metamorphic association and made up of brown, green, yellowish green metalava, metatuff and small amount of metasedimentary rocks. The common mineral assemblages of the metavolcanic rocks are mainly composed of quartz + chlorite + epidote + albite + actinolite + calcite ± sphen ± zircon. This mineral assemblage indicates that these metavolcanic rocks underwent greenschist-facies metamorphism.

Major, trace and rare earth element (REE) geochemistry for metavolcanic rocks from the Biga Peninsula has been determined to reveal their origin and tectonic setting. The metavolcanic rocks have compositions of andesites with calc-alkaline character. Calc-alkaline chemistry is represented by intermediate SiO_2 content, low MgO and low Cr. Chondrite-normalized REE patterns are moderately fractionated (La_N/Yb_N ~ 2.2 to 8.9). Europium anomalies are variable (Eu/Eu* 0.6 to 1.9) and generally negative (average Eu/Eu* 0.83). The plagioclase fractionation is confirmed by a slight development of negative Eu anomaly. The metavolcanic rocks have a distinct negative Nb anomaly with negative Sr, Ba, Hf anomalies in extended element diagrams. The large negative Nb, Sr, Ba and Hf anomalies in the metavolcanic rocks exhibit a crustal involvement in their derivation. The crustal influence may be related to either partial melting at the base of continental crust or contamination of mafic magma with crustal material. On tectonic discrimination diagrams, all metavolcanic rocks cluster within the volcanic arc field away from either the within plate or ocean ridge fields. Those within the volcanic arc field indicate calc-alkaline magma type. Such a magma type is a characteristic of volcanic arc setting for the metavolcanic rocks. Moreover, negative Nb anomalies are also characteristic of the volcanic arc.

Zircon grains from these metavolcanic rocks, which are euhedral with typical magmatic morphologies, were dated by LA-ICPMS. Zircon ages of two samples yielded 328.6 ± 3.5 Ma and 343.2 ± 2.6 Ma, respectively. These are interpreted as the time of protolith crystallization of metavolcanic rocks. This volcanic episode of the Biga Peninsula can be attributed the Variscan magmatic activity and also collisional event leading to the amalgamation of tectonic units took place during Variscan orogenic event.

Relationship between Cenozoic structures and polymetallic mineralizations in the central part of the Serbo-Macedonian massif

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The geodynamic evolution of the Serbo-Macedonian massif can be reviewed in few geological and geotectonic epochs, but very specific is the Cenozoic evolution from geodynamic, geotectonic, structural, magmatic and metallogenetic point of view. Cenozoic activization at the territory of the FYR of Macedonia enclosed the most complex geotectonic units such as Vardar zone and SMM. Its occurrence is mainly along fissures of general NW-SE direction and activated meridian cracking zones and faulting systems of general NE-SW direction. In such conditions came to complete redistribution of the lineament structures network when on the main direction of Mesozoic structures NW-SE (340^o) occurred fault system of the same direction but slightly different angle (320^o). Striking transcurrent faults can be recognized from air and satellite pictures, striking in the same direction as the zone of activation, as well as systems of smaller parallel faults, systems of diagonal jagged faults and systems of straight, tension faults. A special characteristic of the zone of autonomous activation are their numerous ringlike structures. This activization significantly contributed to the localization of the Cenozoic mineralizations within the Eastern FYR of Macedonia. The disruption structures of of NW-SE direction control three major Cenozoic metallogenetic zones (two of them characterized by the Oligocene-Miocene magmatism and mineralization in the Kratovo-Zletovo and Bucim-Damjan-Borov Dol ore regions and third characterized by Miocene volcanics and related mineralization at the Osogovo ore region). Logical metallogenic analysis have confirmed that megastructures in the Tertiary autonomous activation zone correspond to the ore districts and coincide with the centres of magmatic activity, while the distribution of mineral deposits in them is found to be distinctly laterally zoned. The lesser ringlike structures correspond to the structure of the ore fileds or mineral deposits, as it is a case with the Bukovik-Kadiica polymetallic ore system. 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 magmatic 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 (numerous volcanic calderas in the Kratovo-Zletovo volcanic area). The Bukovik-Kadiica ore district, characterized by complex polymetallic mineralization, is located in the most eastern parts of the Besna Kobila-Osogovo-Tassos metallogenic zone. Determination of tectonic elements was done by different methodologies: generalization of horizontals, river networks, interpretation of satellite imagery etc. From north to the east, the lower part of the area, has been surrounded by the raised arc (1600-1700 m). Radial and radial-centrifugal forms allowed determination of two crossed oval structures: southern and northern. 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. Intersection of the oval forms has been complicated by the ring structure 3.5 km in diameter. Its central part 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 the adjacent river valleys. To the east, outer side of the structure has been limited by raised arc. 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. Field observations, desk studies, satellite imagery, metallogenic features, confirmed that morphostructural parameters of the Bukovik-Kadiica area are characterized by structures of two general directions (NW-SE and NE-SW). Also, this study has shown that mineralization was closely associated to the intersection knots of major structures.

Strain geometry and kinematics along the central Pindos Thrust Belt in Northern Greece: implications for the structural evolution of the External Hellenides

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The Pindos Thrust Belt (PTB) represents the intensively folded and thrusted sedimentary sequence deposited in the Pindos basin along the western margin of the Pelagonian microcontinent. Pindos Thrust Belt expands, from northern Greece to the southern Greece on the Peloponnesus, exhibiting a NW-SE strike, thereafter it turns in an E-W striking direction. Its north continuation in Albania is represented by the Crasta –Cukali Zone. PTB is enveloped between the Gavrovo Zone, to the West and the Pelagonian nappe system to the East. The zone accommodates a succession of continuous Mesozoic deep sea sediments, comprising cherts, clay- silt- stones and pelagic limestones. An Upper Cretaceous to Eocene flysch terminates the sequence. Orogenic processes (Neohellenic Stage) associated with plate convergence during Tertiary caused compression and crustal thickening, generating folding and thrusting (PTB) followed by normal faulting and extension.

Based on a quantitative analysis along the N-S striking segment of PTB in Northern - Central Greece we present structural data concerning the Tertiary deformation regime of PTB. Strain and paleostress tensor analysis of deformation were also performed on selected outcrops.

Data analysis point to the following deformation styles to have affected the PTB:

An early D1 deformation style of Paleocene to Eocene age, represented by asymmetrical, angular, tight folds with axes bearing a N-S to NW-SE present day orientation. D1 is associated with the progressive westward to south-westward propagation of thrusting of