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A NEW MODEL FOR THE PRE-PERMIAN BASEMENT OF THE CENTRAL STARA PLANINA MOUNTAIN

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Abstract

After more than 40 years break in the detailed studies of Central Stara Planina an extensive field research on the pre-Permian basement in the area was carried out. The newly gathered data require substantial modification of the existing models. Within the basement we are distinguishing two pre-Variscan rock units: low-grade Lower Paleozoic complex and an associated metagranitoid suite (Ambaritsa suite). A large number of data indicate a prolonged and voluminous Variscan granitoid magmatism in the studied area. On the basis of the intensity and character of the solid-state overprint these magmatic rocks are subdivided into three categories: syn-kinematic (Karlovo-Ribaritsa suite), late-synkinematic (Kalofer suite) and post-kinematic granitoids (the Vezhen pluton, Anton and Rozino/Klisura granites). Also, the existence of migmatitic basement typical for Stara Planina is rejected and the structural data are consistent with intensive Variscan tectonism in the areas supposed to be part of the crust that was consolidated probably in the Cambrian.

Key words: Central Stara Planina Mountain, pre-Permian basement, metagranitoids, Variscan syn-kinematic granitoids

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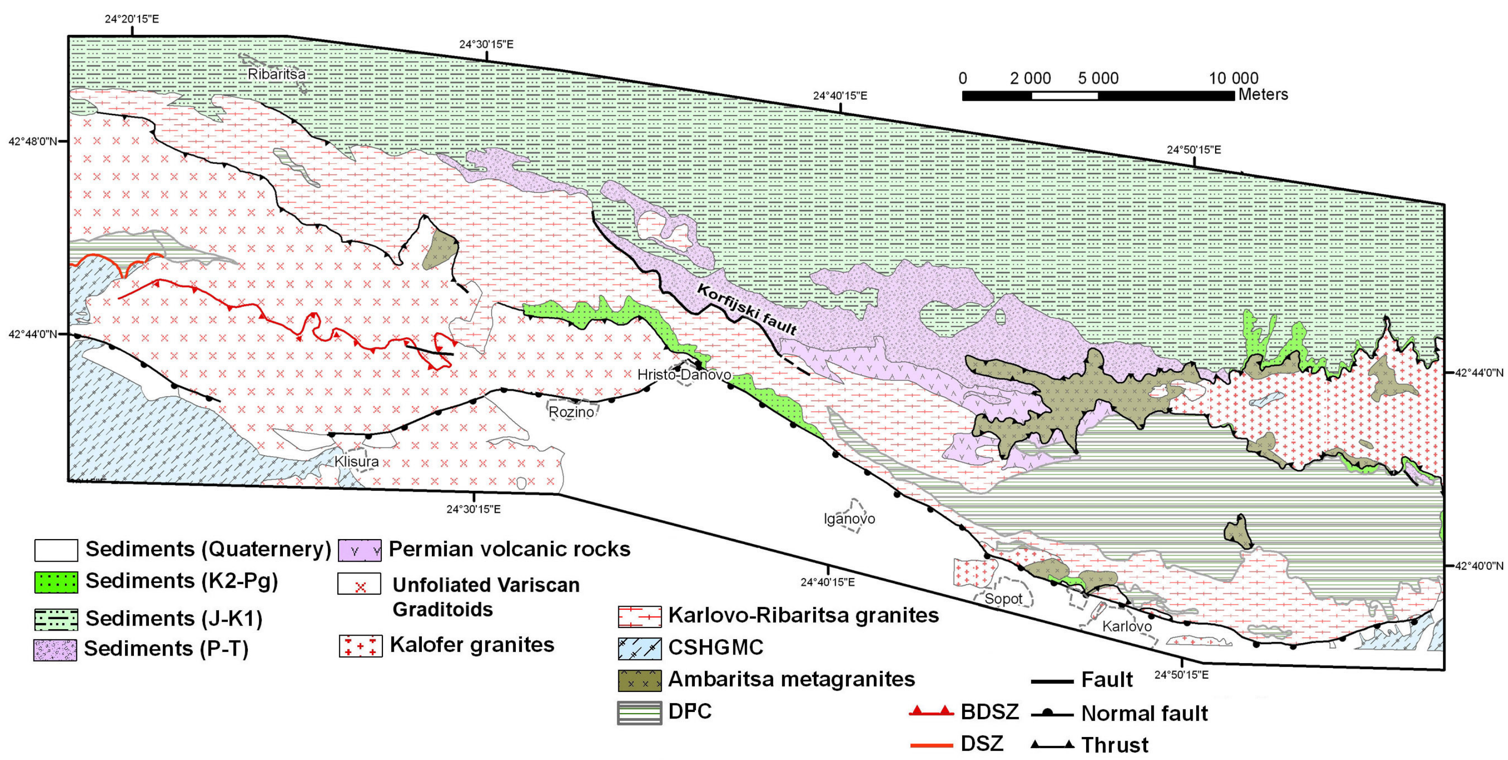
Introduction. The first detailed geological mapping of the central part of the Stara Planina Mountain was realised during the 60-ies of the last century. Since more than 40 years the results of this study [1,2] are the base for all successive publications and regional tectonic models. These highly influential papers launched new models for stratigraphy, tectonics and geodynamic evolution of the central part of the Balkan Peninsula. It is important to note that the proposed models follow the logic of some deeply rooted concepts for: 1) the contrast difference and independent tectonic evolution of the pre-Permian basement in Stara Planina Mountain and Sredna Gora Mountain is assumed; 2) the existence of a major Late Alpine tectonic boundary between the Stara Planina and Sredna Gora tectonic zones; 3) the occurrence of migmatization and granitization phenomena within the very low-grade metamorphic complex in Stara Planina Mountain.

In this contribution we are reporting new data that seriously challenge these assumptions. We are presenting the outlines of a new model for the tectonic evolution of the pre-Permian basement. The main focus of the paper is the supposed existence of high-grade basement interpreted as a product of local migmatization and granitization phenomena [1,2].

Previous ideas. The pre-Permian basement of Central Stara Planina Mountain is composed of various metamorphic and magmatic rocks (Figs 1, 2). Following the scheme of DIMITROV [3] two types of basements were distinguished [1,2], the one of Stara Planina zone consists of a low- to very low-grade metasedimentary sequence and associated ophiolites and metabasic rocks (Diabase-Phyllitoid Complex – DPC); the one of Sredna Gora zone comprises high-grade rocks (migmatic gneisses, amphibolites, rarely orthogneisses, etc.). It was suggested [3] and is still widely accepted the view that both complexes contain unique for each specific suites of granitoids – namely the Strara Planina calc-alkaline granitoids and the suite of Srednogorie granitoids (or the so-called "South Bulgarian granitoids").

Within the basement of the Central Stara Planina Mountain was also distinguished [1,2] a specific metamorphic unit – the Stara Planina High-Grade Metamorphic Complex (SPHGMC) considered to originate due to migmatization and granitization of DPC rocks. These high-grade metamorphic phenomena were related to the syn-kinematic emplacement of the so-called Karlovo granites. Up to now there are not any quantitative or qualitative petrological data for these metamorphic rocks and in all later contributions the authors are referring to the first short and rather incomplete description [1,2].

Fig. 1. Simplified map of Central Stara Planina Mountain (modified after [1,2]). Abbreviations: CSHGMC – Central Srednogorie high-grade metamorphic complex; DPC – Diabase-Phyllitoid Complex; DSZ – ductile shear zones; BDSZ – brittle-ductile shear zones →


24°20'15"E
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24°50'15"E
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42°44'0"N
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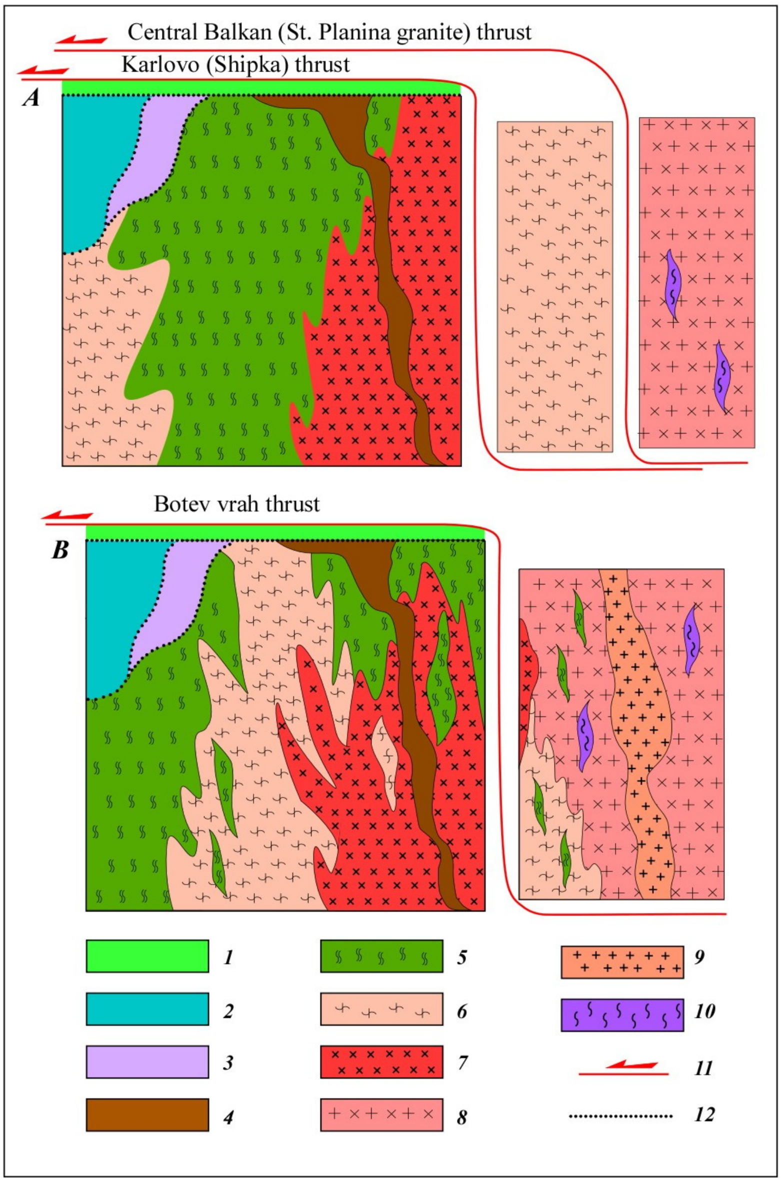
0
2 000
5 000
10 000
Meters
Ribaritsa
Korfijski fault
Hristo-Danovo
Rozino
Klisura
Iganovo
Sopot
Karlovo
Sediments (Quaternery)
Sediments (K2-Pg)
Sediments (J-K1)
Sediments (P-T)
Permian volcanic rocks
Unfoliated Variscan Graditoids
Kalofer granites
Karlovo-Ribaritsa granites
CSHGMC
Ambaritsa metagranites
DPC
BDSZ
DSZ
Fault
Normal fault
Thrust



Central Balkan (St. Planina granite) thrust
Karlovo (Shipka) thrust
A
Botev vrah thrust
B
1
2
3
4
5
6
7
8
9
10
11
12

Stratigraphy of the pre-Permian basement. A large part of the southern slopes of the Central Stara Planina Mountain is built of very low-grade metasediments containing sporadic lenses of metabasic rocks. The metasedimentary complex includes metasandstones, metasiltstones and metapelites, which are usually regarded as part of the DPC. In the studied area, some features of the rocks indicate higher grade metamorphic transformations as these are the presence of biotite (implying temperatures $\sim 400\,^{\circ}$C) and the coarse-grained texture. Respectively, these rocks should be called schists and be clearly distinguished from the phyllites typical for the DPC elsewhere.

In a few places along the southern slope of the Central Stara Planina Mountain migmatic paragneisses are exposed. They were considered to be a part of the metamorphic basement of the Srednogorie Zone. The recently obtained ages of the high-grade metamorphism are Mid Carboniferous [4,5] and these data considerably expand the rock complexes affected by the Variscan orogeny in the Balkan Peninsula.

The significant difference in the metamorphic grade of DPC and the high-grade basement of Srednogorie was used to propose the existence of two distinct Paleozoic tectonic elements [6]. Both units include large, batholithic-scale granitoid bodies with poorly known tectonic position and fabric. There is no doubt that this question is of prime importance, because in the Troyan-Kalofer part of the Stara Planina Mountain the boundary of these two Paleozoic units is masked by the emplacement of variously deformed granitoids [7]. Closely interrelated to this problem is also the question of the nature of the SPHGMC. This unit was an object of our studies for several years now and some results for the Teteven part of the Stara Planina Mountain have been already presented [8]. The field and microfabric studies in the Troyan–Kalofer part of the Stara Planina Mountain confirm the preliminary results and unequivocally indicate that the SPHGMC is a composite unit built mainly of granitoids. Nevertheless, on the basis of the existence of metamorphic overprint, intensity of the solid-state deformation and the relationships with the low-grade rocks of DPC we are distinguishing two main types of granitoids within SPHGMC: the Ambaritsa metagranitoids and the foliated Karlovo-Ribaritsa type granitoids.

← Fig. 2. Comparative stratigraphic schemes for the pre-Permian basement in the studied area. A – According to Milanov et al. [2]; B – This study. 1 – Maastrichtian-Paleocene; 2 – Jurassic-Lower Cretaceous; 3 – Triassic; 4 – Permian volcanics; 5 – DPC(?); 6 – Stara planina high-grade metamorphic complex (on scheme A); Ambaritsa type granitoids (B); 7 – Stara Planina type granitoids (A); Karlovo-Ribaritsa-type granitoids (B); 8 – Srednogorie type granitoids (A); Kalofer type granitoids (B); 9 – undeformed granitoids; 10 – Central Srednogorie high-grade metamorphic complex; 11 – thrust; 12 – unconformity

Except the rocks that used to be assigned to SPHGMC the group of Karlovo-Ribaritsa granites also includes the Karlovo granites of Milanov et al. [2]. It is impossible for us to understand on what criteria one and the same foliated granites were considered as "granitized and migmatized rocks" part of the SPHGMC, in one place, and in the neighboring area the same rocks were distinguished as the so-called Karlovo granites. Another problem for us is to differentiate the "Stara planina-type" from the "Srednogorie-type" granitoids. Instead, we are proposing a classification that is based on the intensity of solid-state overprint and relations with the host rocks. Moreover, none major tectonic boundary was found between these two types of granitoids. Following this logic we are distinguishing late-synkinematic (Kalofer type) granites and post-kinematic granites (the Vezhen pluton, Anton and Rozino/Klisura granites) but their detailed descriptions are beyond the scope of the recent paper.

Stara Planina high-grade metamorphic complex: a composite unit. As it was already stated, SPHGMC is a composite unit including the Ambaritsa metagranites and the Karlovo-Ribaritsa granitoid suite.

Ambaritsa metagranitoids. Under this name we are distinguishing a rather specific and unique for this part of Central Stara Planina Mountain magmatics. They are named on the peak Ambaritsa, where the most typical exposures are located. The dominant rock types are fine-grained, leucocratic granites that are usually strongly foliated and transformed into sericite schists. In some varieties rounded, up to 0.5–0.8 cm in size feldspar and quartz phenocrystals or rarely fine-grain low-strain lenses can be observed. These characteristics suggest that the protoliths were hypabyssal granites to rhyolites. Despite of the strong syn-metamorphic deformation, in a number of places the contacts with the schists of DPC display pristine intrusive features and also formation of meter-scale thick zones of hornfelses.

Another rock type is fine-grained diorites frequently containing small feldspar phenocrystals. They are intensively foliated and transformed into chlorite schists. Rarely the metadiorites associate fine-grained amphibolites and finely laminated quartz-chlorite schists. Most likely they represent metamorphosed basic rocks and tuffs. Their occurrences are restricted and in rare cases of continuous outcrops it can be demonstrated that they form lens- or tongue-shaped domains within the granitoids.

Karlovo-Ribaritsa granitoids. The Karlovo-Ribaritsa granitoid suite includes numerous generally NW- to W-trending sheets or morphologically more complex bodies emplaced within the DPC metamorphites and the Ambaritsa metagranitoids. Compositionally the bodies are rather uniform as most widespread are both the leucocratic muscovite granites and the K-feldspar porphyric (2×4 cm in size) biotite granites but granodiorites and rarely diorites are present as well.

Most of the bodies exhibit steady south-dipping solid-state foliation, which is generally heterogeneously distributed and intensifies approaching the contacts with the host rocks. Weakly or not foliated domains are rarely observed and can be regarded as low-strain lenses. The mineral lineation is less pronounced and is dominantly strike-parallel (E-W to SW-NE oriented). Generally, the sheeted bodies are sub-parallel to the main-phase foliation of the DPC and the solid-state foliation and lineation fabrics do not change their orientations in the granitoids' periphery and interior.

The contacts between the granitoids and DPC schist are spectacular, where in several tens to hundreds of metres wide zones an alternation between screens of foliated granites and metamorphites have been observed. These relationships are a good example of "lit-par-lit emplacement" (in the sense of [9]). Locally, along the margins of some of the granitoid bodies, granodiorite varieties with pronounced gneissic fabric can be observed. These rocks are penetrated by numerous fine-grained and centimeter-wide granitoid and aplitoid veins and dykes. Some of them are tightly folded and intensively foliated but the others are weakly deformed to undeformed. Easily, these domains could be misinterpreted as "migmatite zones", but the sharp contacts of the veins, their finer-grained texture as well as their spatial position (along the contacts of the granitoids) reject such an assumption. We interpret these "injection-type migmatites" (in the sense of [9]) as a result of syn-tectonic emplacement of the leucocratic granites within slightly earlier granodioritic magma pulses.

Rare but highly informative are the domains where magmatic layering is subparallel to the solid-state foliation. The meso- and micro-scale observations indicate mid- to high-temperature greenschist facies conditions of the solid-state overprint and there are no data about higher temperature structures.

Spatial distribution and comparison with previous interpretations. In relation to the Late Alpine thrusting (Fig. 2) we are distinguishing two areas of occurrence of the rocks that have been attributed to SPHGMC: one with autochthonous and another with allochthonous position. Unlike previous interpretations, we are referring to the allochthone only these rocks that are part of Botev vrah klippe/thrust. Despite our efforts during fieldwork we were unable to confirm the existence of Korfiyski reverse fault [2]. Indeed, the contact of the basement (referred to SPHGMC) and the Mesozoic cover is a tectonic one, but most probably it is a strike-slip fault instead of a compressional structure.

The autochthon is built mainly of the Karlovo-Ribaritsa granites. North of Karlovo and Sopot they are leucocratic, medium- to coarse-grained foliated granites. In few localities in this area were established outcrops of the Ambaritsa metagranitoids. The same leucocratic granites are well exposed along the road cuts along the Troyan-Karnare pass. Further west, in the area of the village of

Christo Danovo (along the rivers Damladere and Kavaklidere) the granitoids are K-feldspar porphyritic varieties with associated pinkish aplitic and white pegmatitic dykes. In this area spectacular examples of sheeted pluton margins can be observed presented by a wide zone of "injection-type migmatites".

It was suggested that SPHGMC is building up a separate allochthone, situated below the main thrust that was supposed to emplace Srednogorie type granitoids over the Mesozoic–Tertiary sediments and the Stara Planina type of basement (Karlovo thrust [2], Shipka thrust [10]). Our data confirm this view but only partially. The western part of the Botev vrah klippe/allochthone is built of the Ambaritsa metagranitoids and associated metabasites and metatuffs. It is important to note that the occurrences of these rocks are not only confined to the western part of the klippe, but they are much more widespread, especially in the lowermost parts of the allochthone (see Fig. 1). The distribution of these rocks and their relations with later granitoids will be discussed in a separate paper.

Discussion. It is usually easy to distinguish the Ambaritsa metagranitoids from the Karlovo-Ribaritsa granites. But in some cases, especially close to the contacts with DPC, typical of the Karlovo-Ribaritsa granitoids is a phyllonitic fabric which hampered their distinction from the metagranitoids. In such cases we are applying only one criterion to make distinction. Usually the foliation within Ambaritsa metagranitoids is strongly folded and there is no steady orientation. In contrast, fold structures in the Karlovo-Ribaritsa granites are extremely rarely obserbed.

The age of the Ambaritsa metagranitoids is still unknown. The fact that they intruded the DPC indicates younger age than the Cambrian. Unpublished U-Pb and Ar/Ar geochronological data (von Quadt, G. Ruffet – pers. comm.) point to Late Variscan age of the Karlovo-Ribaritsa granites.

The E-W strike of DPC schists and the same elongation of the magmatic bodies was well documented on all previous maps. The consistent strike and dip of the DPC can be explained by Late Variscan transpression, related to the juxtaposition with the high-grade basement of Central Srednogorie [7], whereas the elongation of the Karlovo-Ribaritsa granites along this strike is one of the strongest arguments for their syn-kinematic emplacement. Other arguments that point to syn-tectonic emplacement of these granitoid suite are: i) a concordance between the solid-state fabric and rarely observed magmatic layering in the granitoids as well as their contacts and the main-phase foliation in the host rocks; ii) a pronounced elongation of the magmatic bodies, conformable to the regional trend of the last penetrative foliation in the host rocks; iii) presence of melts synchronous to the formation of structures with regional significance such as folds and foliations. The lack of high-temperature solid-state overprint within the granitoids could be explained as a result of the so-called down-temperature hiatus [11] due to fast cooling rates, length and nature of a deformation as well as host rock temperatures. Despite the contrast differences in some important details, actually our model confirms the idea for the significant role of syntectonic magmatism in the studied area [1,2].

Conclusions. Our data clearly show that the so-called SPHGMC is a composite unit that includes contrasting rock types and therefore this term must be discarded. Nevertheless, without petrological and geochronological data there is no solid ground for an introduction of new stratigraphic names for the different units.

Within the pre-Permian basement three types of granitoids are distinguished: pre-Variscan (the Ambaritsa-type metagranites), Variscan syn- (the Karlovo-Ribaritsa type) to late syn-kinematic (the Kalofer type) granites, and Variscan post-kinematic (the Vezhen pluton, Anton and Rozino/Klisura granites). Here, we have documented another case of a voluminous Late Variscan granitoid magmatism which feature is rather common in different segments of the Variscan orogen of Europe [12,13].

There is no evidence for the existence of high-grade basement rocks in this part of the Stara Planina Mountain. The observed local increase of metamorphic grade of DPC can be explained by heating caused by syn-kinematic granitoids (the Karlovo-Ribaritsa type).

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