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CRITERIA FOR ORE DEPOSITS PROGNOSES IN THE BOHEMIAN MASSIF

A b s t r a c t: The paper deals with prognoses of ore deposits at the scale 1:500.000. Prognostication was carried out in the region of the Bohemian Massif, its Bohemian part, by confrontation of regional, geophysical, geological, and geochemical factors, or by means of other methods. Main criteria for prognosticating endogenous Au, Sn, W, Mo deposits and deposits of ores of non-ferric metals occurring in shallow-seated subsurface horizons of the Bohemian Massif were determined.

Резюме: Автор в статье занимается прогнозированием рудных месторождений в масштабе 1 : 500 000. Это прогнозирование было проведено в области Чешского массива, в его чешской части сопоставлением региональных, геофизикальных, геологических и геохимических факторов, или при помощи других методов. Были определены основные критерии прогнозирования эндогенных месторождений золота, олова, вольфрама, молибдена и руд нежелезных металлов встречающихся в мелко залегающих подповерхностных горизонтах Чешского массива.

In the years 1981—1983, a synoptic prognostic appraisal of the occurrence of ore deposits in the Bohemian part of the Bohemian Massif on 1 : 500,000 scale was accomplished. A broad team of specialists produced about fifty maps including geophysical, geochemical, geological and economic geological-metallogenic maps. After the mutual confrontation, maps of potential fields of polymetallic deposits, deposits of tin-tungsten and molybdenum ores and of gold were elaborated.

The Bohemian Massif lies in the centre of Europe and its major part extends on the territory of the Czech Socialist Republic. It is the easternmost part of the pre-Variscan fundament of the Hercynian orogene in the continuation of the Massif Central, the Vosges and the Schwarzwald.

The blocks located in positive and negative gravity zones are characterized by specific features. In the negative zones, granite magmatism is extensive and polymetallic mineralization and the Sn-W mineral association prevail. The blocks tend to move upward and no Early Paleozoic cover has been preserved on them as a rule. In the positive gravity zones (except the western part of the Moravian block), the presence of basic massifs and of numerous volcanites and occurence of molybdenite and Cu-Ni mineralization are characteristic features. The blocks have a long-lasting downward-moving tendency and an Early Paleozoic cover. When combined with the results of deep seismic sounding, the gravity maps may support the statement that the oldest structure of the fundaments of Central Europe is characterized by W-E directions which occur notably in the lowermost parts of the Earth's crust. The Cadomian structure of the Bohemian Massif is determined by NE-SW directions and its block disintegration during the Hercynian orogeny and platform development shows NW-SE directions.

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The following conclusions were drawn from statistical appraisal of the relationships between mineralization and selected geological phenomena:
a) The Precambrian volcano-sedimentary formations are carriers of Pb-Zn, Mo, U and notably of pyrite, manganese and iron mineralizations; a direct genetic relationship with Precambrian volcanic activity is probable.
b) The Early Paleozoic volcano-sedimentary formations are carriers of Fe, Cu, V and Sb-As mineralizations which, however, are only indirectly related in space.
c) The probability of the occurence of mineralization in the Cadomian basic massifs and in the Precambrian metaplutonites in general is very low for all elements; an exception is the Ransko massif.
d) Mo, Ti and part of Cu, Co, Ni and Fe mineralizations are distinctly linked with Cadomian intermediate plutonites. Li mineralization is linked with Cadonian granitoids, the possibilities of Sn-W mineralization are indistinctly higher there.
e) Au, Sb-As and U mineralization is spatially linked almost entirely with intermediate and acidic Variscan granitoids, with which also most of the occurrences of Sn-W, Pb-Zn formations and to a lesser extent those of Ba-F, Ti and Li are associated.
f) A striking interdependence exists between the location and indications and deposits of gold and the distribution of porphyry and lamprophyre dykes in the Central Bohemian Pluton. A similar interdependence may be observed in the area of gold occurrences of the Jeseniky Mts.
g) The distribution of deposits in metamorphic zones suggests that sulphidic deposits tend to occur in the zones of lowest-grade metamorphism, greisens and hydrothermal vein deposits are associated with allochthonous granites, medium-grade metamorphic zones are depleted in sulphidic deposits but their Au, Nb-Ta, Li, Ba-F, Ni-Co-Bi concentrations are maximum. In environments converted by higher-grade metamorphism, mainly the elements expulsed from highest-grade metamorphism zones have concentrated. They are promising for occurrence of Au, Mo and U. Numerous gold mineralizations are linked with the boundaries of migmatization zones in the south Bohemian Moldanubicum. The highest-grade metamorphism and ultrametamorphism zones are completely devoid of metallic mineral deposits.
h) A simple statistical method was used to express the relationship between the incidence of mineralizations and the tectonics in the Bohemian Massif. It was found that the greatest number of ore indications and deposits occurs in deep-reaching faults, block structures, areas of crossing of faults and finally in ring structures. The most productive directions of deep faults with respect to mineralization are within the N 65° W—N 35° W interval including the nearby parallel or feathered zones of major structures.

The principal genetic type of endogenic gold mineralization appears to be the "greenstone belts" type that occurs in areas formed by the Upper Proterozoic or Devonian volcanites of the tholeiite and calc-alkaline association altered by low-grade metamorphism predominantly into greenschist facies that are penetrated by strongly contaminated Variscan tonalites. The gold-bearing mineralization occurs there in vein, stockwork and stratiform sulphidic ore deposits. These are related with the course of the fossil deep-seated zone of the Bohemian Massif, whose general N-E direction was interrupted by N-W trend-

ing transverse faults. The second type of gold-bearing mineralization occurs at considerable depth in the metamorphosed sedimentary and volcano-sedimentary series of the Moldanubicum. It is represented by vein and stockwork-type Au deposits with increased contents of Ag and by a newly found metamorphogenic type of scheelite mineralization. Presently performed lithogeochemical research indicates that the material source of the auriferous deposits of the Bohemian Massif is in the Upper Proterozoic volcano-sedimentary complexes that contain a primarily increased amount of gold (2.8—7.5 ppb). The main area of gold-bearing mineralization is in the mobile zone at the boundary between the Barrandian Upper Proterozoic block and the block of the Moldanubicum. The intrusion of Variscan granitoids into this zone caused a remobilization of the gold contained in the rocks. Regional metamorphism may have had a similar effect in the Moldanubian region.

Of the tin and tungsten ores, primarily deposit types closely associated with the contact zone of the Hercynian granite plutons are present in the Bohemian Massif. Most productive in this respect are the endocontact greisens occuring in small granite stocks or elevation structures. The Li, Sn, W mineral association is prevalently linked with lighter plutonites indicated by negative gravity anomalies, increased radioactivity and a variable field delta T. There is a linkage between the existence of plutons differentiated into the granites of the Sn series. Significant are the contacts of plutons with the varied series of the Paleozoic or Precambrian. Also the veins of aplites, granite porphyries or quartz porphyries indicate the possible course of a subsurface granite relief. The shape of the exposed pluton displaying moderate and steep contacts and vents is a significant morphologic criterion. The presence of secondary alteration in the granite or in its mantle rocks such as greisenization, tournalinization, chloritization, etc., witneses to possible mineralization. Positive criteria are also local or regional crossing with the granite contact or the mutual crossing of tectonic zones, the existence of specialized granitoids, abundance of indication elements of the Sn series called Sn type granites and anomalous contents of Sn in stream sediments and cassiterite, wolframite or scheelite anomalies detected in samples from heavy minerals prospecting. The basic prerequisite of scheelite mineralization prognoses is the existence of lithologically varied complexes in the marginal zones of the Bohemian Massif or of the Varied Group of the Moldanubicum, especially of the carbonate bed, of some of the quartzites, further all metabasite layers, particularly amphibolites. Also the Precambrian to Lower Paleozoic volcano-sedimentary series may be promising. A substantial part of these series lies in the contact aureoles of Hercynian plutons.

Molybdenite mineralization occurs preferably in regions characterized by distinctive products of granitoid magmatism. The correlation between Mo mineralization and pronounced density interfaces is significant. These interfaces are connected in turn with the presence of granitoids having granodiorite to diorite character, that are often present as minor more basic granitoid bodies in acidic granitoids. Favourable is the possibility of an extreme concentration of the postgranitoid residual hydrothermal solutions into tectonized zones. The accompanying processes of alkaline, particularly Na-metasomatism including residual silicification, lead to the origin of rocks having almost the character of metasomatites enriched with respect to Na, in places Mo. A significant indi-

cator is also the granitoid magmatism caused by the enrichment in accessory magnetite in tectonized (dynamometamorphosed) deep-reaching zones.

On the basis of a discussion on lithogeochemical units in the Bohemian Massif, several geological formations were specified that are primordial with respect to prospecting for polymetallic ores. These include in the first place some volcano-sedimentary formations of Proterozoic and Early Paleozoic ages having conspicuous magnetic polarity. Sofar known powerful manifestations of stratoid mineralization are in the Devonian volcano-sedimentary rocks of the Jeseníky Mts. The second specified category are granitoid bodies of a more mafic character that correspond to the I types after Chapell and White. Of the mafites category, differentiated massifs were specified. Only one of them is sufficiently known; it contains Cu-Ni mineralization (the Ransko Massif). In addition, mafites were specified that are similarly composed as those in the series at the divergent margins of the plate boundaries. As far as structural-tectonic factors are concerned, the linkage between the occurrence of polymetallic vein deposits and the weakened parts of the crust is observable in some areas; they are marked in some places by the course of deep faults and by their crossing. This applies especially to the zone of the Boskovice Furrow, the Jihlava and Blanice Furrows, the zone of the Central Bohemian Suture, the West Bohemian fault zone, the Jáchymov fault and the zone of the Sázava and Poděbrady faults. The general view of the course of polymetallic mineralization suggests its concentration into the W-E oriented zone leading from Stříbro Kutná Hora, the Železné hory Hills as far as Benešov in northern Moravia. Because of the possibility that Precambrian stratiform types of mineralization exist and have been regenerated during subsequent geological processes, increased attention will be given now to certain areas.

Studies connected with prognoses of various ore deposits in the Bohemian Massif indicate that the gold and tin-tungsten mineralizations have primordial importance for future economic development. The integrated geophysical, geological and regional geochemical methods employed to investigate the surface of the Bohemian Massif during the past decades revealed many possibilities even at shallow depths, that have not been given sufficient attention sofar. Following the performed work, however, we intend to study the metallogenic situation of the Bohemian Massif at depths of about 1000 m in the coming years in order to obtain new information on possible large orebodies at greater depths.We wish to do so in international cooperation with the geological services and organizations of the neighbouring countries which occupy parts of the area of the Bohemian Massif and its border regions.

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The author is responsible for language correctness and content.