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BIOTITIC GABBRO ENCLAVE WITH HERCYNITE IN DURBACHITIC ROCK OF TŘEBÍČ PLUTON IN AREA OF POSITIVE GRAVITY ANOMALY

ENKLÁVA BIOTITICKÉHO GABRA S HERCYNITEM V DURBACHITICKÉ HORNINĚ TŘEBÍČSKÉHO PLUTONU V OBLASTI POZITIVNÍ TÍHOVÉ ANOMÁLIE

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Abstract

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Biotitic gabbro enclave with hercynite in durbachitic rock of Třebíč Pluton in area of positive gravity anomaly

A positive gravity anomaly situated in the northern termination of Třebíč Pluton led to a surface survey and mapping in the area near Zhoř. The non-porphyritic biotite-bearing quartz monzonite prevail in this area. These rocks differ from the typical durbachitic rock of the Třebíč and the Jihlava Pluton by a non-porphyric structure, more felsic character and a whole-rock chemical composition (lower content of MgO (2.14 wt. %), Fe_2O_3 (3.58 wt. %), MnO (0.06 wt. %) and TiO_2 (0.59 wt. %)). A small irregular enclave of hercynite - biotite bearing gabbro was found in this rock. Such enclave has not been described in durbachitic rocks from Třebič Pluton yet. It differs from other enclaves in the durbachites in the Třebíč Pluton due to its mineral association (biotite + plagioclase + hercynite $Hc_{63}Gh_{18}$ $Sp_{17}Mt_{1-2}$. + pyrrhotite + sericite + accessory K-feldspar). Based on the mineral association and the comparison to enclaves with similar composition, the following PT condition of the assimilation and melting process can be assumed: temperatures higher than 800 °C and pressures close to 2 kbar. Furthermore, the studied enclave with a hercynite from the Třebíč Pluton could represent the first evidence of a HT event in the Třebíč Pluton. The presence of the gabbroid enclave and the positive gravity anomaly in the studied area might indicate differences in the surface and deeper subsurface structure the examined area. It suggests that a body of gabbroid rock could appears in a deeper part of the area.

Key words: Třebíč Pluton, gabbroid enclave, hercynite, gravity anomaly, durbachite

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INTRODUCTION

Enclaves and xenolites in durbachitic rocks of the Bohemian Massif were described by Holub (1976), Bažantová (2016), Kotková *et al.* (2009). There are many characterized enclaves and xenolits from the Třebíč Pluton (TP) but none of these have a similar mineral composition to the enclave described in this paper. Most of the enclaves described by Holub (1976) have ellipsoidal to angular shape and they vary in size from a few centimetres to several metres. The most widespread mineral association of the enclaves is:
K-feldspar + plagioclase/andesine/quartz + actinolitic amphibol + Mg-rich biotite + accessory apatite.

In the majority of cases, the enclaves contain more mafic minerals than the surrounding rocks. The enclaves mostly correspond to quartz syenite, syenite, alkali feldspar syenite, monzonite, quartz monzonite and granite. They are generally finer-grained than their host rocks. The whole rock chemical composition of the enclaves shows lower content SiO_2, to a lesser extent in Al_2O_3 and Na_2O, but higher concentration of FeO, MgO, CaO, P_2O_5. Furthermore, increased amounts of trace elements as Ba, Sr, Cr, Ni, V and Co were found in the enclaves. The Mg/Fe and K/Na ratios are considerably higher in the enclaves than in the host rock. The existence of two size categories of biotite flakes and a tendency to an euhedral automorphic form of the largest ones is very frequent. Similarly, Bažantová (2016) characterized numerous mafic microgranular enclaves in durbachites from the TP which are rich in MgO and FeO but are poor in SiO_2 and Al_2O_3. They mainly contain amphibole, biotite, pyroxene, K-feldspar and quartz. Accessory minerals in these enclaves are zircon and apatite. Kotková *et al.* (2009) described medium-grained dark-grey quartz alkali-feldspare melasyenite, which is finer grained then the host melagranite. Main minerals are amphibole, which make up about 50% of the rock, plagioclase, K-feldspare and biotite.

A presence of enclaves similar to the hercynite-bearing enclave from the TP was found and described in post-tectonic granitoids of the Cantabrian and in the eastern part of the West Asturian Leonese zones by Suarez (1992). These enclaves are made up mainly of gabbro- diorites and granodiorites. The mineral association is mostly hercynite / Mg-spinel + plagioclase + corundum + sillimanite / biotite + muscovite (sericite) + magnetite.

GEOLOGICAL SETTING

Třebíč Pluton and durbachitic rock

Occurrences of durbachitic bodies are characteristic for the Moldanubian Zone of the European Variscan belt (Finger *et al.* 1997, Schulmann *et al.* 2008, Holub 1997). The Variscan Třebíč durbachite pluton is situated in the eastern part of the Moldanubian Zone. The Jihlava durbachite pluton is W of the TP. The Jihlava Pluton (JP) is a body elongated in the direction of NNW-SSE. The pluton was intruded into the metamorphic rock. Eastern and southern rims of the pluton are bordered by amphibolites (Tonika 1970). Opx-Cpx-Bt quartz syenite and quartz monzonite up to quartz gabbro are the most typical rocks of the JP (Kotková *et al.* 2009, Suchánková 2006, Leichmann and Švancara 2005, Verner *et al.* 2006). TP and JP are accompanied by several smaller bodies: Drahonín, Nové Město na Moravě and other small occurrences NW of the TP. Smaller bodies near Věžnice and Kamenice (shoshonitic to ultrapotassic melamonzonite to gabbro) are located between the JP and the TP (Leichmann *et al.* 2016, Leichmann and Švancara 2005).

Bubeníček (1968) defined the TP as an ethmolith, which is in contact with the Moldanubian host rock in the E (Gföhl gneisses and migmatitic gneiss) and with the Moravicum in the NE. Host rocks xenolits of amphibolite and migmatitic gneiss are common particularly in a marginal part of the pluton (Stárková *et al.* 1993) (Fig.1). Leichmann *et al.* (2016) confirm the flat, tabular shape of the intrusion.

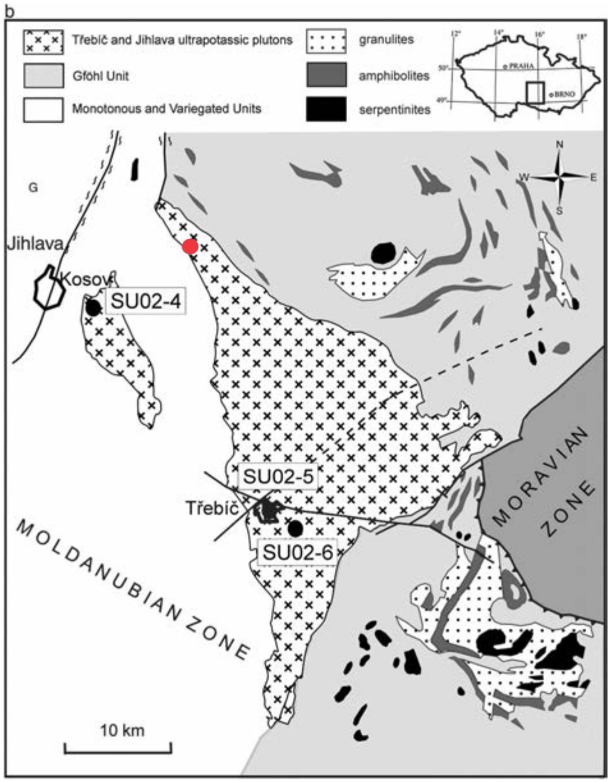


Fig. 1. Geology of Třebíč Pluton, examined location (red point) (FINGER *et al.* 1997).
Obr. 1. Geologická situace třebíčského plutonu s vyznačenou lokalitou (červený bod) (FINGER *et al.* 1997).

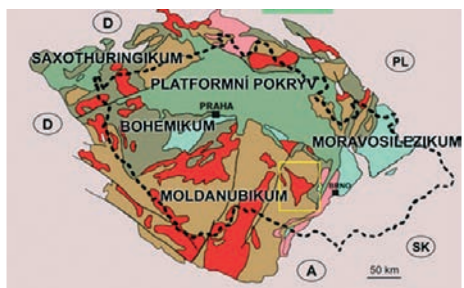


Fig. 2. Position of Třebíč Pluton in Bohemian Massif.
Obr. 2. Pozice třebíčského plutonu v Českém masivu.

The TP consists mainly of porphyritic biotite and amphibole-biotite bearing melagranite to melasyenite that belong to durbachitic rocks series. (KOTKOVÁ *et al.* 2009). Rocks of the durbachite series correspond to the original rock type described by SAUER (1893) in the Black Forest. Durbachitic rocks in Europe were also described in the Vosges (France) and in the Bohemian Massif: Čertovo břemeno Massif, Tábor Massif, Želnava Massif, Netolice Massif, Rastenberg Massif, TP and JP (HOLUB 1997). The durbachitic rock has a specific whole rock chemical composition. They are rich in Mg, Cr and Ni however, it contains large amounts of LIL elements (K, Rb, Ba) and radioactive elements (U, Th) as well. It has a high ratio of Mg/Fe and K/Na (HOLUB 1997, FIALA *et al.* 1983). It is assumed that these rocks were created by mixing of an ultrapotassic mantle magma with an acidic crustal magma (HOLUB 1997, KOTKOVÁ *et al.* 2009). BOWES and KOŠLER (1993) propose that the petrographic features of durbachitic rocks are associated with a process of fractional crystallization and mixing of magmas. Moreover, the geochemical features indicate multiple stages of magma mixing.

The typical durbachitic rock of TP and JP belongs to ultrapotassic rocks (Holub 1997, Kotkova *et al.* 2009, Zachovalová 1999, Suchánková 2006). The rock can be classified as ultrapotassic if it is composed of K_2O> Na_2O>2 and of K_2O and MgO >3 wt. % (Foley *et al.* 1987).

Gravity features and gabbroid rocks near TP

There are several positive gravity anomalies indicated on the map of gravity residual anomalies in Figure 3 (Leichmann *et al.* 2016). Two of them are NW of TP (one in the central part of JP (+ 6mGal) and a small body near Věžnice (+6mGal)). Leichmann and Švancara (2005) described rock in these localities that could be characterized as a gabbro-monzogabbro. These localities are also in a thorium minimum field. Another well-marked positive gravity anomaly is S of the Třebíč fault (+2.75 mGal). Bažantová (2016) described durbachite rock in this area that contains numerous mafic enclaves. This area is in a modest positive Th anomaly.

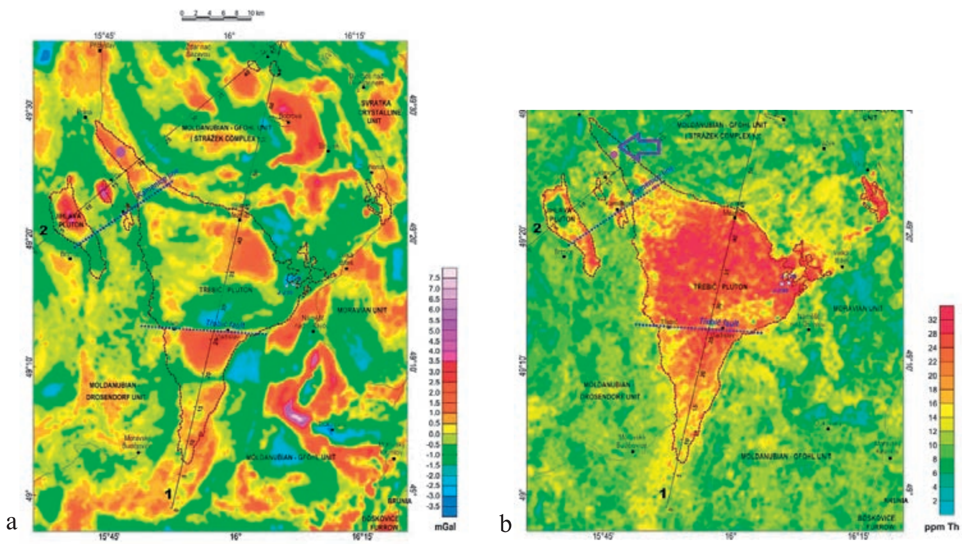


Fig. 3. Gravity residual map (Leichmann *et al.* 2016) (a) and Thorium anomaly map (Leichmann *et al.* 2016) (b), examined location (purple arrow).

Obr. 3. Mapa gravitačních reziduálních anomálií (a) a mapa thoriové anomálie (b), (Leichmann *et al.* 2016), zkoumaná lokalita vyznačena fialovým bodem a šipkou.

The examined locality is situated in the northern part of the TP in an area distinct with both a strong positive gravity anomaly and a positive Th anomaly (Fig. 3). These features constituted the primary cause for a survey in the area.

Methods

Major and trace elements contents in the host rock were determined by ICP-ES and IPS-MS in Acme Analytical Labs, Canada. The electron-microprobe analyses were conducted on CAMECA SX 100 instrument at the Joint Laboratory of Electron Microscopy and Microanalysis, Institute of Geological Sciences, Masaryk University, Brno and Czech Geological Survey, Prague, by Mgr. R. Škoda, PhD. Accelerating potential was 15 kV for all elements, spot diameter 2–5 μm, beam current 10–20 nA. Biotite, spinelide, plagioclase, K-feldspar, zircon and monazite were analysed on the electron-microprobe. Raw data were calculated in the program Formula. The composition of monazite and associated rhabdophane were investigated using a combination of quantitative electron microprobe (EMP) analyses and X-ray element mapping, by Mgr. R. Škoda. The operating conditions included an accelerating voltage of 15 kV, a beam current of 160 nA for monazite and 20 nA for rhabdophane, and a beam diameter of 2 μm for monazite and 5 μm for rhabdophane. Uranium was determined on the U Mβ line (counting time 60 s, detection limit 270 ppm), Th on the Th Mα line (counting time 40 s, detection limit 250 ppm) and Pb on the Pb Mα line (counting time 240 s, detection limit 130 ppm. Data were reduced using the PAP matrix correction routine (Pouchou and Pichoir, 1985). The monazite age was calculated using the method of Montel *et al.* (1996).

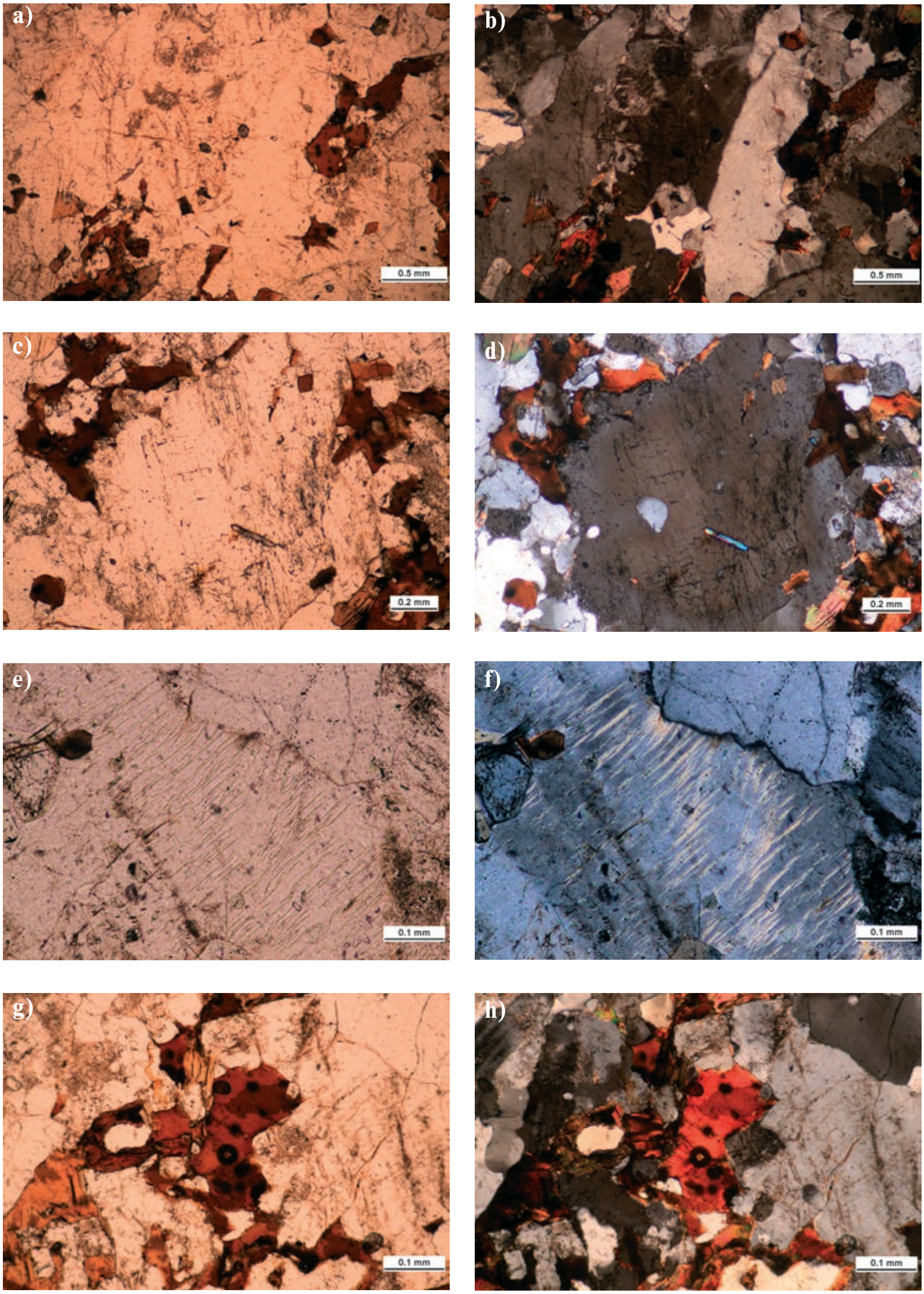
RESULTS

Host rock of the enclave

The host rock of the enclave found in the NW part of the TP near Zhoř varies from other durbachitic rocks in the TP (Zachovalová 1999, Bubeníček 1967, Holub 1997). The rock colour is light grey and the texture is non-porphyric (Fig. 4). Mineral composition is K-feldspar + plagioclase + biotite + quartz.

Fig. 4. Sample of the host rock.
Obr. 4. Vzorek okolní horniny.

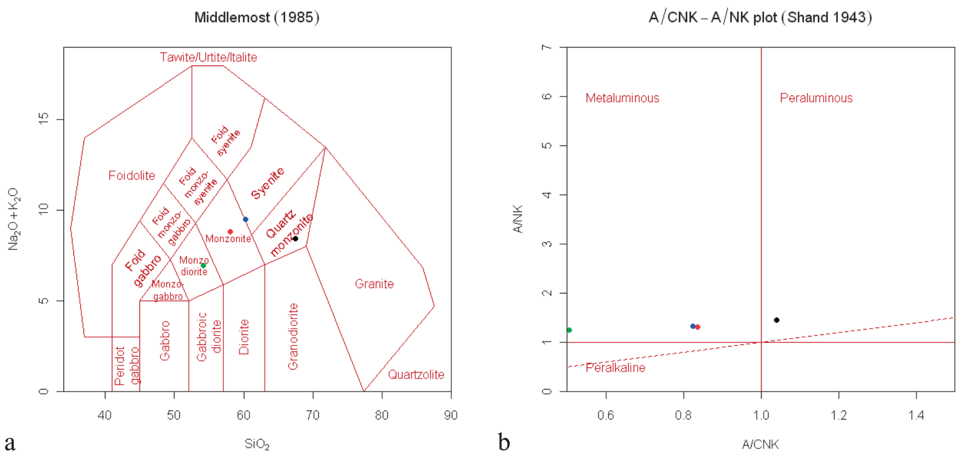
The content of K-feldspar is 39 %, the grains have an anhedral shape and are up to 3 mm in size. There are two types of K-feldspars: perthitic K-feldspar (Fig. 5 e), f)) and zonal K-feldspar (Fig. 5 c), d)). Carlsbad twinning occurs often (Fig. 5 a), b)). Plagioclase occurs up to 3 mm in size and comprises 36 %. It appears either separately or as an inclusion in K-feldspar. The mafic component of the host rock is represented by biotite. Modal abundance of biotite is 15 %. Biotite is present either separately or as an inclusion in K-feldspar. The subhedral grains are up to 4 mm large and have the shape of flakes. The pleochroic halos around the zircon are common (Fig. 5, g), h)). Apatite and zircon are the most common accessory minerals. Apatite's size reaches up to 0.1 mm and it occurs as an inclusion in K-feldspar and biotite. Zircon's size reaches up to 0.2 mm and it occurs as an inclusion in biotite. Grains of monazite can also be found in the host rock. They are present as an inclusion in K-feldspar and their size is up to 0.1–0.2 mm.



Obr. 5. Thin sections of the host rock, left column PPL right column XPL, a), b) – Carlsbad twinning, c), d) – zonal K-feldspar, e), f) – perthitic K-feldspar, g), h) pleochroic halos in biotites.

Fig. 5. Výbrusy z okolní horniny. Vlevo PPL Vpravo XPL, a), b) karlovarský srůst živce; c), d) zonální K-živec; e), f) perthitický K-živec; g), h) pleochroické dvůrky v biotitu.

The host rock chemistry differs from the typical durbachitic rock of TP and JP (Kotkova *et al.* 2009) (Tab. 1). The whole rock analysis show that the host rock is richer in SiO_2 (66.16 wt. %), Al_2O_3 (15.4 wt. %) and Na_2O (2.57 wt. %) as opposed to other rocks from TP or JP. The host rock is relatively poor in K_2O in comparison to the durbachitic rock from TP or JP. The host rock has a lower content of MgO (2.14 wt. %), Fe_2O_3 (3.58 wt. %), MnO (0.06 wt. %) and TiO_2 (0.59 wt. %) than the durbachitic rock form TP and JP. Moreover, the content of Rb (215 ppm), Sr (261 ppm) and Ba (957 ppm) is lower than in the samples from TP or JP. The lower concentrations of Ta (1.2 ppm), Y (20.3 ppm) and U (4.7 ppm) are characterised for the host rock as well as for the sampled from JP. There is a similar concentration of Th (20.2 ppm) in all samples. The K/Rb ratio (220) is higher than in the rocks from JP and TP. There is a smaller amount of rare earth elements in the host rock. The concentration of REE is lower, when compared with TP and JP. The examined rock can be characterized as a quartz monzonite in TAS diagram (Fig. 6). Similarly to other durbachitic rock the host rock are rich in (Th, U). The quartz monzonite cannot be classified as ultrapotassic rock, because of lower content of K and Mg.



Obr. 6 a, b. Comparison of typical durbachitic rock from Třebíč Pluton (red point), Jihlava Pluton (blue point), mafic enclave from Třebíč Pluton (green point) (Kotková *et al.* 2009) with a quartz monzonite (host rock of gabbroid enclave) (black point).

Fig. 6 a, b. Srovnání typického durbachitu z třebíčského plutonu (červený bod), jihlavského plutonu (modrý bod), mafické enklávy z třebíčského plutonu (zelený bod) (Kotková *et al.* 2009) s křemenným monzonitem (hostitelskou horninou gabroidní enklávy) (černý bod).

Table 1. Whole rock chemical composition of typical durbachitic rock from Třebíč Pluton, Jihlava Pluton, mafic enclave from Třebíč Pluton (Kotková *et al.* 2009) and quartz monzonite.

Tabulka 1. Chemické složení typických durbachitů z třebíčského a jihlavského plutonu, mafické enklávy z třebíčského plutonu (Kotková *et al.* 2009) a křemenného monzonitu.

	Unit	**Quartz monzonite**	**Durbachite (JM)**	**Durbachite (TM)**	**Mafic enclave (TM)**
SiO_2	%	66,16	58,91	56,45	52,69
TiO_2	%	0,59	0,92	1,1	0,75
AL_2O_3	%	15,04	14,97	13,28	9,57
Fe_2O_3	%	3,58	5,22	6,67	7,15
MnO	%	0,06	0,07	0,09	0,12
MgO	%	2,14	4,73	7,96	14,06
CaO	%	2,23	3,74	3,17	6,16
Na_2O	%	2,57	2,31	1,48	0,72
K_2O	%	5,71	6,97	7,1	6,04
P_2O	%	0,27	0,68	0,99	1,23
Cr_2O	%	0,013	0,044	0,07	0,11
Ba	ppm	957	1880	1835	1366
Co	ppm	8,7	18,3	33,8	41,5
Cs	ppm	12,5	13,9	23	29
Hf	ppm	6,6	11	16,7	7,7
Nb	ppm	13,3	19,1	36,1	29,1
Ni	ppm	23,3	51	200	507
Rb	ppm	215	330	491	409,4
Sr	ppm	261,1	505,9	496,3	242,1
Ta	ppm	1,2	1	2,4	2,3
Th	ppm	20,2	24,5	36,3	24
U	ppm	4,7	5,2	26,3	12,8
V	ppm	57	87	119	81
Zr	ppm	224,8	412,1	464,3	218,4
Y	ppm	20,3	21,1	35,8	35,2
La	ppm	38,4	39	67,1	70,2
Ce	ppm	84,9	86,5	147,5	155,5
Pr	ppm	9,46	12,02	18,84	19,98
Nd	ppm	37,4	52,1	80,2	80,9
Sm	ppm	6,88	11,49	15,9	16,1
Eu	ppm	1,11	2,09	2,26	2,11
Gd	ppm	5,53	7,74	9,96	9,17
Tb	ppm	0,74	0,96	1,11	1,17
Dy	ppm	4,04	4,38	5,97	5,66
Ho	ppm	0,76	0,76	1,17	1,22
Er	ppm	2,02	1,96	3,3	2,6
Tm	ppm	0,3	0,28	0,42	0,36
Yb	ppm	1,86	1,66	2,61	2,83
Lu	ppm	0,27	0,25	0,34	0,38
K/Rb		220	175	120	122
Rb/Sr		0,82	0,65	0,99	1,69
Th/U		4,29	4,71	1,38	1,88

Mineral chemistry

The chemical composition of each mineral from the host rock differs from the minerals of the enclave. Plagioclase of the host rock contains less Na_2O than the plagioclase of the enclave (Fig. 7). Some of the K-feldspar is strongly perthitic (Fig. 5 G) and has higher quantities of Na_2O_3 (0.6–1.4 wt. %) and BaO (0.4–1.3 wt. %). Biotites from the host rock have a consistent chemical composition. The Mg concentration is 0.50–0.54 and the content of ^{IV}Al is 1.34–1.38 apfu. The content of solid solution components annite and phlogopite is similar (Fig. 8).

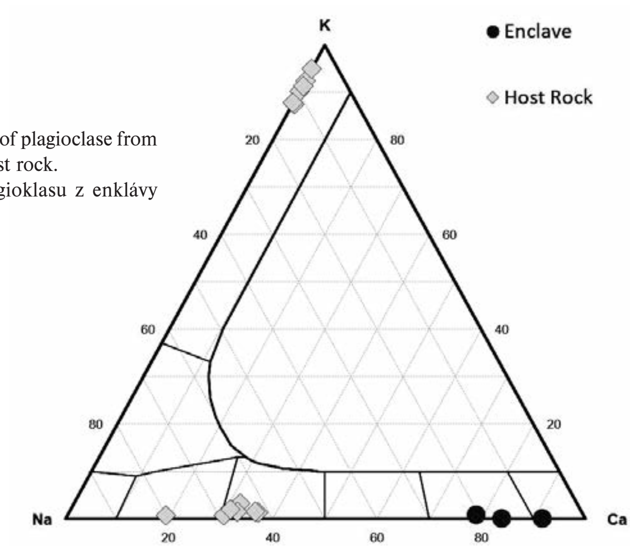


Fig. 7. Chemical composition of plagioclase from the enclave and the host rock.
Obr. 7. Chemické složení plagioklasu z enklávy a okolní horniny.

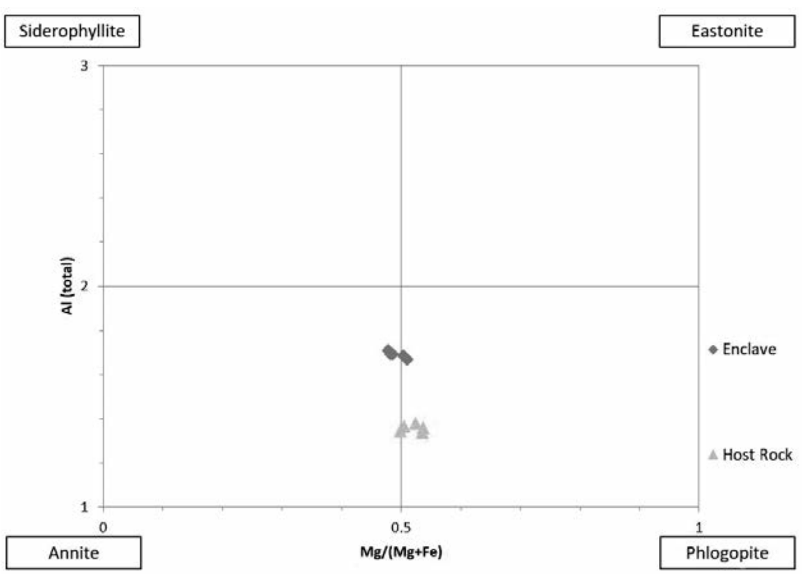


Fig. 8. Chemical composition of biotite from the enclave and the host rock.
Obr. 8. Chemické složení biotitu z enklávy a okolní horniny.

Hercynite-bearing enclave petrography

Although abundant occurrence of various cognate inclusions is typical for durbachitic rocks (Holub 1977), a hercynite-bearing enclave has not yet been discovered in rocks of the durbachite series.

This enclave has diffuse contact with its surroundings host rock (Fig. 9, 10). The mineral association of the enclave is as follows:

biotite + plagioclase + hercynite + pyrrhotite + accessory K-feldspar + secondary sericite

The enclave is richer in mafites than the surrounding quartz monzonite.

Biotites (modal abundance 48 %) found in the enclave exhibit a form of red-brownish flakes up to 0.6 mm long. There are inclusions of zircon in some biotite grains that have subhedral to form and are max. 0.2 mm long.

Hercynites' dark green grains (modal abundance 7 %) are substantially affected by an alteration and have a subhedral form and are up to 0.5 mm in size. Most of the hercynites' grains have been partially altered into sericite.

Pyrrhotites (modal abundance 3 %) represent ore minerals in the enclave. They have a subhedral form and their grains can be up to 0.3 mm long. Major part of the plagioclase (modal abundance 41 %) in the enclave have been altered and replaced by sericite. The accessory minerals (modal abundance 1 %) in the enclave are zircon, monazite, K-feldspar and apatites. Apatites can occur as enclaves in biotite or separately. Based on the modal abundance of the minerals the enclave could be classified as a biotite bearing gabbro.

Fig. 9. Dark enclave in quartz monzonite from TP.
Obr. 9. Tmavá enkláva v křemenném monzonitu z TP.

Mineral chemistry of hercynite -bearing enclave

The chemical composition of biotites in the hercynite -bearing enclave is uniform. The Mg/(Mg+ Fe) ratio in biotites from the enclave and the host quartz monzonite rock (0.48–0.51) are largely consistent. Biotites of the enclave are different from the biotites of the host rock as they are significantly more aluminous (Fig. 8).

Analysed hercynite are essentially solid solutions of hercynite, spinel, and gahnite with minor magnetite. Cr and V are present in trace quantities. The composition range is $Hc_{63}Gh_{18}\ Sp_{17}Mt_{1-2}$.

Plagioclase shows relatively low compositional variation; from An_{79} to An_{84}. They are much more An-rich then the plagioclase in the host rock (Ab_{62}–Ab_{80}) (Fig. 7).

The chemical composition of the accessory mineral monazite was analysed. The content of each chemical element from monazite in the enclave is similar to the content of chemical elements from the monazite in the host rock. The content of ThO_2 in monazite from the enclave is similarly high (8–10 wt. %) to the content in monazite from the host rock (9–11 wt. %). There is low concentration of UO_2 (0.7–1 wt. %) in all monazites. The content of Ce_2O_3 (25–28 wt. %) prevails over the content of La_2O_3 (13–15 wt. %) in monazite-(Ce) from the enclave as well as in monazite-(Ce) from the host rock.

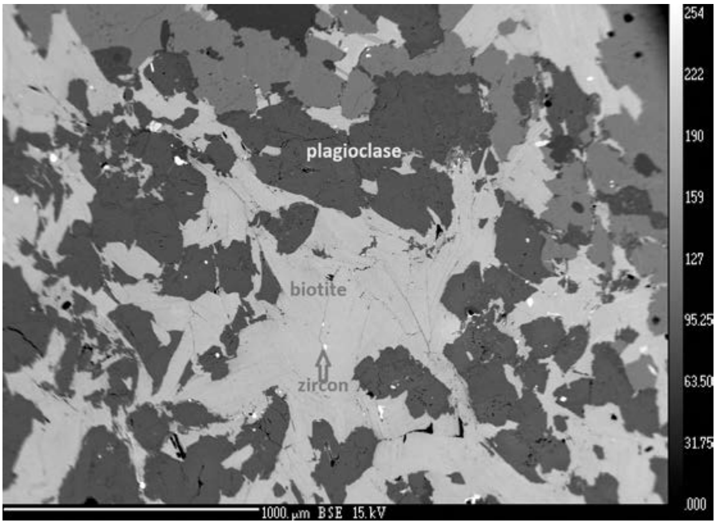


Fig. 10. Back scattered electron image – plagioclase, biotite, zircon from enclave (photo R. Škoda).
Obr. 10. Plagioklas, biotit a zircon z enklávy (zpětně odražené elektrony), R. Škoda.

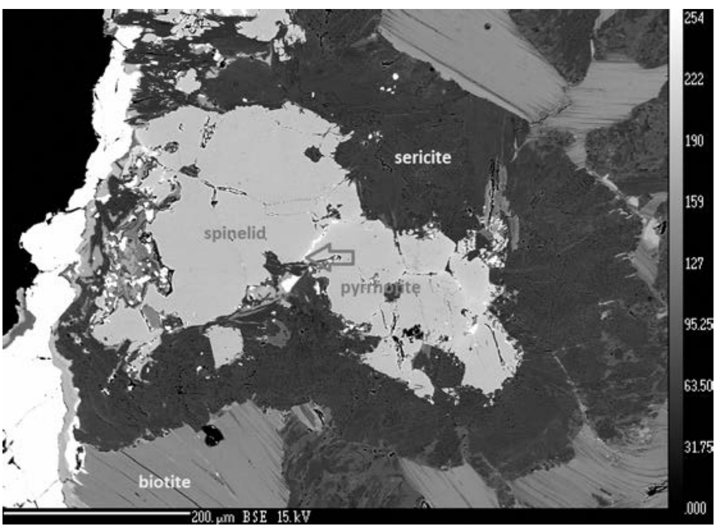


Fig. 11. Back scattered electron image – biotite, pyrrhotite, sericite from enclave (photo R. Škoda).
Obr. 11. Biotit, pyrhotin a sericit z enklávy (zpětně odražené elektrony), R. Škoda.

Monazite U-Pb dating

Monazites-(Ce) from the enclave yielded a chemical age of 331.2 +– 6.8 Ma. A radiometric age of the JP crystallization (U-Pb zircon, TIMS 335.2 +– 0.5 Ma, Kotková *et al.* 2003) and a radiometric age of the TP crystallization (U-Pb zircon, TIMS 334.8 +– 3.2 Ma, Kotková *et al.* 2003) is close to the chemical age of the monazite-(Ce) from the enclave. Furthermore, a monazite age of the gabbro-monzogabbro in JP 335.8 +–6.9 Ma (Leichmann and Švancara 2005) corresponds to the chemical U-Pb age of the monazite-(Ce).

DISCUSSION

Enclave petrogenesis

The gabbroic enclave with hercynite has not yet been described in the durbachitic rocks of the TP. Enclaves from the TP described by Holub (1976) and Bažantová (2016) have a different mineral composition and they lack hercynite.

Enclaves with similar features were described by Suarez (1992). Most of these enclaves have similar mineral composition (hercynite or Mg-spinel, plagioclase, muscovite, biotite) to the enclave from TP. Moreover, the chemical composition of the minerals is similar. The plagioclases are mostly An-rich and the biotites are more aluminous than the biotites from the host rock. The difference is in the chemical composition of spinelids. Hercynite from TP have higher gahnite content and lower spinel content than the enclave described by Suarez (1992).

Suarez (1992) states that all spinelid enclaves could be interpreted as restitic phases after higher stages of partial melting. This explains the absence of quartz in enclaves already incorporated into a melt. The absence of cordierite and garnet indicates high temperature conditions and it implies that spinel forming reactions have taken place in intermediate pressure. According to Suarez (1992), it is reasonable to assume that the assimilation and melting processes which created their restitic enclaves might have occurred at temperatures higher than 800 °C and pressures higher than 2 kbar.

The hercynite and An-plagioclase in the enclave from TP could have formed through the following reaction:

biotite + plagioclase Ca-Na → hercynite + An-rich plagioclase + melt (quartz, K-feldspar, Na- plagioclase and water in the melt).

This prograde reaction could not be observed in the thin section due to very common younger retrograde LT reaction- seritization. On the other hand, with respect to reactions described in Suarez (1992), the prograde reaction in the enclave from the TP could be the first evidence of the HT event in the Třebíč Pluton.

Evidence on the HT event was found in nearby JP. Suchánková (2016) described the following HT mineral association in JP:

orthopyroxene + K-feldspar + An- rich plagioclase.

Furthermore, Leichmann *et al.* (2007) described the HT mineral association in the garnet-sillimanite- cordierite kinzigite from Petrovice in the JP. This mineral assemblage consists of garnet, silimanite I, relics of cordierite, hercynite, rutile I, ilmenite and quartz, retrograde minerals- cordierite II, sillimanite II and Ti- rich biotite, K-feldspar, quartz and plagioclase. According to Leichmann *et al.* (2007), the relic assemblages – cordierit + hercynite and hercynite + quartz may suggest peak metamorphism conditions at T ~ 900 °C and P ~ 5–7 kbar.

Geophysical context

Biotite bearing gabbroid enclave with hercynite that was found in quartz monzogabbro in TP occurs in the area of positive gravity anomaly (Leichmann *et al.* 2016). Although, the rock exposed at the surface are more felsic than typical durbachites characterised by neutral gravity field. It is therefore probable, that the surface geology differs from the deeper subsurface structures. The presence of the gabbroid rocks at the depth could cause this positive gravity anomaly. This presumption is affirmed by the evidence of other bodies of gabbroid rocks nearby. One of them is in the central part of the JP, another is a gabbroid body NE of TP. These were described by Leichmann and Švancara (2005), Štěpánek (1930) and are demonstrated by a well-marked gradient on the maps (Leichmann *et al.* 2016). A gravity gradient in the studied area (Fig. 3a) is not so strong, thus the denser rock could be located deeper under the surface. Nevertheless, it is probable that it can be wide-spread at the depth.

CONCLUSIONS

1. The mineral composition of the enclave is:
   biotite + plagioclase + hercynite + pyrhotine + sericite + accessory K-feldspar.
   A similar enclave has not yet been described in a rock of durbachitic series.
2. Similar kinds of enclaves were discovered and described by Suarez (1992), who similarly assumed the PT condition of the assimilation and melting process at temperatures higher than 800 °C and pressures higher than 2 kbar. A high temperature event was identified in JP (Suchánková 2016, Leichmann *et al.* 2007) but not in the TP yet. The studied enclave with hercynite from the TP could represent the first evidence of the HT event in the TP.
3. The presence of the gabbroid enclave and positive gravity anomaly in the studied area refer to a different rock composition of the surface and deeper parts. It could suggest that a body of gabbroid rock could be found in a deeper part of the area.
4. The quartz monzonite host rock is different from the typical durbachitic rock of the TP and the JP mainly by the non-porphyric structure and the chemical composition. The host rock has a lower concentration of MgO (2.14 wt. %), Fe_2O_3 (3.58 wt. %), MnO (0.06 wt. %) and TiO_2 (0.59 wt. %).

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