

MINERAL DEPOSITS RELATED TO TERTIARY MAGMATISM IN THE SOUTHERN PART OF THE BALKAN PENINSULA

Todor Serafimovski¹, Rade Jelenković², Goran Tasev¹, Pande Lazarov¹

¹*Faculty of Mining and Geology, Sts. Cyril and Methodius University,
Goce Delčev 89, MK-2000 Štip, Republic of Macedonia*

²*Faculty of Mining and Geology, Džusina 7, 11000 Belgrade, Serbia and Monte Negro*

Abstract: Neogene volcanism in the southern parts of the Balkan Peninsula is distributed in wide area, mainly in the terrains of the Vardar zone and Serbo-Macedonian massif. They are, mostly volcano-intrusive complexes, partly with emphasized extrusive-effusive character manifested in area of almost 1200 km² (Kratovo-Zletovo volcanic area, eastern Macedonia). From the geotectonic point of view they are part of Vardar zone and Serbo-Macedonian massif, often they are located at the contact parts between these two geotectonic units. With these volcano-intrusive magmatic complexes with Tertiary age, are connected numerous deposits and occurrences of Pb-Zn, Cu, Mo, Au, Ag, Sb±W, Sn etc.

Key words: Balkan Peninsula; Tertiary magmatism; polymetallic deposit

INTRODUCTION

Spatial distribution of Tertiary magmatism and polymetallic mineralizations in southern parts of the Balkan Peninsula generally has been connected with Neogene tectono-magmatic processes and geotectonic activities in post-collision period. Neogene magmatic complexes generally are grouped in four groups: part which belongs to the Inner Dinarides, part which belongs to the Vardar zone, contact area between Vardar zone and Serbo-Macedonian massif and Neogene volcanism which belongs to the Serbo-Macedonian massif (Fig. 1). With this magmatism are connected a lot of ore

deposits and occurrences of polymetallic character (Sb, Cu, Au, Ag, Pb, Zn etc.). On the connection between magmatism and metallogeny in southern parts of Balkan Peninsula have worked numerous researchers, but for this paper are most important: Karamata et al. 1994a, Karamata et al. 1994b, Janković and Serafimovski 1997, Janković et al. 1997, Serafimovski 1993, Serafimovski and Boev 1996, Serafimovski et al. 1997, Serafimovski et al. 1998, Stojanov et al. 1991, Boev et al. 1995, Boev and Yanev 2001 etc.

DISCUSSION

The Serbo-Macedonian part of the Balkan Peninsula is composed of several tectonic units (Dinarides, Vardar zone, Serbo-Macedonian Massif etc.) which evolution is in close connection with development of the Tethys ocean (the closure of Palaeo-Tethys, opening and evolution of Neo-Tethys, its margins and island arcs, convergence, closure, subduction of oceanic slabs, continent-continent collision, collision of lithospheric fragments, obduction and development of volcanic zones).

Tertiary metallogeny was highly influenced by tectonic processes, resulting in generation of specific

types of mineralization, associations of elements and minerals within specific tectonic settings. From both genetic and economic point of view, the most important are mineralizations related to post-collision setting formed after the closure of the Vardar ocean, and the collision of the African and the Eurasian plates, mainly during late Cretaceous-Eocene time. Magmatic complexes are large volcano-intrusive systems the petrochemical composition of which indicates the dominance of calc-alkaline and calc-alkaline rocks with high potassium contents and minor alkaline magmatic complexes.

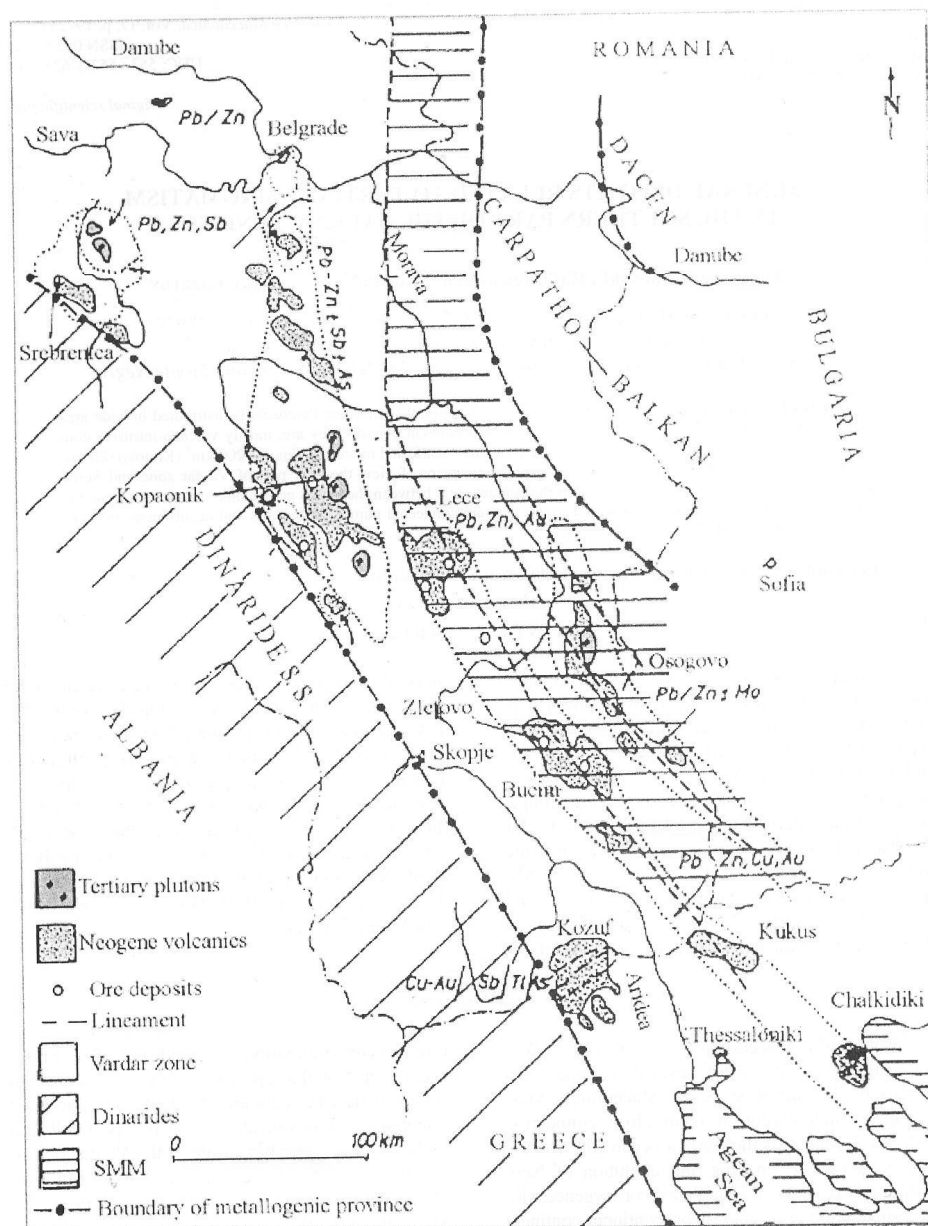


Fig. 1. Geotectonic distribution of the Tertiary magmatism and major polymetallic mineral deposits in the southern parts of the Balkan Peninsula

The absolute age of magmatic rocks, based on K/Ar method, ranges in the interval between 37.5 Ma and 14 Ma, but locally such as the Kozuf-Aridea complex is formed in the range 7.0–1.8 Ma (Table 1). The volcanic activity in some complexes took place within several phases, lasting continuously up to 5–10 Ma.

Table 1

Absolute ages (K/Ar) of selected volcanic rocks from the southern parts of Balkan Peninsula

Rock location	K %	Absolute age, Ma
Latite, andesite, dacite, Avala		25.1–23.5
Monzogranite, Kosmaj		30–29
Q-latite, Kosmaj		26–23.5
Granitoid, Zeljin	4.2–7.7	24–20
Granitoid, Polumir, Kopaonik	7.54	22
Granodiorite, Kopaonik	1.0–6.96	35.6–30.0
Granodiorite, Golija	3.54–7.44	18.02–17.3
Andesite, Lece	2.12	29.2
Andesite, Lece (Tulare)		23.0
Dacite, Lece (Tulare)	1.66	37.5±1.5
Q-latite, Zletovo	3.56	26.5±2.0
Andesite dyke, Zletovo		16.0±3.0
Trachyandesite, Bajlovci, Zletovo	3.20–4.15	32.26±2.5
Latite, Bučim	3.04	28.3–26.7
Andesite, Bučim	3.12	26.0
Rhyodacite, Gerakario	3.44	31.±2.5
Granodiorite, Stratonik Chalkidiki		29.6
Latite, Q-latite, Kožuf		7.0–1.8

The distribution pattern of Tertiary volcano-intrusive activity in the area of consideration is mainly controlled by the following structures:

- The dislocation zone developed along the western contact of the Vardar zone and the Dinarides.
- The Central lineament (or dislocation zone) of the Vardar zone can be traced from the Fruska Gora in the north, to the south of Pristina.
- The dislocations and magmatic complexes situated along an active continental margin formed along the contact between the Vardar zone and the SMM.

- Along the dislocation zone running from Rupilje in the NW to the Struma region in the southeast, over Besna Kobilica and Osogovo at intervals several volcano – intrusive magmatic complexes.
- An almost E-W striking dislocation zone developed along the southern margin of the Pannian basin (south of the River Sava) controls distribution of several granitoid complexes.
- Ring-radial structures associate with up-doming and volcano-sedimentary complexes of several types.

Major genetical types of mineral deposits include:

Endogene deposits:

- Deposits related to granitoid complexes (plutonic intrusions) and pegmatite bodies:
 - (i) Pegmatite /Sn, W, Nb-Ta/, (ii) Graissen /veinlets and stockwork-dissemination Sn, W, Nb-Ta/, (iii) Skarn (lenses, irregular ore bodies, etc.) Fe, Bi, W, Sn, Cu, Mo, Pb-Zn a.a., (iv) Hydrothermal vein and replacement type /Pb-Zn, Sb, F, U a.a./.
- Deposits related to subvolcanic intrusions, volcanic rocks and mineralizations related to volcanic structures: (i) Hydrothermal veins in volcanics accompanied by impregnations of Pb-Zn, U, Sb, Au, (ii) Skarn and replacement type of deposits /Pb-Zn, U, Bi, Ag, Fe, Mn, Ag/, (iii) Impregnation in "hydroquartzite" along contact with serpentinite /Pb-Zn, Sb, As, Ti/, (iv) Porphyry copper /Cu/, (v) Hydrothermal stockwork disseminated mineralization /Pb-Zn, Cu, Mo, Au, Ag, Hg, a.a./.
- Low temperature hydrothermal deposits located far away from magmatic complexes: (i) Vein and stockwork disseminated types of deposits /Sb/.
- Hydrothermal-sedimentary deposits of boron deposits.

Exogene deposits:

- Alluvial deposits /Sn, Nb-Ta, Au/.
- Infiltration type of deposits /U/.

The objective of paper is to provide an overview of the principal metallogenic districts of the Serbo-Macedonian metallogenic province and most important groups of deposits at consideration area.

Detailed of all of this different kinds of deposits are shown in the Table 2, which follows.

Table 2

The isotopic age and $^{87}\text{Sr}/^{86}\text{Sr}$ ratio for the Tertiary magmatic rocks from the Vardar Zone Compressional area

	Lokality	Type of rock	Age in m. y	$^{87}\text{Sr}/^{86}\text{Sr}$
I	Boranj	Granodiorite	32.5–30	0.70815–0.70864
	Golija	Granodiorite	18.02–17.3	–
	Zeljin	Granitoide	24.20	–
	Rogozna	Andezite, dacite	33–27.2	0.7077–0.7066
II	Avala	Latite, andezite, dacite	25.1–23.5	–
	Bukulja	Granitoide	19–15	0.708
	Brajkovac	Granitoide	30	0.7066
	Cer	Quartz monzonite	30–22	0.708078–0.708238
	Straznica (Cer)	Leucocratic granite	18–15	0.7212–0.7213
	Kopaonik	Granodiorite	35.6–30.0	–
	Kozuf	Latite,	1.8±0.1	–
	Kozuf	Latite,	5.0±0.2	0.708546
	Kozuf	Q-latite	6.5±0.2	0.709019
	Kozuf	Andezite	4.8±0.2	–
	Lece	Andezite	29.2	–
	Tulare	Andezite	23.0	–
	Bajlovci	Trachuandezite	32.26	–
	Zletovo	Q-latite	26.5±2.0	0.706318
III	Zletovo	Latite	24.7±0.4	–
	Bucim	Andezite, latite	26–24	0.706928
	Borov Dol	Andezite	29	0.706633
	Damjan	Andezite	28.6	0.706633
	Gerakaria	Ryodacite	31.5	–
	Stratoni (Chakidiki)	Granodiorite	29.6	–
	Skouries	Poppyritic syenite	19	0.7080
	Toranica	Andesite	25–14	0.709785
IV	Sasa	Andesite, latite	14.0±3.0	0.710641
	Sasa	Q-latite	24.0±3.0	0.710244

From the Table 2, can be seen that major types of mineral deposits are connected with granitoid-plutonic intrusion complexes and Neogene

sub-volcanic intrusions. To the second group are connected Cu and Pb-Zn deposits formed during different stages of hydrothermal cycle.

CONCLUSIONS

As result of intensive post-collision tectono-magmatic activities in southern parts of the Balkan Peninsula were formed numerous and different volcanic and volcano-intrusive complexes connected with numerous polymetallic ore deposits and occurrences. In the southwestern part of the area of the consideration of special interest are the magmatism and mineralization in the area of Boranja, and then follows magmatic complexes and miner-

alizations of Kopaonik, Rogozna and Golija with Pb, Zn, As, Sb, W mineralizations. In the contact parts of the Vardar zone and Serbo-Macedonian Masiff are dominating volcanic complexes such as Lece, Zletovo and Eastern Chalkidiki with numerous Pb, Zn and Cu deposits. In the eastern parts of the area of consideration are dominating Neogene volcanites and Pb-Zn deposits in frame of the Oso-govo-Besna Kobila zone.

REFERENCES

- Boev, B., Stojanov, R., Serafimovski, T., 1995: Tertiary magmatism in the southwestern parts of the Carpatho-Balkanides with a particular reference on magmatism in the area of the Republic of Macedonia. *International Workshop, UNESCO-IGCP Project 356*, Štip.
- Boev, B., and Yanev, Y., 2001: Tertiary magmatism within the Republic of Macedonia: a review. *Acta Vulcanologica*, Vol. 13 (1-2) 57-71.
- Cvetković, V., Prelević, D., Downes, H., Jovanović, M., Vaselli, O., Pécskay, Z., 2002: Origin and geodynamic significance of Tertiary post-collisional basaltic magmatism in Serbia (central Balkan Peninsula). *Acta Vulcanologica* (in print).
- Janković, S., Serafimovski, T., 1997: Alpine metallogeny of SE Europe: regional geo-tectonic setting and major ore deposits. *Annual General Meeting of IGCP 356 Carpatho-Balkan Metallogeny*, Glasgow University, January 8-11.
- Janković, S., Serafimovski, T., Jelenković, R., Čifliganev, V., 1997: Metallogeny of the Vardar zone and Serbo-Macedonian Mass. *Symposium-Annual Meeting*, Proceedings, 29-67, Dojran.
- Karamata, S., Pécskay, Z., Knežević, V., Memović, E., 1994a: Origin and age of Rogozna (Central Serbia) volcanics in the light of new isotopic data. *Bul. T. CVIII, Acad. Serb. dep. Sci. et dep. Arts. CII, Sci. math. et nature., Sci. Naturel.* No. 35, Beograd, 41-46.
- Karamata, S., Vasković, N., Cvetković, V., Knežević, V., 1994b: The Upper Cretaceous and Tertiary magmatics of the central and eastern Serbia and their metallogeny. *Ann. Geol. Penin. Balk.*, 58, 169-170.
- Serafimovski, T. 1993: Structural Metallogenetic Characteristics of the Lece-Chakidiki Zone: Types of mineral deposits and distribution). *Special edition of RGF Štip*, No 1, 328 p. With extended summary in English, Štip.
- Serafimovski, T., Boev, B., 1996: Mineral Deposits Related to the Tertiary volcanism on the Balkan Peninsula. *30th International Geological Congress*, Beijing, China.
- Serafimovski, T., Tomson, I. N., Kocneva, N. T., 1997: Alpine orogenic structures and metallogeny in the Serbo-Macedonian massif and the Vardar zone of the territory of Macedonia. *Symposium, Annual Meeting, Proceedings*, 113-117, Dojran.
- Serafimovski, T., Stefanova, V., Bogoevski, K., 1998: Metallogenic features of some epithermal gold deposit in the Republic of Macedonia. *XVI Congress of the Carpathian-Balkan Geological Association*, Vien, Austria.

Резиме

МИНЕРАЛНИТЕ НАОЃАЛИШТА ПОВРЗАНИ СО ТЕРЦИЕРНИОТ МАГМАТИЗАМ ВО ЈУЖНИТЕ ДЕЛОВИ НА БАЛКАНСКИОТ ПОЛУОСТРОВ

Тодор Серафимовски¹, Раде Јеленковић², Горан Тасев¹, Панде Лазаров¹¹Рударско-геолошки факултет, Универзитет „Св. Кирил и Методиј“, Гоце Делчев 89, МК-2000 Штип, Република Македонија²Рударско-геолошки факултет, Гушина 7, 11000 Белград, Србија и Црна Гора**Клучни зборови:** Балкански Полуостров; терциерен магматизам; полиметалично наоѓалиште

Неогениот вулканизам во јужните делови на Балканскиот Полуостров е распространет во широка област, главно на терените на Вардарската зона и српско-македонскиот масив. Тоа, главно, се вулcano-интрузивни комплекси со делумно нагласен ефузивно-екструзивен карактер во област со површина од речиси 1200 km² (вулканска област Кратово-Злетово, ис-

точна Македонија). Од геотектонска гледна точка тие се дел на вардарската зона и српско-македонскиот масив, честопати лоцирани во контактните делови меѓу овие две геотектонски единици. Со овие вулcano-интрузивни магматски комплекси се поврзани бројни наоѓалишта и појави на Pb-Zn, Cu, Mo, Au, Ag, Sb±W, Sn и др.