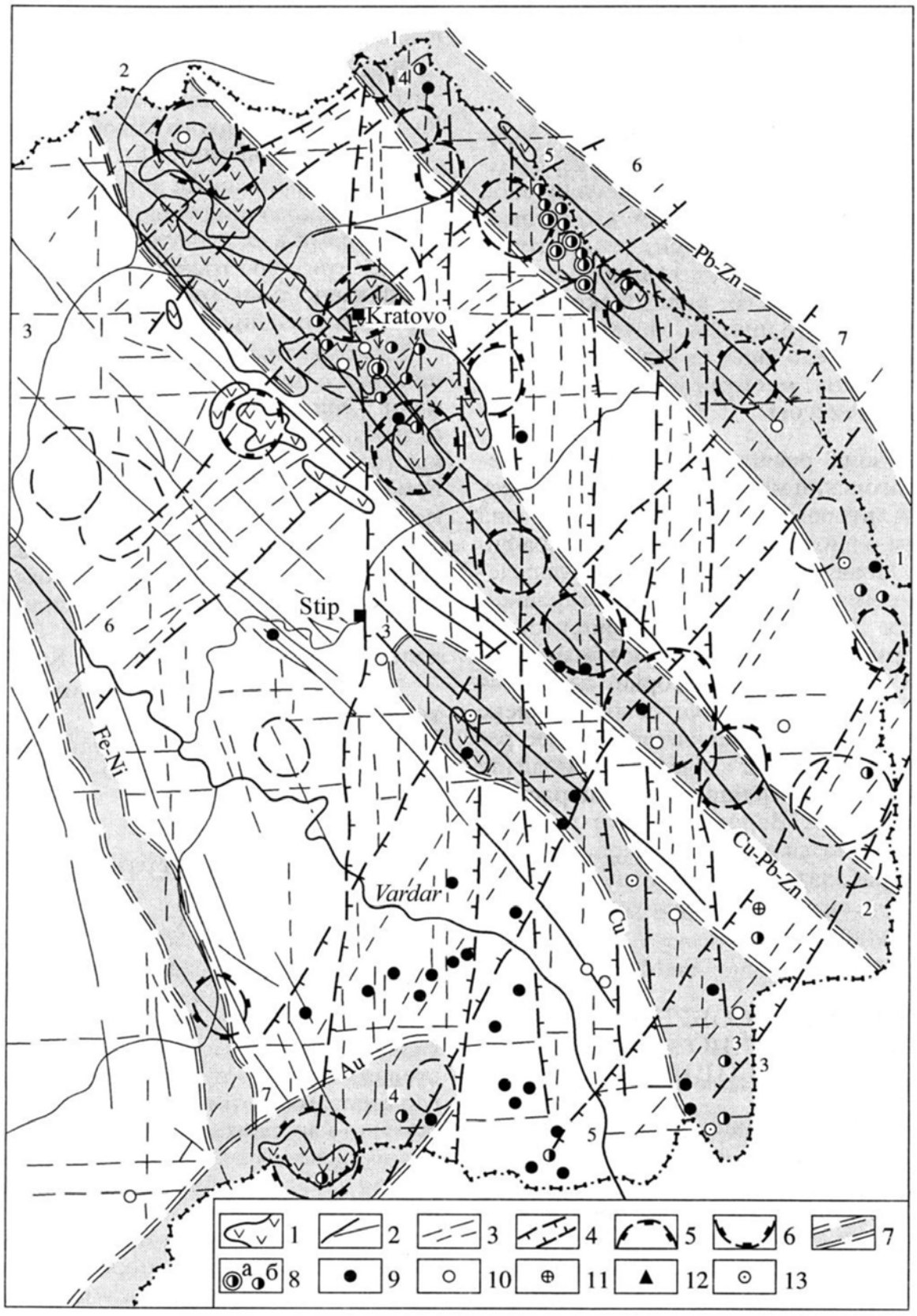

Fig. 4. Scheme of the Cenozoic metallogeny in the Eastern Macedonia
1) Cenozoic magmatic rocks, 2) Followed fissure, 3) Faults defined by satellite images and morphostructural analysis, 4) Fissure zones and cracking systems, 5) Semi-curved structures and calderas, 6) Pericline structures, 7) Metallogenetic zones, 8) Polymetallic deposits (a) and ore occurrences (b), 9) Copper deposits and occurrences, 10) Uranium deposits, 11) Tungsten deposits, 12) Antimony deposits, 13) Iron deposits

These systems practically determined the angle of graben structures, which have been filled with Cenozoic sediments. Numerous drill holes drilled in the Kocani geothermal area confirmed the composition of those graben structures. It should be pointed out that along the fissure structures, of general direction NW-SE, was localized Tertiary magmatism, also. It controled the Cenozoic metallogenetic zones (Fig. 4).

Activated cracking zones of meridian direction quite common comply with flexures directions of flexures in already formed sediments in grabens. Mainly were distinguished three crack zones, which have played an important role as ore bearing structures and localization of the ore fields and ore knots (Fig. 4).

Especial feature within these structural elements are the faulting structures with general direction NE-SW which relicts are saved up to date. They have controled seismic zones and have shown influence to the loalization of mamatic bodies and ore mineralization on places where structures of NW-SE cross cut. These types of structures are common in so called wide zones of relaxation. After the activization of Cenozoic faults followed stage of formation of pericline structures and systems of concentric structures of volcanic type. In that context were distinguished numerous volcanic calderas in frame of the Kratovo-Zletovo volcanic area. With satellite images and morphostructural analyses has been determined that within older concentric structures occurred radial fissures which have been manifested by common presence of faults with NW-SE direction (Fig. 4).

MORPHOSTRUCTURAL FEATURES OF THE BUKOVIK-KADIICA MINERALIZED SYSTEM

The Bukovik-Kadiica ore district has been located in the most eastern parts of the Besna Kobila-Osogovo-Tassos metallogenic zone (Aleksandrov, 1992) and it has been characterized by complex polymetallic mineralization. Within this ore district were determined ore body systems and intersected dykes of quartz-latites with an absolute age of 24–12 Ma. In this zone were located some ore districts while by the detailed analyses were found structures of the Osogovo polymetallic ore district, where it was confirmed that the deposits are situated on the dome's margins and their intersection and crossing with the fissures of SW meridian system and fissures of NW direction (Serafimovski et al. 1997; Janković and Serafimovski, 1997; Thompson et al. 1998). All structural elements were determined with detailed morphostructural analysis and interpretation of satellite imagery. Since earlier it was proven that the Macedonian territory had long and uninterrupted development that allows use of the tectonic elements in the field in determination of the ore controling structures.

By analogy to Osogovo, structural-geomorphological analysis helped in the study of the Bukovik-Kadiica ore district. Determination of tectonic elements in the recent relief was done by use of different set of metodologies: generalization of horizontals, study of river network, interpretation of satellite imagery etc. Relief analysis was based on the topographic map at 1 : 100 000 scale and remote prospecting materials at different scales. For eaxmple, we were using Earth Sat satellite images at scale range 15 to 50 m (step 5m) and covered area in range of 7.5 × 7.5 km to 25 × 25 km (step 2.5 km). Also, it was performed detailed desk study of some previous materials related to the area of interest.

Studied area has been located in the upper parts of the Bregalnica River, Pehcevska River and Celevica. In these water streams were formed two systems: *centrifugal* in the upper parts of Bregalnica and *centripetal* within the boundaries of the Kadiica Mountain. the northern part of the area is of mild mountain character and raises up to 1700-1900 m above the sea level, while the southern part is slightly lower with altitude of 1000–1300 m, divided by wide valley with loose direction and numerous water streams inflowing into the main water-way (Tasev et al. 2008).

From north to the east, the lower part of the area, has been surrounded by the raised arc with altitudes of 1600–1700 m. Radial and radial-centrifugal form of raised water-ways and lowered parts allowed determination of two crossed oval structures: southern one (11 × 8 km) and northern one (7.5 × 6 km). Higher points, erosion study and alluvial accummulation are pointing our to a slope-like development with characteristic valleys and slopes on the southern oval structure and raise of the northern oval structure (Fig. 5).

Intersection of the oval forms has been complicated by the ring structure 3.5 km in diameter. The central part of that structure overlaps with the

independently raised bukovik (1700 m). Around the raised area there is a depression belt, which has been articulated with the highest parts of Celevica, Pehcevska-Rakocevica river valleys. To the east, outer side of the structure has been limited by an arc raised up to 1700–1900 m.

Located group of ring structures has been located on the intersection between the two metallogenic zones: the polymetallic Besna Kobila-Osogovo-Tassos and Kožuf-Aridea (encloses Alšar deposit) with associated Pliocene mineralization.

The area of intersection is higher than earlier mentioned zones and have complex composition. According to that the Bukovik ring structure has been located within the intersection of orthogonal system of fissures determined on the linear tectonic elements of the recent relief (Serafimovski et al. 2010). Dispositions of meridian direction represented as more fractured zones were determined from the satellite imagery, while on the topographic they were shown as fine linear elements in the relief.

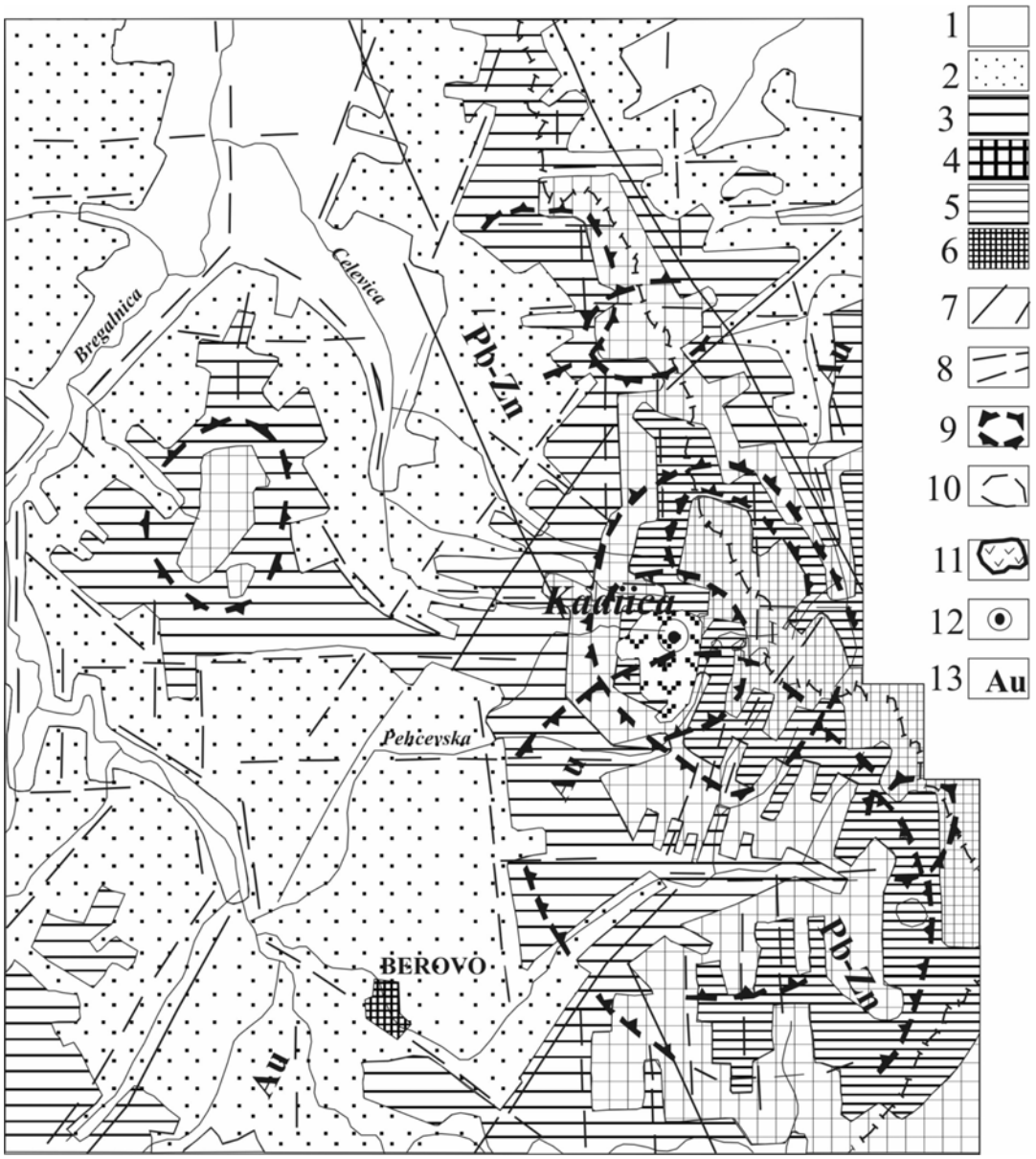

Fig. 5. Morphostructural map of the Bukovik-Kadiica area, Macedonia (Tasev et al. 2008)
1–6 – hypsometric levels (in m): 1) lower than 800 m; 2) 800–1000 m; 3) 1000–1200 m; 4) 1200–1500 m; 5) 1500–1700 m; 6) more than 1700 m; 7) metallogenetic zones, structures, ocurrences on the topographic and satellite imagery; 8.) linear dislocations; 9) concentric structures boundaries; 10) concentric dislocations; 11) pliocene volcanics manifestations; 12) Bukovik-Kadiica ore deposit; 13) specialized metallogenetic zones

These linear lineaments are directly exposed to the upright systems (articulated tectonic flatening, large water-ways curves recent graben incavations). As it has been said already, orthogonal systems run by direction and quite often are connected by the fissure zones. Within the Bukovik-Kadiica area has been detected linear zone that can be followed from Gradiska until the Kadan Bunar, in the corner of the upright Kožuf-Aridea metallogenetic zone. It is a deeply eroded zone defined by welded rectilinear valleys, which can indicate deep zones with the highest permability at the surface.

According to the field and desk study of reality in the field, satellite imagery, metallogenetic features, professional literature etc., we have concluded that morphostructural parameters of the Bukovik-Kadiica area are characterized by structures of two general directions, NW-SE and NE-SW ones. Also this study that mineralization was closely associated to the intersection knots of major structures have shown.

CONCLUSION

Macedonia experienced two periods of extension separated by two abbreviated periods of shortening in Cenozoic time.

The Cenozoic activization of NW-SE strike diagonaly crossed through the large tectonic units Dinarides, Vardar Zone, central parts of the Serbo-Macedonian Massif and Rhodope massif. This activization significantly contributed to the localization of the Cenozoic mineralizations within the Eastern Macedonia

The disruption structures of of NW-SE direction control three major Cenozoic metallogenetic zone. Two of them are characterized by the Oligocene-Miocene magmatism and mineralization in the major ore region Kratovo-Zletovo and Bucim-Damjan-Borov Dol and the third one has been characterized by Miocene volcanics and related mineralization in the Osogovo ore region (Bukovik-Kadiica).

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Р е з и м е

ГЛАВНИТЕ АЛПИСКИ СТРУКТУРИ И Cu-ПОРФИРСКА МИНЕРАЛИЗАЦИЈА ВО СРПСКО-МАКЕДОНСКИОТ МАСИВ

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Клучни зборови: Српско-Македонски масив; морфоструктури; Кенозојска активизација; полиметалични минерализации; рудни системи

Геодинамичката еволуција на Српско-Македонскиот масив може да се разгледува во неколку геолошки и геотектонски епохи, но многу специфична е Кенозојската еволуција геодинамички, геотектонски, структурен, магматски и металогенетски аспект. Кенозојските лонгитудинални структури се длабоки и претставуваат граница кон Вардарската зона од една страна и Струма зоната од друга страна.

Морфоструктурните формии од различен ранг и интензитет се од големо значење за просторната дистрибуција на рудната минерализација (Pb-Zn-Cu рудна област Кратово-Злетово, Cu-Au-Fe рудна област Бучим-Дамјан, рудоносен систем Cu-Au-Ag-Fe Буковик-Кадиица и др.). Доминантни структури во рамките на Српско-Македонскиот масив се оние со правец СЗ-ЈИ, кои служеле како рудоносни системи, исто така (рудна зона Бесна Кобила-Осогово-Тасос и металогенетска зона Леце-Халкидики).