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A Contribution to the Mineral Potential of the Southern Bohemian Massif (Austria)

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With 2 Figures

Niederösterreich
Oberösterreich
Böhmische Masse
Lagerstätten
Rohstoffpotential

Österreichische Karte 1 : 50.000
Blätter 1–9, 12–23, 28–39, 51–55

Contents

Zusammenfassung

Rund 3000 km² des insgesamt ca. 9500 km² betragenden österreichischen Anteiles an der Böhmischen Masse wurden in den 80-er Jahren mit modernen Methoden prospektiert. Dabei wurden bisher unbekannte Mineralisationen von Wolfram, Molybdän, Uran und Eisen sowie erste Anzeichen für das Auftreten von epithermalen Gold-Mineralisationen aufgefunden.

Wolfram ist ausschließlich durch das Auftreten von Scheelitmineralisationen in Kalksilikatgesteinen vertreten.

Zwei an Greisengesteine gebundene Molybdänglanzmineralisationen wurden aufgefunden. Deren enge räumliche, wahrscheinlich auch genetische Verknüpfung mit Magnetit und somit mit aeromagnetischen Anomalien läßt eine weitere Untersuchung aller bekannten, über Graniten liegenden magnetischen Anomalien sinnvoll erscheinen.

Der Nachweis von epithermalen Alterationen granitischer Gesteine in Zusammenhang mit goldführenden Bachsedimenten stellt den ersten Hinweis auf die Möglichkeit des Auftretens epithermaler Goldmineralisationen in der Südlichen Böhmischen Masse dar.

Es wurden keinerlei Hinweise auf primäre, granitgebundene Zinnmineralisationen aufgefunden.

Das hohe Uranpotential, auch der Südlichen Böhmischen Masse, wurde durch das Auffinden teilweise ausgedehnter Urananomalien im Boden sowie ausgeprägter sekundärer Uranmineralisationen bestätigt.

Abstract

About 3000 km² out of the approximately 9500 km² belonging to the Bohemian Massif in Austria have been prospected during the eighties. So far unknown mineralizations of tungsten, molybdenite, uranium and iron as well as first indications of epithermal gold mineralizations have been discovered.

With respect to tungsten, only minor, calc-silicate hosted scheelite mineralizations have been found.

The spatial, probably also genetic linkage of both greisen-style molybdenite mineralizations discovered with magnetic anomalies favour a further investigation of the latter.

Gold-bearing stream sediments in close spatial vicinity to hydrothermally altered granites indicate for the first time the possible occurrence of epithermal gold mineralizations in the Southern Bohemian Massif.

No primary granite-related tin mineralization has been found.

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The high uranium potential of the Southern Bohemian Massif is proven by partially extended, secondary uranium mineralizations.

1. Introduction

The Austrian, southernmost part of the Bohemian Massif, some 9500 km², is generally described as deeply eroded peneplain as most recently emphasized by WURSTER (1988). With the exception of very few, small skarn-type magnetite deposits, which have been the subject of small scale mining during the last century, no other ore mineralizations of any significance were known. Nevertheless, recent exploration activities led to the discovery of previously unknown occurrences of molybdenite, gold, scheelite, uranium and stratiform iron ores.

This paper presents a comprehensive summary of the present knowledge. The localities of the mineralizations described are given in Fig. 1.

2. Description of Mineralizations

2.1 Molybdenite

2.1.1. The Molybdenite Mineralization at "Nebelstein"

Situated some 20 km SW of Gmünd (Fig. 1), the molybdenite mineralization at Nebelstein is related to greisen-type rocks, the latter being the result of a progressive muscovitization of a suite of various granites (GÖD and KOLLER, 1987 and 1989). The granites affected by this alteration are of peraluminous, acidic and leucogranitic composition with S-type characteristics. They were perfectly delineated by an airborne spectrometric survey (SEIBERL & HEINZ, 1986).

The alteration itself is characterized by a moderate increase in SiO_2, an increase in iron and especially by a substantial decrease in sodium. With respect to trace elements, the greisens are predominantly enriched in molybdenum and, to a far lesser degree, in tin, tungsten and copper. No enrichment of lithium, beryllium and boron has been observed which makes the non-ore mineralogy of the greisens comparably simple.

The partly porous greisens occur either as irregularly shaped bodies some meters in diameter or in zones of some meters thickness paralell to the contacts as shown in Fig. 2a. Contrary to mineralizations commonly related to S-type granitoids, the mineralization is characterized by a disseminated pyrite-molybdenite-pyrrhotite-chalcopyrite paragenesis. The molybdenite content of the greisens is in the order of some hundred ppm over some meters thickness. No mineralized quartz veins or veinlets (i.e. "sheeted vein system") or similar features have been observed. A further striking feature is a homogeneously distributed magnetite content of the greisens and their surrounding granites. The formation of these magnetites is obviously genetically related to the greisenization. Therefore, the magnetite seems to be a very useful guide to greisen-style mineralizations in the Southern Bohemian Massif (see also section 2.2). The greisens yield a Rb/Sr whole rock age of 311±16 my (S. SCHARBERT, 1987). Field observations as well as drilling results and geochemistry suggest that the present level of erosion is cutting the root zone of a former, larger mineralized structure.

2.1.2. The Molybdenite Mineralization at "Hirschenschlag"

The molybdenite mineralization Hirschenschlag, some 10 km NE of Litschau is directly located at the Austrian-Czechoslovakian border. Presumably, the greater parts of the mineralization belong to Czechoslovakia, where the locality is known as "Kozy-Hora" and delineated on the geological map (DUDEK, 1963) as "greisen body". As there are no publications available on the Czechoslovakian part of the mineralization so far, the following summary is exclusively restricted to what is known on the Austrian sector.

Host rock of the mineralization and by far the dominating rock is the Eisgarn-type granite, a two-mica granite with Mu>Bi (S. SCHARBERT, 1965). In addition, subordinate pinkish muscovite-granite, reddish biotite-granite and aplitic muscovite-granites with hypabyssic textures occur in close vicinity to the mineralization. A dyke of deeply reddish fluorspar-bearing granite has been observed in one of the trenches. The mutual relation between these granites is not known at present, though the Eisgarn-type granite is most likely the relative oldest.

Two types of molybdenite mineralizations can be distinguished:

❶ molybdenite related to greisens and
❷ molybdenite bound to qartz veins (see Figs. 2b and c).

The mineralized greisens are massive, probably lens-shaped bodies with some 10 m(?) in length. They occur amidst the Eisgarn-type granite and are surrounded by an alteration haloe of deeply reddish colour, approx. 1 m in extension. The greisens consist petrographically of quartz, chlorite, muscovite and minor (relictic) plagioclase, whereas the disseminated ore mineralization itself comprises pyrite – molybdenite – chalcopyrite – sphalerite – galena and minor arsenopyrite. The molybdenum content reaches a maximum of about 1600 ppm over a thickness of 1 m. The non-sulphide mineralization consists mainly of magnetite and traces of fluorspar. Like at "Nebelstein" (section 2.1) the magnetite seems to be again cogenetic to the greisenization which emphazises the mutual relation of magnetite formation and greisen-style mineralizations in the Southern Bohemian Massif and caused another prominent aeromagnetic anomaly in the area around Hirschenschlag/Kozy Hora (GUTDEUTSCH & SEIBERL, 1987).

The other type of molybdenite mineralization, closely linked to qartz veins, appears as given in Fig. 2b. All transitions, from mm-thick, barren fissures accompanied by small micaceous seams up to mineralized quartz veinlets shown in the above mentioned figure, can be observed.

Considering local geology as well as the N–S to NW–SE strike of all the veinlets, one can draw the picture 2 c. It clearly shows the distinct increase of the number of veins per length unit and the simultaneous increase of molybdenite mineralization with depth.

In conclusion, the center of mineralization has to be assumed on the Czechoslovakian side of the state boundary.

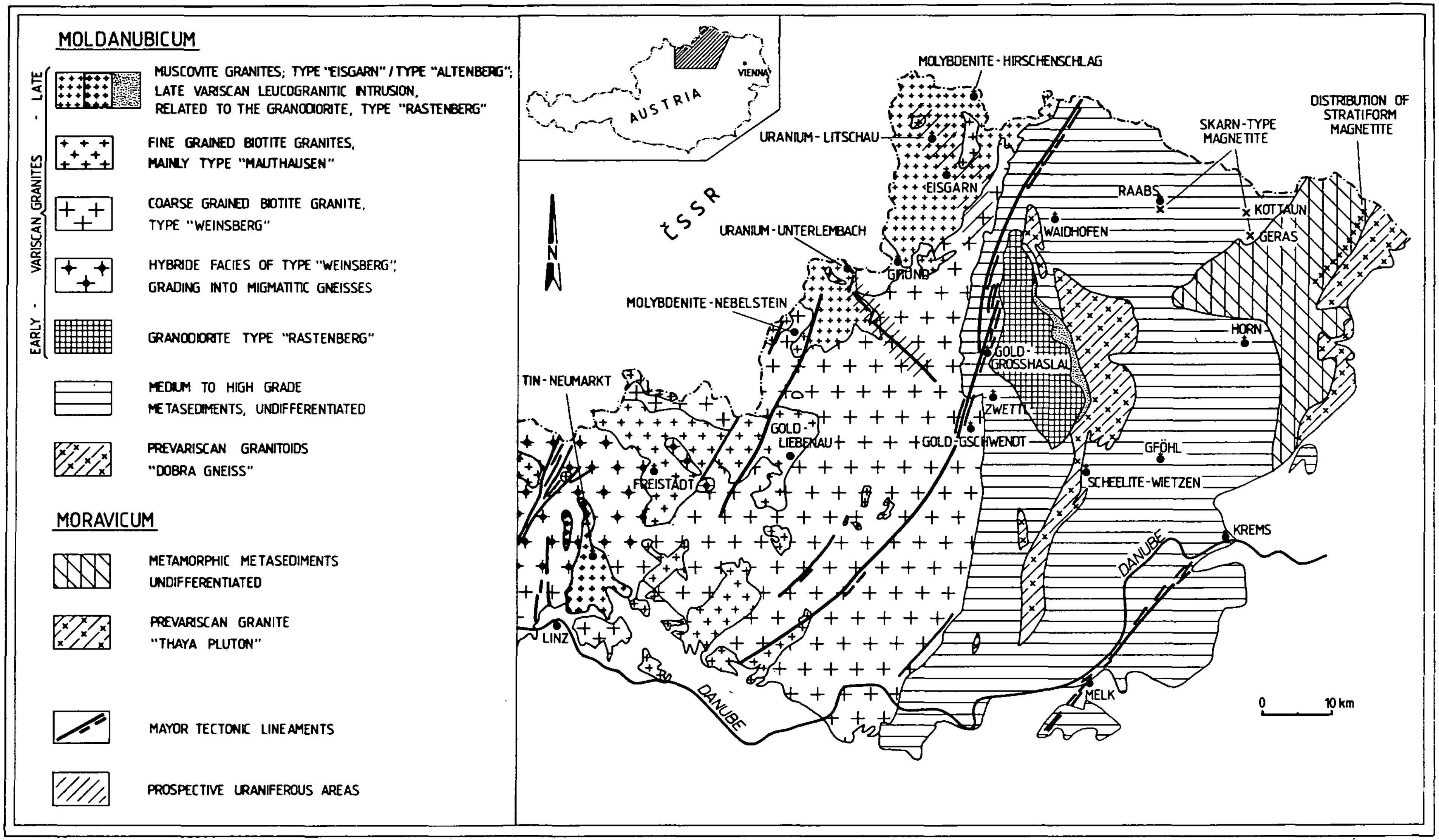

Fig. 1.
Geographic position of the mineralizations.
Geology after FUCHS & MATURA (1976), simplified.

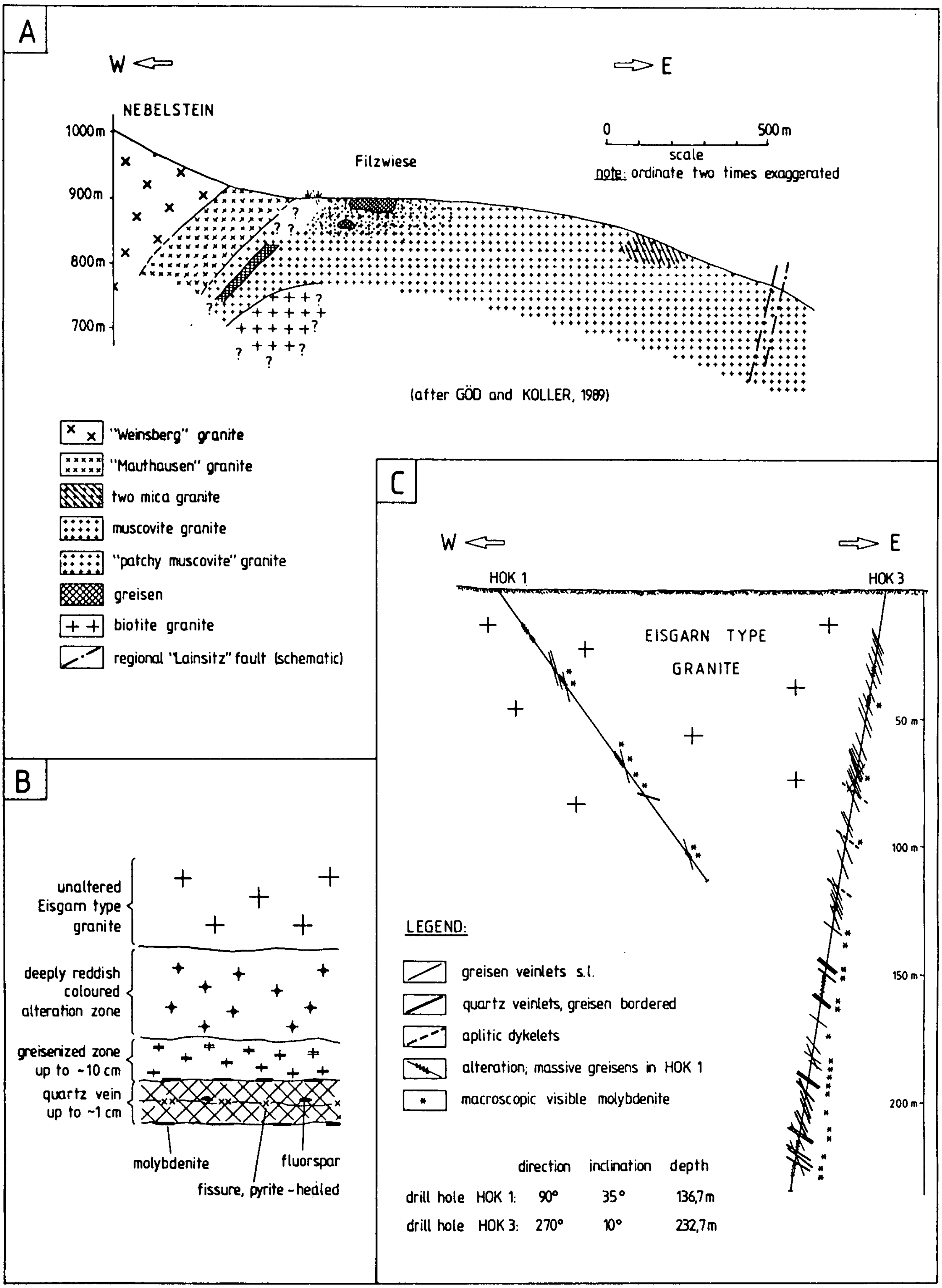

Fig. 2.
A) Cross section through the molybdenite mineralization at Nebelstein (after GÖD & KOLLER, 1989).
B) Schematized cross section through a mineralized quartz veinlet; molybdenite mineralization Hirschenschlag.
C) Spatial orientation and distribution of molybdenite in two drill cores, Hirschenschlag.

2.2. Uranium Occurrences

A regional uranium exploration programm covering selected parts of the Bohemian Massif, an uranium orientation phase mission carried out by the OECD-Nuclear Energy Agency (IUREP report 1981) and the results of a federal airborne spectrometric survey (SEIBERL & HEINZ, 1986) delineated uranium mineralizations and areas of high prospectivity as shown in Fig. 1.

The north-eastern target area, centered more or less by the small town Litschau, is characterized by highly anomalous uranium concentrations of up to 100 ppm in soil samples. The anomalies follow preferentially a NW–SE direction. A distinct uranium mineralization, consisting of minerals of the autunite group, located very close to the town of Litschau, emphasizes the potential of that area. Shallow drill holes (down to a max. depth of approx. 100 m) did not intersect primary mineralizations.

In the southeastern area, W of Gmünd, the most prominent uranium mineralization in the Southern Bohemian Massif known so far has been found following up a huge airborne spectrometric anomaly (SEIBERL & HEINZ, 1986) near the village of Unterlembach.

The mineralization (minerals of the autunite group) is controlled by a major, NW–SE trending structure, which extends the prospective area over almost 20 km. Preliminary analytical data indicate the mono-elemental character of the mineralization.

2.3. Gold Occurrences in Stream Sediments

2.3.1. Gold-Bearing Stream Sediments at "Liebenau"

Creeks and rivers N and NW of Liebenau, some 30 km WSW Zwettl, are interesting because of their gold-bearing sediments. The anomaly covers an area of approximately 10 km^2, underlain by a fine grained granite (Mauthausen-type granite). In the heavy mineral concentrates, the gold is accompanied by scheelite, traces of native bismuth and unusual high contents of epidote.

The gold grains with a size of maximal 1 mm , contain silver in the range between 25 to 50 % Ag (KURAT, 1985) and exhibit inclusions of illite and other, yet unidentified clay minerals (KURAT, ibid.) The silver content as well as grain surfaces indicate the autochthonous origin of the gold. Core drilling repeatedly intersected significantly altered granites. The alteration zones are usually in the range of some meters in thickness and may even exceed 25 m; they obviously form an irregular network. The alteration is characterized by hematitization, causing a deep red colour of the granite, by chloritization, by the formation of kaolinite and illite and not at least by an epidotization. The epidote occurs mainly as matrix of mm-thick, brecciated veinlets in the granite. There is a general lack of sulphides, no traces of any kind of silicification have been observed. A further striking feature of the alteration zones is their porosity. Analytical data so far did not show gold values above the limit of detection (2 pp). However, the general situation remains unsolved.

2.3.2. Gold-Bearing Stream Sediments at "Großhaslau" and "Gschwendt"

Both localities, some 5 km N and SW of Zwettl respectively, are situated closely to a major tectonic structure as shown in Fig. 1. In the case of Großhaslau, the stream sediment anomaly, covering some 3 km^2, overlaps exactly the primary contact of a granitic body (granodiorite, type "Rastenberg") with paragneisses. The gold reveals silver contents in the range between 20 and 40 % (KURAT, 1986), pointing to its autochthonous origin.

In case of the locality Gschwendt, the smaller anomaly covers a granitic bedrock only (Weinsberg-type granite), which exhibits similar "epidote-healed veinlets" like the ones observed at Liebenau.

Both anomalies can presently be interpreted as being caused by only local and small auriferous qartz veins.

2.4. Tungsten

2.4.1. The Scheelite Mineralization at "Wietzen"

In analogy to scheelite mineralizations related to calc-silicate rocks known in the Bavarian (JUNG & HÖLL, 1982) as well as in the Czechoslovakian part of the Bohemian Massif (TENCIC, 1980, pers. comm.; see also MORAVEK & PUNCOCHAR, 1985), an investigation of equivalent rocks in the so called "Variegated series" led to the discovery of a similar mineralization close to the small village Wietzen, some 20 km W of Gföhl (GÖD, 1981; BERAN et al., 1985). The mineralization is bound to greenish calc-silicate rocks, intercalated in sillimanite-bearing gneisses. Diopside, scapolite, plagioclase, quartz and calcite are the main constituents of these rocks. The scheelite, accompanied by minor pyrrhotite and chalcopyrite, is exclusively linked to a calc-silicate variety, the composition of which is characterized by diopside-scapolith contributing to approximately four fifth of the whole rock. This close correlation of scheelite and rock composition, traceable at surface for about four km length suggests a genetic linkage between both.

The only other very minor scheelite occurrence is known at Streitwiesen, some 23 km SW of Wietzen and is again related to the same rock type as described above. In any case field evidence points to a stratabound, synsedimentary model of ore genesis (BERAN et al., 1985).

2.4.2. Remarks on Wolframite

So far, no wolframite mineralization has been found in the Southern Bohemian Massif. Nevertheless, wolframite is a minor but not uncommon constituent of heavy mineral concentrates taken from granitic areas. The only significant wolframite anomaly ever found lies around the Nebelstein (section 2.1.1.) and led directly to the discovery of the molybdenite-bearing greisens described earlier, though the greisens themselves are not wolframite-bearing at all. The origin of the wolframite grains is still unidentified.

2.5. Remarks on Tin

The only primary tin mineralizations known so far in the Southern Bohemian Massif are pegmatite-bound cassiterite showings around Neumarkt (Fig. 1; KIRCHNER et al., 1969). Nevertheless, cassiterite is a common constituent in almost all heavy mineral concentrates derived from granite-covered areas, though anomalous concentrations are spatially related to the Eisgarn-type granite. Field evidence doubtlessly links the cassiterite contents in stream sediments with the degree of weathering, emphasizing the secondary deposition of the mineral grains. An excellent example are the extended cassiterite anomalies between Gmünd and Litschau close to the state boundary. This area is already influenced by a comparably intensive weathering due to its neighbourhood to the eastern border of the Mesozoic to Tertiary basin of Southern Bohemia. In general, the cassiterite (with the exception of the above mentioned pegmatite-bound cassiterite) has to be interpreted as primary, accessory component of granitic rocks, secondary concentrated by weathering. No hints or indications on any kind of greisen- related tin mineralization have been found so far in the Southern Bohemian Massif.

2.6. Iron Ore Deposits and Mineralizations

2.6.1. Skarn-Type Magnetite Deposits

Refering to old reports as summarized in HOLZER & NEUWIRTH (1962), three skarn-type magnetite occurrences have been the subject of insignificant mining activities during the 19th century (Fig. 1): Lindau, Wolfsbach and Kottaun, the latter being the most important.

At Lindau and Wolfsbach practically no relics can be detected in the field any more.

Kottaun, however, has been investigated geophysically (GÖSCHKE & WINKLER, 1978) and mineralogically (GÖTZINGER, 1981) and represents the type of these mineralizations per se.

The mineralization is characterized by a pyroxene-magnetite rock and is hosted by paragneisses of the so-called "Variegated series". According to GÖTZINGER (1981), the deposit lacks sulphides completely. The pyroxene rocks are locally scheelite-bearing (GÖTZINGER, 1989; pers. comm.; this mineral has been also detected at the locality Lindau: THIELE, 1987; pers. comm.). Field evidence as well as compositional parameters of the pyroxenes emphasize a synsedimentary deposition of the iron and permits an interpretation of the mineralization as polymetamorphic internal reaction skarn (GÖTZINGER, ibid.). This is in sharp contradiction to NEMEC (1979), who generally describes equivalent regionally metamorphosed skarns on the Czechoslovakian territory as derived from "true skarns", formed by high-temperature metasomatism of carbonate rocks.

2.6.2. Stratiform Magnetite Mineralizations

An aeromagnetic survey (GUTDEUTSCH & SEIBERL, 1987), followed up by a ground check (J. ROSENTHALER, pers. comm.) led to the discovery of magnetite-bearing chlorite schists, traceable at surface for about 20 km. The mineralization continues on Czechoslovakian territory for at least another couple of km. The schists, probably of Precambrian age, belong to the Moravian zone of the Bohemian Massif and contain up to 20 vol.-% of magnetite and ilmenite. According to LIBOWITZKY (1989), the magnetite is hosted by metasediments, which comprise chlorite-schists, chloritic micaschists and biotite-rich schists; no metabasics have been observed. Following this author, thicknesses of the fine-grained, banded, magnetite-rich layers are in the order of 1 to 2 cm with a maximum of approximately 20 cm. The total thickness of the magnetite-containing rock sequence may reach about 100 m. The magnetite layers lack sulphides completely. Field evidence and chemical results strongly emphasize a sedimentary origin of the ore minerals, derived from a Proterozoic basic magma complex (LIBOWITZKY, ibid.).

3. Conclusions

1. Greisen-style mineralizations, petrogenetically related to relative shallow depths, seem to disprove a general interpretation of the Southern Bohemian Massif as being "deeply eroded".
2. With respect to the most likely genetic linkage of magnetite formation: with greisen-style mineralizations (sections 2.1.1. and 2.1.2.), all aeromagnetic anomalies discovered (SEIBERL & HEINZ, 1986) are worthwhile to be investigated under a minerogenetic point of view.
3. An economic importance of the molybdenite mineralization at Nebelstein has to be excluded due to the obviously deep level of erosion cutting the mineralized system at present. An economic potential of the molybdenite mineralization at Hirschenschlag is unlikely, as field evidence and drilling results suggest the center of the mineralized body located already on Czechoslovakian territory. Nevertheless, some more drilling is necessary for final interpretation.
4. The situation at the gold-prospect Liebenau remains unsolved. Though a genetic link between the silver-rich gold grains in stream sediments and the drilled alteration zones can hardly be denied, no ore body as such has been discovered so far. However, further prospecting activities seem to be worthwhile and should start with a detailed petrographic study concerning the alteration phenomena. To the best knowledge of the author and referring to MORAVEK (pers. comm.), the situation at Liebenau seems to be rather unique in the Bohemian Massif. In any case, the situation at Liebenau seems to be the very first indication to the possible occurrence of epithermal gold mineralizations in the Southern Bohemian Massif.
   The locally gold-bearing creeks at Grosshaslau and Gschwendt do not favour further prospecting, though the major structure passing the two areas (Fig. 1) would be an exploration target.
5. There is no doubt on the high prospectivity of the uraniferous areas indicated on Fig. 1.

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