THE HERCYNIAN COLLISIONAL METALLOGENY IN BULGARIA

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ABSTRACT. Ordovician – Lower Carboniferous sedimentation, calc-alkaline and potassium-alkaline magmatism and tectonic deformations mark the Hercynian collisional stage within the frame of the Neoproterozoic – Hercynian epoch. Mainly the magmatic processes define the metallogenic characteristic. The calc-alkaline plutons control the Stara Planina Metallogenic Zone with iron, lead, copper, gold, fluorite and other deposits. The potassium-alkaline magmatism defines the Berkovitsa-Shipka Metallogenic Zone with uranium deposits as well as with tungsten, copper, polymetallic and other ore occurrences.

Keywords: Hercynian magmatism, metallogeny, iron, lead, gold, uranium deposits.

ХЕРЦИНСКАТА КОЛИЗИОННА МЕТАЛОГЕНИЯ В БЪЛГАРИЯ

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РЕЗЮМЕ. Херцинският колизионен етап, в рамките на неопротерозойско-херцинската епоха, се бележи от ордовишко-долнокарбонска седиментация, калциевно-алкален и калиево-алкален магматизъм и тектонски деформации. Металогенната характеристика се определя главно от магматичните процеси. Калциевно-алкалните плутони контролират Старопланинската металогенна зона с железни, оловни, медни, златни, флуоритови и др. находища. Калиево-алкалният магматизъм определя Берковско-Шипченската металогенна зона с уранови находища, както и волфрамови, медни, полиметални и др. рудопроявления.

Ключови думи: Херцински магматизъм, металогения, железни, оловни, златни, уранови находища.

Introduction

Neoproterozoic and Paleozoic rocks are exposed in the cores of the Alpine orogeny structures. They are formed during the Neoproterozoic – Hercynian cycle, including spreading, subduction and formation of magmatic arcs, collision and post-collisional orogenesis. The collisional events from this cycle are demonstrated by the presence of typical sedimentary and magmatic complexes. The metallogenic processes are marked mostly by the formation of iron, lead-zinc, gold, uranium and other deposits related to the evolution of the magmatic structures.

Geology

The Hercynian collisional stage covers the time from the Ordovician to the Lower Carboniferous, when the sedimentary or volcano-sedimentary rocks, Stara Planina grandiorite-granite and Stara Planina potassium-alkaline complexes and the associating mineral deposits were formed (Fig. 1). The pre-collisional basement consists of Neoproterozoic ophiolite (ultramafite, gabbro, cumulates, dikes and pillow lava), high grade metamorphites as well as by Neoproterozoic – Cambrian low grade metamorphic rocks, as green schist, marble, meta-diabase, tuff, meta-gabbro to meta-granitoid and others (Haydutov et al., 1979; Хайдутов и др., 2012; Marinova et al., 2008; Zagorchev et al., 2015, etc.).

The Ordovician – Lower Carboniferous sedimentary complexes were formed as a result of the epicontinental terrigenous marine sedimentation, with interruptions, transgressions and tectonic deformations. Green schist terrigenous rocks (Dalgidel Group) overlay Cambrian rocks in the Stara Planina Mountain area. The Ordovician – Devonian section is compounded by aleurolite, argillite, less sandstone, quartzite, lydite and conglomerate. Calcareous-terrigenous (Stakevo Formation) and terrigenous-volcanogenic (Rayanovo Formation) Lower Carboniferous (?) sediments were noted (Haydutov et al., 1979; Хайдутов и др., 1995a, b; Angelov et al., 2010, etc.). The Ordovician – Lower Carboniferous complexes in SW Bulgaria are in green schist facies, and the terrigenous meta-rocks with meta-gabbro-dolerite intercalations predominate (Zagorchev, et al., 2015; Marinova et al., 2008).

The Stara Planina granodiorite-granite complex (Хайдутов и др., 1995a,b) is represented by subequatorial series of plutons in Western and Central Stara Planina Mountain. They are compounded by hypabyssal granodiorite and granite, rarely diorite and gabbro. The Belogradchik, Rayanovtsi, Sveti Nikola, Kopilovtsi (Kopren), Petrohan (Berkovitsa), Mezdra, Rzhana, Etropole, Vezhen, Karlovo, Tvarditsa and other smaller plutons are determined. The Lyutskan and Ruy plutons, which are found in SW Bulgaria (Kraishte region) and are intruded along NNW structures, belong to the same complex. The petrography of these rocks was studied by numerous authors (Димитров, 1946; Белев, 1960; Драгов, 1961; Вутов, 1962; Димитрова и др., 1964; Чунев, 1967;

Куйкин и др., 1971; Иванов и др., 1974; Kamenov et al,. 2002; Dyulgerov et al., 2006, 2010a; Marinova et al., 2008, etc.). On the basis of the rare elements ratios Kamenov et al. (2002) define these rocks as calc-alkaline to high potassium calc-alkaline, and of island-arc type. Furthermore, Dyulgerov et al. (2010a) show that the rocks have crustal-mantle origin with predominant crustal component. The calc-alkaline plutons cut the Old Paleozoic rocks and are covered by the Upper Carboniferous sediments, which mark their Upper Devonian – Lower Carboniferous age (Хайдутов и др., 1995a,b). The absolute age data (360-314 Ma) of these rocks confirm this conclusion (Amov et al., 1981; Kamenov et al., 2002; Carrigan et al., 2005; Peytcheva et al., 2006; Dyulgerov et al., 2006; Nedialkov et al., 2007, etc.)

The Stara Planina potassium-alkaline complex (Хайдутов и др., 1995a,b) is represented by the Seslavtsi and Svidnya plutons and small bodies in Shipka Mountain. Syenite, quartz-syenite, monzonite, gabbro-syenite, ultramafic cumulates and dykes from micro-syenite, granite porphyry, syenite porphyry, lamprophyre are determined (Димитров, 1946; Angelov et al., 2010; Dyulgerov, 2011). The complex includes the described by Popov et al. (1988) Zverino volcano-plutonic structure (trachyandesite, trachybasalt, monzodiorite porphyrite, granite porphyry, syenite porphyry, quartz-syenite), the volcanic rocks in Belogradchik area (Хайдутов и др., 1995b), the Proboynitsa pluton (granosyenite, quartz-syenite, shonkinite) (Marinov, 1995), Prokop pluton (monzodiorite) (Marinov, 1982) and small plutonic bodies and dykes (granosyenite, alkaline quartz syenite and shonkinite), together with potassium metasomatic alterations over the older rocks (Marinov, 1995). The rocks are related to metamorphosed, enriched mantle source (Dyulgerov, 2011; Dyulgerov and Platevoet, 2013). They are intruded in different Paleozoic rocks, including the calc-alkaline plutons, and are overlaid by the Upper Carboniferous sediments (Тенчов и Янев, 1963; Popov et al., 1988; Попов и Попова, 1990; Хайдутов и др., 1995a,b, etc.). This marks their Lower Carboniferous age, which is confirmed by the absolute age determinations (350 – 303 Ma) (Dyulgerov et al., 2010b).

The collisional stage is characterized by development of fold and fault structures. The antiform positions of the rock complexes are delineated, as Caledonian and Neoproterozoic units are outcropped within them. Small fold structures are noted, most often with subequatorial to east-southeastern direction, as the planar and linear structural elements mark three to four deformations (Angelov et al., 2010).

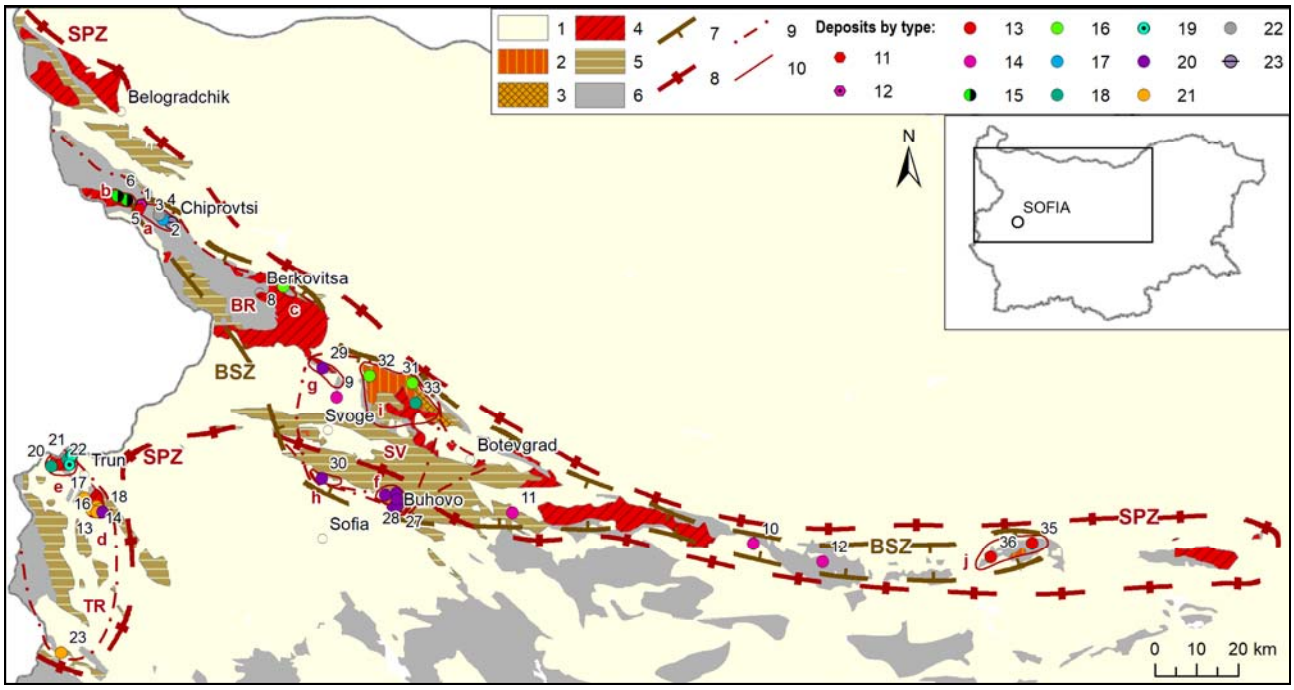

Fig. 1. Metallogenic scheme of Bulgaria for the Hercynian collisional stage from the Neoproterozoic – Hercynian epoch.
1 – Post-Paleozoic rocks; 2 – Upper Devonian-Lower Carboniferous Stara Planina potassium-alkaline Complex; 3 – Upper Devonian-Lower Carboniferous sub-alkaline volcanic rocks; 4 – Upper Devonian-Lower Carboniferous Stara Planina granodiorite-granite Complex; 5 – Ordovician-Lower Carboniferous sediments; 6 – Neoproterozoic and Cambrian metamorphic rocks; *7-8 – Metallogenic zones*: 7 – Berkovitsa-Shipka (BSZ), 8 – Stara Planina (SPZ); 9 – Ore regions (BR – Berkovitsa, SV – Svoge, TR – Tran); 10 – Ore fields (a – Chiprovtsi, b – Gorni Lom, c – Pesochnitsa, d – Lyutskan, e – Ruy, f – Buhovo, g – Proboynitsa, h – Kurilo, i – Zverino, j – Shipka); *Ore deposits and occurrences by type:* (11-12 scarn) 11 – iron, 12 – uranium-bearing molybdenum-tungsten, (13-23 – hydrothermal) 13 – iron vein, 14 – molybdenum, 15 – copper-pyrite massive sulfide, 16 – copper vein, 17 – lead-zinc, 18 – polymetallic, 19 – gold polymetallic, 20 – uranium, 21 – gold, 22 – barite, 23 – fluorite stratiform;
Ore deposits and occurrences by numbers on the map: 1 – Martinovo, 2 – Chiprovtsi, 3 – Lukina Padina, 4 – Martinovo-2, 5 – Gorni Lom, 6 – Byala Voda, 7 – Pesochnitsa, 8 – Pesochnitsa-2, 9 – Bov, 10 – Hristo Danovo, 11 – Kobilya, 12 – Kazanite, 13 – Zlata, 14 – Yamka, 15 – Krushev Dol-2, 16 – Krastato Darvo, 17 – Busintsi, 18 – Beli Bryag, 19 – Lomnitsa-1, 20 – Zelenigrad, 21 – Logo, 22 – Nadezhda, 23 – Zlogosh, 24 – Seslavtsi, 25 – Goten, 26 – Chora, 27 – Borcha, 28 – Chamilov Kamak, 29 – Proboynitsa, 30 – Kurilo, 31 – Ignatitsa, 32 – Levishte, 33 – Gabrovnitsa, 34 – Prekop, 35 – Bedek, 36 – Shiroka Polyana.

Metallogeny

The metallogenic processes, related to Hercynian collisional events, are determined mainly by the evolution of the calc-alkaline and potassium-alkaline magmatic complexes. Series of different ore deposits, described by Костов (1949), Николаев и Тонев (1964), Драгов, (1960, 1971, Dimitrov (1964), Димитрова и др. (1964), Драгов и Обретенов (1974), Стойков (1976), Тонев,(1980), Атанасов и Павлов (1982), Popov et al. (1988), Милев и др., (2007), etc., are formed as a result of these processes.

In the general metallogenic analysis of the Bulgarian territory Йовчев (1960), Милев и Богданов (1974) and Димитров (1988) noted part of the studied Paleozoic deposits, connected to the Hercynian or Caledonian (?) magmatism, in the frame of the Balkan or West Balkan Metallogenic Zone. However, this zone is formed during the Alpine tectonogenesis, with typical Alpine ore mineralizations. The described ores, related to the Paleozoic magmatism, are formed as a result of earlier tectonomagmatic processes and are included in other metallogenic units.

The modern methods of the metallogenic analysis are based on paleo-tectonic principle. Thereby, within the Neoproterozoic – Hercynian geotectonic cycle is differentiated the Hercynian collisional stage. It is characterized by the calc-alkaline and potassium-alkaline hypabyssal magmatic complexes, which determine the positions of the Stara Planina and Berkovitsa-Shipka Metallogenic Zones respectively (Fig. 1).

The Stara Planina Metallogenic Zone is determined by the plutons from the Stara Planina granodiorite-granite complex and the ore deposits connected with them. Skarn iron and hydrothermal lead-zinc, gold, copper, fluorite and smaller polymetallic, gold-polymetallic, molybdenum, barite, iron and other ores are found. The ore formation associates with metasomatic alterations represented by Ca-skarn around the contacts with marbles, as well as with the distinct silification accompanied by sericitization, epidotization, carbonatization, etc. The ore bodies are lens-like, bedding, irregular, columnar, and nest-like in the marble beds or veins and share zones in the fault structures cutting the different rocks. Depending on the ore type, the main ore minerals are magnetite, galena, native gold, chalcopyrite, fluorite, pitchblende, molybdenite. The Berkovitsa and Tran Ore Regions and individual ore manifestations are differentiated (Table 1).

The Berkovitsa Ore Region is controlled by the Sveti Nikola, Mezdra, Petrohan and some smaller plutons. They are intruded in Neoproterozoic ophiolite, Neoproterozoic – Cambrian green schist, volcano-sedimentary and metaplutonic rocks and Ordovician – Lower Carboniferous sediments. The Chiprovtsi, Gorni Lom and Pesochnitsa Ore Fields are distinguished.

The Gorni Lom Ore Field (S from the town of Belogradchik) is marked by the copper-pyrite massive sulfide Gorni Lom deposit and series of ore occurrences (Николаев и Тонев, 1964; Драгов, 1971). They are represented by complicated ore veins in faults along the pluton's contacts.

The Chiprovtsi Ore Field is developed SW from the Sveti Nikola pluton, in Neoproterozoic – Cambrian rocks. The Martinovo skarn iron deposit, the hydrothermal Chiprovtsi lead-zinc (Fig. 2) and Lukina Padina fluorite deposits, and barite, lead-zinc and copper ore occurrences are traced consecutively. The ore is developed in a zone of boudinaged marble (Николаев и Тонев, 1964; Dimitrov, 1964; Драгов и Обретенов, 1974; Атанасов и Павлов, 1982).

The Pesochnitsa Ore Field (NW from the town of Berkovitsa) is connected to the Mezdrea pluton. The skarn iron Pesochnitsa-1 (Drena) ore occurrence, the hydrothermal copper Pesochnitsa-2 (Bistrovets) ore occurrence, etc., are localized in its contacts with the Paleozoic marble (Стамболски, 1961ф).

The Bov-2, Kobilya, Hristo Danovo and Kazanita *molybdenum ore occurrences* are individually formed, outside the ore fields.

The Tran Ore Region (W Bulgaria) is determined by the Ruy and Lyutskan plutons, intruded in the high grade metamorphic rocks and in the green schist, metadiabase, tuff and gabbro. The Lyutskan and Ruy Ore Fields and the separate Zlogosh ore occurrence are distinguished.

The Lyutskan Ore Field (W from the town of Tran) (Fig. 2) is controlled by the Lyutskan pluton. The Zlata, Yamka, Krushev Dol and Krastato Dere gold deposits and numerous ore occurrences are found. They are represented by quartz-sulfide ore veins within NNE faults cutting the granitoid and metamorphic rocks (Драгов, 1960; Милев и др., 2007). The Beli Bryag and Vodopada uranium ore occurrences are also noted (Стойков, 1976).

The Ruy Ore Field (NW from the town of Tran) is determined by the ores related to the Ruy pluton. The Ruy, Lomnitsa-1, Zabel, Zelenigrad polymetallic and Logo and Nadezhda gold-polymetallic ore occurrences are found. They are represented by quartz-sulfide ore veins or brecciated zones (Димитров, 2007ф).

The Zlogosh gold ore occurrence (NNW from the town of Kyustendil) is marked by quartz-sulfide veins, concordant to or intersecting the foliation (Милев и др., 2007).

The Berkovitsa-Shipka Metallogenic Zone is controlled by the magmatic bodies from the Stara Planina potassium-alkaline complex and the associated ore deposits. It covers Western Stara Planina Mountain, between the towns of Belogradchik and Shipka. Considerable uranium deposits and tungsten, copper, polymetallic and rare earth mineralizations are found. The host rocks are represented by alkaline plutons, older granitoids and different Paleozoic schists and marbles. In the individual areas they associate with metasomatic alterations as silicification, sericitization, berezitization, greizenization, albitization, K-feldspatization, low temperature Na-metasomatites, etc., and with Ca-skarns in some places. The ore bodies were formed along the contacts between the plutons and host rocks or in faults, often complicated in structure. The ore formation was favored by the host marbles and schists. Lens-like, nests, stockwerks, columnar, vein and

Table 1.

Characteristics of the Hercynian collisional ore deposits in Bulgaria

Ore Region	**Ore Field**	**Deposit, *Ore occurrence***	**Main minerals**	**Secondary of importance and *rare* minerals**	**Structural position**	**Ore bodies, morphology**	**Host rocks**	**Metasomatic alterations**
STARA PLANINA METALLOGENIC ZONE								
Berkovitsa Ore Region	Chiprovtsi Ore Field	Martinovo (Fe)	magnetite	pyrrotine, chalcopyrite, sphalerite, galena, *n. gold, bismutite, joseit, petzite n. bismuth, electrum,*	granitoid-marble contact	lens-like, pipe-like, nest-like, irregular	ophiolite - Pt; greenschists, marble, diabase, tuff - Pt-Pz_1; granitoide - Pz_2	Ca-skarns (biotite, amphibole, *garnet, pyroxene*) *epidote, quarz, titanite, calcite*
		Chiprovtsi, *Zhelezna*, *Chervenata Skala* (Pb, Ag)	galena (+Ag)	sphalerite, chalcopyrite, pyrite, arsenopyrite, *markasite, tetrahedrite, bournonite, boulangerite, polybasite, pyrargyrite, stephanite, pyrostilpnite, n. silver, n. gold*	marble	columnar, pipe-like, vein-like, nest-like		silicification, chloritization, carbonatization
		Lukina Padina (F)	fluorite	quarz, calcite, barite, ankerite, cinabar, pyrite, galena, sphalerite, etc.	marble	lens-like		
		Martinovo 2 (Ba)	barite	ferrodolomite, quarz, *ankerite, calcite, galena, tetrahedrite, chalcopyrite*	fault	veins		
		Yavorova Glava, *Martinovo-N, Ostra Chuka*, (Cu)	chalcopyrite, tetrahedrite	galena, sphalerite, pyrite, *antimonite, n. silver, Pb–Sb, Cu–Pb–Sb sulfosalt*	marble, fault	lenses, veins		
	Gorni Lom Ore Field	Gorni Lom, *Byala Voda*, *Gorni Lom–S*, *Rakov Vrah, Lumparitsa* (Cu)	pyrite, chalcopyrite	magnetite, hematite, pyrrotine, sphalerite, galena	fault zone	share zone		silicification, carbonatization, epidotization, albitization, sericitization
	Pesochnitsa Ore Field	Pesochnitsa-1 (Drena) (Fe)	magnetite, hematite	chalcopyrite	contact granitoid - marble	lens-like, irregular	greenschist, marble Pt-Pz_1; granitoid	Ca-skarns – garnet, epidote, *calcite*, quarz, amphibole, chlorite; silicification
		Pesochnitsa-2 (*Bistrovets*) (Cu)	chalcopyrite, chalcocite					
	Individual occurrences	*Bov, Hr. Danovo*, *Kobilya, Kazanite* (Mo)	molybdenite, pyrite	pyrrotine, arsenopyrite, chalcopyrite	fault	veins	granitoid, metamorphite	silicification, sericitization
Tran Ore Region	Lyutskan Ore Field	Zlata, Yamka, *Erul* Krushev Dol, Krastato Darvo, *Busintsi*, (Au); *Beli Bryag*, *Vodopada* (U)	pyrite, n. gold; pitchblende	scheelite, uraninite schapbachite, *n. silver*, pitchblende*, wolframite, chalcopyrite, galena, tetrahedrite, sphalerite, molybdenite*	fault	veins, share zone	granitoid - Pz_2 metamorphite, gabbro - Pt-Pz_1	sericitization, silicification, carbonatization
	Ruy Ore Field	*Ruy, Lomnitsa-1, Zabel, Zelenigrad* (Pb Zn Cu Au); *Logo, Nadezhda* Au (Pb Zn Cu)	pyrite (Au), galena, chalcopyrite (Au)	sphalerite, hematite, scheelite	faults	veins	granitoid; greenschist, tuff, metadiabase	
	Individual occurrence	*Zlogosh* Au (Pb Zn Cu)	pyrite, n. gold	arsenopyrite, magnetite, galenite, sphalerite, chalcopyrite	faults	veins	granitoid greenschist	
BERKOVITSA – SHIPKA METALLOGENIC ZONE								
Svoge Ore Region	Buhovo Ore Field	Seslavtsi 1, 2, 3, Goten, Chora, Borcha, Chamilov Kamak (U)	pitchblende	pyrite, chalcopyrite, tennantite, galena, sphalerite, *nickeline, gersdorffite, millerite, rammelsbergite, bravoite, arsenopyrite, hematite,*	contact syenite - black shale	lens-like, nest-like, pipe-like, vein-like, stockwerk	monzonite, syenite Pz_2; black shale Pz_1;	quartz-sericitization, beresitization
	Proboynitsa Ore Field	Proboynitsa, *Byalo Gabare* (U)	pitchblende	chalcopyrite, pyrite, hematite, *galena, bornite, sphalerite, arsenopyrite, covellite, molybdenite, stibnite, markasite,*	faults	nest-like, lens-like, veins, columnar, stockwerk	greenschist; granitoid; K-alc syenite, shonkinite	greisenization, albitization, silicification, Na low t° metasomatites hydromicatizaiton
	Kurilo Ore Field	Kurilo, *Katina* 1, 2, *Tayna* (U)	pitchblende	chalcopyrite, barite, calcite	faults	vein-like, stockwerk	terrigenous sediments (Pz_{s-d})	
	Zverino mineralized area	*Ignatitsa, Levishte* (Cu)	pyrite, chalcopyrite, pyrrotine	arsenopyrite, markasite, hematite, titanomagnetite,	fault zones	veinlet-disseminated	montzodiorite, shonkinite, syenite, granite, Pz_2;	K-feldsparisation, secondary quartzite, propylitization, sericitization, kaolinization,
		Gabrovnitsa (Pb Zn Cu)	pyrite, galena, sphalerite, chalcopyrite	tennantite, pyrrotine, hematite, ilmenitite, bornite				

Ore Region	Ore Field	Deposit, *Ore occurrence*	Main minerals	Secondary of importance and *rare* minerals	Structural position	Ore bodies, morphology	Host rocks	Metasomatic alterations
	Individual occurrence	*Prekop* (W, Mo, U)	molybdenite	scheelite, uraninite	contact marble – montzo-diorite	lens-like, irregular	montzodiorite	Ca-skarns (andradite, diopside, hedenbergite)
	Shipka mineralized area	*Bedek, Shiroka Polyana, Tsiganski Ushetsi, Solta,* (Fe)	magnetite,	hematite, pyrite	concordant fault zones, faults	share zone, vein-like	greenschist Pz_1; syenite Pz_2;	

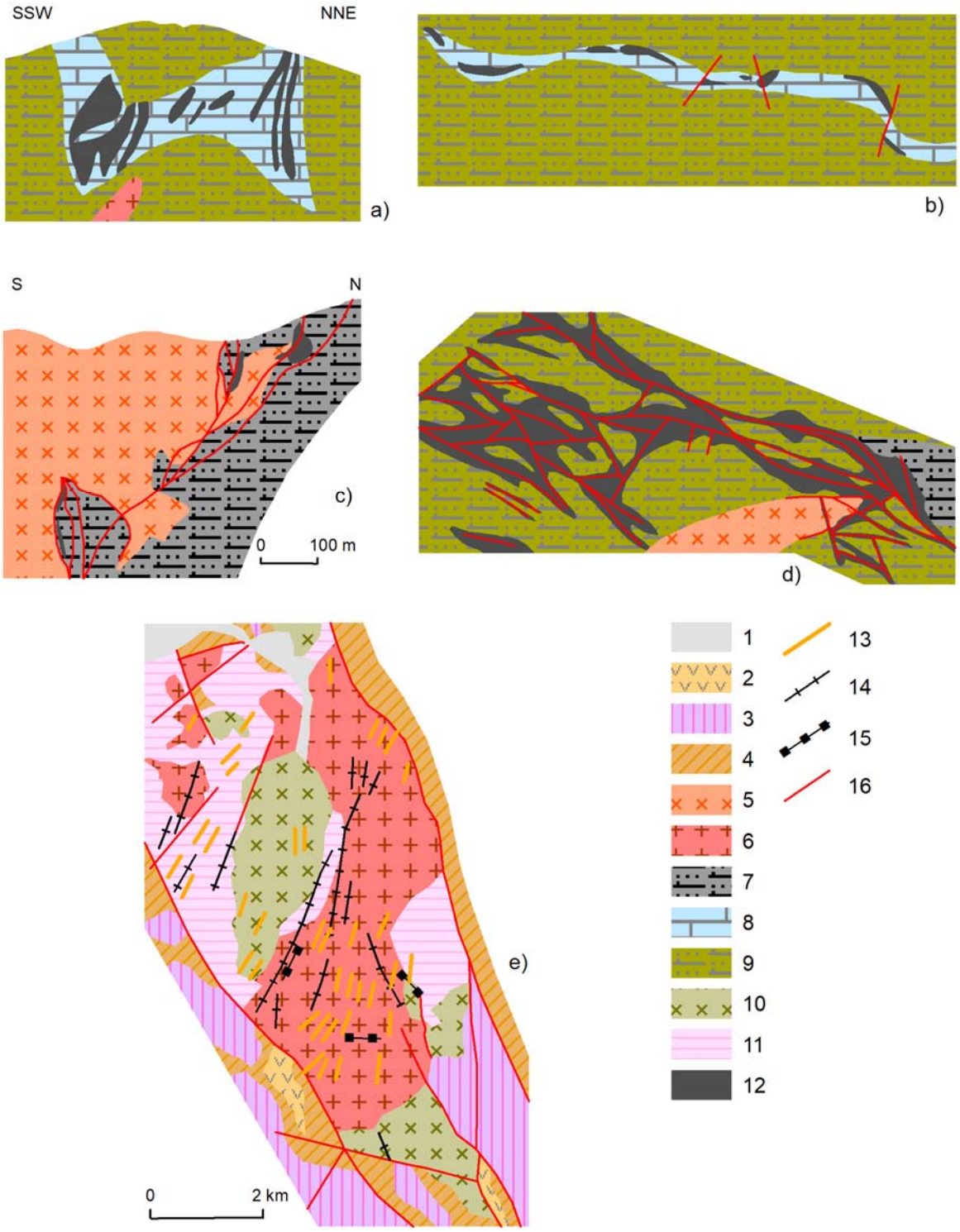

Fig. 2. Ore deposits: a) Martinovo; b) Chiprovtsi; c) Seslavtsi; d) Proboynitsa (plane of the central part); e) Lyutskan Ore Field.
1 – Quaternary sediments; 2 – Priabonian – Oligocene volcanic rocks; 3 – Mesozoic sediments; 4 – Upper Carboniferous and Permian sediments; 5 – Lower Carboniferous K-alkaline pluton; 6 – Devonian – Lower Carboniferous granitoid; 7 – Silurian black shale; *Neoproterozoic-Cambrian rocks (8-11):* 8 – marble, 9 – green shale, 10 – Struma diorite and gabbro, 11 – high grade metamorphic rocks; 12 – ore bodies; 13 – Lower Carboniferous K-alkaline dyke; 14 – gold vein; 15 – uranium ore vein, 16 – fault and brecciated zone.

share zone types of ore bodies are observed. The main ore mineral in the uranium ores is nasturan (pitchblende), and in the other ores are molybdenite, magnetite, galena, sphalerite, and chalcopyrite. The Svoge Ore Region and some small individual tungsten-molybdenum mineralizations are differentiated (Table 1).

The Svoge Ore Region is defined by the development of Seslavtsi, Svidnya and Proboynitsa intrusives, Zverino volcano-plutonic structure and smaller bodies and dikes. The Buhovo, Proboynitsa and Kurilo Ore Fields and the Zverino mineralized area are distinguished. Rare earth and uranium mineralizations in the Svidnya pluton are also found, west of the town of Svoge.

The Buhovo Ore Field (NE from Sofia City) is controlled by the Seslavtsi pluton. The Seslavtsi 1, 2, 3 (Fig. 2), Goten, Chora, Borcha and Chamilov Kamak uranium deposits are found here (Стойков, 1976; Тонев, 1980). The ore is formed along the northern and eastern contacts of the pluton with Paleozoic, predominantly Silurian rocks, in association with a fault system.

The Proboynitsa Ore Field (in the area of Bov and Lakatnik villages) is related to the homonymous pluton. The Proboynitsa uranium deposit (Fig. 2) and several ore occurrences are found (Стойков, 1976; Драгоманов и др., 1995ф). The ore is developed in complicated fault structure, which cut the pluton and the Paleozoic metamorphic rocks.

The Kurilo Ore Field (NE from Sofia City) is controlled by small bodies of K-alkaline rocks intruded in Paleozoic terrigenous sediments. The Kurilo uranium deposit and several ore occurrences are found. The ore mineralization is developed in the cutting areas between sub-equatorial and northeastern faults (Стойков, 1976; Драгоманов и др., 1995ф).

The Svidnya rare earth ore occurrence (west of the town of Svoge) is related to the homonymous pluton. The increased contents of La, Ce, Nd and less Pr, Sm, Gd and Y are determined in the apatite (Стефанова, 1973ф). Uranium mineralization within faults has also been observed (Бахнева и др., 1963ф).

The Zverino mineralized area (Zverino village, the Iskar River defile) is defined by the development of Zverino volcano-plutonic structure. The Ignatitsa and Levishte coper, Gabrovnitsa polymetallic and other ore occurrences are found (Popov et al., 1988).

The Prekop molybdenum-tungsten, uranium-bearing ore occurrence (NE from the town of Chiprovtsi) is related to the homonymous pluton. The ore type is skarn, along the contact of the Prekop pluton with Paleozoic marble.

The Shipka mineralized area is located in the Shipka area in Stara Planina Mountain. The Bedek, Shiroka Polyana, Solta and Tsiganski Ushetsi iron ore occurrences are related to the K-alkaline magmatic bodies and are developed in brecciated zones or faults (Костов, 1949).

Conclusion

Ca and K-alkaline magmatic processes are of primary importance for the Hercynian collisional metallogeny in Bulgaria. The Stara Planina Metallogenic Zone with iron, lead-zinc, gold, copper, fluorite deposits and other small mineralizations originates with the Devonian – Lower Carboniferous Ca-alkaline, predominantly crustal plutonism. The Berkovitsa-Shipka Metallogenic Zone with important uranium deposits and some tungsten-molybdenum, iron and copper mineraliztions is formed in relation to the Lower Carboniferous K-alkaline mantle magmatism.

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