, and in the strongly deformed areas there are signs of rotation of the ilmenite crystals.

Paraamphibolites are mainly found in the lower parts of the section of TG in association with unpure marbles and carbonate-rich schists. They are melanocratic, small-grained, thin-banded and strongly foliated with nematoblastic texture. The rocks contain amphibole, quartz, epidot, plagioclase, tourmaline, chlorite, rutile, magnetite, iron oxides and hydroxides.

Amphibole is observed as elongated to needle-like crystals, forming the foliation of the rock, and rarely as short-prismatic oblique to the foliation crystals. It has the same composition (tschermakite) but it has lower Si content and higher X_{Mg} due to the higher MgO content in the rocks compared to orthoamphibolites.

The quartz forms small to medium-grained xenoblast crystals, clear, without undulose extinction.

The epidote is represented by rare xenoblastic crystals and forms small porphyroblasts among the amphibole-rich bands.

Plagioclase forms rare, isolated xenoblastic grainss, elongated along the foliation and has a much more homogeneous composition (An_{18-30}).

Chlorite is represented by small-grained flakes or irregularity distributed aggregates.

Rutile is found only in paraamphibolites as small to medium-grained, xenoblastic, elongated to the foliation-extended grains.

Magnetite is the main ore mineral. It forms small elongated or idioblastic crystals with a square shape sections.

A potassium feldspar is also found in the paraamphibolites as a detrital mineral.

The SiO_2 contents of the rocks vary from 46.47 to 52.33 wt%, and both rock types are indistinguishable. Distribution of the REE in orthoamphibolites is typical for basic magmatic rocks – a slightly pronounced slope of curves, showing slight enrichment of LREE and low negative Eu anomaly (Eu^*/Eu_n=0.51–0.99). The distribution of REE in paraamphibolites is much more irregular, with positive Eu anomaly, and in general the REE distribution patterns are much more “flat”. Due to their geochemical characteristics, orthoamphibolites can be discriminated as island-arc basalt.

The P-T conditions of the metamorphism are in the range of 510–555 °C (6–8 kbar) for paraamphibolites and 625–635 °C (6.5–8.0 kbar) for orthoamophibolites (geothermobarometer of Plyusnina, 1983). Higher temperature values obtained for orthoamphibolites are probably due to their position in the section – they are part of the VTC.

Conclusions

Our study presence evidences for the presence of ortho- and paraamphibolites in the section of Volcanic-Terrigenous Complex and Topolovgrad Group, the first predominate in VTC and are not found in the TG rocks. Both types of amphibolites have similar mineral composition. The orthoamphibolites contain ilmenite, and the para-rocks – magnetite and rutile. This is probably due to the higher oxidation regime during the metamorphism in these rocks. Tourmaline is found only in paraamphibolites. Differences are also found in the P-T conditions of metamorphism – a higher temperature for the ortho-amphibolites of VTC.

Acknowledgments: The present study was carried out thanks to the financial support of the University Research Fund (contracts 96/2014 and 86/2016).

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