Резюмета на научните публикации на
доц. д-р Камен Богданов

за участие в конкурса за заемане на академичната длъжност "*професор* " по научно направление *4.4 „Науки за земята",* научна специалност *„Геология и проучване на полезни изкопаеми"* обявен от СУ „Св. Климент Охридски", ГГФ, катедра „Минералогия, петрология и полезни изкопаеми"

1. Ivanov Zh., Nedialkov, R., **Bogdanov, K.** 2014. Magmatic and ore-related breccias in the Elatsite porphyry-copper deposit (PCD), Bulgaria. *In: Proc. XX Congr. CBGA, Sept.24-26,Tirana, Albania*, vol. I, 158-161.

Abstract. Several ore-related breccia types are associated with the porphyric granodiorite intrusions in the Elatsite Cu-porphyry deposit, Bulgaria, and they contain: 1) magmatic breccias, 2) magmatic hydrothermal injection breccias, 3) collapse decompression breccias, 4) mosaic breccias, 5) crackle breccias and 6) pebble dike breccias. Both clast supported and matrix supported breccias are widespread. All of them occur as single or clusters of pipe-like bodies with steep (65-80^{o}) to vertical dips, ranging from centimeter to meter scale and rarely to 5 x 30 m in size. Magmatic contact, injection and pebble dyke breccias have been generated due to volume increasing as a mechanical effect of the intrusion pressure, while the change of magmatic and hydrothermal fluid pressure has led to formation of magmatic-hydrothermal and collapse breccias. Pre-, syn- and post-mineralization breccias have also been recognized.

2. Jemmali, N., Souissi, F.,Carranza E., Torstenn, W., Vennemann,T., **Bogdanov, K.** 2014. Geochemical constraints on the genesis of the Pb-Zn deposit of Jalta (northern Tunisia):implications for timing of mineralization, sources of metals and relationship to the Neogene volcanism.*Chem der Erde*,**74**,601-613.

Abstract. The occurrence of Pb–Zn deposits of Jalta district (northern Tunisia) as open space fillings and cement sand breccia in the contact zones between Triassic dolostones and Miocene conglomerates along or near major faults provides evidence of the relationship between the mineralization and tectonic processes. Pb isotopes in galena from the deposits yielded average$^{206}Pb/^{204}Pb$,$^{207}Pb/^{204}Pb$ and$^{208}Pb/^{204}Pb$ ratios of 18.821, 15.676 and 38.837, respectively, implying a well-mixed multi-source upper crustal reservoir of metals. Magmatism and compressional tectonics during the Alpine orogeny favoured Pb–Zn mineralization in the Jalta district. The enrichment in Pb, Zn, Cd and Co of the Triassic carbonates and enrichments in Pb, Zn and Cd in Triassic clayey shales is associated with hydrothermal alteration around faults. Alunite in the deposit has $\delta^{34}S$ values (−2.5 to −1.5‰ VCDT), which could have been formed at and above the water table in a kind of steam-heated environment, where fluids containing H_2S mixed with fluids containing K and Al. The H_2S could have been produced by TSR of sulfates at high temperature at depth and then leaked upward through deep-seated faults, whereas the K and Al could have been acid-leached from Miocene volcanic rocks.

3. Zlatkov,G., Tasev, G., Stefanova,V., **Bogdanov, K.,** Serafimovski, T. 2014.Composition of some major mineral phases from the Plavica epithermal gold deposit, Eastern Macedonia. *Geologica Macedonica*, **28**, 2, 149–163.

Abstract. High-sulphidation epithermal gold has been determined and studied in the Plavica deposit, which is an integral part of the Kratovo-Zletovo volcanic area. Epithermal gold and associated mineral phases have been determined in silicified tuff, secondary quartzite, quartz-pyrite-enargite veins and mainly disseminated within an altered, but mostly silicified volcanic setting. Beside gold within this acid-sulphate volcanic environment was determined the presence of contaminated pyrite, zinc-

tetrahedrite,enargite, and certainly seligmanite regularly and commonly present copper association led by chalcopyrite,followed by bornite, chalcocite, covellite, as well as slightly higher temperature associations of arsenopyrite and molybdenite. Most of these accessory sulphide mineral phases within this study were observed under state of the art polarized optical microscope, and the electron microprobe, which results are presented in detail in this paper. For illustration we want to emphasize that in pyrite were found increased concentrations of copper and zinc and less silver, then enargite with increased zinc concentrations (0.24–7.56 Zn), antimony (0.46–1.33% Sb) and silver (0.09–0.54% Ag) , tennantite with increased iron (0.21–1.55% Fe), zinc (6.24–9.06% Zn) and silver (0.08–0.87% Ag), while within the molybdenite elevated concentrations were detected for sulfur and iron.

4. Bonev, N., Dilek, Y., Hanchar, J.M., **Bogdanov, K**., Klain, L. 2012. Nd-Sr-Pb isotopic composition and mantle sources of Triassic rift units in the Serbo-Macedonian and the western Rhodope massifs (Bulgaria-Greece). *Geological Magazine*, **149**,1, 146-152.

Abstract. We report on the field occurrence and isotopic compositions of metamafic rocks exposed in the Serbo-Macedonian (Volvi and Therma bodies) and western Rhodope (Rila Mountains) massifs of Bulgaria and Greece. These metamafic units consist of high- and low-Ti gabbroic and basaltic rocks, whose Nd–Sr–Pb isotopes are compatible with mantle derived MORB and OIB components with a smallamount of crustal material involved in their melt source. These isotopic features combined with the field observations are consistent with an intra-continental rift origin of the metamafic rocks protolith, and are comparable to those of the Triassic riftrelated mafic rocks in the northern Aegean region.

5. Kouzmanov, K., Moritz, R., Von Quadt, A.,Chiaradia, M., Peytcheva, I., Fontignie, D.,Ramboz, C., **Bogdanov, K.** 2009. Late Cretaceous porphyry Cu and epithermal Cu–Au association in the Southern Panagyurishte District, Bulgaria: the paired Vlaykov Vruh and Elshitsa deposits. *Miner. Deposita*, **44**,6,611–646.

Abstract. Vlaykov Vruh—Elshitsa represents the best example of paired porphyry Cu and epithermal Cu–Au deposits within the Late Cretaceous Apuseni–Banat–Timok–Srednogorie magmatic and metallogenic belt of Eastern Europe. The two deposits are part of the NW trending Panagyurishte magmato-tectonic corridor of central Bulgaria. The deposits were formed along the SW flank of the Elshitsa volcano-intrusive complex and are spatially associated with N110-120-trending hypabyssal and subvolcanic bodies of granodioritic composition. At Elshitsa, more than ten lenticular to columnar massive ore bodies are discordant with respect to the host rock and are structurally controlled. A particular feature of the mineralization is the overprinting of an early stage high-sulfidation mineral assemblage (pyrite ± enargite ± covellite ± goldfieldite) by an intermediate-sulfidation paragenesis with a characteristic Cu–Bi–Te–Pb–Zn signature forming the main economic parts of the ore bodies. The two stages of mineralization produced two compositionally different types of ores—massive pyrite and copper–pyrite bodies. Vlaykov Vruh shares features with typical porphyry Cu systems. Their common geological and structural setting, ore-forming processes, and paragenesis, as well as the observed alteration and geochemical lateral and vertical zonation, allow us to interpret the Elshitsa and Vlaykov Vruh deposits as the deep part of a high-sulfidation epithermal system and its spatially and genetically related porphyry Cu counterpart, respectively. The magmatic–hydrothermal system at Vlaykov Vruh–Elshitsa produced much smaller deposits than similar complexes in the northern part of the Panagyurishte district (Chelopech,Elatsite, Assarel). Magma chemistry and isotopic signature are some of the main differences between the northern and southern parts of the district. Major and trace element geochemistry of the Elshitsa magmatic complex are indicative for the medium- to high-K calc-alkaline character of the magmas. 87Sr/86Sr(i) ratios of igneous rocks in the range of 0.70464 to 0.70612 and 143Nd/144Nd(i) ratios in the range of 0.51241 to 0.51255 indicate mixed crustal–mantle components of the magmas dominated by mantellic signatures. The epsilon Hf composition of

magmatic zircons (+6.2 to +9.6) also suggests mixed mantellic–crustal sources of the magmas. However, Pb isotopic signatures of whole rocks (206Pb/204Pb=18.13–18.64,207Pb/204Pb=15.58–15.64, and 208Pb/204Pb=37.69–38.56) along with common inheritance component detected in magmatic zircons also imply assimilation processes of pre-Variscan and Variscan basement at various scales. U–Pb zircon and rutile dating allowed determination of the timing of porphyry ore formation at Vlaykov Vruh (85.6±0.9 Ma), which immediately followed the crystallization of thesubvolcanic dacitic bodies at Elshitsa (86.11±0.23 Ma) and the Elshitsa granite (86.62±0.02 Ma). Strontium isotope analyses of hydrothermal sulfates and carbonates (87Sr/86Sr=0.70581–0.70729) suggest large-scale interaction between mineralizing fluids and basement lithologies at Elshitsa–Vlaykov Vruh. Lead isotope compositions of hydrothermal sulfides (206Pb/204Pb=18.432–18.534, 207Pb/204Pb=15.608–15.647, and 208Pb/204Pb= 37.497–38.630) allow attribution of ore-formation in the porphyry and epithermal deposits in the Southern Panagyurishte district to a single metallogenic event with a common source of metals.

6. Zimmerman, A., Stein, H., Hannah, J., Koželj, D., **Bogdanov, K.,** Berza, T. 2008. Tectonic configuration of the Apuseni–Banat—Timok–Srednogorie belt, Balkans-South Carpathians, constrained by high precision Re–Os molybdenite ages. *Miner Deposita*, **43**,1–21.

Abstract. The Apuseni–Banat–Timok–Srednogorie magmatic–metallogenic belt (ABTS belt), forms a substantial metallogenic province in the Balkan-South Carpathian system in southeastern Europe. The belt hosts porphyry, skarn, and epithermal deposits mined since pre-Roman times. Generally, the deposits, prospects, and occurrences within the belt are linked to magmatic centers of calcalkaline affinity. Fifty-one rhenium-osmium (Re–Os) ages and Re concentration data for molybdenites define systematic geochronologic trends and constrain the geochemicalmetallogenic evolution of the belt in space and time. From these data and additional existing geologic-geochemical data, a general tectonic history for the belt is proposed. Mineralization ages in Apuseni-Banat, Timok, and Panagyurishte (the central district of the larger E–W Srednogorie Zone) range from 72–83, 81–88, and 87–92 Ma, respectively, and clearly document increasing age from the northwestern districts to the southeastern districts. Further, Re–Os ages suggest rapidly migrating pulses of Late Cretaceous magmatic–hydrothermal activity with construction of deposits in ~1 m.y., districts in ~10 m.y., and the entire 1,500 km belt in~20 m.y. Ages in both Timok and Panagyurishte show systematic younging, while deposit ages in Banat and Apuseni are less systematic reflecting a restricted evolution of the tectonic system. Systematic differences are also observed for molybdenite Re concentrations on the belt scale.
Re concentrations generally range from hundreds to thousands of parts per million, typical of subduction-related Cu–Au–Mo–(PGE) porphyry systems associated with the generation of juvenile crust. The geochronologic and geochemical trends are compatible with proposed steepening of subducting oceanic slab and relaxation of upper continental plate compression. Resulting influx of sub-continental mantle lithosphere (SCML) and asthenosphere provide a fertile metal source and heat, while the subducting slab contributes connate and mineral dehydration fluids, which facilitate partial melting and metal leaching of SCML and asthenosphere. Cu–Au–Mo–(PGE) porphyry deposits may develop where melts are trapped at shallow crustal levels, often with associated volcanism and epithermal-style deposits (South Banat, Timok, and Panagyurishte). Mo–Fe–Pb–Zn skarn deposits may develop where felsic melts are trapped adjacent to Mesozoic limestones at moderate crustal levels (North Banat and Apuseni). Systematic spatial variations in deposit style, commodity enrichment, Re–Os ages, and Re concentrations support specific tectonic processes that led to ore formation. In a post-collisional setting, subduction of Vardar oceanic crust may have stalled, causing slab steepening
and rollback. The slab rollback relaxes compression, facilitating and enhancing orogenic collapse of previously thickened Balkan-South Carpathian crust. The progression of coupled rollback-orogenic collapse is evidenced by the width of Late Cretaceous extensional basins and northward younging of Re–Os ages, from Panagyurishte (~60 km; 92–87 Ma) to Timok (~20 km; 88–81 Ma) to Apuseni-Banat (~5 km; 83–72 Ma). Generation of a well-endowed mineral belt, such as the ABTS, requires a

temporally and spatially restricted window of magmatic–hydrothermal activity. This window is quickly opened as upper plate compression relaxes, thereby inducing melt generation and ingress of melt to higher crustal levels. The window is just as quickly closed as upper plate compression is reinstated. The transient tectonic state for economic mineralization in the ABTS belt may be a paleo-analogue to transient intervals in the present subduction tectonics of SE Asia where much mineral wealth has been created in the last few million years.

7. **Bogdanov, K**., Filipov, A. 2006. Bi-Te mineral assemblages of gold in porphyry-epithermal systems: examples from the western segment of the Tethian-Eurasian copper belt. *Proceedings of IGCP Project 486, Field Workshop, Au - Ag - Te - Se deposits. Izmir, Turkey, 24 - 29 September 2006*, 24-28.

Abstract. The global Tethyan-Euarsian Copper Belt extends from Romania, Serbia and Bulgaria trough Turkey, Iran, Afghanistan and Pakistan and hosts significant porphyry-copper and epithermal Cu-Au deposits. Gold is commonly associated with enargite-luzonite and bornite-rich HS assemblages in the epithermal deposits of Bor (Serbia), Chelopech, Krassen, Radka, Zidarovo, Vurly Bryag (Bulgaria), Kirazli, Madendag, Agi Dagi, Altintepe, Eskine Yaylashi, Altintepe and Bahcecik (Turkey) and Abolhassani (Iran). Tellurides are most abundant in bornite-chalcopyrite ores (e.g., skarns, porphyry cores) and within chalcopyrite-tennantite epithermal ore associations that accompany Au in all the above Cu-porphyry to epithermal deposits and assemblages. Bi-Te-Au mineral assemblages commonly occur in **"**A-type" granular quartz veins with disseminated bornite, magnetite and chalcopyrite, often with K-feldspar envelope and secondary biotite. The Bi-Au assemblages seem to be more common in the chalcopyrite (± molybdenite) "B-type" of veins of the porphyry-copper deposits where tetradymite is often associated with hessite, tellurobismuthite, cuprobismuthite and aikinite in addition to rare minerals such as larosite, bohdanowiczite and petzite.

8. **Bogdanov, K.,** Filipov,A., Kehayov,R. 2005. Au-Ag-Te-Se minerals in the Elatsite porphyry-copper deposit, Bulgaria.Proc. Au-Ag-Te-Se deposits, IGCP Project 486, 2005 Field Workshop, Kiten, Bulgaria *Geochem. Miner. Petrol.*, **42**. 13-19.

Abstract. Elatsite is one of the largest operating porphyry-copper deposits in Eastern Europe, and is also enriched in Au-Ag-Te-Se and PGE. The magnetite-bornite-chalcopyrite ore assemblage, preserved mainly in the central K-alteration core, has been examined by means of electron microprobe and SEM. Au-Ag-Te-Se minerals are abundant, and include macroscopic gold with high fineness. The ores are also enriched in hessite, stützite, sylvanite, merenskyite, empressite, wittichenite and clausthalite, found as exsolutions in bornite and chalcopyrite. Paragenetic relations display initial saturation of native Te with sylvanite ($AuAgTe_2$), followed by increasing Me/Te ratio from 1:1 to 2:1 in hessite (Ag_2Te). Tellurides within bornite with early macroscopic (>100 μm) gold with high fineness (>900) took place at high fTe_2 (-4; -8) and fO_2 conditions near to the magnetite-hematite buffer. The hessite-clausthalite association in chalcopyrite and the formation of stephanite, together with the drop in fineness of the late microscopic (<100 μm) gold (<650), indicate decrease of fTe_2 (-18;-19) and fS_2 (-13;-14) and temperatures <200°C in the late Te-, Se- and Au bearing associations.

9. Kouzmanov, K., **Bogdanov, K.,** Ramboz, C. 2005. Te- and Bi-bearing assemblages in the Elshitsa and Radka epithermal deposits, Central Srednogorie, Bulgaria: Mineralogy and genetical features. Proc. Au-Ag-Te-Se deposits, IGCP Project 486, 2005 Field Workshop, Kiten, Bulgaria. *Geochem. Miner.Petrol.*, **42**. 108-112.

Abstract. The Late Cretaceous Elshitsa and Radka epithermal Cu-Au deposits, located in the southern part of the Panagyurishte district, Bulgaria, are closely related to porphyry-copper deposits and were formed by high to intermediate-sulphidation hydrothermal systems. Rare

bismuth, copper, bismuth-copper, gold, and goldsilver tellurides, sulphotellurides (buckhornite), and bismuth sulphosalts are typomorphic for the main economic stage of mineralisation. This paper summarises the particularities of the Te- and Bi-bearing assemblages in the two epithermal deposits and their genetical features.

10. Кехайов, Р., **Богданов, К.** 2005. Минерални асоциации на злато от медно-порфирното находище Елацite. *Год. СУ „Св. Кл. Охридски", ГГФ, Геология,* **98**, 127 – 145.

Abstract. The Panagyurishte ore district hosts famous Late Cretaceous porphyry-type ore deposits, among which the Cu-Au-PGE monzodioritic to granodioritic intrusion-related deposit Elatsite is the most prominent one. The chemical evolution and morphology of gold from Elatsite Au-PGM deposit has been traced and quantified by using EPMA and SEM analysis. Five successive ore assemblages of gold and has been described in detail. During the Mt-Bn-Cp assemblage, characterized by microscopic (4-20 μm) to macroscopic gold (>100 μm) with high fineness (994-903‰). High salinity (60-40% NaCl Equiv.) and high temperature (600-530°C) fluids were responsible for the precipitation of zonal cube-octahedral and octahedral gold crystals. The complex nature gold precipitation define leopard" skin type texture, oscillatory zonation and cluster crystal arrangement. During the successive deposition of Q-Cp-Py, Q-Mo, Q-Py and Q-Gn-Sp assemblages the gold is precipitated from progressively cooler (535-200° C), less saline fluids (50-20 % NaCl Equiv). The transition between Q-Py and Q-Gn-Sp is marked by abrupt decrease of the gold fineness (from ~838 to ~650‰) and microscopic size (5-15 μm) which corresponds to the drop of the salinity of the fluid (from 40 to 20 % NaCl Equiv). The economic Au and Cu in the deposit are precipitated as a result of boiling processes during the deposition of Q-Cp-Py assemblage, a feature corresponding to the 3D model of Cu distribution. Pd, Pt, Se, Te, Bi are common trace elements of gold from mt-bn-cp assemblages where PGM tellurides (merenskyite-moncheite) have been precipitated. Fe and Cu are typical for the gold of the later Q-Cp-Py assemblage.

11. Kouzmanov, K., Ramboz, C,, Bailly, L., **Bogdanov, K.** 2004. Vinciennite-bearing Cu-As-Sn (±Au) assemblage from the Radka copper epithermal deposit, Bulgaria: Mineralogy and infrared microthermometry of enargite. *Canad. Mineral.*, **42**, 1501-1521.

Abstract. The Radka deposit is one of the largest Cu–Au epithermal deposits related to Late Cretaceous volcanic arc-type magmatic activity in the Panagyurishte ore region, central part of the Srednogorie zone, Bulgaria. The mineralogical and geochemical features of a vinciennite-bearing Cu–As–Sn (± Au) assemblage at Radka show very similar characteristics to those in other vinciennite-bearing high-sulfidation epithermal deposits worldwide. The assemblage consists of enargite, Cu-excess tennantite, chalcopyrite, gold, vinciennite, colusite, and minor covellite, within a gangue of barite, illite, and quartz. A detailed electronmicroprobe study of vinciennite and associated minerals reveals the heterovalency of Cu and Fe. New data on the composition of vinciennite sheds light on aspects of its crystal chemistry, such as incorporation of Cu^{2+} and Fe^{3+} and Sn^{4+} Ge^{4+} substitution,and leads us to propose a new empirical formula: $Cu^{+}8Cu^{2+}2Fe^{3+}3(Fe,Cu)^{2+}(Sn,Ge)^{4+}(As,Sb)^{5+}S^{2-}{}_{16}$. Infrared microthermometry of enargite-hosted fluid inclusions provides constraints on the conditions of deposition of this unusual assemblage in the context of the evolution of the magma-related ore-forming system at Radka. The assemblage was formed by oxidized and slightly acid fluids, with a dominantly magmatic signature, high fugacity of sulfur and intermediate salinity (about 10 wt.% eq. NaCl) at a temperature of about 275°C. In view of the geology of the Radka deposit, its mineralogical and geochemical peculiarities, ore textures, type of hydrothermal alteration and the character of the fluids, we interpret the deposit as a deep part of a high-sulfidation epithermal mineralization, possibly genetically related to a porphyry copper system.

12. **Bogdanov, K.,** Ciobanu,C.,Cook, N. 2004. Porphyry-epithermal Bi-Te-Se assemblages as a guide for gold ore enrichment. *In: Au-Ag-telluride deposits of the of the Golden Quadritrilateral, Apuseni Mt., Romania. Intern. Field Workshop of IGCP project 486, Alba Iulia, Romania, Ext. Abs.*, 211-214.

Abstract. The Bi-Se-Te mineral associations commonly occur with Au-minerals, lending the assemblages significance as a tracer of fO_2/fS_2 buffered reactions and a guide to Au-enriched parts of the ore. Bi-Te-Se signature as mineralogical tracer for gold ore enrichment. have also been recognized in a range of deposits from shield (e. g., Fennoscandian, Ukrainian , African) and orogenic (Iberian, Carpatho-Balkan) areas despite deposit type (Skarn, Porphyry, Mesothermal, Epithermal, VMS) and age (from Archean to Neogene). Bi-Se-Te signature with pronounced Au enrichment is a characteristic feature for porphyry and epithermal environment in the ABCD belt. The Bi dominant trace mineralogy is characteristic for this belt and reflects, in particular in the southern part of the Panagyurishte ore district the, IS to HS type of epithermal environment, suggesting shared magma sources and convergence of the processes in the porphyry-epithermal systems. Tetradymite (Bi_2Te_2S) tellurobismutite (Bi_2Te_3) and hessite (Ag_2Te) are most common trace minerals spatially and paragenetically associated with gold in skarn, porphyry and epithermal deposits across the Upper Cretaceous orogenic belt. The presence of gold with native Bi and maldonite Bi_2Au in the early bornite-chalcopyrite rich assemblages results from high-temperature conditions combined with more reduced and low fS_2 environment in both porphyry and epithermal systems. Widespread development of the ore remobilization processes across wide range of porphyry to epithermal deposits facilitate formation of a specific range of Bi, Se, Te, minerals.

13. **Bogdanov, K.,** Popov, K. 2003. Cu-Au Epithermal Systems in the Southern Part of the Panaguyrishte Ore Region, Bulgaria. *In: Cretaceous Porphyry-epithermal systems of the Srednogorie zone, Bulgaria. Society of Economic Geologists Guidebook Series, (Ed: K. Bogdanov and S. Strashimirov).* **36**, 91-114.

Резюме. В работата е направен обзор на медно-златоносните рудни системи в южната част на Панагюрския руден район и е предложен обобщен модел за развитието на епитермалните хидротермални системи в находищата от района. Разгледани са последователно находищата Елшица, Радка и Красен, като за всяко от тях са приведени данни за геоложкия строеж на района на находището, характерните вместващи скали и хидротермални промени, минералните парагенези, както и последователността в тяхното развитие. Освен публикувани към момента данни, в работата са отразени и редица нови резултати, касаещи предимно минералния състав на рудните асоциации в отделните находища, както и вариациите и преходите от високо-сулфиден към умереносулфиден тип на рудите при развитие на конкретните епитермалните системи. Въз основа на данните, отразени в работата, е направена реконструкция на еволюцията на епитермалните системи от южната част на Панагюрския руден район. Подчертана е тясната асоциация на епитермалните и медно-порфирните находища в района с конкретни вулкано-плутонични центрове, с близки характеристики по отношение на изотопния състав на сярата и оловото, минералните асоциации и измененията в температурата и солеността на разтворите в процеса на развитие на порфирно-епитермалните системи. В заключение на работата е подчертан полицикличният характер на рудообразувателните процеси и процесите на ремобилизация на рудите довели до обогатяване с Au и Ag, както и с Ge-, Ga-, Bi-, Se-, Te-, In-, Sn-, V- и W-съдържащи минерали характеризиращи развитието на епитремалните медно-златоносни системи от южната част на Панагюрския руден район.

14. **Богданов, К.** 2003. Минерални асоциации на злато в Банат-Средногорска металогенна зона. *IV Нац. Симпоз. Металогения на, Сб. Резюмирани доклади, 7-9 Май, 2003, София,* 27-32.

Абстракт. За рудните находища в Банат-Средногорската металогенна зона са характерни асоциации на злато в борнит, халкопирит, пирит, галенит и сфалерит с: 1) Бисмутови минерали; 2) Телуриди и селениди; 3) ПГМ; 4)Минерали на Ga, Ge, In, Co, Ni и Sn. Богатите на борнит руди в медно-порфирните, скарновите и епитермалните находища на Банат-Средногорската металогенна зона са важен носител на Au и Ag (PGE), а често и на Se, Te, In, Ge, In,Co и PGE. Асоциацията на Au с минерали на Bi е характерна за различни генетични типове находища, но е най отчетливо проявена в находища, при които се наблюдава директна връзка между вместващата интрузия и рудната минерализация (скарнови, порфирни, жилни находища - Байта Бихор, Окна де Фер, Медет, Асарел, Елаците, Върли Бряг), както и при по дълбок ерозионен срез на хидротермалните системи (Елшица). Специфичните минерални асоциации на златото са отражение на унитарния характер на коровата контаминация, магматичната и металогенната еволюция и са индикатор за източниците на минералообразуващите флуиди и механизмите на транспорт и отлагане благородните метали.

15. Tarkian, M., Hünken, U., Tokmakchieva, M., **Bogdanov, K.** 2003. Precious-metal distribution and fluid-inclusion petrography of the Elatsite porphyry copper deposit, Bulgaria. *Miner. Deposita*. **38**, 261-281.

Abstract. The Elatsite porphyry copper deposit occurs in an island-arc setting hosted by Late Cretaceous monzonitic-monzodioritic porphyry stocks which were emplaced into Precambrian-Cambrian phyllites. Trace element data of the Late Cretaceous intrusive rocks suggest that they are I-type volcanic arc granitoids. Two main ore mineral assemblages are distinguished:
(1) magnetite–bornite–chalcopyrite, and (2) chalcopyrite–pyrite. The first one is linked to potassic-propylitic, and the second to phyllic-argillic alteration. Minor ore minerals are hematite, molybdenite, sphalerite, pyrrhotite, marcasite, hessite, and solid solutions of linnaeite–siegenite–carrollite, tetrahedrite–tennantite, clausthalite–galena, gold–electrum and merenskyite–moncheite. Precious-metal contents are relatively high throughout the deposit but Au, Pd and Pt are concentrated more strongly in the magnetite–bornite–chalcopyrite assemblage. Average grades of Au, Ag, Pd and Pt calculated for the 0.33% Cu ore body are 0.96, 0.19, 0.007 and 0.002 g/t respectively. Analyses of flotation concentrates revealed 25.6% Cu,and Ag, Au, Pd and Pt contents of 33.0, 13.6, 0.72 and 0.15 g/t respectively. The copper mineralisation at Elatsite took place at pressures of 120 to 300 bar, corresponding to depths of formation of 1 to 3 km under hydrostatic conditions. The precious metals were probably transported jointly as chloride complexes in highly saline magmatic-hydrothermal solutions.The fluids had temperatures of 340 to >700 ^{0}C and salinities of 28 to 64% NaCl, and mixed with meteoric water.

16. .Ciobanu, C., Cook, N., **Bogdanov, K.**, Kiss, O., and Vucovic, B., 2003, Gold enrichment in deposits of the Banatitic Magmatic and Metallogenic Belt, southeastern Europe. *7th Biennial SGA meeting "Mineral Exploration and Sustainable Development" August 24–28, Athens, Greece, Abs. Vol., Eliopoulos et al. (eds)*,1153 – 1156.

Abstract. Recent ideas on mechanisms of Au-enrichment in ores concern the role played by Cu-Fe sulphides or Fe-Ti oxides as Au-carriers in magmatic hydrothermal systems . In this paper we consider such mechanisms for Au-enrichment in ores from the Late Cretaceous Banatitic Magmatic and Metallogenetic Belt (BMMB).Investigation of ores from Late Cretaceous deposits in southeastern Europe allows two mechanisms of gold enrichment to be recognized. Firstly, high-temperature bornite

ss is a gold-carrier when saturation temperatures meet formation conditions, as in the case of proximal skarn and porphyry bornite. Secondly, retrograde stages activate Bi as a scavenger for gold, seen in abundant Au-Bi-Te assemblages. We thus emphasize that Bi-tellurides and bornite can be used as a 'guide' to Au-enrichment in certain ore fields. Bearing in mind that 10 of 60 deposits and prospects in the belt are currently under mining, the kind of arguments presented may be applicable to mineral assessment and prospecting activities in the belt.

17. Strashimirov, S., **Bogdanov, K.**, Popov, K., Kehayov, R. 2003. Porphyry systems of the Panagyurishte ore region. *In: Cretaceous Porphyry-epithermal Systems of the Srednogorie Zone, Bulgaria. Guidebook Series of the Society of Economic Geologists, Inc. (Ed: K. Bogdanov and S. Strashimirov)*,**36**, 74 – 117.

Резюме. В работата са обобщени данните за медно-порфирните рудноносни системи в находищата от Панагюрския руден район и е предложен модел за развитието на медно-порфирните хидротермални системи в находищата от района. Разгледани са поотделно находища Елаците, Медет, Асарел, Цар Асен и Влайков връх, като за всяко от тези находища са приведени данни за геоложкия строеж на района на находището, характерните вместващи скали и техните хидротермални промени, минералните асоциации и парагенези, както и последователноста в тяхното развитие във времето и пространството. Наред с известните публикувани към момента данни, в работата са отразени и редица нови резултати, касаещи предимно минералния състав на рудните асоциации в отделните находища, както и температурния режим на развитие на порфирните системи. Базирайки се на данните, отразени в работата, е направена реконструкция на еволюцията на рудообразувателните флуиди в порфирните системи от Панагюрския руден район. Като базови находища са избрани Елаците, Асарел и Медет, които са и най-големите медно-порфирни находища в района, като за тях е направено сравнение по отношение на характеристиката на изследваните флуидни включения в типови минерални асоциации и измененията в температурата и солеността на разтворите в процеса на развитие на порфирните системи. В заключение на работата е направено обобщение на приведените данни, като са изведени главните особености, характеризиращи развитието на рудообразувателните системи в медно-порфирните находища от Панагюрския руден район.

18. Peytcheva, I., von Quadt, A., Kouzmanov, K., **Bogdanov, K.** 2003. Elshitsa and Vlaykov Vruh epithermal and porphyry Cu (-Au) deposits of Central Srednogorie, Bulgaria: source and timing of magmatism and mineralisation. *7th Biennial SGA meeting "Mineral Exploration and Sustainable Development" August 24–28, Athens, Greece, Abs. Vol., Eliopoulos et al. (eds)*, 371 – 373.

Abstract. Host rocks of the Elshitsa epithermal and Vlaykov Vruh porphyry copper deposits and hydrothermal rutiles from the porphyry-style mineralisation are investigated, using U-Pb, Lu-Hf and Rb-Sr isotope methods. Zircons of the Elshitsa granite representing the plutonic part of the magmatic system reveal an intrusion age of 86.62 ± 0.02 Ma. For the Elshitsa subvolcanic dacites an age of 86.11 ± 0.23 Ma was obtained.The Ɛ-Hf values of the concordant zircons range from +6.05 to +8.74 and give evidence for mixed crustalmantle origin of the ore-bearing magma. They are in agreement with the initial strontium characteristics, changing in all studied acid rocks in a narrow range between 0.70514 and 0.70583. Similar Sr and Hf-zircon isotope characteristics, additional to the close ages argue for a common magma chamber of all acid rock varieties in the Elshitsa and Vlaykov Vruh deposits. The mean $^{206}Pb/^{238}U$ age of high-temperature hydrothermal rutiles from Vlaykov Vruh is 85.65 ± 0.15 Ma. This age reflects probably the onset of the hydrothermal mineralisation. Low temperature anatase from epithermal ore bodies in Elshitsa was not suitable for U-Pb analyses because of the low uranium and radiogenic lead content.

19. Melfos V, Vavelidis, M., **Bogdanov K**. 2003. Occurrence, mineralogy and chemical composition of primary gold from Tertiary ore mineralizations in the Rhodope massif (Greece-Bulgaria). *7th Biennial SGA meeting "Mineral Exploration and Sustainable Development" August 24–28, Athens, Greece, Abs. Vol., Eliopoulos et al. (eds)*, 1201 – 1204.

Abstract. The present work summarises the mode of occurrence of primary gold in the Tertiary gold deposits from the Rhodope massif extending between Greece and Bulgaria. The mineralogical features and the chemical composition are discussed and compared. Numerous gold deposits were formed during the Tertiary magmatism in the area including: high- and low-sulphidation polymetallic epithermal deposits (Perama Hill, Pefka, Sapes, Madjarovo, Chala, Lozen), hydrothermal veins (Kamilski Dol) and skarn deposits (Xanthi). The Ag content in the high-sulphidation epithermal deposits is very low (average 0.69 to 1.50 wt%), while the low-sulphidation epithermal mineralisations contain gold with intermediate to high Ag content (average 6.04-30.79 wt%). The hydrothermal vein-type mineralisation is characterised by gold grains with intermediate Ag content (5.05 and 13.18 wt%). High Ag content (22.40 and 24.80 wt%) is concentrated in the gold from the skarn deposit, which is characterised by the presence of PGE, mainly Ir.

20. Kehayov,R., **Bogdanov,K.,** Fanger L, Quadt A., Pettke T, Heinrich C.2003. The Fluid chemical evolution of the Elatsite porphyry Cu-Au-PGE Deposit, Bulgaria. *7th Biennial SGA meeting "Mineral Exploration and Sustainable Development" August 24–28, Athens, Greece, Abs. Vol., Eliopoulos et al. (eds)*,1173 – 1176.

Abstract. The Panagyurishte ore district hosts late Cretaceous porphyry-type ore deposits, among which the Cu-Au-PGE monzodioritic to granodioritic intrusion-related deposit Elatsite is the most prominent one. Four successive mineral stages can be distinguished. During the first Mt-Bn-Cp stage, characterized by high concentrations of Au and PGE and significant Cu, the minerals crystallized from high-salinity aqueous fluids with 60 – 42 wt.% NaCl equiv. The next three, Q-Cp-Py , Q-Py and Q-Gn-Sp, stages are precipitated from progressively cooler and less saline fluids (44 – 20 wt.% NaClequiv.). LA-ICPMS fluid chemical data demonstrate that the pre-ore fluid of the Mt-Bn-Cp stage contained up to 4 wt.% Cu and elevated other base metal contents.Work is in progress to characterize the chemical evolution of the fluid through the depositional sequence of the mineralization in order to confine chemical processes responsible for the formation of the deposit.

21. Kouzmanov K, Ramboz C, Lerouge C, Deloule E, Beaufort D, **Bogdanov K.** 2003. Stable isotopic constrains on the origin of epithermal Cu-S (±Au, Ag) and related porphyry copper mineralisations in the southern Panagyurishte district, Srednogorie zone, Bulgaria. *7th Biennial SGA meeting "Mineral Exploration and Sustainable Development" August 24–28, Athens, Greece, Abs. Vol., Eliopoulos et al. (eds)*, 1181 – 1184.

Abstract. The Panagyurishte district is characterised by a high abundance of copper and copper-gold deposits, related to an Upper Cretaceous magmatic activity in the central part of the Srednogorie metallogenic zone in Bulgaria. Quartz, hydroxyl-bearing alteration minerals, and some oxide minerals from the Elshitsa Au-Cu epithermal deposit and the Vlaykov Vruh porphyry-Cu deposit, from the southern part of the district, were analysed for their oxygen and hydrogen isotopic compositions to establish the source of paleohydrothermal waters. The isotopic geothermometers record temperatures of ore deposition in the range 500-635 °C during ore stages I and II at Vlaykov Vruh. The $\delta^{34}S$ values of sulphides and sulphates from both, the epithermal and the porphyry copper deposits indicate a magmatic origin of the sulphur and progressive oxidation of the mineralising fluids.

22. Кольковски,Б., **Богданов,К**., Бородаев,Ю., Найденова,Е., Ескенази,Г.2002. Бимутова минерализация в находище Върли бряг, Бургаски руден район. *Год. СУ, ГГФ,Геол,*1,**95**,103-131.

Abstract. New data on the mineral assemblages, mineral and chemical composition of the Bi sulphide and sulphosalt minerals from the Vurli Bryag vein-copper deposits in Bulgaria were presented in this study, based on 82 electron microprobe analyses. Tetradymite, pecoite, krupkaite, fridrichite, junoite, beriite, matildite and the phases $Cu_3Pb_3Bi_5S_{12}$ and Cu_8 $Bi_{10}S_{19}$ are new foundings for the deposit in addition to the re-examined emplektite, wittichenite, aikinite, bismuthinite and the phase $CuPbBi_7S_{12}$.The observed succession of the Bi → Cu-Bi → Cu-Pb-Bi → Ag-Bi minerals deposition could be explained with the decreasing temperatures of formation from 340-310 in the earlier to 280-230 ^oC in the later mineral assemblages.

23. Cook N, Ciobanu C, **Bogdanov K**, Kiss O, Vucovic B. 2002. Gold and other precious metals in deposits of the Upper Cretaceous Banatitic Magmatic and Metallogenic Belt, S.E. Europe. *In: Geology and metallogeny of copper and gold deposits in the Bor metallogenic zone. Symp. 100 Years Bor.24-25Oct., 2002, Bor Lake*,149-156.

Abstract. We briefly review the occurrence, localization and speciation of gold (as well as silver and PGE) in the broad range of ore deposits within the Upper Cretaceous Banatitic Magmatic and Metallogenic Belt, stressing the gold-enriched character of almost all deposits. It is important to stress that the gold-rich character of the belt goes beyond the large porphyry-copper and epithermal deposits in Serbia and Bulgaria, and is in fact found in considerable quantities within deposits elsewhere in the belt: the vein deposits of Eastern Bulgaria (e.g. Bakadjik, Rossen), and also including those, such as the Fe-Cu-Zn-Pb scarn at Ocna de Fier-Dognecea (Romania), where it's widespread presence probably went largely overlooked during the exploration. A range of Ag-bearing Bi-sulphosalts are locally abundant across the belt particularly in the Romanian skarn deposits and also in the vein skarn deposits of Yambol, Burgas and Malko Turnovo districts in Bulgaria. Despite the relatively low gold grade of most deposits, the gold enriched character of the entire belt makes it an attractive target for exploration. We believe there exist considerable potential for the discovery of gold deposits in non-traditional environments throughout the belt (i.e. not only porphyry and epithermal environments).

24. Cook N, Ciobanu C, **Bogdanov K**. 2002. Trace mineralogy of the Upper Cretaceous Banatitic magmatic and metallogenic belt, SE Europe. *11^{th} IAGOD Symp.and Geocongress, Windhoek, Namibia, 22-26 July 2002. CD vol of ext. abs. Geol. Surv. Namibia.*

Abstract. Minerals containing Au, Ag, Se, Te, Co, Ni, Cd, In, Ge, PGE, and in particular, Bi, are characteristic trace constituents of skarn, porphyry, vein and epithermal deposits in Romanian and Bulgarian segments of the Upper Cretaceous Banatitic Magmatic and Metallogenetic Belt. Many of the ~50 deposits in the belt are known for diverse or spectacular mineralogy and occurrence of rare species. The belt has yielded 11 type minerals. Differing sulphidation/ oxidation parameters in environments across the belt, result in a full range of Bi/Te(+S,Se) ratios in prevailing Bi-tellurides/tellurosulphides. Fundamental differences between different parts of the belt are due, to varying sulphidation and oxidation states, local Te/Se availability, and local environment (host rocks, structural controls). The uniquely diverse Bi-dominant trace mineralogy is characteristic for BMMB, especially to separate it from the Tertiary Drina-Rhodope and Lece-Chaldidiki Arcs.This geochemical affinity suggests a common, or similar, source of mineralising fluids.

25. **Bogdanov,K**.,Fillipov,A.2001.Mineral chemistry and thermodynamics of tetrahedrite-tennantite mineral series from Eastern Rhodopes, Bulgaria. *Ann Sof.Univ.,1*, **91**, 109-116.

Abstarct. Mineralogical and thermodynamic studies on tetrahedrite-tennantite (TD-TN) mineral series in the base-metal deposits Madjarovo, Lozen, Sv. Marina, Zvezdel-Pcheloyad and Spahievo have been carried out. The importance TD-TN mineral series as physic-chemical indicators for gold and silver-bearing mineral assemblages formation has been discussed. Tetrahedrite-tennantite mineral assemblages with sphalerite, chalcopyrite and galena are most commonly observed in some ore fields (Spahievo, Lozen, Sv. Marina) as well as with Bi, Sb, Pb,and Ag sulphosalts in others (Madjarovo, Zvezdel-Pcheloyad). A widespread predominance of Zn replaced tetrahedrite with Zn:Fe ratio from 2:1 to 10:2 and constant presence of Fe and Ag has been displayed in the TD-TN series form the Eastern Rhodopes. Our study based on electrum and TD-TN composition in the studied deposits indicate that in the most of them the Ag-bearing mineral assemblages have been deposited at the range of $lgfO_2$ from -37 to -39, $lgfS_2$ from -6 to -15, and pH 6-8. The earlier TD-TN and gold-bearing assemblages with Au fineness over 850%o have been deposited at values of $lgfS_2$ -6 -8 and temperatures below 280°C, while the Sb and Ag-poor tennantite crystallized at values of $lgfS_2$ below -15. As a result of extracting from TD-TN the Ag has been deposited as electrum with fineness around 700%o in the late low temperature (230-150°C) Au-Ag assemblages.

26. **Bogdanov,K.,** Vavelidis,M.2000. Bismuth minerals from ore deposits in Bulgaria and Greece. *Ann Sof.Univ.*,**92,** 75-84.

Abstract. This paper reports the comparative studies of Bi sulphide and sulphosalt minerals from different genetical type (massive sulphide, porphyry-copper, vein-copper, base-metal, etc.) of mineral deposits in Bulgaria and Greece with focus on the mineral chemistry. The minerals of the aikinite-bismuthinite series are most commonly observed in the studied deposits. The highest Ag, Se and Fe contents have been recorded in the Bi sulphosalts from Madjarovo deposit, Bulgaria. In the studied Bi minerals from Greece the Ag content is not high, but more constant and commonly present. The different genetical types of mineral deposits are distinguished by Bi minerals with diverse Ag, Se and Fe contents. The minerals of the aikinite-bismuthinite series are most commonly observed in the deposits of the studied area. The aikinite was presented in more than 54% ,while the bismutinite covers 15% , emplectite 13% and cosalite 9% of the examined Bi minerals.

27. Tsonev, D., **Bogdanov, K**. 2000. Gold fineness in the massive sulphide deposits from Sredna Gora zone, Bulgaria. *Ann Sof.Univ*., **92**, 1, 61-74.

Abstract. Gold fineness, morphology and grain size of the sulphide and sulphate mineral assemblages from the Upper Cretaceous volcanic –hosted massive sulphide deposits Radka, Elshitsa, Krassen and Chelopech have been examined by means of microprobe. The gold fineness most commonly is at the range from 764 to 998%o. The average gold fineness based on 120 microprobe analyses is as follows: Krassen-966%o; Elshitsa-940%o; Radka-930%o and Chelopech-925%o. In the copper-rich mineral assemblages with chalcopyrite, bornite, enargite, chalcocite and tennantite the macroscopic gold is much more abundant and the total gold fineness increases as compared to the earlier chalcopyrite-pyrite and the latter galena-sphalerite-chalcopyrite mineral assemblages. In the late (anhydrite-gypsum) mineral assemblage the average gold fineness increases and reaches maximum values of 997%o for Krassen and 976%o for Radka, while in Elshitsa and Chelopech the average fineness values are similar, or decreasing as compared to the

earlier mineral assemblages. The native silver veinlets in bornite that as a rule do not exceed 0,5mm are also found. In the massive pyrite ore bodies gold is not so frequent and is submicroscopic in size and this explains why in the early gold mineralization in the high gold grade pyrite ores with 8-10 g/t Au has poor recovery. All the studied deposits are important not only as a source for Au and Ag, but also as a significant Ga, Ge, In, Se and Te carriers.

28. Dekov, V.M., Damyanov, Z.K., Kamenov,G.D., Bonev,I.K.,**Bogdanov, K.B**. 1999. Native coper and α-copper-zinc in sediments from the TAG hydrothermal field (Mid-Atlantic Ridge, 26°N): nature and origin. *Marine Geol.***,161**, 229-245.

Abstract. Native copper and a-copper–zinc occur as strands and elongated grains _up to 300 mm in length. within the sediments from the Trans-Atlantic Geotraverse (TAG) hydrothermal field Mid-Atlantic Ridge, 26°N). They are remarkably similar in composition and crystal structure to copper and copper–zinc occurrences found in other natural environments. The results of mineralogical studies are discussed in terms of the possible mechanisms of native metal formation in the complex TAG field: with an asymmetric and highly-fractured rift valley, and mature active and relict sulfide mounds. Native copper and a-copper–zinc grains disseminated in the TAG sediments are either inherited from: (1) primary magmatic or metamorphic crustal source; (2) hydrothermal deposits; and (3) the alteration of primary deposits, or formed (1) authigenically, or (2) biogenically withinron the sediment cover. Native metallic particles could have been formed as accessory minerals disseminated in the ridge crest basic rocks andror massive sulfide mounds. Degradation of these rocks and mass wasting of the mounds have liberated the metallic grains which have, in turn, been deposited into adjacent sediments.

29. **Bogdanov, K.,** Tsonev,D. Kuzmanov, K. 1997. Mineralogy of gold in Elshitsa massive sulphide deposit, Sredna Gora zone, Bulgaria. *Mineral. Depos*. **32**, 219-229.

Abstract. The Elshitsa volcanic hosted massive sulphide deposit occurs in the central part of the Srena Gora metallogenic zone in Bulgaria. The gold-bearing massive sulphide mineralization is considered to be the product of an island arc volcano-plutonic process and hydrothermal activity that took place during the Late Cretaceous. In addition to the major gold-hosted opaque minerals such as pyrite, chalcopyrite, sphalerite and galena there are minor phases of tennantite, goldfieldite, Se-bearing aikinite, native silver and bornite in the massive sulphide lenses and stringer zones. Most of the sulphide minerals are Se-bearing. All of the six mineral assemblages that were deposited during the pyrite and copper-pyrite stages of mineralization are gold-bearing. The gold tenor as a rule is less than 1 g/t. Native gold and electrum occur as blebs or intergranular particles in the sulphide minerals. Gold in the early massive pyrite is of submicroscopic type (< 0,1 μm) and of colloidal origin. Pyrite deformation and recrystallization in the temperature range 250°-160 °C has led to Au and Ag migration to cracks and grain boundaries of the sulphide minerals. As a result of these process the native gold and electrum grain size increases from submicroscopic (< 0,1 μm) in the early colloform pyrite to microscopic (0,1-100 μm) and macroscopic (> 100 μm) in the late gold-sulphide assemblages. The electrum fineness in 41 individually studied grains varies between 780 and 992‰ with a mean of 895‰. Native silver was found in association with bornite. Cu, Te, Sb and Bi are the most common trace-elements in gold and electrum. The Cu-Zn-Pb association is most important as a Au-Ag-carrier. A model for gold behaviour during sulphide deformation is proposed involving coarsening of gold grain size from the earlier to the later sulphide mineral assemblages.

30. **Bogdanov, K.**1997. Epithermal gold mineralization from Chala deposit, Eastern Rhodopes, Bulgaria. *In: 50 years Geology. Sofia Univ. Press*,51-56.

Abstract. Chala deposit is situated in the northern part of the Spahievo ore field in the Eastern Rhodopes, Bulgaria. The gold-quartz mineralization is characteristic for the latite-hosted quartz-sericite breccia vein zone № 8 of Chala deposit where the gold grade is about 4-10g/t, and over 20g/t in some samples. Two types of gold assemblages: 1)Gold-quartz and 2) Gold-quartz-hematite assemblage have been observed. Most of the 103 measured gold grains (92%) in both assemblages could be attachedto microscopic in size (0,1-100 μm) gold. The grain size for more than 50% of them is from 11 to 40 μm. The gold fineness ranges between 719-947‰ with Fe (0,4-1,4wt%), Cu (0,13-0,87 wt%) and Te (0,67-1,53 wt%) as most commonly found constituents. The rcent fluid inclusion study indicate temperature range 240-180^{o}C and 2,2-8,7%NaCL eqw. for the the fluids deposited the low-sulphidatin gold mineralization in Chala.

31. **Богданов,К.,** Кузманов,К.1996. Минерални парагенези и генезис на златото и среброто в находище Елшица, Панагюрски руден район. *Год. СУ,ГГФ*,1,**89**, 121-151.

Абстракт. Поведението на злато-сребърната минерализация в находище Елшица е изследвано по отношение на минералните парагенези, ,морфологията, размера и разпределението на минералните зърна, минералният и химичен състав и генетичните условия на образуване.Всички шест минерални парагенези: пирит-кварцова, халкопирит-пиритова, борнит-тенантитова, медно-полиметална, и кварц-пиритова са злато-съдържащи. Размера на зърната на златоато нараства от субмикроскопичен (<0,1μm) от ранната пиритова парагенеза до микроскопичен (0,1-100 μm) и макроскопичен (>100 μm) в късните сулфидни парагенези. Преобладава микроскопичното злато с размери 1-12 μm. Пробността на електрума варира от 780 до 990‰ . Медно-полиметалната парагенеза може да се определи като важен носител на Au и Ag в находище Елшица.

32. **Богданов, К**., Младенова,В., Цонев,Д., Филипов,А.1995. Еволюция на ендогенните минерални парагенези на златото (на примера на някои фанерозойски находища в България). *Нац. симпоз. Металогения на България,23-24 ноември,1995.С. Сб. Рез.,7-10.*

Абстракт. Отделени са типоморфни злато-пиритна, злато-полиметална и злато-кварц-карбонатна парагенези на златото характерни за редица фанерозойски находища в България.Определянето на асоциациите на злато - изцяло включено в даден минерал, в междузърновото пространство, на границата между два и повече минерала или в микропукнатини има пряко значение при извличане на златото. Накратко са характеризирани важните аспекти при изследване на златото: морфологията и размерите наа златото, минералния и химичен състав и процесите на деформация и прекристализация в късните парагенези, водещи до миграция на златото в микропукнатини , уедряване на размера на зърната и повишаване на неговата пробност.

33. Vavelidis, M., Melfos,V., Slavounos, S., Bogdanov, K., Dreisner, Th. 1995. Bi-Te-Ag bearing Cu mineralization in the Panagia area, Thasos island (Northern Greece). *Third Biennial SGA Meeting, Prague,Czech Republic, Ext. Abs*., 21-23.

Абстракт. Bi-Te-Ag bearing Cu mineralization was found in Thasos Island, Northern Greece, hosted in quartz veins and segregations. Crosscutting the schistosity of the crystalline basement complex relationships of the quartz veins suggest epigenetic hydrothermal origin. The mineralization consists of chalcopyrite, pyrrhotite, framboidal pyrite, fahlore, gersdorfite, tetradymite and hessite. Ag contents up to 1230 ppm has been recorded in ore-bearing bodies. Fluid inclusions study indicate temperatures 360-320^{o}C during the formation of the Bi-Te-Ag-Cu bearing quartz veins.

Научна монография

Попов, П., Страшимиров Стр., Попов К., **Богданов К.,** Каназирски М., Радичев Р., Димовски С., Стойков С. 2012. **Геология и металогения на Панагюрския руден район**. *Изд. "Св. Иван Рилски", С.,* 227 с.

Резюме. В монографията е направена подробна характеристика и обобщение на материали за геоложкия строеж и металогенните особености на Панагюрския руден район, като са включени данни от самото начало на геоложкото изследване на района до наши дни. Голяма част от интерпретираните съвременни изследвания на района са резултат на авторския колектив на монографията. Разгледани са общата геоложка, геотектонска и металогенна характеристика на района, като е обърнато внимание на околорудните изменения и формационната принадлежност на метасоматитите. В отделна глава са интерпретирани основните елементи на гравитационното и геомагнитно поле и връзката им с геоложкия строеж на района. Поотделно са разгледани обособените рудни полета в района – Елашко-Челопешко, Асарел-Медетско, Красен-Петеловско, Радкинско и Елшишко рудни полета. За всяко едно от тях подробно е разгледан геоложкия строеж, металогенните особености, структурата на рудното поле, хидротермалните изменения на вместващите скали, проявените находища и по-големи рудопроявления с техния минералния състав, условията и последователноста в развитие на рудообразувателните процеси. За всяко рудно поле е проследена еволюцията в развитието на рудно-магматичната система. В заключение на работата са обобщени основните характеристики на района като елемент от Апусени-Банат-Тимок-Средногорския магматичен и металогенен пояс. Подчертана е определящата роля на находищата от медно-порфирен и епитермален злато-медносулфиден тип доминиращи в района, като е представена тяхната подялба на отделни групи с различаваща се типоморфна характеристика. С използване на данните от минералния състав на рудите и хидротермалните околорудни промени са отделени различни типове епитермални находища като високосулфидизирани, високо-умерено сулфидизирани (кисело-хлориден интензивно аргилизитов тип), умерено-сулфидизирани (березитов и серицитов тип), като са посочени и техните представители в района. Съвместното пространствено разположение на медно-порфирните и асоцииращите с тях злато-медносулфидни епитермални находища е една характерна особеност на района, насочваща към едишнен източник и определена последователност в развитие на рудообразувателните системи, доказателство за което се намира и в изотопните изследвания на флуидните системи в някои от находищата в района. Като характерна черта в металогенията на района е посочена миграцията на магмената активност от север на юг и появата на специфични минерални съобщества маркиращи възможното участие на коров материал и по-дълбочинно генериране на магмите в северната част на рудният район.

III.3. Учебни помагала

Геология и металогения на Панагюрския руден район. 2012. Попов, П., Страшимиров Стр., Попов К., **Богданов К.,** Каназирски М., Радичев Р., Димовски С., Стойков С. *Изд. "Св. Иван Рилски", С., 227 с.*

Монографията се използва като учебно помагало за задължителния курс по „Металогения", за магистри, специалност „Геохимия"