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A REVIEW OF THE STRATIGRAPHIC CHARACTERISTICS AND AGE DATA OF THE MAIN ROCK UNITS IN THE BOR METALLOGENIC ZONE (TIMOK MAGMATIC COMPLEX)

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Abstract

This study reports on the stratigraphic characteristics of the main units and indicates the link between magmatism and mineralization in the Bor Metallogenetic Zone (BMZ) - the Timok Magmatic Complex (TMC). Existing data are supplemented by the latest different systematic long-term geological and stratigraphic surveys and new and contemporary mineral exploration methods. The TMC extends on a continental crust composed of different types of the Proterozoic to the Lower Cretaceous units and consists of the volcanic/magmatic, volcanogenic-sedimentary and sedimentary rock packages. Sedimentary processes and magmatism were almost continuous throughout the Late Cretaceous. The sedimentation lasted from the Albian-Cenomanian to the Maastrichtian. Magmatism occurred in at least two phases from the Upper Turonian to the Upper Campanian: I volcanic phase - V1 (90-82 Ma), II volcanic phase - V2 (83-78 Ma), with a steady decrease in age from east to west. Cu-Au porphyry mineralization occurs between 87-80 Ma. The major epithermal and porphyry mineralization is related to the V1 magmatic phase predominantly developed in the easternmost part of the BMZ.

Key words: *Bor Metallogenic Zone, Timok Magmatic Complex, stratigraphy, volcanism, age data, mineralization.*

1. Introduction

The Timok Magmatic Complex (TMC) overlaps almost completely with the Bor Metallogenetic Zone (BMZ), which belongs to the Late Cretaceous Apuseni-Banat-Timok-Srednogorje Belt (ABTS, [1,2]) and together belong to the transcontinental Tethyan-Eurasian Metallogenic Belt [3]. Because the TMC and the BMZ as the entire ABTS are known to host some of the largest Cu and Au deposits in Europe, their geology has been systematically studied over a long period of time (e.g., [4,5,6,7,8,9,10,11] among others). The studies covered various geological aspects of the origin and evolution of many parts of this belt and established solid genetic links between volcanic/magmatic processes and mineralization events. In this respect, the information based on stratigraphic relationships and high precision geochronology that includes Ar/Ar [5,6], U/Pb zircon dating (e.g., [4,9,11,12,13]) and Re/Os molybdenite dating [7] was of paramount importance.

In this study, the stratigraphy, mineralization relationships and radiometric age data of the rocks and mineralization of the BMZ (TMC) are revised, supplemented and systematized. The term TMC is used in the discussion on stratigraphy and age data and BMZ on mineralization and ore deposits. The existing data are supplemented by the latest different long-term systematic stratigraphic and geological relationships established by field observations and new and contemporary mineral exploration methods (primarily exploration drilling), as well as a series of published radiometric ages for volcanic rocks and mineralization. The BMZ is famous for its more than one hundred significant metallic occurrences 22 of which have been recorded as ore deposits (see review of [17]). Some of them are world class porphyry copper systems with high- intermediate- and low-sulphidation epithermal Cu-Au, or Au ore deposits [14,15,16,17,18]. For a long time, it was believed that the old, long-explored areas were unpromising in terms of discovering new ore bodies, but research over the last 15 years and the discovery of Čukaru Peki, a large copper and gold deposit, are rekindling interests in further investigating of the BMZ, both in research and scientific context [19,20,21,22,23,24].

Systematically collected latest research data

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presented in this paper confirm that the main mineralization phase in the BMZ was formed during the I (first) volcanic phase (V1) which was formed in the easternmost part of the TMC. In addition, the I volcanic phase yielded both mineralized and non-mineralized andesitic subgroups of rocks (V1A and V1B) with subtle but measurable and macroscopically visible petrological differences, which may lead to new insights into the main mineralization event in this area [12,19,23,24]. On the other hand, according to previous researches, there are numerous different morphogenetic types of mineralization in the central and western part of TMC, which is most likely related to the II (second) volcanic and magmatic phase (V2), but is less promising in terms of the discovery of significant deposits of porphyry copper [11,17]. The age of the rocks in TMC and their relationship with the existing mineralization is reviewed and commented on in a separate section of this study.

2. Stratigraphy of the BMZ (TMC)

The geology of the TMC and the location of the major ore deposits are given in Figure 1. The stratigraphy and time space development of the TMC and the relationships between the published sedimentary formations and volcano-sedimentary units, magmatic suites and mineralized rocks [8,25,26,27] are given in Figure 2. The TMC developed on a continental crust composed of different types of the Proterozoic to the Lower Cretaceous rocks partially overlaid by Miocene and Holocene sediments (M in Figure 2). Late Cretaceous units in the TMC that we will focus on in this study are: Sedimentary formations (Lenovac Formation, Oštrelj Formation, Bor Clastic and Bukovo Formation); volcanic-sedimentary unit (Metovnica Epiclastite); magmatic suites (Timok Andesite, Osnić Basaltic andesite, Ježevica Andesite, and Valja Strž Plutonite).

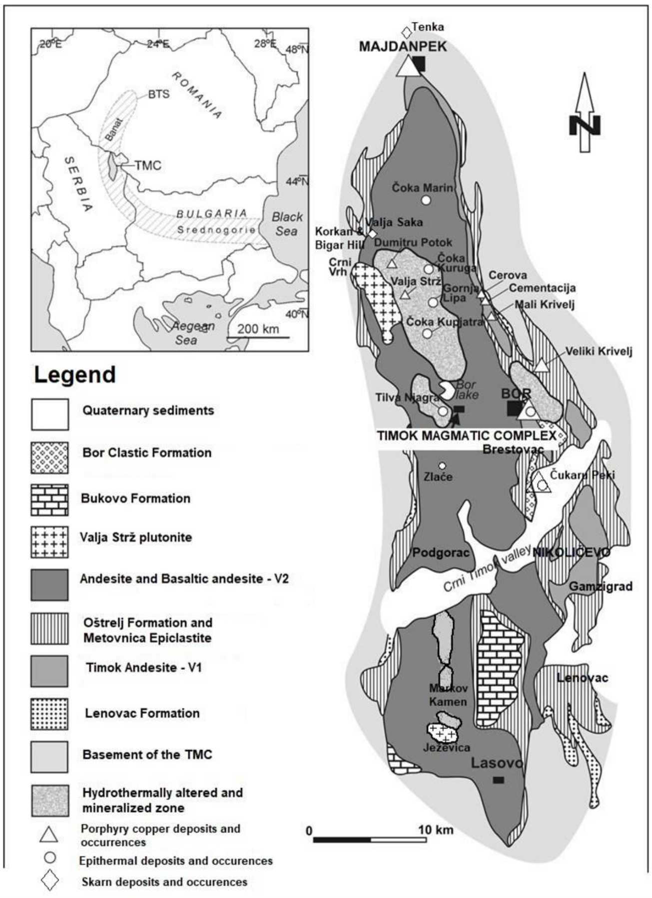

Figure 1 Simplified geological map of the TMC with the locations of major ore deposits and toponyms mentioned in this paper; the inset shows the regional geotectonic position

After a continuous carbonate sedimentation from the Early Jurassic to the Lower Cretaceous (Figures 2, 2a), a new sedimentation period commenced with the Albian transgression and unconformably overlies the Lower Aptian sandy limestones, (Figure 2). These Albian–Cenomanian sedimentation processes had clastic character and were related to oscillations and changes in the sedimentation regime of the depositional environment (Lenovac Formation, [26,27], LE in Figure 2). In the literature, this formation is also referred to as Stublica Clastics [25], but it was first described as Lenovac Beds [28] and therefore the author accepted this name for the Formation. This geological unit is built of sandy claystones, sandy marlstones and sandy siltstones topped by sandstones with siderite, and often rich in planktonic foraminifera content from the Upper Albian-Cenomanian [25].

After a hiatus, the Turonian–Senonian evolution commenced with a new sedimentary cycle. The sediments discordantly overlie the Lenovac Formation (Figure 2b). This started with basal conglomerate and continues over wide area in the TMC with clastic to carbonate sediments (Oštrelj Formation, [25], OS in Figure 2). The lowest part of the sediments contains microfauna (usually *Helvetoglobotruncana helvetica*), indicating the Lower to the Middle Turonian age [25]. During the Upper Turonian to the Senonian, the whole TMC area shows a considerable difference in the evolution between the eastward and the westward tectonic block (Timok East and Timok West in Figure 2 [26]).

In the eastward block, predominate volcanic rocks of biotite-hornblende andesite (±dacite) compositions (Timok Andesite, [8,12], V1 in Figure 1, 2). These rocks stratigraphically overlie the Lenovac Formation or the Turonian clastic to carbonate sediments (Oštrelj Formation, Figure 1). The available U/Pb zircon ages of the V1 andesite phase range 90-82 Ma [4,9,12,13]. The V1 andesite phase can be subdivided into two different andesite sub-phases: V1A (older) and V1B (younger, Figure 2c), which systematically differ in their stratigraphic position and petrography, age, and their link to mineralization [12,23,24].

The V1A sub-phase (older) andesite can be termed plagioclase-hornblende phyric, has predominantly holocrystalline (glass-free) groundmass and with the relative number of phenocrysts higher than 50% vol. In this andesite plagioclase, phenocrysts predominate over hornblende pheno- and microphenocrysts, both in terms of size and relative abundance (Figure 2c). The rock is represented by coherent lava flows, shallow intrusions (dykes and domes – P1 in Figure 2), monomictic breccia (autobreccia and hyaloclastites) and different facies of monomictic syn-eruptive volcaniclastic rock. The textural characteristics of the V1A volcanites unequivocally indicate the non-explosive (effusive) character of volcanism, and the monomictic composition of the volcaniclastic indicates their volcanogenic origin. The age of the V1A (Table 1) ranges widely from 90 to 85 Ma [4,5,6,7,12]. The are all situated and related to the V1 (V1A) magmatic phase [24]. The V1A andesite is strongly altered and mineralized by epithermal high sulphidation massive Cu–Au ore and/or porphyry disseminations or stockwork ([12,21,22,23,24], Figures 2d,e) and hosted the world-class epithermal, high-sulfidation Cu-Au deposit of Bor and Čukaru Peki-Upper zone and large porphyry Cu-Au deposits of Veliki Krivelj, Majdanpek, Bor-Borska Reka and Čukaru Peki-Lower zone. As mentioned above, the latest researches, primarily [12,13,21,22,23,24] indicate that the rocks of the V1A sub-phase are the hosts of mineralization in the Čukaru Peki deposit. The thickness of the entire V1A package is significantly greater than 1500 m. However, [23] showed that precisely in the Čukaru Peki deposit V1A sub-group was divided into three groups according to the texture (size and amount of phenocrysts) and the degree of mineralization.

The V1B sub-phase (younger) can be termed hornblende-plagioclase phyric andesite. It is a fresh, non-mineralized rock displaying holo- to hypocrystalline texture and occasionally fluidal fabric. The hornblende phenocrysts are clearly noticeable, often large and much more represented than in V1A (Figure 2c). The V1B is represented by coherent, brecciated and volcaniclastic facies formed via submarine effusive eruptions. This unit is in Čukaru Peki deposit up to 200 m thick [23]. The V1B sub-phase shows an age (Table1) range of ~85 to 83 Ma [4,12]. The V1B is overlain by the Metovnica Epiclastites or gray to reddish marls of the Oštrelj Formation (Figure 2).

During the volcanism and especially after its interruption, in a shallow water environment, andesite volcanics begin to be resedimented, transported and formed post-eruptive volcano-sedimentary package – epiclastic. These rocks are known as the Metovnica Epiclastite [8], (ME in Figure 2). The ME are represented by polymictic andesite breccia, volcaniclastic conglomerate and sandstone, with clasts of volcanic and non-volcanic origin. Matrix is often composed of clay, fine grained sandstones or reddish marls. The clasts are usually semi-rounded to rounded, less often semi-angular (Figure 2f). The composition of the clasts differs in the Timok East block and the Timok West block of the TMC. In the east it is mainly clasts of Timok andesite - V1, while in the west it is mainly clasts of andesite and basaltic andesite - V2. ME are often layered and laminated, usually interlayered with marls and siltstone. ME sometimes contain well-preserved microfauna the Coniacian–Campanian age and in the wider area of the copper deposits contain a significant amount of altered and mineralized clasts ([8,12,26,27,29], Figure 2f).

The sedimentary series of the Oštrelj Formation (OS in Figure 2) have developed continuously and can be found over the Early Cretaceous rocks of the volcanic basement rock but also as underlying or overlying the V1 and V2 volcanites and their epiclastic products (Figure 2). Thick packages of these sediments are particularly well developed in areas lateral to the volcanic centers or in parts of the TMC where no volcanism has occurred. OS are represented by layered to laminated grayish siltstones, marls sandy limestones and calcareous sandstones and contain Turonian–Campanian micro fauna [25]. In Čukaru Peki area, these sediments are laminated grayish siltstones and marls (Figure 2g), up to 250 m thick. The deepest parts of the sediment package in the Čukaru Peki area consist of red siltstone and marl (Figure 2h), which are nowhere more than 20 m thick. OS in the Čukaru Peki area undelay the Bor clastites and overlay the rock package consisting of ME and V1B.

Towards the west of the TMC, the V1 andesite grade into the hornblende-pyroxene- to pyroxene andesite and basaltic andesite – V2 (Ježevica Andesite (Figure 2i) and Osnić Basaltic andesite (Figure 2j), V2O and V2J in Figure 2 [8]). Dark grey to gray rocks of porphyritic texture, characterized by mm sized pyroxene, hornblende and feldspar phenocrysts and has mostly hypocrystalline groundmass. They are predominantly emplaced as submarine extrusive volcanics (lava and hyaloclastic breccia) and shallow intrusions. These volcanic rocks reveal U/Pb zircon ages range of 83-81 Ma (Table 1), but related to andesite or trachyte dykes [4]. They are also stratigraphically interlayered with the above mentioned the Senonian sediments (Oštrelj Formation) and are at places covered by their volcano-sedimentary - epiclastic products (Figure 2).

In the northwestern and southwestern part of the TMC occur plutonic rock from monzodiorite and monzonite to diorite, Q-diorite, granodiorite, syenite and rare gabbro compositions (Valja Strž Plutonite, P2 in Figure 2, [8]). They are grey to dark-grey rocks of hypidiomorphic granular texture and massive structure (Figure 2k). This rock intruded in to the basaltic andesite and andesite, V2 volcanics and surrounding sediments and dated at 83-78 Ma ([4,11] Table1). Mineralization and a large number of morphogenetic types of mineralization in V2 rocks are mainly concentrated in the vicinity of the discovered intrusions, Valja Strž in the northwest and Ježevica in the southwest TMC (Figure 1, P2 in Figure 2). It is characteristic of this part of the BMZ that there are smaller porphyry and epithermal systems (Figure 2l) relatively close to the surface, there are also polymetallic replacements and skarn-type deposits (e.g. Valja Saka, Dumitru Potok, Čoka Kuruga, Valja Strž, Lipa, Čoka Kupjatra, among others (Figure 1 and MP2 in Figure 2, [11,17]). The low-sulfidation Au deposit Zlaće was also discovered here, as well as the Korkan-Bigar Hill sediment hosted Au mineralization [11,30], and also minor occurrences of manganese mineralization interpreted to be related to the VMS/SEDEX type of mineralization [31].

From the Upper Campanian to the Maastrichtian, in the Timok West block, reef sedimentation commenced (Bukovo Formation, [25], Figure 1, BS in Figure 2). At the same time, in the Timok East block, coarse-grained and regressive clastites were deposited (Bor Clastic, [25], Figure 1, BK in Figure 2). This was the period when TMC underwent intensive tectonic uplift, ceased to exist as an active volcanic area, and at the end of this period also as a sedimentation area [26].

The Bukovo Formation overlies the Oštrelj Formation. There are moderate bedded siltstones and marlstones overlain by sandy limestones with intercalated layers of claystones rich with benthic foraminifera, rudists, gastropods and corals dated as the Upper Campanian-Maastrichtian age. The age is also supported by the index of planktonic foraminiferal species [25].

The Bor Clastic are polymictic coarse to fine-grained conglomerate (Figure 2m) and sandstone. It is built by pebbles of the Upper Cretaceous volcanites and sediments originated from the TMC, pebbles of the Paleozoic metamorphic and igneous rocks, the Paleozoic sediments, the Jurassic and the Lower Cretaceous carbonate rocks, that originated from the basement of the TMC [32]. The micropaleontological content in the Bor Clastic suggests the Upper Campanian- Maastrichtian age [25,32,33].

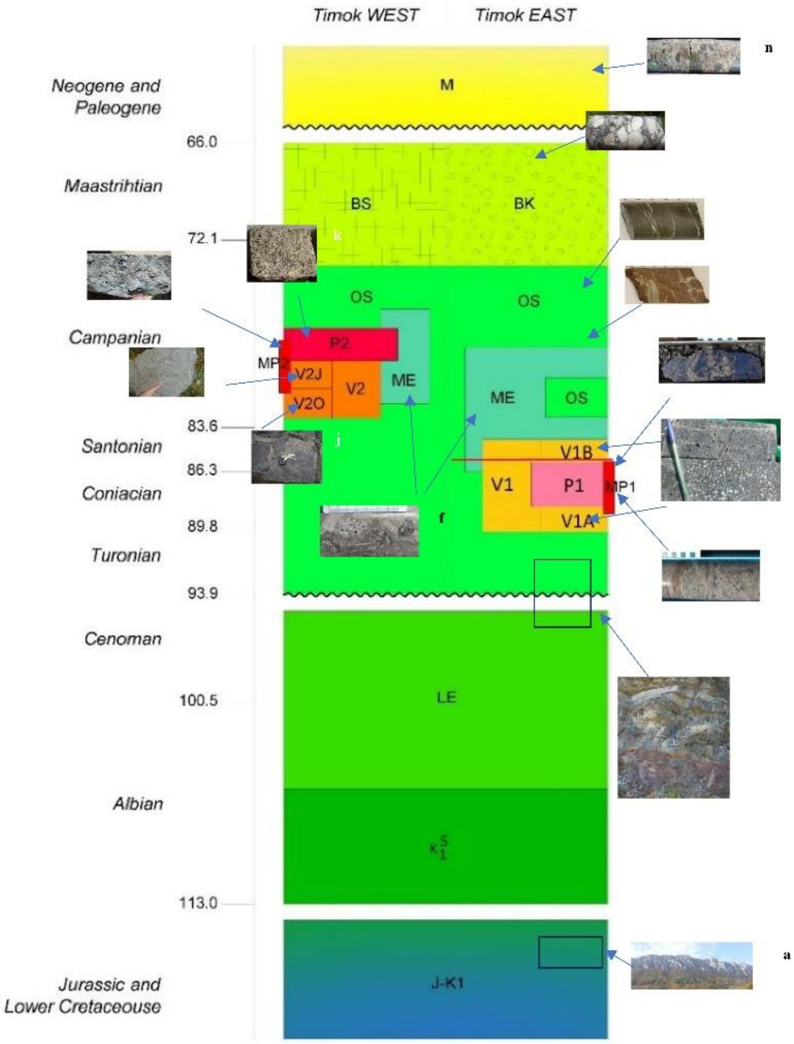

Figure 2 The stratigraphic and time space development of the TMC and the relationship of sediment formations and magmatic suites [8,25,26,27]. On the left side is a schematic stratigraphic chart with epoch and age in million years. LE – Lenovac Formation, OS – Oštrelj Formation, V1 – Timok Andesite, volcanic first phase, V1A – Timok andesite sub-phase, V1B – Timok andesite sub-phase, P1 – Shallow intrusions in V1, possible source of mineralization, MP1 – Porphyry mineralization in the Timok East, ME – Metovnica Epiclastite, V2 – volcanic/magmatic second phase, V2O – Osnić Basaltic andesite, V2J – Ježevica Andesite, P2 – Valja Strž Plutonite, MP2 – Porphyry, skarn and epithermal mineralization in the Timok West, BS – Bukovo Formation, BK – Bor Clastic, M – Miocene sediments, Timok EAST – The eastward tectonic block, Timok WEST – the westward tectonic block. The red line highlighted schematic unconformity of the porphyry mineralization in the eastward tectonic block. a) Outcrop of Jurasic-Lower Cretaceous limestone – Veliki Krš Mts. b) Lenovac Formation overbeded by gray marlstone of the Oštrelj Formation. The red line highlights the border of these two formations and a clear discordance; c) Comparative macroscopic appearance of fresh hornblende andesite V1B (above) and fresh feldspar rich andesite V1A (below); d) Typical stockwork type of porphyry mineralization in andesite V1A; e) Epithermal, high-sulfidation mineralization in andesite breccia V1A; f) polymictic epiclastic andesite breccia – Metovnica Epiclastic, composed of fresh clasts of V1B andesite and fresh and altered clasts of V1A andesite; g) drill core sample of gray marl – Oštrelj Formation; h) drill core sample of reddish marl – Oštrelj Formation; i) Greenish gray Ježevica Andesite – V2; j) Dark gray Osnić Basaltic andesite – V2; k) Valja Strž Plutonite; l) Epithermal mineralization in V2 andesite; m) Drill core sample of coarse grained conglomerate – Bor Clastic; n) Drill core sample of coarse grained gravel – part of Miocene sediments

Thinner layers of gray to yellow calcareous-clayey sandstones in to the Bor Clastic are rich in well preserved Maastrichtian spores and pollen [25].

After the big hiatus, new sedimentation cycles started in the Miocene. The Miocene sediments reflect differences in the development in the area of Čukaru Peki and in the area south of Timok. In the area around Čukaru Peki the sediments form the lower and upper parts. The lower part consists of siltstone-clay and marl sediments. The upper part consists of gravel and sand. The greatest thickness of the Miocene sediments around Čukaru Peki is about 300 m. In the area south of Timok, in vertical succession, the Miocene sediments were deposited in different environments: non-marine, marine and brackish ones (from the bottom to the top, [34]).

3. Review of the geochronological age data of rock and mineralization in the BMZ

Geochronological data of the age of rocks and mineralization in the BMZ have been collected for years, published by many different authors and systematically presented in this work (Table 1). The methods for the geochronological age of rocks are U/Pb from separated zircon crystals and Ar/Ar from separated hornblende or biotite crystals, while for porphyry mineralization age are Ar/Ar from separated white mica and Re/Os from separated molybdenite.

Analyzing these data, it can be concluded that the age of the V1 volcanic phase, in different areas of the TMC, correspond from 90.97 to 82.08 Ma [4, 5, 6, 9,12,13].

Table 1 Summary of rock and mineralization geochronological age data in the TMC [4, 5, 6, 9,12,13] zr-zircon, ho-hornblende, bi-biotite, mo-molybdenite, wm-white mica

Location	Lithology	Method	Age Ma	Volcanic phase	
Majdanpek	Fresh andesite-dacite	U/Pb zr	85.2±4.2-86.0±7.2 [9]		
Majdanpek-Dolovi	Fresh andesite dyke	U/Pb zr	82.73±0.03 [4]		
Majdanpek-Tenka	Polymetallic mineralization	Re/Os mo	83.37±0.4-83.77±0.5 [7]	V1	
Majdanpek-Tenka	Polymetallic mineralization	Ar/Ar wm	83.15 [5]		
Veliki Krivelj	Altered andesite dyke	U/Pb zr	86.17±0.15-86.29±0.32 [4]		
Veliki Krivelj	Andesite dyke	Ar/Ar ho	85.5±1.3 [5]		
Veliki Krivelj	Porphyry mineralization	Re/Os mo	87.88±0.5 [7]		
Bor	Unaltered andesite	Ar/Ar ho	83.4±1.7-84.6±1.1 [6]		
Bor	Unaltered andesite	Ar/Ar bi	89.0±0.6 [5]		
Bor	Altered andesite	U/Pb zr	82.08±0.08; 85.6±0.11 [13]		
Bor-Borska reka	Porphyry mineralization	Re/Os mo	85.94±0.4-86.24±0.5 [7]	V1A	
Bor-Borska reka	Porphyry mineralization	Ar/Ar wm	86.3±1-86.9±1.1 [6]		V1
Čukaru Peki	Unaltered andesite	U/Pb zr	85.03±0.09 [13]		
Čukaru Peki	Mineralized andesite	U/Pb zr	86.5±0.13; 88.25±0.28 [13]		
Nikoličevo	Unaltered andesite	U/Pb zr	89.49±0.42-90.97±0.39 [12]		
Gamzigrad	Unaltered andesite	U/Pb zr	88.6±8.0 [9]		
Lenovac	Volcaniclastic	U/Pb zr	89.9±6.0 [9]		
Nikoličevo	Fresh andesite	U/Pb zr	84.89±0.75-85.56±0.53 [12]	V1B	
Krivelj	Fresh andesite	U/Pb zr	84.66±0.5 [4]		
Brestovac cross road	Trachyte dyke	U/Pb zr	81.79±0.5-82.27±0.35 [4]		
Podgorac	Basaltic andesite	U/Pb zr	80.8±4.8 [9]		
Valja Strž	Monzonite	U/Pb zr	78.62±0.44 [4]		
Valja Strž	Granodiorite	U/Pb zr	78.9±5.2-82.2±5.4 [9]		
Valja Strž	Diorite	U/Pb zr	78.5±1.3-82.5±0.4 [11]	V2	
Čoka Kuruga	Diorite	U/Pb zr	83.6±0.5 [11]		
Crni Vrh	Diorite	U/Pb zr	80.8±0.6 [11]		
Dumitru Potok	Diorite	U/Pb zr	82.1±0.7-82.2±1.2 [11]		
Dumitru Potok	Porphyry mineralization	Re/Os mo	80.69±0.4-80.82±0.45 [7]		

The age of fresh or altered rocks that can be confidently claimed to belong to the V1A volcanic sub-phase, in the area of Veliki Krivelj, Bor, Čukaru Peki and Nikoličevo generally correspond from 90.97 to 85.03 Ma [4,5,12,13], except for one sample of andesite from the Bor deposit drill hole that shows a drastically younger age of 82.08 Ma [13]. An unmineralized andesitic dyke from the Dolovi area, north of Majdanpek has a similar age (82.73 Ma, [4]). The possibility that these two samples belong to andesites of the V1B sub-phase cannot be ruled out. A trachyte dyke near Brestovac as intruded into basaltic andesite of the V2 volcanic phase have a similar age too (82.27-81.79, [4]).

The porphyry mineralization and the fresh-unmineralized and altered andesitic host rocks associated with the V1A volcanics in the Veliki Krivelj and Bor deposits clearly correspond (Table 1). The age of porphyry mineralization on molybdenite sample from the Veliki Krivelj deposit shows an age of 87.88 Ma [7], while the age of mineralization in the Bor-Borska Reka deposit takes place between 86.9-85.9 Ma [6,7]. Polymetallic mineralization in the Tenka deposit, north of Majdanpek, is younger and amounts to 83.77-83.15 Ma [5,7]. The age of the epithermal mineralization has not yet been determined, but it is most likely younger than the porphyry mineralization.

Unmineralized andesites of the V1B sub-phase from the area of Krivelj and Nikoličevo villages are clearly younger than V1A andesites and their age range from 85.56 to 84.66 Ma [4,12].

There is not much age data for the volcanic rocks of the V2 phase. But, the age of Valja Strž Plutonite which is dated 83.6-78.6 Ma is much better documented [4,9,11]. Volcanites V2 phase and the Valja Strž Plutonite are host rock of copper porphyry mineralization related to diorite porphyry cluster to which the deposits and occurrences on Crni Vrh belong (Valja Strž, Dumitru Potok etc. [17]). The age of the porphyry mineralization at Dumitru Potok deposit range between 80.82-80.69 Ma [7] and clearly corresponds with Valja Strž Plutonite.

4. Conclusion

The review of the stratigraphy, the time space development, the relationship of sediment formations and the magmatic suites and available geochronological age determinations of the TMC rocks and the BMZ mineralization imposed the following conclusions:

- After a generally uniform development from the Early Jurassic to the Lower Cretaceous, during the Upper Turonian to the Senonian, area of the TMC shows a significant difference in evolution between the eastward (Timok East) and the westward (Timok West) tectonic block. The sedimentation and magmatism continued throughout nearly the whole Late Cretaceous and developed different sedimentary formations and igneous suites (see Figure 2).
- The volcanism/magmatism occurred in at least two phases from the Upper Turonian to the Upper Campanian: V1 (90-82 Ma), V2 (83-78 Ma). The available geochronological ages and volcanological analyses reveal that the I volcanic phase - V1 can be split into two sub-phases: V1A and V1B. The Timok andesite V1A is older (90-85 Ma) and the V1B is younger (85-83 Ma). The V1A sub-phase is associated with mineralization and V1B is clearly postdates the main porphyry mineralization event in the eastern margin of the BMZ.
- The porphyry mineralization in the BMZ ranges widely from 87-80 Ma and the age of the epithermal mineralization has not yet been determined, but is most likely younger. The major epithermal and porphyry mineralization situated along the eastern margin of the BMZ and this metallogenetic zone is probably one of the most prospective areas in Europe for exploration. The discovery testifies that even old and presumably well-investigated mining areas may host significant ore deposits that await to be found, in particular in deeper parts of the existing systems.

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PREGLED STRATIGRAFSKIH KARAKTERISTIKA I STAROSTI STENSKIH JEDINICA U BORSKOJ METALOGENSKOJ ZONI (TIMOČKI MAGMATSKI KOMPLEKS)

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Izvod

Ovaj rad prikazuje stratigrafske karakteristike i starost glavnih stenskih jedinica i vezu između magmatskih procesa, mineralizacije i orudnjenja u Borskoj metalogenetskoj zoni (BMZ) - Timočki magmatski kompleks (TMK). Postojeći, višedecenijski podaci o geološkim istraživanjima u ovoj oblasti dopunjeni su najnovijim podacima sistematskih geoloških istraživanja dobijenih primenom najsavremenijih istraživačkih metoda. Timočki magmatski kompleks se razvija na kontinentalnoj kori izgrađenoj od različitih stena paleozojske do donjokredne starosti i čine ga vulkanske/magmatske, vulkanogeno-sedimentne i sedimentne stene. Sedimentni procesi se u kontinuitetu mogu pratiti kroz čitavu gornju kredu, od alb-cenomana do mastihta, dok vulkanizam/magmatizam traje oko 10 miliona godina, dok vulkanski produkti bivaju mlađi od istoka prema zapadu. Vulkanizam se može podeliti u dve glavne faze koje traju od gornjeg turona do gornjeg kampana: prva vulkanska faza - V1 (90-82 miliona godina) koja dominira u istočnim delovima TMK i druga vulkanska faza - V2 (83-78 miliona godina) koja izgrađuje centralne i zapadne delove TMK. Najznačajnija ležišta bakra i zlata vezana su za prvu vulkansku fazu, a starost do sada otkrivene porfirske i epitermalne mineralizacije je u rangu od 87-80 miliona godina.

Ključne reči: *Borska metalogenetska zona, Timočki magmatski kompleks, stratigrafija, vulkanizam, starost, mineralizacija.*