HERCYNIAN POST-COLLISIONAL METALLOGENY OF BULGARIA

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ABSTRACT. The geology of Bulgaria is determined by the Alpine Balkan Orogenic System, which is developed over on the Neoproterozoic-Hercynian basement. The Hercynian Post-Collisional Complex was formed during Late Carboniferous-Permian and is demonstrated by extensional tectonics. Two magmatic zones are outlined. The first one covers parts of the Stara Planina (Balkan), Fore-Balkan, East Sredna Gora Mountains and the Sveti Iliya Hills, where a subaerial acid volcanic complex intercalated with molasse coal-bearing sediments are developed. The second zone is traced in the Srednogorie, Sakar and Strandzha Mountains, and is represented by the Late Paleozoic Granitoid Complex. The Belogradchik-Vatia and Koprivshtitsa-Hisarya Metallogenic Zones are delimited.

The Belogradchik-Vatia Metallogenic Zone is outlined by the development of Late Paleozoic volcanic rocks. It is represented by vein type small deposits of gold, lead-zinc, and barite, as well as copper, copper-molybdenum ore occurrences. The Belogradchik, Govezhda, and Vatia Ore Fields are distinguished.

The Koprivshtitsa-Hisarya Metallogenic Zone is determined by the Srednogorie Granitoid Complex. Several uranium ore occurrences are found in this zone. Numerous molybdenum and gold ore occurrences and pegmatites are described as well.

Key words: metallogeny, Hercynian Post-Collisional Complex, ore fields.

ХЕРЦИНСКА ПОСТКОЛИЗИОННА МЕТАЛОГЕНИЯ НА БЪЛГАРИЯ

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РЕЗЮМЕ. Геологията на България се определя от Алпийската Балканска орогенна система, която се формира върху неопротерозойско-херцински фундамент. Херцинският постколизионен комплекс се формира през къснокарбонско-пермско време в екстензионни условия, като се очертават две магматични зони. Първата зона обхваща Стара планина, Предбалкана, Източна Средна гора и Светиилийските възвишения, където са развити субаерални кисели вулканити, прослояващи се с моласови въгленосни седименти. Втората зона се следи в планините Средногорие, Сакар и Странджа, където е развит комплекс от палеозойски гранитоиди. Очертават се металогенните зони Белоградчик-Ватия и Копривщица-Хисаря.

Белоградчик-Ватийската металогенна зона се определя от къснопалеозойските вулканити. Тя е представена от малки златоносни, оловно-цинкови и баритови находища, както и медни и молибденови рудопроявления. Очертават се Белоградчишкото, Говежденското и Ватийското рудни полета.

Копривщенско-Хисарската металогенна зона си обособява от Средногорския гранитоиден комплекс. Тук са установени няколко уранови рудопроявления. Освен това са отбелязани редица молибденови и златни рудопроявления и пегматитови прояви.

Ключови думи: металогения, херцински постколизионен комплекс, рудни полета.

The Post-Collisional Stage of the Neoproterozoic-Hercynian Tectonic Epoch was developed through the Late Carboniferous and the Permian, after the intensive Devonian–Early Carboniferous collisional processes. It is characterised by extensional vertical block dislocations and the formation of Post-Collisional “ProtoBalkan” Orogeny (Nachev and Yanev, 1980), which covers most of the area of the Stara Planina (Balkan), the Fore-Balkan, and part of the Sredna Gora Mountains (Fig. 1). Intensive molasse continental sedimentation is realised in the intermountain depressions within the orogeny and in the foothill depression to the north, distinguishing the Late Carboniferous-Permian Post-collisional Molasse Complex. Terrigenous coal-bearing limnic or paralimnic complexes were formed in humid conditions during the Late Carboniferous, and red bed complexes were formed in arid environment through the Permian (Nachev and Yanev, 1980).

Two separate zones of magmatic activity are distinguished during the Post-Collisional Stage and are outlined by the Late Paleozoic volcanic and Srednogorie granitoid complexes (Fig. 1). The Late Paleozoic volcanics (Late Carboniferous-Permian) are wide-spread in the Western and Central Stara Planina (Balkan), the Fore-Balkan, and partly in the Eastern Sredna Gora Mountains and in the Sveti Iliya Hills. This complex is set up by lava sheets, subvolcanic and dike bodies composed of calc-alkaline rocks, represented by andesite to dacite-andesite, quartz porphyry, and dacite. They are formed in subaerial conditions, as the effusive rocks intercalate with the continental molasse sediments (Tenchov and Yanev, 1963; Čunev et al., 1965; Čatalov, 1965; Popov and Tsanova, 1967). A series of ore mineralisations associate with the Late Paleozoic volcanites and determine the Belogradchik-Vatia Metallogenic Zone (Popov and Popov, 2022).

The Srednogorie granitoid complex is traced in the areas of the Srednogorie, Sakar, and Strandzha Mountains. That complex includes a series of granite, granodiorite to quartz diorite, as well as earlier basic to ultrabasic rocks (Dabovski et al., 1972). The absolute age of these plutons is determined by Rb-Sr or U-Pb dating as 342 to 283 Ma (Zagorchev et al., 1989; Machev et al., 2013; Bonev et al., 2019). Numerous ore mineralisations are associated with these granitoids and outline the Koprivshtitsa-Hisarya Metallogenic Zone (Popov and Popov, 2022).

The molybdenum mineralisation Likuryashki Dol of an unclear genesis and age is noted south-east of the village of Kosti in the Strandzha Mountain area.

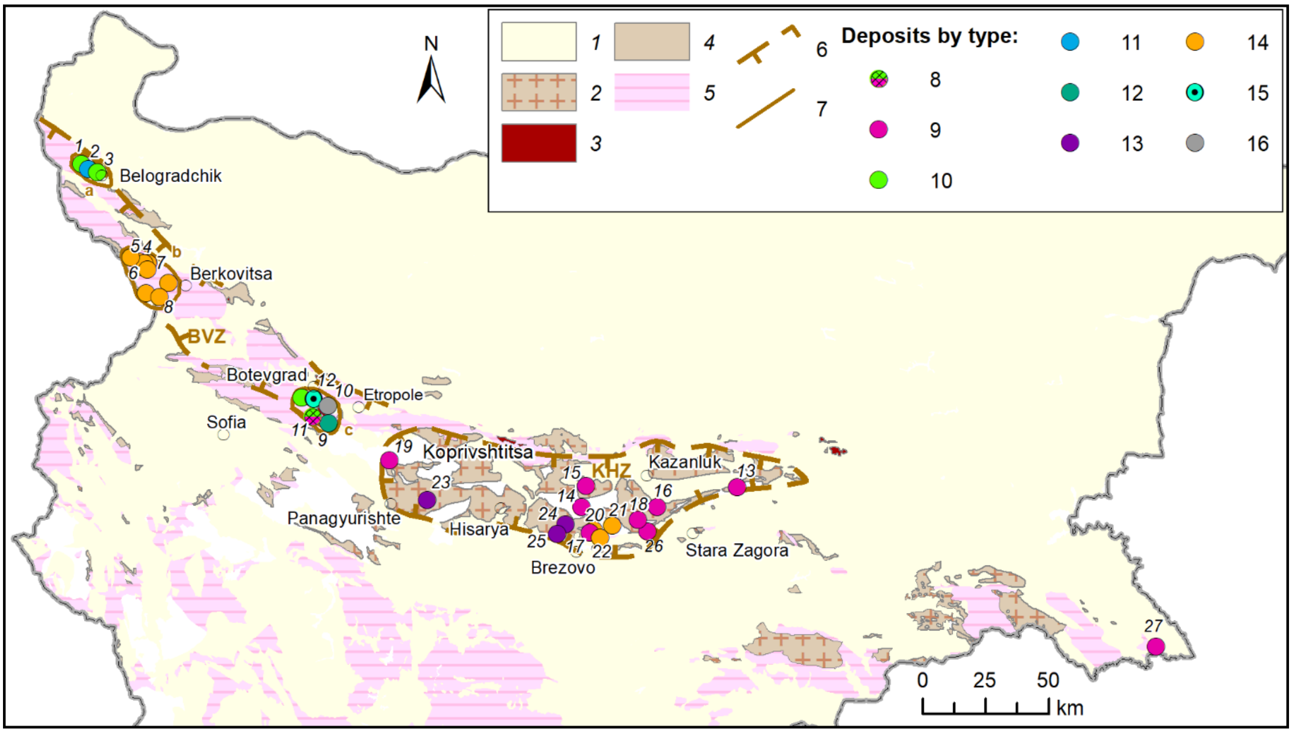

Fig. 1. Metallogenic scheme of the Hercynian Post-Collisional Stage from the Neoproterozoic-Hercynian Tectonic Epoch.
1 – Post-Paleozoic rocks; 2 – Permian Srednogorie granitoid; 3 – Late Carboniferous-Permian volcanic and plutonic rocks; 4 – Late Carboniferous-Permian Post-Collisional Molasse Complex; 5 – Neoproterozoic-Early Carboniferous rocks; 6 – Metallogenic Zone (BVZ – Belogradchik-Vatia Zone, KHZ – Koprivshtitsa-Hisarya Zone); 7 – Ore Field (a – Belogradchik, b – Govezhda, c – Vatiya); *Ore type*: 8 – porphyry copper (molybdenum-bearing); 9 – molybdenum; 10 – copper veins; 11 – lead-zinc; 12 – polymetallic; 13 – uranium, 14 – gold; 15 – gold-polymetallic; 16 – barite.
Ore deposits and occurrences by number on the map*:* *1* – Granichak, *2* – Tumbarite, *3* – Shtastie, *4* – Rusichov Rat, *5* – Rupski Rat, *6* – Kumanov Dol, *7* – Milev Dol, *8* – Srebarna, *9* – Vatiya, *10* – Visok, *11* – Markova Chukla, *12* – Ribni Vir, *13* – Dolno Panicherevo, *14* – Sredna Reka, *15* – Saplamata, *16* – Marashite, *17* – Kuv Dere, *18* – Kazanka, *19* – Rezidentsiyata, *20* – Lisichi Dupki, *21* – Gorno Novo Selo, *22* – Kolyu Marinovo, *23* – Valk, *24* – Sarnegor, *25* – Varben, *26* – Ruda, *27* – Likuryashki Dol.

The Belogradchik-Vatia Metallogenic Zone

The Belogradchik-Vatia Metallogenic Zone is defined by the Late Paleozoic volcanism within the Western Stara Planina Mountain. A series of copper, lead-zinc, gold, and barite small deposits and occurrences are formed in the Western Stara Planina Mountain and are grouped in the Belogradchik, Govezhda, and Vatia Ore Fields.

The Belogradchik Ore Field is to the west of the homonymous town (Fig. 1). The basement comprises Neoproterozoic-Cambrian green shists, Middle Devonian Belogradchik granitic pluton, and Early Carboniferous (?) terrigenous sediments and basic volcanites (Haydutov et al., 1995c). Late Carboniferous and Permian terrigenous coal-bearing sediments and andesite-dacite-rhyodacite volcanics are developed upwards. The Paleozoic rocks are covered by Triassic and Jurassic terrigenous and carbonate sediments. The ore field is characterised by copper and lead-zinc small deposits and numerous ore occurrences, genetically associated to the Permian volcanism. The Shtastie and Granichak copper and Tumbarite lead-zinc ore occurrences are more important (Popov and Popov 2022).

The Shtastie copper ore occurrence is related to Permian albitophyre dikes and dacitic bodies, which are intruded in Devonian-Early Carboniferous Belogradchik granitic pluton and associated dikes. More than 17 small quartz-sulphide ore veins intersect granitoid rocks and Permian dikes. The ore-bearing faults are developed along albitophyre dikes (Fig. 1, 2). The ore mineralisation is represented by chalcopyrite, pyrite, pyrrhotite, arsenopyrite, marcasite. Secondary of importance are galena, sphalerite, siderite, chlorite, sericite, and calcite, and as rare are loellingite, tetrahedrite, molybdenite, schapbachite, native gold, and native bismuth (Dragov, 1971).

The Granichak copper ore occurrence is formed in an area consisting of Early Carboniferous basalt and andesite-basalt and Permian dacite dikes (Fig. 1, 3). These rocks are intersected by fault zone of brecciated or intensively fractured hydrothermally altered rocks, with direction of 130° and dip of 55–80°, length about 800 m and thickness of 20 m, and several lesser structures (Peshev, 1992f). The ore mineralisation of veinlets-disseminated type is concentrated in separate intervals of the zone. It is represented mainly by pyrite and chalcopyrite, lesser magnetite, and pyrrhotite, tetrahedrite, marcasite, hematite, galena, and sphalerite (Dragov, 1971). The non-ore minerals are mainly quartz, calcite, and lesser ankerite, chlorite, sericite, rarely barite, kaolinite, epidote. Oxidation and cementation zones are developed near the surface.

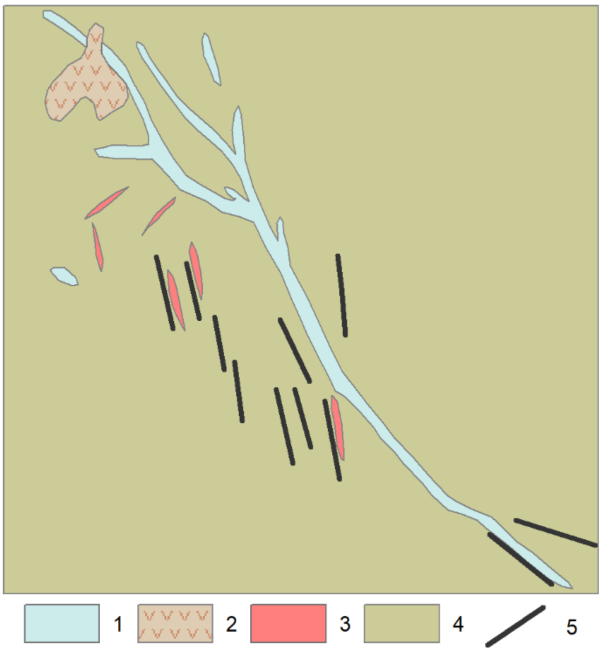

Fig. 2. Geological map of the Shtastie copper ore occurrence (by Dimitrov, 1964fb).
1 – Permian albite porphyry dike; 2 – Permian subvolcanic dacite; 3 – Devonian-Upper Carboniferous diorite porphyrite; 4 – Neoproterozoic-Cambrian greenschist metamorphic rock; 5 – copper ore vein.

Fig. 3. Geological section across the Granichak copper ore occurrence (by Dimitrov, 1964fa).
1 – Neoproterozoic – Cambrian diabase; 2 – brecciated, hydrothermally altered rock; 3 – copper ore vein.

The Tumbarite lead-zinc ore occurrence is situated to the north-west of the town of Belogradchik, where the Early Carboniferous basic volcanites, terrigenous sediments, and Permian dacite are exposed (Fig. 1). Explosive neck breccia and areas of intensive cracking are observed in the dacite rocks. Two ore bodies are formed in the cracked zones and partly in the sediments (Peshev, 1992f). The ore mineralisation is represented by numerous veinlets, impregnations, and nests. The main ore minerals are pyrite, sphalerite, less galena, rarely pyrrhotite, marcasite and chalcopyrite, very rarely – arsenopyrite, tennantite-tetrahedrite, stephanite, scheelite, native gold, etc. (Dragov, 1971).

The Govezhda Ore Field is located to the west of the town of Berkovitsa, in the area of the villages of Govezhda, Kopilovtsi, Dalgi Del, and Diva Slatina (Obretenov, 2007; Popov and Popov, 2022) (Fig. 1, 4). The basement in this area consists of Neoproterozoic-Cambrian green shist metamorphic rocks of the Berkovitsa Group (Haydutov et al., 1995a,b). Early Ordovician low-grade metamorphosed terrigenous sediments of the Dalgidel Group with olistolith of diabase, gabbro-diabase, and gabbro lie upwards in the section. Devonian-Early Carboniferous Stara Planina granodiorite-granitic plutons are intruded in them. Fragments of Permian volcanic structure set up of dacitic lava sheets and dikes are outcropped between the villages of Kopilovtsi and Diva Slatina (Čunev et al., 1965; Obretenov, 2007). The enumerated rocks are covered by Permian terrigenous rocks, as well as by Mesozoic terrigenous and carbonate sediments (fig. 4).

More than 100 quartz-gold-sulphide veins were discovered in the ore field. The postmagmatic processes around the ore-forming faults are present by silicification, chloritisation, sericitisation and pyritisation. The highest concentration of ore veins is observed between the villages of Kopilovtsi, Govezhda, and Diva Slatina (the so-called Central sector) where the Rusichov Rat, Milev Dol, and Kumanov Dol ore deposits were mined. The Rupski Rat (Rupeto) and Zeleni dol ore occurrences are outlined within the same sector. The Stokina Chuka ore occurrence and some other poor quartz-sulphide veins were found to the north, to the village of Kopilovtsi and to the southwest near the village of Dalgi Del. They are pointed out in the geological reports as Kopilovtsi, Diva Slatina, Zeleni dol, Haydushka padina, and Tyutyunarnika ore occurrences. The Yavorov Preslap and Srebarna ore occurrences are developed in the southeastern parts, and the Chereshovitsa ore occurrence – in the east-southeastern part of the ore field (Obretenov and Peev, 1971; Obretenov, 2007).

The ore veins are developed concordantly or discordantly to the bedding in schists, as well as in the brecciated contacts of the dikes (Nikolaev and Tonev, 1962; Obretenov and Peev, 1971; Obretenov, 2007). The veins are of variable thickness, complex morphology, and often with apophyses along the feather joints (Fig. 4). The length of veins varies from several dozen to 650 m, the thickness is from several centimeters to 4-5 m, and the vertical range exceeds 500 m. The ore veins with ESE (115–130°) direction and with SSE (145–155°) direction in some parts predominate. Veins with meridional, NNE (30–40°) or equatorial directions are also observed. This data shows that the strikes of ore veins correspond to the orientations of tectonic faults and of some Carboniferous and Permian dikes. Ore columns are formed in the opened areas of changing of the strike of ore-bearing faults (Obretenov, 2007). The ore veins are displaced by small transversal and diagonal faults. The development of ore veins along the contacts of dacitic dikes marks the Permian age of ore mineralisations (Dragov, 1971). The arcuate development of ore-bearing structures in the Central section demonstrates the manifestation of Late Paleozoic volcanic complex (Čunev et al., 1965).

The main economic minerals are native gold and electrum, as pyrite and arsenopyrite are widespread. Minor minerals are sphalerite, galena, chalcopyrite, scheelite, native silver, pyrargyrite, stephanite, proustite, polybasite, pyrrhotite, marcasite, cinnabarite, tennantite, bournonite, magnetite, and hematite. The main vein mineral is quartz, as sericite, chlorite, carbonate minerals and some gypsum are also represented. The main ore metal is gold and secondary of importance are silver and rarely lead, copper, zinc, and tungsten (Nikolaev and Tonev, 1962).

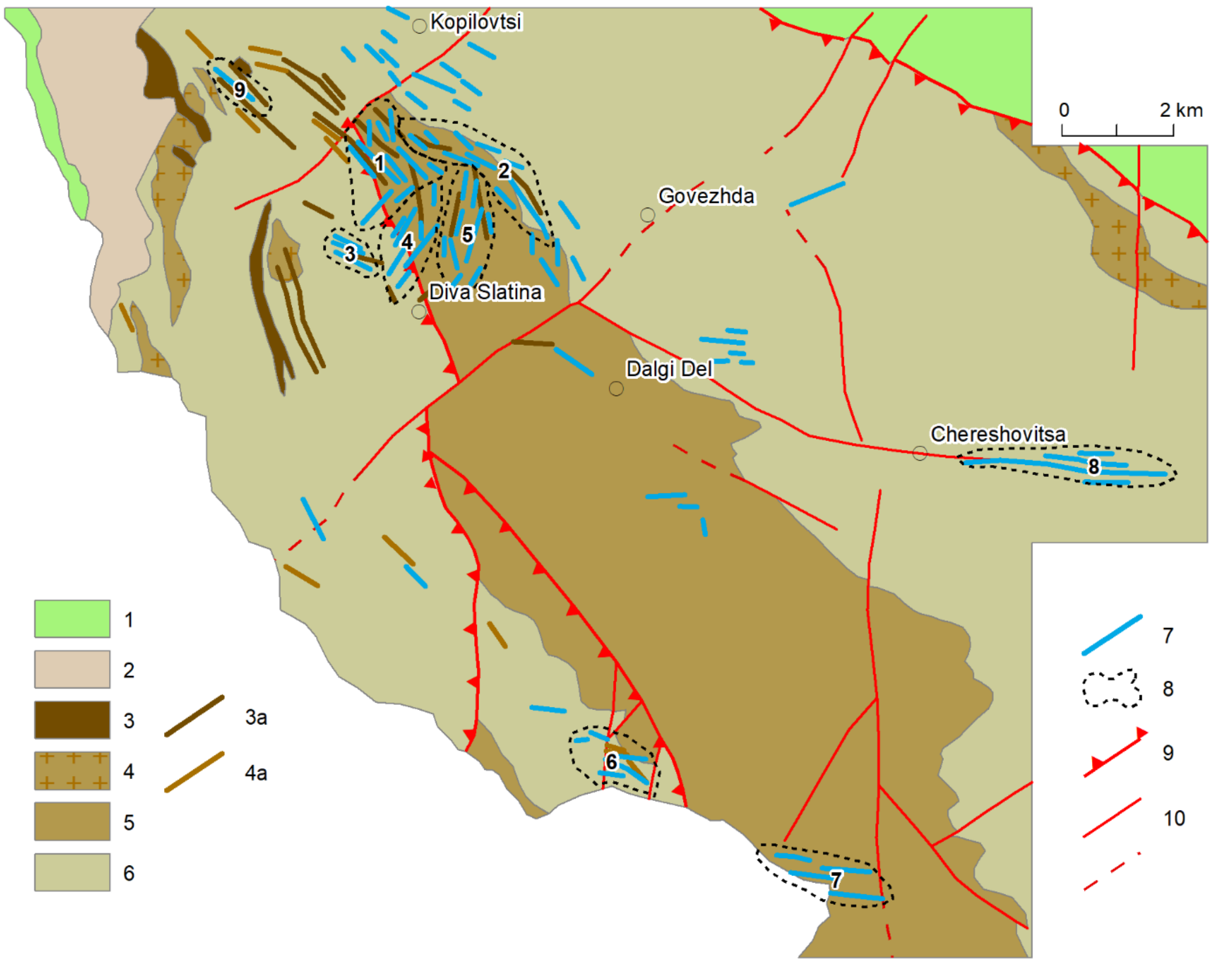

Fig. 4. Geological map of the Govezhda Ore Field (by Haydutov et al., 1995a, 1995b; Obretenov and Peev, 1971).
1 – Mesozoic sediments; 2 – Permian sediments; 3 – Permian dacite and dacitic dike (3a); 4 – Lower Carboniferous granitoid and dike (4a); 5 – Ordovician low-grade metamorphic terrigenous rock (Dalgidel Group); 6 – Riphean-Cambrian greenschist metamorphite (Berkovitsa Group); 7 – quartz-gold ore vein; 8 – outline of the ore deposits and occurrences (*1* – Rupski Rat, *2* – Rusichov Rat, *3* – Zeleni Dol, *4* – Kumanov Dol, *5* – Milev Dol, *6* – Yavorov Preslap, *7* – Srebarna, *8* – Chereshovitsa, *9* – Stokina Chuka); 9 – thrust; 10 – fault.

The Vatia Ore Field is in the Etropole Mountain, around the Arabakonak passage, about 40 km ENE of the city of Sofia and 12-13 km SSE of the town of Botevgrad (Popov and Popov, 2022). The basement is composed of Cambrian(?)-Ordovician felsitic argillite, meta-argillite, meta-aleurolite, aleurolite, quartzite, and quartzite sandstone (Haydutov et al., 1979; Angelov et al., 2010). The ore field is determined by Late Paleozoic Bebresh volcano-plutonic complex (310 Ma) of diorite and quartz diorite, associated with andesitic and andesitic-dacitic lava breccia, lava clast, agglomerate tuff, lapilli tuff, and ash tuff, with rare argillite intercalations (Voutov, 1962; Angelov et al., 2010). Permian conglomerate, breccia conglomerate, sandstone, and aleurolite, as well as Triassic, Jurassic, and Turonian sediments overlay the Bebresh magmatic rocks in some areas. The main NNW Bebresh fault (145–155°) and associated smaller sub-meridional to NNE (0–25°), ENE (50–70°) and subequatorial or ESE (90–120°) faults are observed in the area (Fig. 5) (Kalaidžiev, 1983; Angelov et al., 2010). Obviously, the Bebresh fault controls the magmatic activities and ore forming processes.

The Vatiya ore field is characterised by several small ore deposits, occurrences, and mineral indications, predominantly of vein type, rarely of ore zones or porphyry stockworks (Fig. 5). The copper-lead-zinc ores are most widely developed, like the Vatiya ore deposit and the Tvardomeshnitsa-1, Kapcha-1, 2, 3, Raynovskoto, Zvezdata, and Shaft “G. Dimitrov” ore occurrences. The Drenova Mogila and Visok-2 copper and the Arabakonak-2 lead ore occurrences are also included in this group. The barite mineralisations in the Visok deposit and the Arabakonak-1 (Tvardomeshnitsa-2) and Zvezdata-2 occurrences are economically important. The Ribni Vir gold-lead-zinc and the Markova Chukla molybdenum-bearing porphyry copper ore occurrences should be noted as well (Kalaidžiev, 1983).

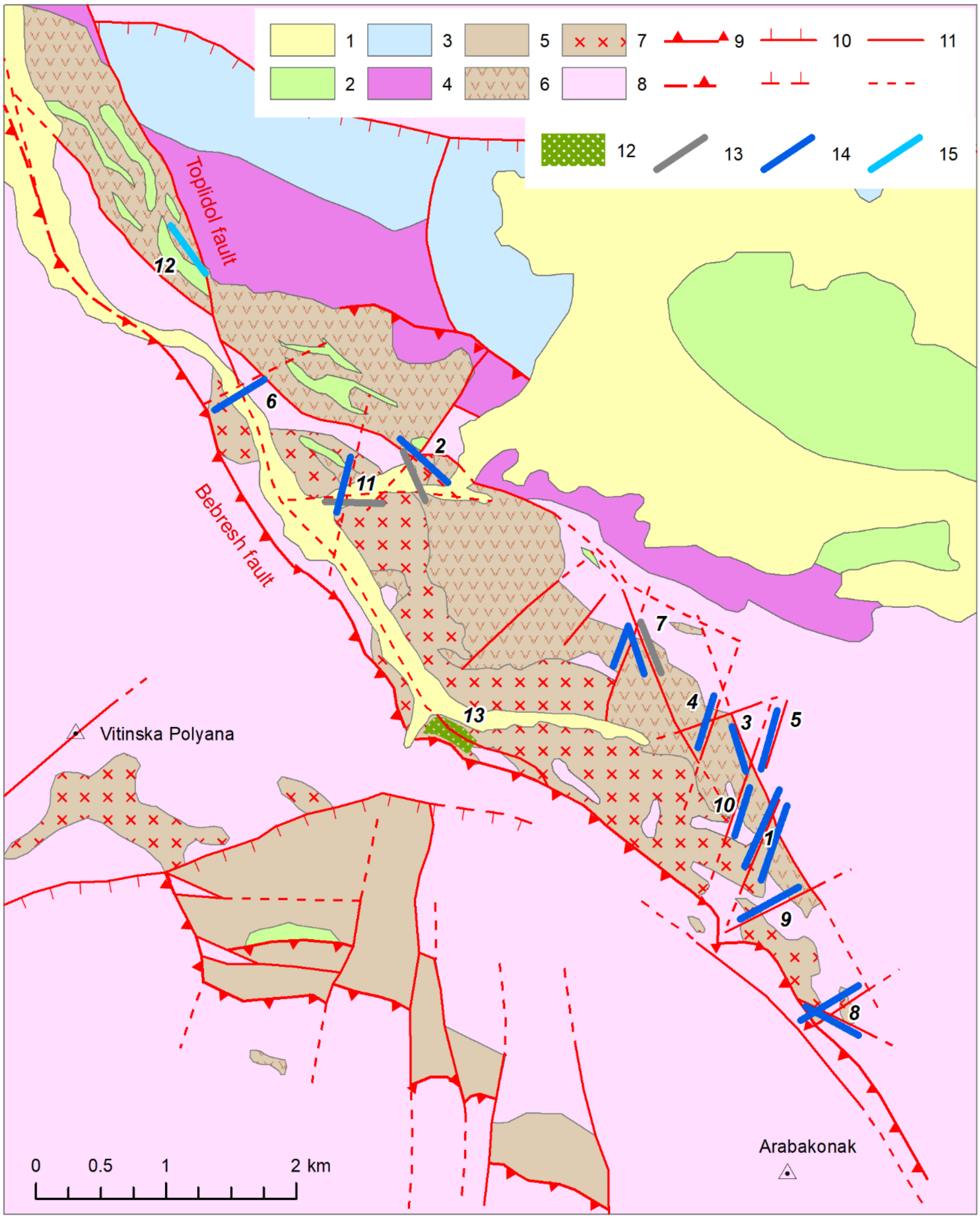

Fig. 5. Geological map of the Vatiya Ore Field (by Kalaidžiev, 1983; Angelov et al., 2010).
1 – Quaternary depositions; 2 – Upper Cretaceous rocks; 3 – Jurassic sediments; 4 – Triassic sediments; 5 – Permian sediments; 6 – Permian volcanics; 7 – Permian Bebresh pluton; 8 – Cambrian and Ordovician sediments; 9 – thrust; 10 – normal slip fault; 11 – fault; *Ore type:* 12 – porphyry copper, molybdenum-bearing; 13 – barite; 14 – polymetallic; 15 – gold-polymetallic.
***Ore deposits and occurrences by number on the map**:* *1* – Vatiya, *2* – Tvardomeshnitsa, *3* – Kapcha-1, *4* – Kapcha-2, *5* – Kapcha-3, *6* – Raynovskoto, *7* – Zvezdata, *8* – Drenova Mogila, *9* – Arabakonak-2, *10* – Shahta G. Dimitrov, *11* – Visok, *12* – Ribni Vir, *13* – Markova Chukla.

The Vatiya ore deposit is represented by two NNE ore veins, which intersect the Early Paleozoic rocks and Permian Bebresh pluton (Konstantinov, 1958f; Ushev, 1954f). The ore contains mostly copper and less lead and zinc. The ore mineralisation is represented by pyrite, galena, sphalerite, chalcopyrite, rarely cobaltite, tennantite, hematite, magnetite, and pyrrhotite. The veins are set up mainly by quartz and less calcite, barite, dolomite, and chlorite (Minčeva-Stefanova, 1959). The other ore veins in the Vatiya, Kapcha-1, 2, 3, Shaft “G. Dimitrov”, Tvardomeshnitsa-1, Zvezdata, and Raynovskoto polymetallic ore occurrences, as well as in the Visok and Drenova Mogila copper and Arabakonak-2 lead ore occurrences have similar characteristics.

The Visok and Arabakonak-1 (Tvardomeshnitsa-2) barite deposits are represented by veins with strike of 90–120°, thickness of 0.2–0.4 m, and length of 20–120 m. They consist mainly of barite, ankerite, less quartz, and sulphide minerals. The barite vein in Tvardomeshnitsa crosses the polymetallic veins. These deposits were mined during the 20th century.

The Markova Chukla porphyry copper-molybdenum ore occurrence is in small granodiorite porphyrite stockwork and Paleozoic schists. The host rocks are sericitised and quartzitised. The ore minerals are pyrite, chalcopyrite, molybdenite, and lesser sphalerite, martite, mushketovite, rarely galena. Magnetite, quartz-sulphide, quartz-sulphide-carbonate, and carbonate stages of mineralisation are distinguished (Dinchev et al., 1965f).

The Ribni Vir gold-lead-zinc ore occurrence is situated in the northwestern parts of the ore field, where the Late Paleozoic effusive rocks and diorite porphyrite dikes are exposed. Five NNW fault zones are traced here. They are with veinlets-disseminated mineralisation of linear stockwork type. Small quartz-sulphide ore veins with similar mineralisation are developed as well. The ore bodies of lenticular and pipe-like shapes are localised in intersection areas with equatorial or north-northeastern faults. The ore mineralisation is represented by pyrite, sphalerite, galena, chalcopyrite, tennantite-tetrahedrite, arsenopyrite, pyrrhotite, native gold, electrum, and hematite (Kovachev et al., 1998f; Mutafchiev and Miteva, 2001f).

The Vrachesh ore occurrence, located near the homonymous village, can be also included in the Vatiya Ore Field. It is represented by NW quartz-carbonate veins crossing the Paleozoic rocks and containing sulphide gold-lead-zinc-copper mineralisation (the Ozenitsa and Kosachitsa sectors). Equatorial faults with gold-bearing quartz-hematite mineralisations (the Sechkov Dol sector) are traced as well (Mutafchiev and Miteva, 2001f).

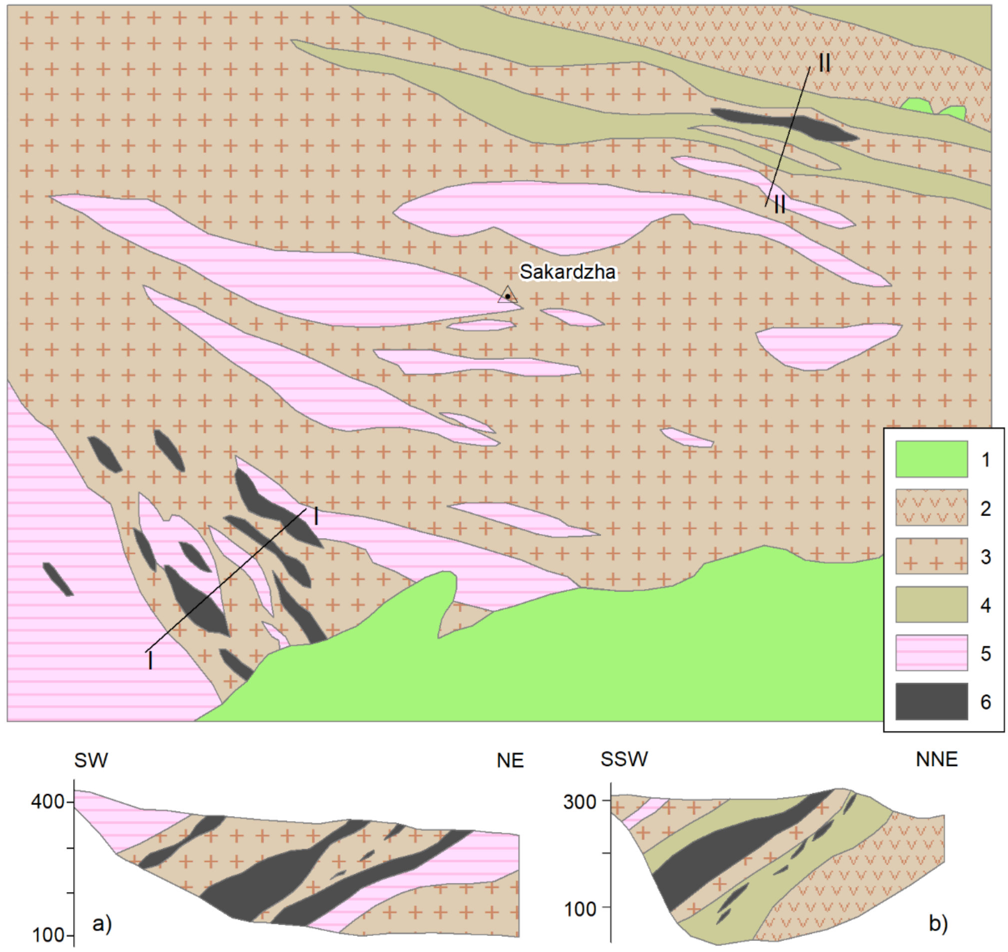

Fig. 6. Geological map of the Dolno Panicherevo molybdenum ore occurrence and sections across the Demirboklu (a) and Kohukdere (b) sites (by Staykov et al., 1968)**.**
1 – Mesozoic sediments; Permian quartz-porphyry tuff; 3 – Permian Srednogorie granitoid; 4 – Neoproterozoic – Cambrian greenschist; 5 – Neoproterozoic high-grade metamorphic rocks; 6 – ore body.

The Koprivshtitsa-Hisarya Metallogenic Zone

The Koprivshtitsa-Hisarya Metallogenic Zone is determined by the Late Paleozoic Srednogorie Granitoid Complex developed within the Srednogorie region (Popov and Popov, 2022). Several granitic plutons intruded in high-grade metamorphic rocks (gneiss, gneiss-schist, amphibolite) are outcropped in the area. They are intersected by diorite-porphyrite dikes and Permian volcanites. These rocks are covered in the periphery by Mesozoic and younger sediments.

The Granitoid Complex determines the development of a series of small ore occurrences of molybdenum, gold, and uranium, without economic importance (Fig. 1). Several small pegmatitic ore deposits and occurrences are observed as well.

The molybdenum ore occurrences have limited distribution in the metallogenic zone, predominantly in the Eastern Sredna Gora Mountain, where the Dolno Panicherevo (Demirboklu and Kohukdere), Sredna Reka, Ruda (Minata, Lozen), Saplamata, Marashite, Kuv Dere, and Kazanka ore occurrences were found. Besides, the Rezidentsiyata ore occurrence is developed in the Western Sredna Gora Mountain (the Panagyurishte area). The molybdenum ore mineralisations are localised in intensively fractured and brecciated zones in the granites (Dolno Panicherevo, Minata, Kazanka, Sredna Reka, Marashite, Kuv Dere) or in the metamorphites (Saplamata, Rezidentsiyata) (Staykov et al., 1968; Slavov and Katev, 1964). Those zones are 50 to 800 m long and 10–15 m thick. The ore mineralisation is developed as numerous small quartz-sulphide veins, veinlets and impregnations and build up narrow linear stockworks (Fig. 6).

The post-magmatic ore forming processes start with auto-metasomatic potassic feldsparisation with some molybdenite. The subsequent greisenisation consists of quartz, cassiterite, fluorite, muscovite, and sericite. They are followed by sericitisation, albitisation, epidotisation, and silicification, which accompany the ore mineralisation represented by pyrite, molybdenite, pyrrhotite, chalcopyrite, and galena. The high content of rhenium in molybdenite of Dolno Panicherevo should be noted. The Triassic sedimentary rocks overlay the mineralised granite (Staykov et al., 1968). The diorite-porphyritic dikes, crossing granite and the Permian quartz-porphyritic tuffs developed in these areas, are also not affected by the ore mineralisations.

The gold ore occurrences associated with the Srednogorie Granitoid Complex are developed in the areas of the towns of Stara Zagora, Kazanlak, and Brezovo. Numerous old mining works of small quartz-gold ore veins are observed (Ignatovski et al., 1994f). These veins can be merged into three ore occurrences: Morozovo (Lisichi Dupki), Gorno Novo Selo, and Kolyu Marinovo. The ore veins cross the granitoids and rarely high-grade metamorphic rocks. The host rocks are affected by quartz-sericitic alterations. The ore mineralisation is characterised by native gold in association with scheelite, pyrite, pyrrhotite, chalcopyrite, galena, native bismuth, lead-bismuth sulfosalts, etc. Apart from the relationships with granite, there is no other reliable data for the age of these veins.

The uranium ore occurrences associated with the Late Paleozoic Srednogorie granitoids are found between the towns of Panagyurishte and Brezovo. They are represented by the Valk (near the town of Strelcha), Sarnegor, Varben (between the towns of Brezovo and Hisarya), and other ore occurrences. The hosting rocks are granodiorite, together with veins and bodies of aplitic granite, aplite, and pegmatite. The ore mineralisation is in faults, usually with east-southeastern directions, often with albitisation of the rocks. The ore mineralisation is developed in the oxidation zone and is represented by autunite and pyrite (Dragomanov et al., 1993f).

Conclusions

Late Carboniferous-Permian Post-Collisional Complexes are developed in the Neoproterozoic-Hercynian basement of the Alpine Balkan Orogenic System. Two magmatic zones with west-northwestern to equatorial directions are observed. The Belogradchik-Vatiya Metallogenic Zone is traced to the northwest and is determined by subaerial acid volcanics, intercalated with molasse coal-bearing sediments. They associate with gold, lead-zinc, and barite deposits, and copper and molybdenum ore occurrences. The Koprivshtitsa-Hisarya Metallogenic Zone is outlined in the Central Bulgaria and is characterised by the Srednogorie Granitoid Complex associated with a series of uranium, molybdenum and gold ore occurrences.

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