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The Homolka Magmatic Centre – an Example of Late Variscan Ore Bearing Magmatism in the Southbohemian Batholith (Southern Bohemia, Northern Austria)

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10 Text-Figures, 6 Tables and 2 Plates

Czech Republic
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Bohemian Massif
Southbohemian Batholith
Homolka Granite
Petrology
Ore Mineralization
Geochemistry
Geochronology

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Zusammenfassung

Das Homolka-Intrusionszentrum liegt im nordwestlichen Teil des Südböhmischen Batholiths im Zentralmoldanubischen Pluton, der hauptsächlich aus dem zweiglimmerführenden Eisgarner Granit gebildet wird. Das Zentrum umfaßt mehr als dreißig Gänge mit Granitporphyren, Rhyoliten und dem gangförmig auftretenden Josefsthal Granit. Die Gänge verlaufen in einer deutlich N–S ausgerichteten Zone, die 20 km lang und 5 km breit ist. Im mittleren Teil der Zone, nahe der österreichisch-tschechischen Grenze, tritt ein stockförmiger, mittelkörniger, leukokrater Albit-Muskovit-Topas führender Granit auf, der Homolka Granit.

Der Homolka Granit ist aus einer hoch entwickelten, differenzierten, peraluminen Schmelze entstanden. Er ist stark angereichert an Lithium (über 500 ppm), Rubidium (mehr als 1000 ppm), Fluor (0.5–1 %), Zinn (50–300 ppm), Niob (bis 150 ppm) und Tantal (bis 60 ppm). Im Gegensatz dazu sind Ti, Mg, Fe, Ca, Sr, Ba, Zr und die Seltenen Erden stark abgereichert. Bemerkenswert hoch ist der Gehalt an Phosphor (0.5–1 %), der vornehmlich in den Alkalifeldspaten eingebaut ist.

Der Homolka Granit enthält disseminierte Körner von oxidischen Erzmineralen – gewöhnlich Cassiterit und sporadischen Ferrocolumbit und Nb-Ta hältige Rutile. Das Vorkommen der Erzminerale in Glimmerblättchen, die Columbit- und Rutileinschlüsse im Cassiterit und das Fehlen von durchdringender Vergreisung läßt auf ihre magmatische Entstehung schließen.

Sechs Proben des Homolka Granits ergeben nach der Rb-Sr-Methode ein Alter von 319±7 Mio. J., das durch Abkühlalter an Muskoviten, die nach der Ar-Ar Methode 317±2 bzw. 315±3 ergeben, gut abgesichert wird. Das initiale Sr-Verhältnis von 0.716±0.010 weist auf krustales Ausgangsmaterial hin.

Aus allen Daten läßt sich ein Modell für den Zentralmoldanubischen Pluton ableiten, nach dem Anatexis, Fraktionierung, Intrusion und Verfestigung des Eisgarner Granits gefolgt wurde von einer Intrusion stärker fraktionierter Gänge, die in der Platzname des Homolka Granits in einem seichten Niveau ihren Höhepunkt hatte. Diese Vorgänge dauerten ungefähr 10 Mio. J. (329–319 Mio. J.).

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Abstract

The Homolka magmatic centre is situated in the NW part of the Southbohemian batholith, formed mainly by two-mica Eisgarn type granite. The centre comprises more than 30 dykes of granite porphyries, rhyolites and dyke Josefsthal granite forming a distinct N–S trending 20 km long and 5 km wide zone. In the central part of the zone close to the Bohemian-Austrian border a stock of medium-grained leucocratic albite-muscovite-topaz granite (termed "Homolka" type) was found.

The Homolka granite represents a highly evolved peraluminous melt. It is strongly enriched in Li (more than 500 ppm), Rb (more than 1000 ppm), F (0.5–1 %), Sn (50–300 ppm), Nb (up to 150 ppm) and Ta (up to 60 ppm). In contrast, the contents of Ti, Mg, Fe, Ca, Sr, Ba, Zr, REE are strongly depleted. Remarkable is the high content of phosphorus (0.5–1 % P_2O_5) which is concentrated in alkali feldspars.

The Homolka granite contains disseminated grains of oxidic ore minerals – commonly cassiterite and sporadic ferrocolumbite and Nb-Ta rutile. The position of ore minerals within mica flakes, character of columbite and rutile inclusions in cassiterite and lack of pervasive greisenization suggest their magmatic origin.

Six samples of Homolka granite analysed by Rb/Sr method define the age of 319±7 Ma, which is in good agreement with Ar/Ar age of two muscovite samples giving a cooling age of 317±2 and 315±3 Ma. The initial Sr ratio 0.7160±0.010 supports a crustal protolith.

All data are consistent with a model of anatexis, fractionation, intrusion and solidification of batholith of two-mica Eisgarn type granite followed by a more fractionated granite dyke sequence and culminating in the high level intrusion of Homolka granite. This process lasted approximately ten million years (329–319 Ma).

1. Introduction

The Variscan Southbohemian (Moldanubian) batholith is the largest granitoid complex (6000 km^2) within the Bohemian Massif. It intruded high grade metamorphosed Moldanubian rocks on the both sides of Bohemian-Austrian border between Jihlava on the north and Donau river on the south.

The batholith is a complex body built by many intrusions of granitoids of different types. The succession of the individual granite types has been recently interpreted by FINGER & HÖCK (1986), SCHARBERT (1987), LIEW et al. (1989), KOLLER (1994) and VELLMER & WEDEPOHL (1994). All granitoids can be roughly divided into four principal groups:

1) The oldest, late-orogenic, variably deformed (350–335 Ma), associated with migmatitization and with relicts of charnockitic precursors (Weinsberg type granite and Rastenberg type granodiorite, KOLLER, 1994).
2) Younger, late- to post-orogenic, mostly undeformed (335–315 Ma) I-type biotite granodiorites and granites (Mauthausen type, Freistadt type).
3) Peraluminous two-mica Eisgarn type granite (328 Ma).
4) Different "post-Eisgarn" biotite and muscovite ore-bearing granites intruded in connection with late Variscan crustal relaxation and uplift (320–311 Ma).

The studied area lies in the central part of the so called "Central Moldanubian pluton", the largest individual (but not homogenous) body of the batholith. It is characterized by peraluminous two-mica granites of the third and fourth groups. From field evidence the following sequence of individual granite types can be established:

1) The "Lásenice" type granite – a fine-grained biotite to two-mica granite. It forms the NW margin of the Central Moldanubian pluton and several isolated bodies to the NW. It is slightly deformed in the vicinity of major shear zones (KLEČKA & RAJLICH, 1984).
2) The "Eisgarn" type granite – mainly medium-grained, partly porphyritic two-mica granite – forms the largest part of the pluton. A fine- as well as a coarse-grained variety were described, both probably slightly younger than the main medium grained facies. In the Bohemian part, the medium-grained type is termed "Číměř", the coarse-grained one "Landštejn".
3) Several types of granitoids intruded into Eisgarn granite forming dykes or small stocks:
   A) A fine-grained biotite granite with associated molybdenite-magnetite mineralization and indications of alkaline metasomatism, Hirschenschlag-Kozí hora type (GÖD, 1989).
   B) Different types of acid dyke rocks.
   C) A medium-grained albite-Li-muscovite-topaz granite with indications of cassiterite and columbite mineralization, Homolka type (BREITER et al., 1994).

From all these rocks, until now, only the Eisgarn granite was dated by Rb/Sr method giving 328 Ma (SCHARBERT, in prep.).

We suppose that the Homolka granite and the dyke swarm in its surrounding between Lásenice and Litschau are cogenetic, building a "Homolka magmatic centre". This paper aims to briefly characterize all rock types belonging to the Homolka magmatic centre (particularly in its southern part) and solve their petrogenetic and chronological relations, as well as their relations to the Eisgarn type granite.

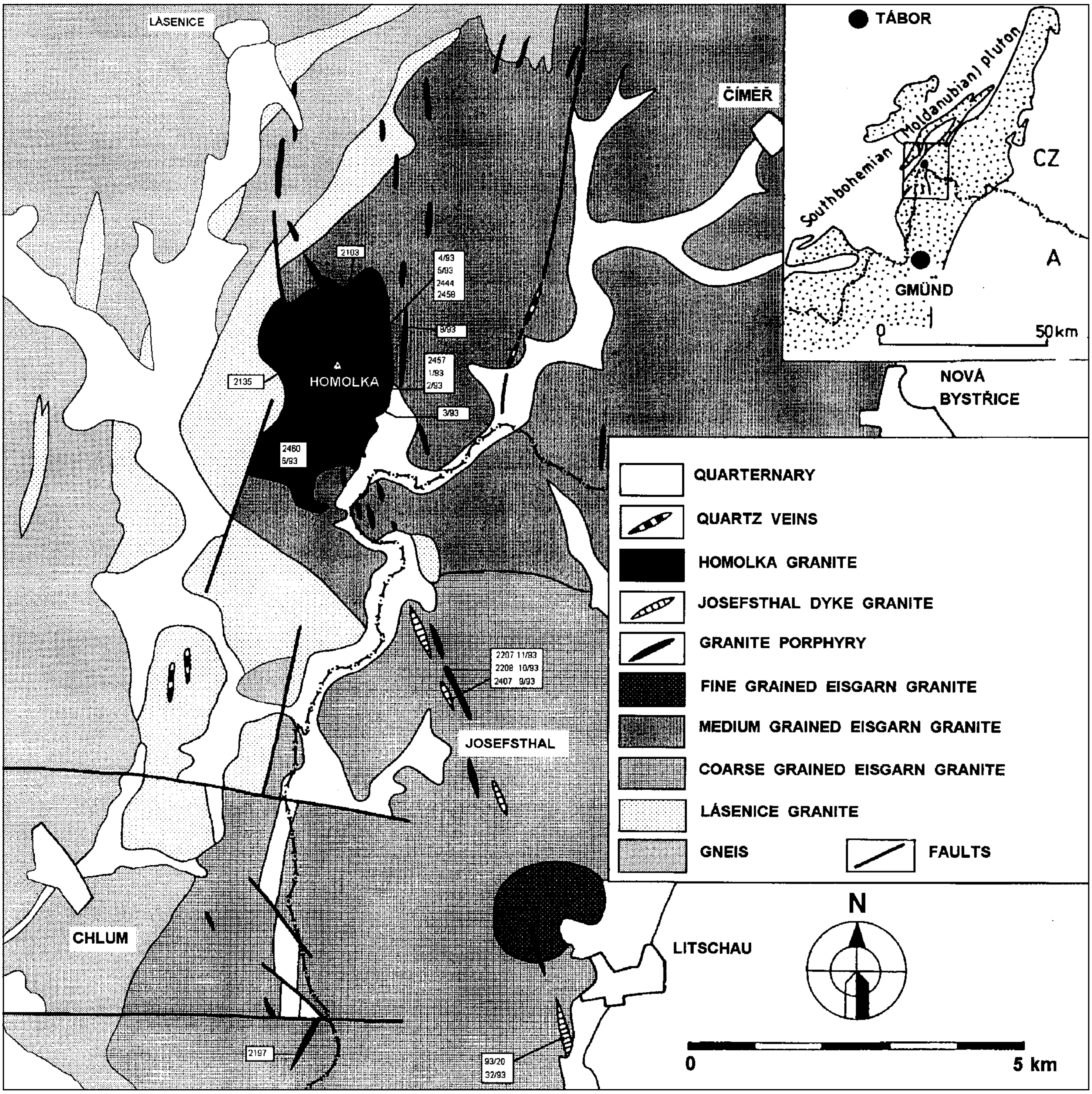
2. Geological setting

The studied area is situated in the NW part of the Central Moldanubian pluton of the Southbohemian batholith. The pluton is represented here mainly by two-mica Eisgarn granite, only along the NW margin the older Lásenice granite crops out. The country rocks of the pluton are cordierite-biotite paragneisses. The western part of the area is partly covered by Tertiary and Quaternary sediments (gravels, peat bogs) (Text-Fig. 1).

A swarm of more than 30 dykes of granite porphyries and dyke rhyolites forms a distinct N–S trending zone, about 20 km long and 5 km wide, between Lásenice in the north and Litschau to the south. The Austrian part of the zone was mapped by WALDMANN (1950), dykes in the surroundings of Lásenice were mapped by ZELENKA (1922) and newly interpreted by KLEČKA & VAŇKOVÁ (1988). After VRÁNA (1990), the dykes between Lásenice and Litschau are part of a longer, but not continuous "zone of volcano-tectonic activity" extending to the north of Pelhřimov town.

A new type of rock within this swarm was distinguished just recently in the surroundings of the settlement Josefsthal, WNW of Litschau. This is a fine-grained granite ("Josefsthal" type), its dykes run parallel to the dykes of granite porphyry.

Orientation of individual dykes is dominantly N–S in the northern part, and NW–SE in the southern part of the zone. A NE–SW trending dyke was also found. Individual dykes



Text-Fig. 1.
Geological map of the Homolka magmatic centre.

are 2–20 m thick and up to 1.5 km long. The dykes intruded both granites (Eisgarn as well as Lásenice) and gneisses of the pluton mantle. All dykes are subvertical, their contacts are sharp, without or with very weak alteration of country rocks.

In the central part of the zone, close to the Bohemian-Austrian border, a stock of medium-grained leucocratic granite has been found recently. Its surface outcrop of 6 km^2 is slightly elongated in N–S direction and forms a morphological elevation. After a hill in the centre the body was termed “Homolka” type granite (BREITER et al., 1994).

Several xenoliths of Eisgarn type granite and granite porphyry up to XOO m^2 were found in the central part of the granite body. Thus the granite is younger than the swarm of dyke rocks and represents the youngest intrusion of the Central pluton from geological field evidence.

According to geophysical parameters, the zone of dyke rocks and the Homolka granite stock lie in the western gradient zone of distinct gravity minimum whose center is south of Nová Bystrice. The minimum is interpreted (MOTTLOVÁ, 1982) as the root zone of the Eisgarn type granite intrusion in a depth of about 15 km. The magnetic field shows no anomalies in the studied area. Gamma-spectrometric survey (GNOJEK, BREITER, in prep.) shows a spectacular image of Homolka granite in the U/Th field in contrast to the surrounding Eisgarn and Lásenice granites.

3. Petrography and Mineral Chemistry

The dyke rocks in the area between the Homolka granite and the surrounding of Litschau can be divided in the field into three types (see textures on Plates 1 and 2):

Table 1.
Representative alkali feldspars compositions [%].
Microprobe analyses (analyst: J. Frýda). Recalculated on basis 8 oxygen atoms.
2103, 2017 = equigranular Homolka granite; 2135 = porphyritic Homolka granite; 2434 = Josefsthal dyke granite; 2196 = felsitic granite porphyry, SE Chlum u Třeboně; 2205 = granite porphyry, NW Litschau.

	2103	2017		2135				2434		2196		2205	
				porphyroblasts		groundmass		porphyroblasts		porphyroblasts		porphyroblasts	
SiO_2	64.64	62.89	68.08	65.10	68.41	65.21	68.36	64.76	67.68	64.58	66.81	65.18	69.35
Al_2O_3	18.98	19.17	19.77	18.61	20.01	19.00	20.06	18.11	20.39	18.665	21.35	18.23	19.71
CaO	.05	–	.135	–	.10	–	.14	.20	.18	.08	1.62	.09	.20
BaO	–	–	–	–	–	–	–	–	–	–	–	.20	–
K_2O	16.41	16.29	.16	15.78	.15	16.18	.10	16.38	.49	16.245	.04	16.47	.10
Na_2O	.36	.10	11.40	.80	11.57	.74	11.32	.31	11.13	.50	10.61	.37	11.59
P_2O_5	1.085	1.274	.493	.426	.30	.586	.33	.39	–	.190	.202	–	–
Suma	101.53	99.55	100.02	100.70	100.49	101.80	100.31	100.10	99.83	100.26	100.62	100.41	100.89
Si	2.94	2.91	2.97	2.98	2.97	2.96	2.97	2.99	2.96	2.98	2.91	3.01	3.00
Al	1.02	1.05	1.02	1.00	1.02	1.02	1.03	.99	1.05	1.01	1.09	.99	1.00
Ca	–	–	.01	–	–	–	.01	.01	.01	–	.08	–	.01
K	.95	.96	.01	.92	.01	.94	.01	.96	.03	.96	–	.97	.01
Na	.03	.01	.97	.07	.98	.06	.96	.03	.95	.04	.90	.03	.97
P	.042	.05	.018	.016	.011	.023	.012	.015	–	.007	.007	–	–

a) Felsitic dyke rhyolites, partly with fluidal fabric.
b) Granite porphyries.
c) Fine grained leucocratic Josefsthal dyke granite.

The structure of some thicker dykes is zonal and exhibits the fluidal rhyolite (type a) at the contact which passes gradually into granite porphyry towards the centre (type b). Josefsthal type granite crops out as separate dykes with chilled margins only in places.

The granite porphyry contains phenocrysts of quartz and red coloured alkali feldspar (up to 1 cm in size), rarely biotite, muscovite, and altered cordierite in a fine-grained groundmass of grey colour. The feldspar phenocrysts are mainly albite ($An_{<1}$, $Or_{<1}$) in the centre with kalifeldspar rims, but phenocrysts of pure albite ($An_{<2}$) and pure orthoclase ($Ab_{2–7}$) are found as well. Biotite is Al-rich and Si- and Mg-poor (Mg/Mg + Fe = 0.1–0.2). The groundmass contains quartz, albite ($An_{4–8}$), K-feldspar, and sericite.

The dyke rhyolite is macroscopically a massive rock. Microscopically it looks like the groundmass of the granite porphyry, in some cases with relicts of devitrified glass.

The Josefsthal dyke granite is of beige colour, fine-grained, equigranular, with only sporadic phenocrysts of alkali feldspar and quartz up to 3 mm. The rock contains quartz, albite (An_1), kalifeldspar ($Ab_{2–3}$), and sericite. Apatite is accessory.

The Homolka stock is relatively homogenous, composed of an equigranular medium grained leucocratic alkali feldspar granite (Plate 1). Only some schlieren of a porphyritic variety are developed in the W part of the body. It contains up to 1 cm large, almost euhedral and partly crushed quartz and even bigger feldspar phenocrysts in a fine-grained groundmass. Also schlieren and/or dykes of a fine-grained variety were found in several places. The marginal pegmatite (stockscheider) in form of big K-feldspar crystals (up to 10 cm) floating in a fine-grained granitic groundmass develops in some parts at the S- and W-contact of the stock and forms a rim around major xenoliths of Eisgarn type granite and granite porphyries in the central part of the body.

All textural varieties of Homolka type granite are built by quartz, albite ($An_{<5}$), orthoclase and Li-muscovite. Topaz is frequent, apatite, cassiterite, ferrocolumbite, and rutil are accessory. Albite ($An_{<1}$, $Or_{1–2}$; Tab. 1) is regarded as being of primary magmatic origin, since no indications of albitization of pre-existing plagioclase were observed. Subhedral to euhedral quartz grains sometimes contain inclusions of albite parallel arranged along their growth planes. This so-called “snow ball quartz” (Schwartz, 1992) are characteristic magmatic feature of rare-metal granites.

Orthoclase ($Ab_{2–3}$) forms mainly anhedral grains in interstices and subhedral phenocrysts in the porphyritic facies (here with $Ab_{4–8}$).

Muscovite is rich in Li (0.7–1.0 %), Rb (0.7 %), F (1.7–2.6 %) and Zn (800–900 ppm) and this corresponds to the rare type of Li-muscovite (Neiva, 1982) (Tab. 2). It occurs as sub- to anhedral flakes in interstitial fillings between feldspars and quartz. Some amounts of younger muscovite (sericite) were found to replace feldspars.

Topaz forms sub- to anhedral grains in interstices. According its shape belongs to a relatively late but yet magmatic phase.

A particularly remarkable feature of both feldspars, K-feldspar as well as albite, from all studied rocks is the high content of phosphorus in their crystal lattice (Frýda & Breiter in print). The P-content is systematically higher in K-feldspars than in albite. It increases from about 0.1 % P_2O_5 in feldspar phenocrysts of granite porphyries to about

Table 2.
Representative micas compositions [%].
Microprobe analyses (analyst: J. FRÝDA). Recalculated on basis 22 oxygen atoms.
2135 = porphyritic Homolka granite; 2103 = equigranular Homolka granite; 2017 = equigranular Homolka granite, by wet chemistry 1.04 % Li_2O, 0.69 % Rb_2O and .61 % F; 2106 = fine-grained Homokla granite; 2434 = Josefsthal dyke granite; 2196 = felsitic granite porphyry, SE Chlum u Třeboně; 2205 = granite porphyry, NW Litschau.

	Li-muscovite						muscovite			biotite	
	2135	2135	2103	2017	2106	2106	2434	2434	2205	2205	2196
SiO_2	46.02	45.94	47.21	46.99	47.20	46.35	47.23	47.22	46.60	33.10	33.82
TiO_2	.19	.36	–	–	.11	.11	.07	.24	–	6.08	3.07
Al_2O_3	34.02	30.58	31.29	33.02	31.14	34.14	35.11	28.83	36.20	18.13	18.72
FeO	2.46	5.43	5.59	4.76	4.66	3.20	2.78	8.74	.90	24.80	28.35
MgO	.48	.39	.16	.08	–	.12	.26	.19	–	4.12	2.25
MnO	.14	–	–	.23	.17	–	–	.26	–	.35	.79
Na_2O	.78	.47	.49	.56	.53	.51	.36	.05	.38	.08	.30
K_2O	10.72	10.38	11.13	10.9	10.77	11.06	10.98	10.94	10.21	9.15	9.46
Suma	94.95	93.75	95.98	96.68	94.53	95.66	96.90	96.67	94.07	95.51	96.47
Si	6.21	6.36	6.40	6.29	6.45	6.22	6.23	6.46	6.23	5.19	5.35
Al^{IV}	1.79	1.64	1.60	1.71	1.55	1.78	1.77	1.54	1.77	2.81	2.65
Al^{VI}	3.62	3.35	3.40	3.50	3.47	3.62	3.69	3.11	3.93	.55	.84
Ti	.02	.04	–	–	.01	.01	–	.02	–	.72	.37
Fe	.28	.63	.63	.53	.53	.36	.31	1.00	.10	3.26	3.75
Mg	.10	.08	.03	–	–	.02	.05	.04	–	.96	.53
Mn	.02	–	–	.03	.02	–	–	.03	–	.05	.11
Na	.20	.13	.01	.15	.14	.13	.09	.01	.10	.02	.09
K	1.85	1.83	1.93	1.86	1.88	1.89	1.85	1.91	1.74	1.83	1.91

1 % P_2O_5 in the feldspars of the equigranular Homolka granite (0.8–2.1 % in K-feldspar, 0.5–0.8 in albite).

All these minerals are of primary magmatic origin. Deuteric processes are restricted. Rare quartz veinlets with greisen rims, patchy chloritization, veinlets of barren milky quartz and flakes of U-micas in fissures were observed during detailed mapping (LOCHMAN, 1992, BREITER, 1993) and exploration activities (LITOCHLEB et al., 1991).

4. Geochemistry

About 60 samples of all rock types described were analysed in the chemical laboratory of Czech Geological Survey. The contents of major elements were analysed by wet chemistry, trace elements by XRF (Rb, Sr, Zr, Sn, Zn, Nb, Pb), OES (B, Be, Cu, Mo).

A few samples were analysed for REE , U, Th, Cs, Ba, Hf by ICP-MS at the Hahn-Meithner Institute in Berlin, and for Cl, Cs, Tl, Th, U, and W by XRF at the Technical University Berlin.

Representative analyses of all rocks types are listed in Tabs. 3 and 4.

The rocks of the Homolka magmatic centre represent a peraluminous (alumunium saturation index ASI 1.1–1.3) strongly differentiated suite. In comparison to the enclosing Eisgarn type granite they are enriched in Na, Rb, Li, Cs, F, P, Sn, Nb and Ta and depleted in Fe, Mg, Ca, Sr, Ba, Zr, Y, V, REE etc.

These chemical characteristics are well expressed by the dyke rocks, but much better by the Homolka granite itself (Figs. 2, 3).

Characteristic contents of major elements are: SiO_2 72–74 % , Al_2O_5 14–15 % in dykes and 14–16 % in granite, $Fe_2O_3 < 1$ %, MgO< 0.1 %, Na_2O 3.2 % in dykes and 4.0–4.5 % in granite. The potassium content decreases from 4–5 % K_2O in the dyke suite to 3.5–4 % K_2O in Homolka granite, where it is exceeded by sodium.

Table 3.
Representative chemical analyses of rock types [%].
Analysed by wet chemistry in CGS Praha (analysts: V. SIXTA et al.). A/CNK = aluminium saturation index $Al_2O_3/(CaO = + Na_2O + K_2O)$.
2103 = medium-grained Homolka granite, N part of the body; 2457 = medium-grained Homolka granite, E part of the body; 2444 = medium-grained Homolka granite, central part of the body; 2458 = fine-grained aplitic granite, central part of the body; 2460 = border pegmatite (stockscheider), SE margin of the body; 2135 = porphyritic Homolka granite, W part of the body; 2407 = Josefsthal dyke granite, NW Litschau; 2208 = felsitic granite porphry, NW Litschau; 2197 = felsitic granite porphry, SE Chlum u Třeboně; 2207 = granite porphyry, NW Litschau.

No.	2103	2457	2444	2458	2460	2135	2407	2208	2197	2207
SiO_2	72.86	73.11	72.33	73.37	69.81	73.29	74.40	72.39	74.36	73.39
TiO_2	.01	.01	.02	.03	.05	.07	.04	.11	.047	.046
Al_2O_3	14.64	14.94	15.36	15.08	16.64	14.56	13.89	14.37	14.46	14.02
Fe_2O_3	.75	.62	.80	.41	1.10	.87	.81	1.28	.91	.85
MnO	.05	.197	.034	.036	.026	.04	.038	.035	.03	.037
MgO	.02	.04	.04	.04	.09	.96	.04	.20	.11	.06
CaO	.61	.63	.42	.58	.46	.47	.54	.59	.28	.45
Li_2O	.160	.070	.092	.033	.101	.088	.049	.052	.028	.025
Na_2O	4.34	4.50	4.44	5.01	2.83	4.01	3.80	3.94	2.33	4.12
K_2O	3.55	3.39	3.72	3.64	7.37	4.23	3.84	4.17	3.70	3.77
P_2O_5	.77	.93	.43	.78	.63	.48	.35	.48	.327	.368
F	.53	.479	.325	.381	.427	.33	.36	.34	–	.239
LOI	1.25	0.99	1.24	.84	1.22	1.15	1.16	1.12	1.30	.97
TOTAL	100.13	100.00	100.07	100.57	100.41	99.25	99.13	98.91	97.85	98.23
A/CNK	1.21	1.19	1.27	1.14	1.23	1.21	1.22	1.19	1.73	1.20

Table 4.
Representative trace and rare earth elements contents [ppm].
Ba, Cs, Hf, Pb (part), Th, U, Y and REE by ICP-MS (analyst: P. DULSKI). Others by XRF (analyst: M. PELIKÁNOVÁ).
Numbers of samples see table 3.

No.	2103	2457	2444	2458	2460	2135	2407	2208	2197	2207
As	<7	<7	<7	<7	21	24	<7	<7	<7	<7
B	12	21	33	19	20	46	20	10	18	13
Ba	–	6	9	11	10	–	9	104	–	10
Be	2	2	2	2	2	2	3	2	4	2
Bi	<2	3	4	2	16	<2	3	<2	<2	<2
Cs	112	64	65	62	123	48	34	41	–	32
Cu	2	3	9	5	1	3	1	1	2	34
Ga	35	37	41	32	41	34	35	32	42	40
Hf	–	1.6	2.3	1.8	1.8	–	1.4	1.8	–	1.6
Mo	2	1	1	1	2	<1	2	1	<1	1
Nb	47	61	46	64	37	31	19	26	32	19
Pb	<7	3	4.9	3.4	8.9	<7	9.4	15.1	<7	12.7
Rb	1220	1305	984	1211	1034	802	601	388	751	590
Sn	145	166	75	83	58	58	22	10	29	27
Sr	294	37	22	33	21	21	–7	15	60	–7
Ta	25	–	–	–	–	18	9	–	–	–
Th	–	.6	1.9	.2	1.8	–	2.4	6.9	–	1.6
U	9	21	31	2.1	3.9	11	4.9	5.5	<15	5.4
V	<2	<2	<2	<2	<2	<2	<2	2	2	<2
W	–	–	12	–	–	–	4	–	–	–
Y	4	2.3	14	1.6	8	14	7	8.4	<7	4.6
Zn	98	88	114	58	90	94	50	28	35	43
Zr	22	10	23	–7	24	10	14	–7	17	–7
La		.658	2.41	.402	2.57		1.85	10.1		2.09
Ce		1.52	5.78	.788	6.02		4.47	21.7		4.34
Pr		.207	.762	.102	.798		.588	2.68		.559
Nd		.788	2.95	.372	2.91		2.06	9.98		2.01
Sm		.393	1.129	.241	1.14		.904	2.53		.745
Eu		.0024	–	.0072	.0152		–	.197		.0289
Gd		.414	1.25	.265	1.25		.986	2.348		.824
Tb		.0931	.274	.0601	.293		.212	.358		.175
Dy		.460	1.42	.293	1.53		1.21	1.73		.922
Ho		.0568	.209	.0329	.218		.203	.256		.136
Er		.138	.492	.805	.544		.547	.613		.352
Tm		.0218	.081	.0117	.0756		.080	.0834		.05
Yb		.164	.491	.0970	.524		.498	.510		.35
Lu		.0185	.060	.0110	.0626		.060	.0670		.0418

Remarkable is the high content of volatils: F (0.3–0.6 %) and P (0.3–0.4 % P_2O_5 in dykes, 0.4–1.0 % in granite), while Cl and B are negligible (Cl < 25 ppm, B < 30 ppm).

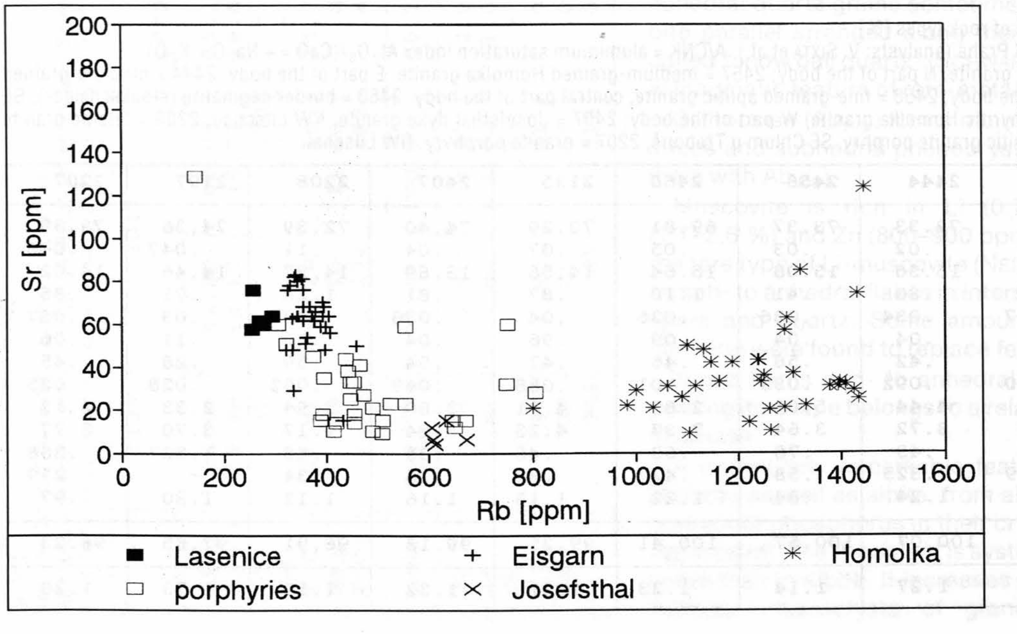
The high grade of magmatic fractionation is demonstrated by the enormous amount of rare alkalies – Rb (400–1500 ppm), Li (250–700 ppm) and Cs (50–100 ppm).

Remarkably high are the contents of rare metals in Homolka type granite like Sn (30–300 ppm), Nb (30–150 ppm) and Ta (up to 60 ppm), the highest values even identified within the Bohemian Massif. In contrast, contents of these elements are much lower in dyke rocks (Sn < 30 ppm, Nb < 30 ppm, Ta < 10 ppm).

From other metals, Zn is in the suite slightly enriched (60–90 ppm), which is a characteristic feature of many rare metal granites. Other ore elements like Bi, Cu, Mo and W, which are enriched in some Sn-granites (Cu in Cornwall, Mo in eastern Erzgebirge etc.), are depleted in the Homolka suite.

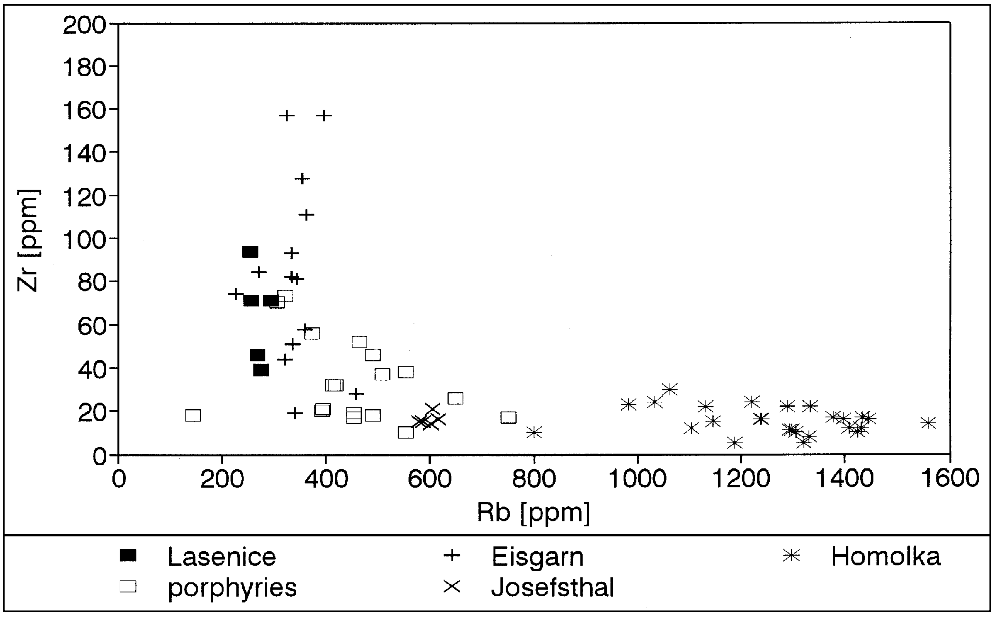
The compatible trace elements are depleted in dyke rocks and in the granite their contents are even lower: Sr (10–60 ppm), Ba < 50 ppm, Zr 20–50 ppm in dykes, < 20 ppm in granite, Y mostly < 10 ppm, Th 2–10 ppm in dykes, < 5 ppm in granite, V mostly < 2 ppm, Sc 1–3 ppm.

Still, we must mention the high content of Sr, up to 300 ppm, in a few places in visibly unaltered granite. This feature was found in other P-rich rare metal granites as well (Beauvoir granite, RAIMBAULT & AZENCOT, 1987), but not explained.



Text-Fig. 2.
Sr vs. Rb plot for rocks of Homolka magmatic centre.

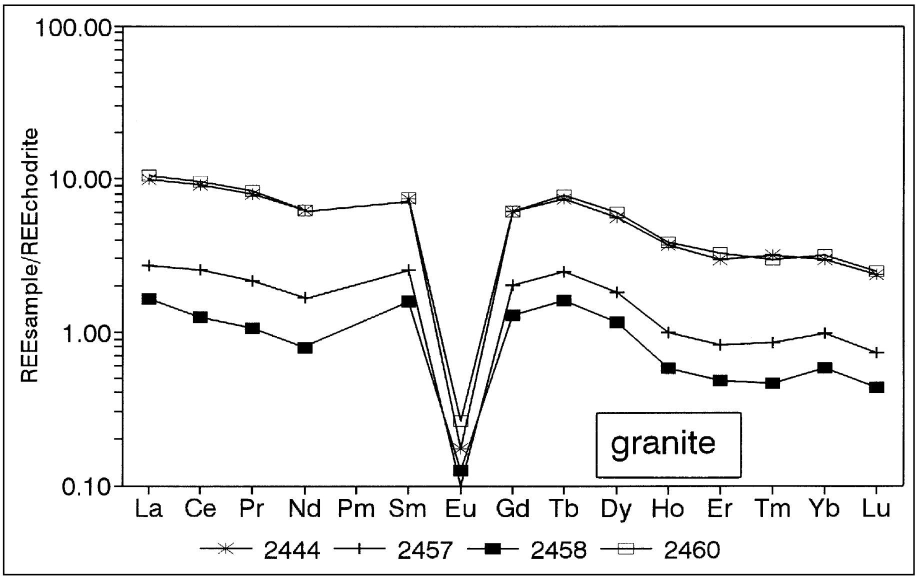
Text-Fig. 3.
Zr vs. Rb plot for rocks of Homolka magmatic centre.



Uranium is enriched in the suite, in the Homolka type granite it rises to 30–40 ppm. While the Th content is very small, the U/Th is high (5–10). The U/Th ratio in the enveloping Eisgarn type granite is about 1–2. These contrasting values are suitable for a gamma-spectrometry survey to detect a boundary of granite in badly exposed areas (GNOJEK, BREITER in prep.).

The content of REE is consistent with other geochemical characteristics (Figs. 4, 5). The total amount of REE is very low in dyke rocks and extremely low in Homolka type granite. LREE are slightly enriched ($Ce/Yb_{CN} < 5$), and all rock types show prominent negative Eu-anomaly.

All chemical characteristics support a long evolution of magma via fractional crystallization.

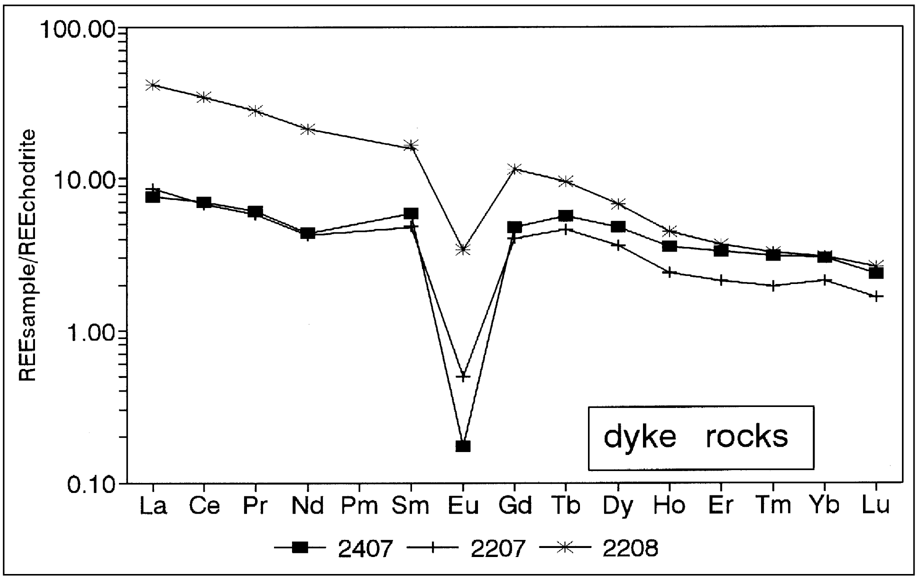


Text-Fig. 4.
Chondrite-normalised distribution of REE in the Homolka granite.

5. Ore mineralization

The Homolka type granite contains disseminated grains of oxidic ore minerals – commonly cassiterite and sporadic ferrocolumbite and Nb-Ta rutile.

Cassiterite forms mainly subhedral inclusions (0.x mm) in micas, but in placers along W-contact of the granite body were found

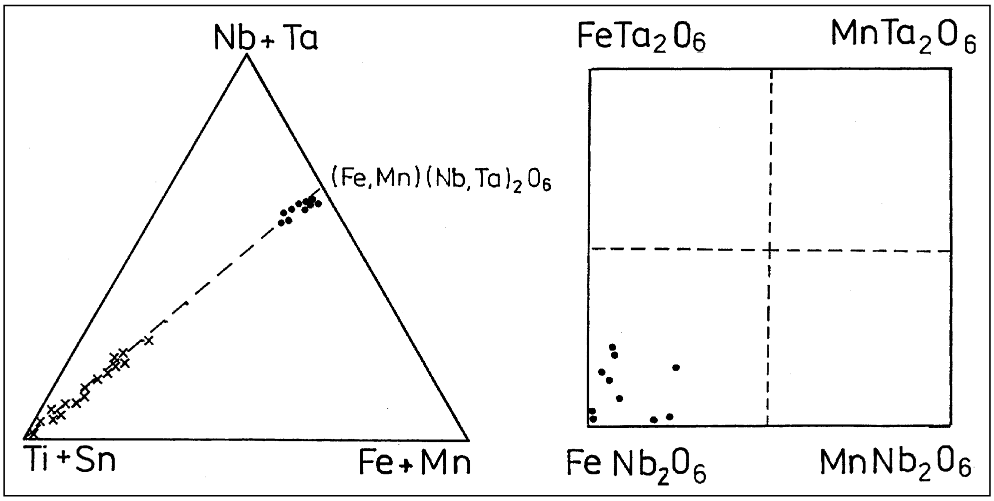


Text-Fig. 5.
Chondrite-normalised distribution of REE in dyke rocks.

Table 5.
Representative Sn-Nb-Ta-Ti mineral compositions [%].
Microprobe analyses (analyst: J. FRÝDA). Recalculated on basis 12 oxygen atoms for columbite and 2 oxygen atoms for rutile and cassiterite.

	columbite				rutile			cassiterite	
FeO	14.76	19.16	17.28	13.90	3.41	7.81	7.86	.23	.46
MnO	.72	.31	.58	5.11	–	–	–	–	–
CaO	–	–	–	–	–	.18	–	.37	.51
TiO_2	7.30	4.13	6.29	3.76	87.72	54.37	53.20	.51	.65
SnO_2	2.67	.98	1.67	1.06	1.71	3.2	2.94	99.06	95.53
Nb_2O_5	49.88	66.66	57.78	54.97	6.26	18.91	14.37	.55	1.38
Ta_2O_5	20.87	3.90	14.82	17.14	6.07	17.10	23.86	–	1.12
WO_3	1.91	5.04	1.43	3.11	–	–	–	–	–
TOTAL	99.07	100.23	99.90	99.08	102.30	101.39	100.80	100.80	97.45
Fe	1.60	1.83	1.695	1.41	.04	.105	.11	.005	.01
Mn	.07	.03	.06	.53	–	–	–	–	–
Ca	–	–	–	–	–	.003	–	.01	–
Ti	.67	.35	.555	.34	.89	.66	.66	.01	.01
Sn	.13	.04	.08	.05	.01	.02	.02	.975	.95
Nb	2.74	3.44	3.06	3.02	.04	.14	.11	.006	.015
Ta	.69	.12	.47	.57	.023	.075	.11	–	.008
W	.06	.15	.04	.10	–	–	–	–	–

Text-Fig. 6.
Classification diagrams for Nb-Ta minerals.
a) triangle Nb+Ta – Fe+Mn – Ti+Sn shows substitution between columbite and Nb-rutile.
b) columbite-tantalite classification diagram.



grains up to 5 mm in diameter. The high Nb- and Ta-contents of cassiterite (see Tab. 5) is in agreement with its supposed high temperature (magmatic) origin (TAYLOR, 1979).

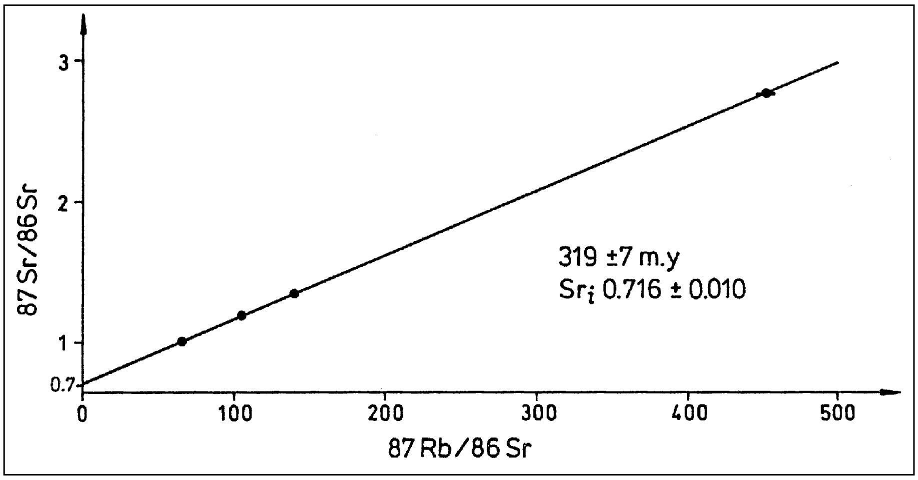
Ferrocolumbite occurs mainly as inclusions in cassiterite, rarely as individual grains (NOVÁK et al., 1994). Its chemistry (Nb>Ta, Fe>>Mn, Tab. 5) is consistent with other occurrences in sodic granites (ČERNÝ & ERCIT, 1989).

In cassiterite rare inclusion of Bi-rich minerals – bismuthine weylandite were found.

Rutile occurs as inclusions in cassiterite. Its composition ranges from near pure TiO_2 to having a significant columbite component (Text-Fig. 6). This is a common feature of rutile crystallised from pegmatite and pegmatite-like melt (ČERNÝ, 1989). The ratio Ta/Nb in rutile is higher than in columbite.

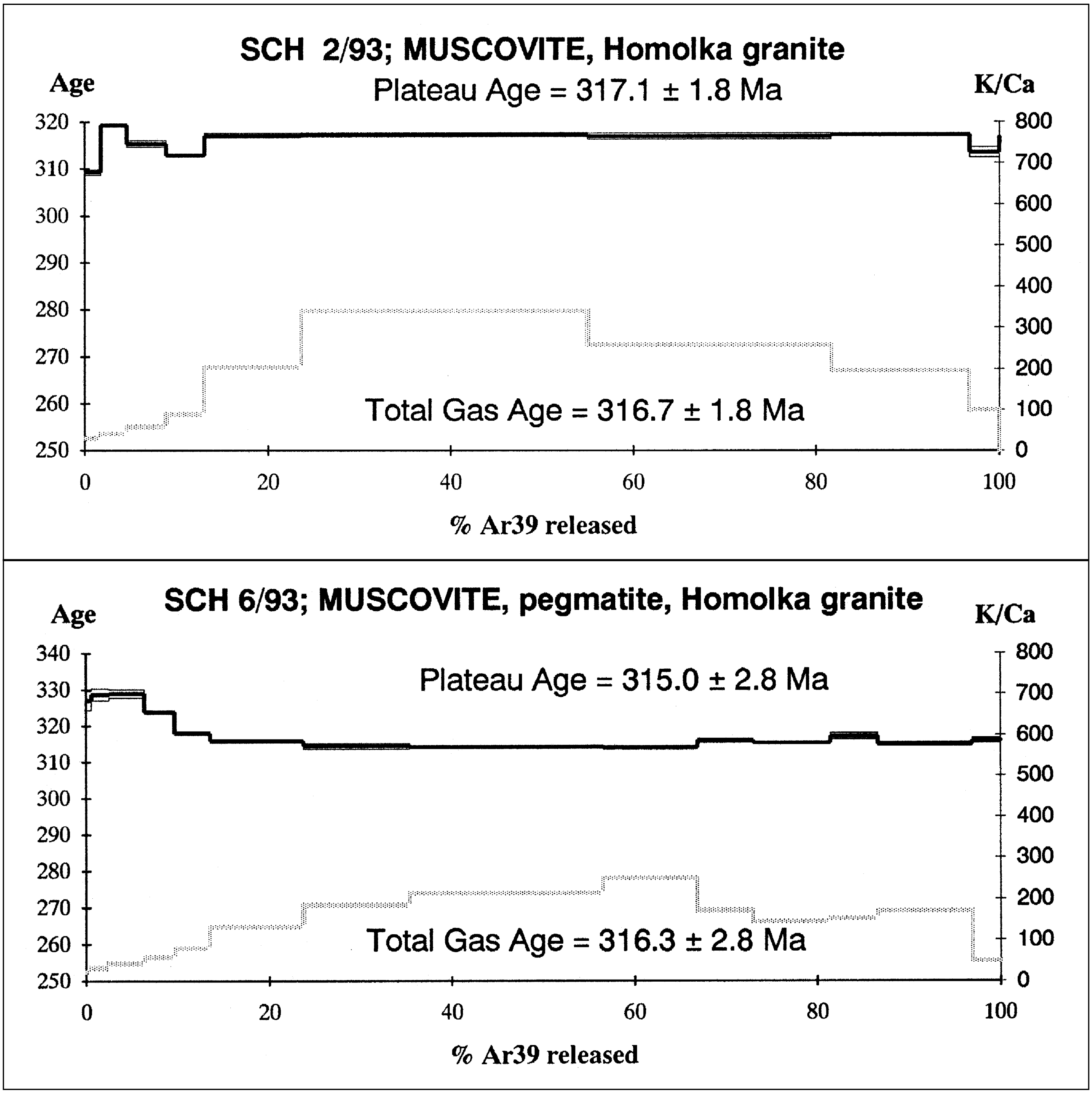
Table 6.
Rb and Sr analytical data of Homolka and Josefsthal granites.

Sample	Locality sheat	longitude	latitude	Rb ppm	Sr ppm	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	Error
Homolka granite								
1/93	ÖK 1	652400	433030	1394	30.59	140	1.35201	0.00021
2/93	ÖK 1	652400	433030	1262	9.718	453	2.76498	0.00019
3/93	ÖK 1	652075	433075	1250	36.4	104.4	1.19374	0.00011
4/93	ÖK 1	651700	433175	1162	33.2	106.3	1.19572	0.00011
5/93	ÖK 1	651715	433350	1100	49.9	65.86	1.01409	0.00009
6/93	ÖK 1	651300	431750	1001	28.6	106.4	1.20434	0.00019
Josefsthal granite								
9/93	ÖK 5	652900	429300	632	14.9	130	1.30073	0.00016
10/93	ÖK 5	653030	428800	611	4.295	505	2.97898	0.00022
32/93	ÖK 5	655020	422875	608	5.88	347	2.30583	0.00013
93/20	ÖK 5	655020	422850	673	5.85	395	2.50921	0.00021



Text-Fig. 7.
Isochron plot of Homolka granite.

Both, rutile as well columbite, form irregularly shaped and distributed inclusions in cassiterite. This suggests that the inclusions were trapped, i.e. that it did not originate by exsolution, and that crystallisation of all three minerals was penecontemporaneous (LINNEN & WILLIAMS-JONES, 1993). The position of ore minerals grains in mica and lack of pervasive greisenization support the primary


SCH 2/93; MUSCOVITE, Homolka granite

SCH 6/93; MUSCOVITE, pegmatite, Homolka granite

Text-Fig. 8.
Ar-release pattern of muscovites from Homolka type granite.

magmatic origin. Postmagmatic quartz veinlets with greisen rims (mm to cm in dimension) have been found only rarely.

In some parts of the border pegmatite (stockscheider) common euhedral crystals of arsenopyrite (up to 5 mm) were found. The flakes of U-mica in fissures in the central part of the Homolka body are a postmagmatic product of ground water circulation. Uranium being leached from primary minerals in granite is precipitated in oxidic near-surface conditions.

In a granite porphyry dyke N from the Homolka body quartz veinlets with Fe-rich wolframite (KLEČKA, 1986) were found.

6. Geochronology

For isotope dating we collected a suite of six Homolka type granite samples, four samples of Josefsthal type granite dykes and several granite porphyries (Text-Fig. 1). The dykes are still a matter of current investigation.

Total rock samples were analysed for Rb and Sr by isotope dilution method using standard ion exchange techniques and a mixed spike enriched in ^{84}Sr and ^{87}Rb. The isotopic ratios were measured with a MM30 solid source mass spectrometer. The ^{87}Sr/^{86}Sr ratios were calculated from spiked samples. The constants used for calculations are those from STEIGER & JÄGER (1977). The isochrons were calculated with the computer program ISOPLOT by LUDWIG (1992) using the York fit model (YORK, 1969), where the scatter of points is assumed to be due to analytical errors. All errors quoted are on the 95 % confidence level.

Muscovite was isolated from two sample localities by crushing, sieving and repeated grinding followed by magnetic purification. After irradiation in an ASTRA reactor at the Forschungszentrum Seibersdorf and cooling the ^{40}Ar/^{39}Ar ratios were measured by stepwise heating an a VG5400 gas mass spectrometer. The analytical procedure of the Ar/Ar techniques is described by FRANK & SCHARBERT (1995, in prep.).

The data of the analysed samples are given in Tab. 6.

The coarse grained granite porphyries are rather uniform in regard with Rb and Sr, while the fine grained types ("felsitic dyke rhyolites") vary much more and have higher Rb/Sr ratios. The Josefsthal granite dykes sampled around Rubitzko pond and S of Litschau at Schönau are poorest in Sr compared to all other magmatites, and rich in Rb. A preliminary age calculation on the basis of four samples analysed gives an apparent age of 319 Ma. The surrounding Eisgarn type granite must have cooled off already because the dyke at Schönau exhibits chilled margins toward the contact.

The Homolka type granite samples vary in texture from normal medium grained to fine grained types (sample 4/93). Sample 6/93 has a pegmatitic texture as it is often developed at the contact to Eisgarn granite (stockscheider). One sample (2/93) was taken from close to a altered portion, having the lowest value in Sr, and thus demonstrating the depletion of Sr during high temperature alteration. Still the sample falls on the isochron (Text-Fig. 7). Like the young intrusion of Nebelstein (SCHARBERT, 1987) this also proves that cristallisation/solidification of the granite material and transformation to greisen type rocks are very close in time. The six samples analysed, all extremely rich in Rb, define a line whose slope corresponds to an age of 319±7 Ma. Due to the high Rb/Sr valuesthe initial Sr isotopic ratio is poorly defined with a value of 0.716±0.010 (MSWD 2.34).

The cooling of muscovites through the 400–370°C temperature interval is dated by ^{40}Ar/^{39}Ar plateau ages of 317±2 and 315±3 Ma which are identical within the limits of error, and very close to the cristallisation age of the granite (Text-Fig. 8).

7. Discussion

7.1. Relation to Other Moldanubian Granites

In the last five years relatively young, late Variscan P-rich granitoids were found throughout the whole Moldanubicum – from Pelhřimov on the NE (VRÁNA, 1990), through Homolka (this study), the Nové Hrady area (BENDL et al., 1994), Jenín at Rožmberk (BREITER, 1995), Sedmihoří at Domažlice (unpublished author's materials) to Waidhaus-Rozvadov area on the W (BREITER & SIEBEL in print). All these granitoids

– intruded as small stocks or dykes after large volumes of two-mica (Eisgarn-type) granites had formed,
– are geologically the youngest intrusions in all areas,
– intruded in N–S zones of extensional tectonics,
– are mineralogically characterised by albite, Li-mica (Li-muscovite or zinnwaldite), topaz, and accesory cassiterite and columbite,
– are chemically peraluminous, strongly differentiated, enriched in P, F, Li, Rb, Sn, Nb and depleted in Fe, Mg, Ca, Sr, Ba, Zr, REE etc.

Within the Moldanubicum also pre- or early-Variscan P-rich granitoids were found – orthogneisses (POVONDRA & VRÁNA, 1993) and metaaplites and metapegmatites (BREITER & SIEBEL in print), those without enrichement of rare alkalies and metals in contrast to the late Variscan ones.

Generally two models are proposed to explain the genesis of the P-rich granitoids:

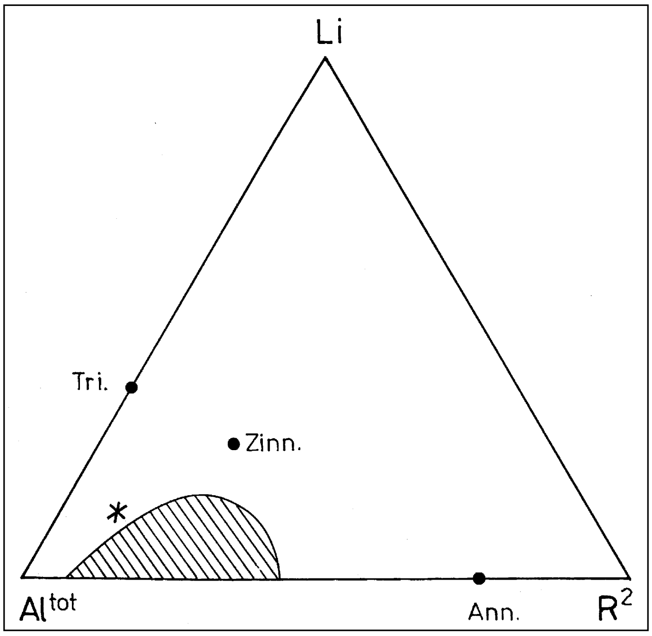
1) The P-rich granitoids are the product of independent magma batches, evolved from a specific P-rich protolith. In this case, the P-rich magmas can be produced during pre- or early-Variscan to late Variscan times in some regions, but can not explain the enormous enrichment of rare alkalies and ore elements.
2) P-rich granitoids represent a rest after evolution of large volumes of two-mica granites via fractional crystallisation. This is supported by a high degree of chemical specialisation of granites of the Homolka type explainable only through long fractional crystallisation. The propagation of P-granites in short time interval to the slightly older two-mica granites also supports the genetic relations. Also the high Sr_i is consistent with a high-level crustal protolith and not with a new input from the deep crust.

On the basis of all mentioned arguments, we support the interpretation of the Homolka and other Moldanubian P-rich rare metal-bearing granites as the latest products of crystal fractionation of peraluminous melts, whose main product was the Eisgarn two-mica granite. High peraluminity caused an unusual enrichment of phosphorus (LONDON et al., 1993) and rare metals in latest small portions of melt.

7.2. Geological Significance of High P-content

The unusually high content of phosphorus in all rock types of the Homolka magmatic centre is mineralogically expressed by particularly high P-content in alkali feldspars (Frýda & Breiter, 1995). The content of P_2O_5 in the melt determined the melt structure and hence their physical and thermodynamic properties (Dingwell et al., 1993, London et al., 1993). The content of P_2O_5 in magmatic batches increased throughout the main stages of magma crystallization. Since the crystallization of apatite in peraluminic melts is metastably suppressed, the phosphorus enters the feldspar crystal structure. The increase of P-content in the order feldspar phenocrysts in granite porphyry – feldspars in groundmass in granite porphyry – feldspars in Homolka granite is concordant with the increase of the P-content in the same sequence of rocks (nucleation of apatite was suppressed). During the late stages of granite crystallisation the P-content in feldspar sharply dropped due to apatite nucleation and crystallization. Thus following aplite has lower P-content and it contains alkali feldspars nearly without phosphorus.

High F- and P-contents in peraluminous melt have distinct influence on the decrease of melt viscosity (Dingwell et al., 1993) and solidus temperature, and thus was one of the features which enabled the magma to rise near to the paleosurface. This is consistent with preliminary results of fluid inclusions giving the depths of Homolka granite-crystallization about 1 km (Belocky & Högelsberger, 1994).



Text-Fig. 9.
Position of Li-muscovite from Homolka granite within the mica classification diagram after Monier & Roberts (1986). The inmiscibility gap between muscovite and ferrous micas is shown.
Tri = trilithionite; Zinn = zinnwaldite; Ann = annite.

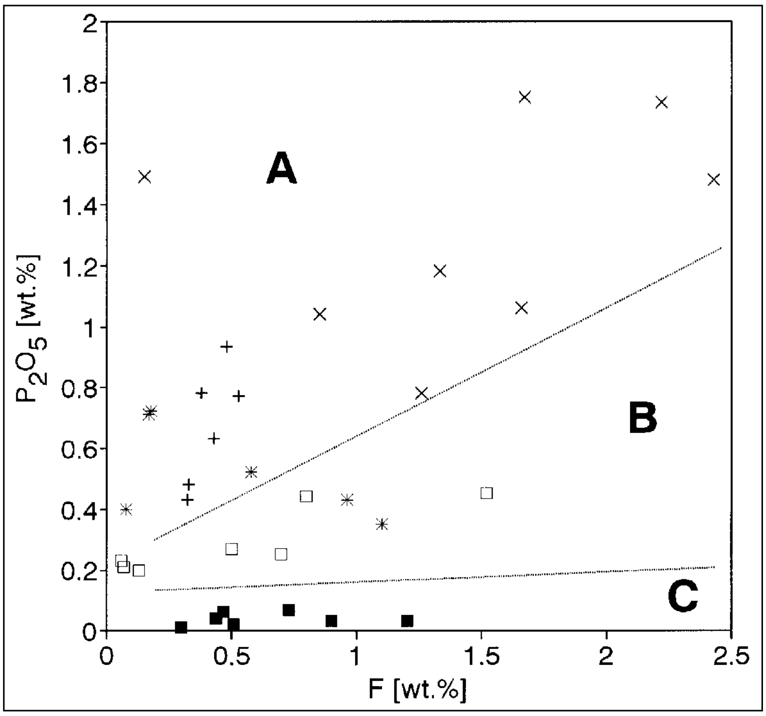
7.3. Lack of Mineralization

Though the content of rare metal in unaltered Homolka granite is very high – Sn 30–300 ppm, Nb 30–150 ppm, no visible mineralization was found in outcrops. Only disseminated grains of ore minerals occur in some samples. The relatively high content of ore minerals and topaz in Quaternary and Tertiary sediments S and W from the granite body supports a model of greisen-like mineralization in apical, now eroded portions of the intrusion.

7.4. Primary Character of Li-Mica

The Li-muscovite in Homolka granite is primary looking. The minimum pressure at which primary muscovite can crystallize is commonly considered at 3 kbar (11 km). That is in controversy to geological evidences. From fluid inclusion studies and fast cooling rates derived from geochronological data the shallow depth of the Homolka intrusion is confirmed (1–2 km, Belocky & Högelsberger, 1994). Schleicher & Lippolt (1981) and Pichavant et al. (1988) showed that muscovite may be a low pressure magmatic phase, if the melt is felsic, peraluminous and F-enriched. F-rich muscovite can crystallize at temperatures of 650–600°C and pressures of 1–0.5 kbar (Pichavant et al., 1988). Experimental data for Li-rich muscovite are lacking. In analogy to peraluminous melt whose solidus temperature is lowered by lithium and fluorine (Stewart, 1978) it can be expected that the stability curve of muscovite is shifted to lower temperature and pressure too. The crystallization conditions at 0.5 kbar are consistent with an intrusion depth of 1–2 km estimated by Belocky & Högelsberger (lc.).

Lithium-rich muscovites are more scarce than Li-Fe micas of protolithionite-zinnwaldite type. For Li-muscovites the criteria proposed for distinguishing primary/secondary muscovite origin (Miller et al., 1981, Dempster et al., 1994) are unapplicable. In Cornubian granites,



Text-Fig. 10.
The P_2O_5 vers. F typology of ore-bearings granites after Breiter, 1994).
A = field of rare-metal granites from the Moldanubian zone of Variscan Europe; B = field of typical tin-bearing granites; C = field of “anorogenic” granites; + = Homolka granite; ✳ = Křížový kámen/Kreuzstein granite from the western Bohemia-Oberpfalz border; × = granites from French Massif Central (Cuney & Raimbault, 1991); ■ = granites from the eastern Krušné hory Mts.; □ = granites from the western Krušné hory Mts.

the Li-muscovites are interpreted as secondary, as a product of zinnwaldite alteration (Henderson et al., 1989). The Homolka granite is more felsic (0.4–0.8 % Fe_2O_3 tot) than most of Cornubian granites (1–1.8 % Fe_2O_3 tot, Charoy, 1986; Stone, 1992) and no rests of older Fe-richer mica were found here. The composition of Homolka muscovite lies out of the inmiscibility gap between muscovite and Fe-rich micas (Text-Fig. 9, Monier, Roberts, 1986), thus the crystallization of this mica directly from melt is possible and we assume that it is a primary magmatic phase.

7.5. Comparison with Other Rare-Metal Granites

The Homolka granite is an example of a relatively scarce type of rare metal-bearing granites. In general, granite suites enriched simultaneously in Sn, Nb and Ta (apart from the peralkaline rocks with Nb>>Sn, Ta) can be divided after their contents of F and P into two groups (compare with Pollard, 1989; Raimbault et al., 1991; Taylor, 1992):

1) Granites poor in phosphorus with F>>P ($P_2O_5 < 0.1$ %) – build suites with dominantly biotite granites. The youngest phases are rich in albite, Li-mica (zinnwaldite or lepidolite) and topaz. Geochemically there are significantly high contents of HFSE-Th, Y, Zr, HREE.
   Geologically they are associated with extension tectonics, volcanism and building of caldera. Examples are the Proterozoic granites of Saudi Arabia (Jackson, Ramsay, 1986), the Jurassic granites of Nigeria (Bowden, 1985), the Orlovka massif in Transbaikalia, the Ongon Khairkhan in Mongolia (Stemprok, 1991), the Cínovec granite in eastern Krušné hory/Erzgebirge Mts. (Breiter et al., 1991). There are plutons with a relatively "early" disseminated mineralization, e.g. in the albite-lepidolite varieties with Ta>Sn (Orlovka, Transbaikalia). Others have a late mineralization in greisens controlled by brittle tectonics, mostly with Sn>Nb+Ta (Cínovec).
2) Granites rich in phosphorus with P = F or P>F ($P_2O_5 > 0.5$ %) build dominantly small stocks of albite-Li-muscovite or lepidolite granite with topaz and disseminated ore minerals. Chemically they are extremely poor in HFSE, rich in ore elements in unaltered rocks.
   These granites are less common. The best known occurrences are in the Massif Central in France – Beauvoir and Montebras (Raimbault & Azencot, 1987, Cuney & Raimbault, 1991). The Yichun granite in China (Raimbault et al., 1991, Schwartz, 1992), the Bosworgey granite in Cornwall (Ball & Basham, 1984) and the Podlesí granite in western Krušné hory/Erzgebirge (Breiter, 1994) show similar features. The ore in P-rich granites is mostly of magmatic origin, the postmagmatic alterations are of subordinate importance for the mineralization. The Homolka granite is comparable to the well described Beauvoir granite.

The typical Variscan Sn-W bearing granites (without Nb and Ta) from Cornwall and Krušné hory/Erzgebirge Mts. have a transitional position in the P-F plot (Text-Fig. 10).

The Rhenohercynian and Saxothuringian zones of European Variscan are characterized by Sn-bearing granites with moderate or low P-contents. The only exceptions are the P-rich granites of Podlesí in Krušné hory/Erzgebirge (Saxothuringian zone) and of Bosworgey in Cornwall. In contrast, in the Moldanubian zone, which was considered as non productive in respect to ore-bearing granites, all new founds of Sn, Nb, Ta-enriched granites belong to the P-rich type. Thus the central (Moldanubian) zone of the European Variscan, the Czech-Austrian-Bavarian Moldanubicum and French Massif Central, represents the largest known province of P-rich rare-metal granites.

8. Conclusions

The Homolka magmatic centre represents one of the youngest Variscan magmatic events within the Moldanubicum, located in a N–S trending zone of extensional tectonics. It consists of a suite of dyke rocks and a stock of granite. They belong to the rare type of ore-bearing P-rich peraluminous magmatites enriched in Li, Rb, Cs, F, Sn, Nb, and Ta.

The bulk and trace chemistry, as well as the Rb/Sr isotopic composition of all rock types corroborate the S-type melt formation due to anatexis and subsequent fractionation: The intrusion of two-mica Eisgarn granite was followed by the dyke sequence and finally by the emplacement of Homolka granite. This process lasted approximately ten to fifteen million years. From field evidence and age analyses the last pulse of melt formation, intrusion and solidification took place around 319 Ma. ago.

These data and field evidence necessitated a revision of the previously published data on Eisgarn type granite (Scharbert, 1987; Scharbert & Veselá, 1990). We can prove now that the intrusion of this wide spread two-mica granite occurred approximately 10 Ma earlier (Scharbert in prep.).

Younger magmatic activities like the Nebelstein intrusion, the intrusive biotite granite in Hirschenschlag as well as (grano)dioritic dykes are decoupled from the previously described magmatic event. From trace elements and their low initial Sr isotopic ratios (Scharbert in prep., Koller et al., 1994) they must be derived from different crustal sources and lower levels.

The fund of disseminated Sn-Nb-Ta mineralisation in the Homolka granite modifies the traditional opinion about the presumably sterile character of the Moldanubian Variscan granites.

The discovery of Homolka and similar type granites in the southern part of the Bohemian Massif and the already known granites in the Massif Central characterize the Moldanubian zone as the largest yet known province of P-rich ore-bearing granitoid magmatisms.

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Plate 1

Rock types of the Homolka magmatic centre

Homolka granite

Fig. 1: Normal medium-grained variety.
Sample 2444 and 5/93.

Fig. 2: Fine-grained variety.
Sample 2458 and 4/93.

Fig. 3: Border pegmatite (Stockscheider).
Sample 2460 and 6/93.

Fig. 4: Porphyritic variety.
Sample 2135.

Scale on each photo is 1 cm.

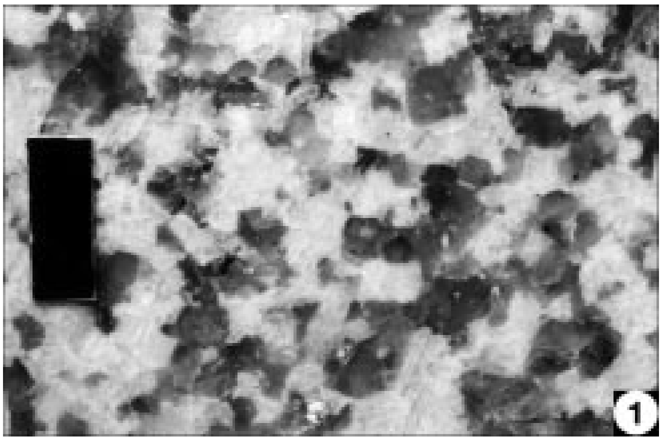
Dyke rocks

Fig. 5: Josefsthal granite, central part of the dyke at Schönau.
Sample 32/94.

Fig. 6: Josefsthal granite, chilled margin of the dyke near Schönau.
Sample 93/20.

Fig. 7: Granite porphyry with relative medium-grained groundmass.
See the idiomorphic and rounded quartz phenocrysts and reddish alkali feldspar.
Sample 2207.

Fig. 8: Granite porphyry with biotite.
Sample 8/93.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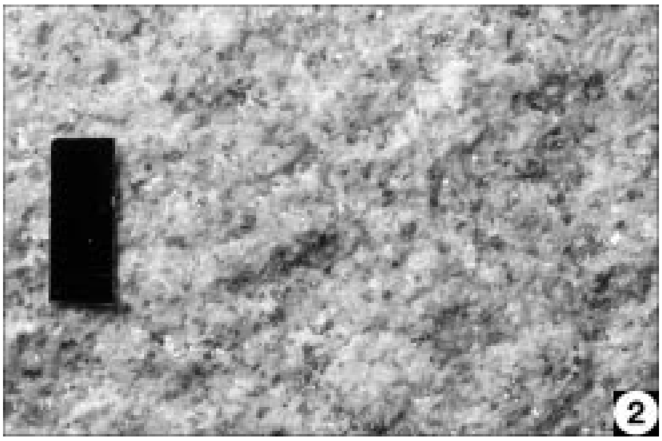
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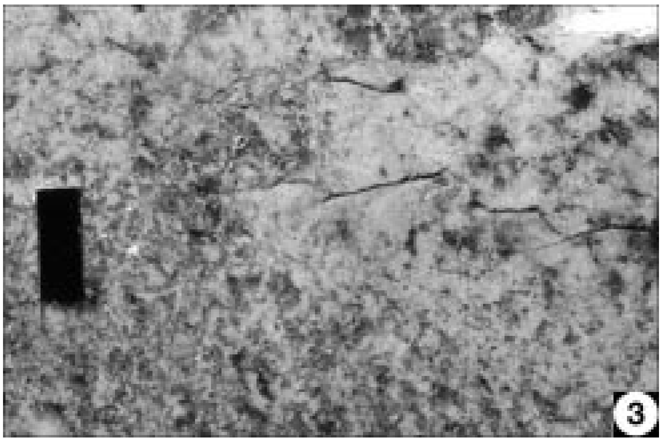
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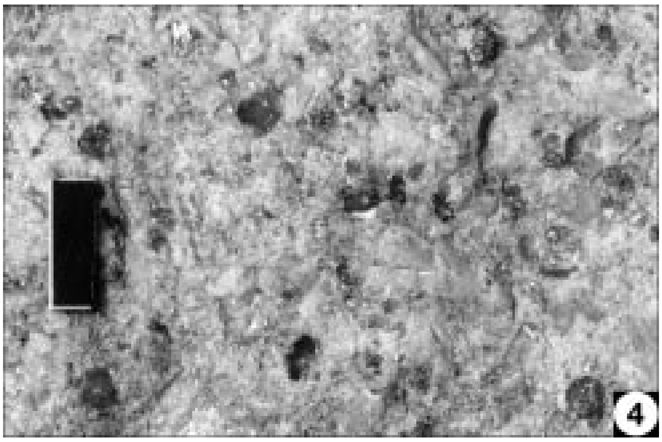
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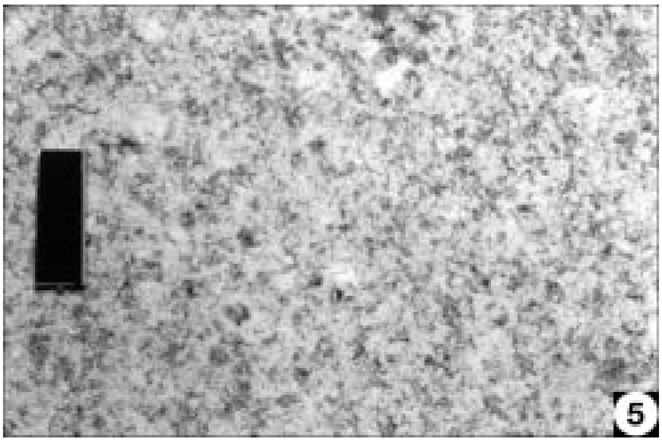
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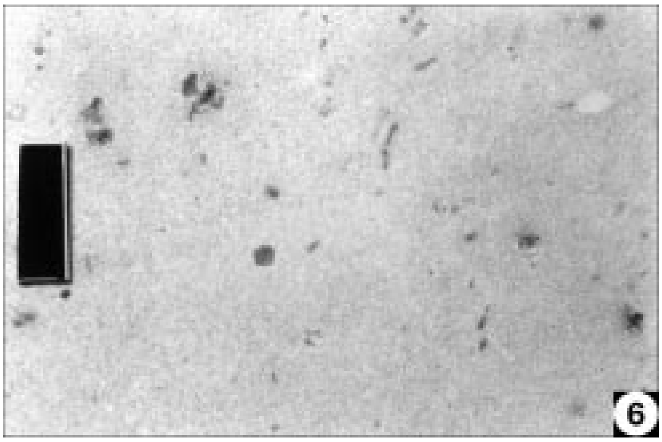
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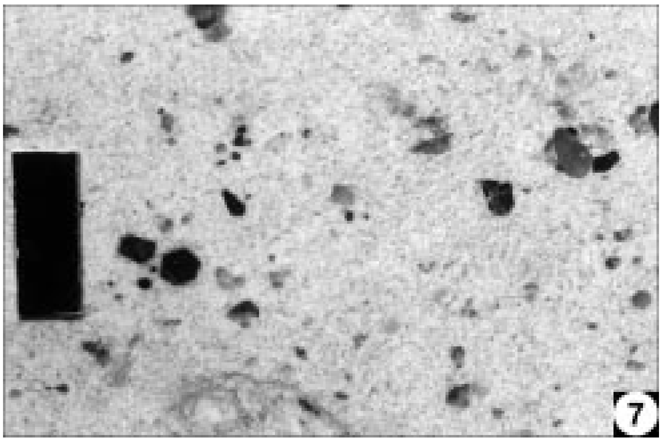
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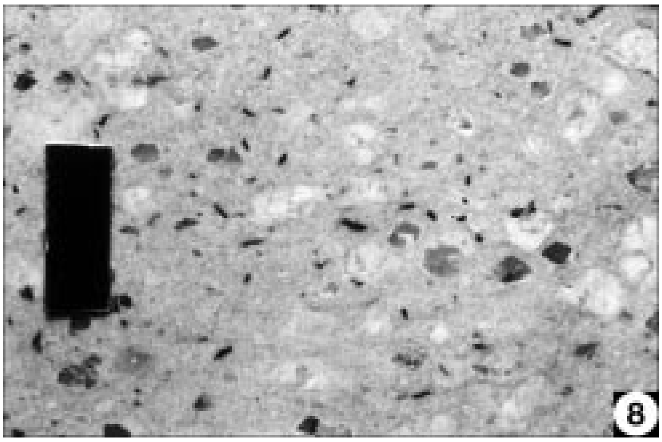
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Plate 2

Microphotographs

Homolka granite

Fig. 1: Porphyritic variety of Homolka granite, phenocrysts of quartz and albite in fine-grained groundmass.
Sample 2135, × 8.25.

Fig. 2: Medium-grained variety of Homolka granite with topaz.
Sample 2458, × 11.7.

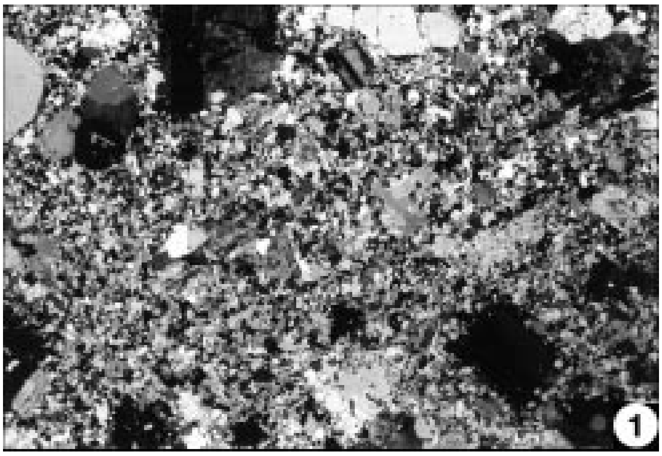
Dyke rocks

Fig. 3: Granite porphyry, albite phenocrysts $Ab_{99}Or_{01}$ surrounded by K-feldspar $Or_{98}Ab_{2}$.
Sample 2208, × 20.6.

Fig. 4: Josefsthal granite, quartz and K-feldspar phenocrysts in fine-grained groundmass.
Sample 2407, × 20.6.

Fig. 5: Josefsthal granite, myrmekitic intergrowths of quartz and K-feldspar.
Sample 2407, × 20.6.

All photos in crossed polars.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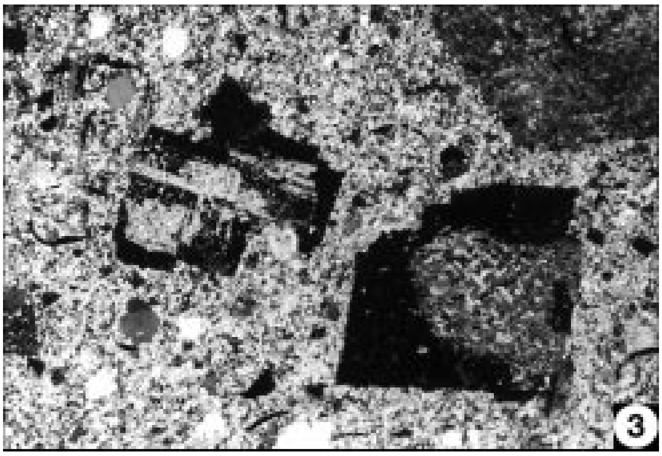
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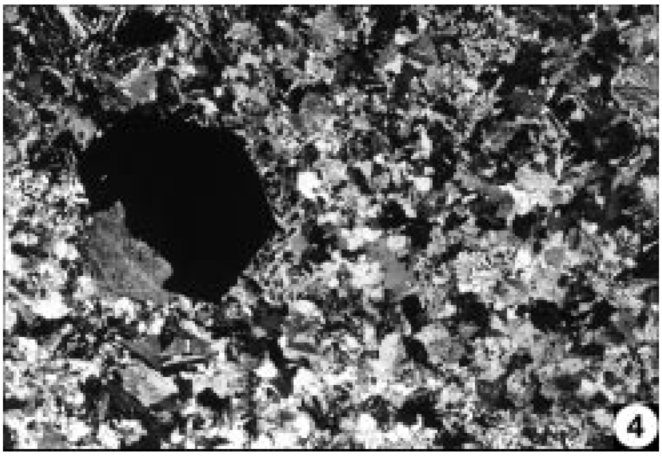
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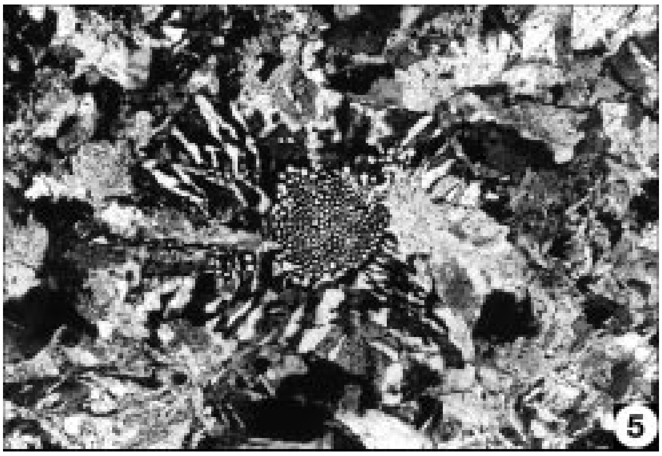
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