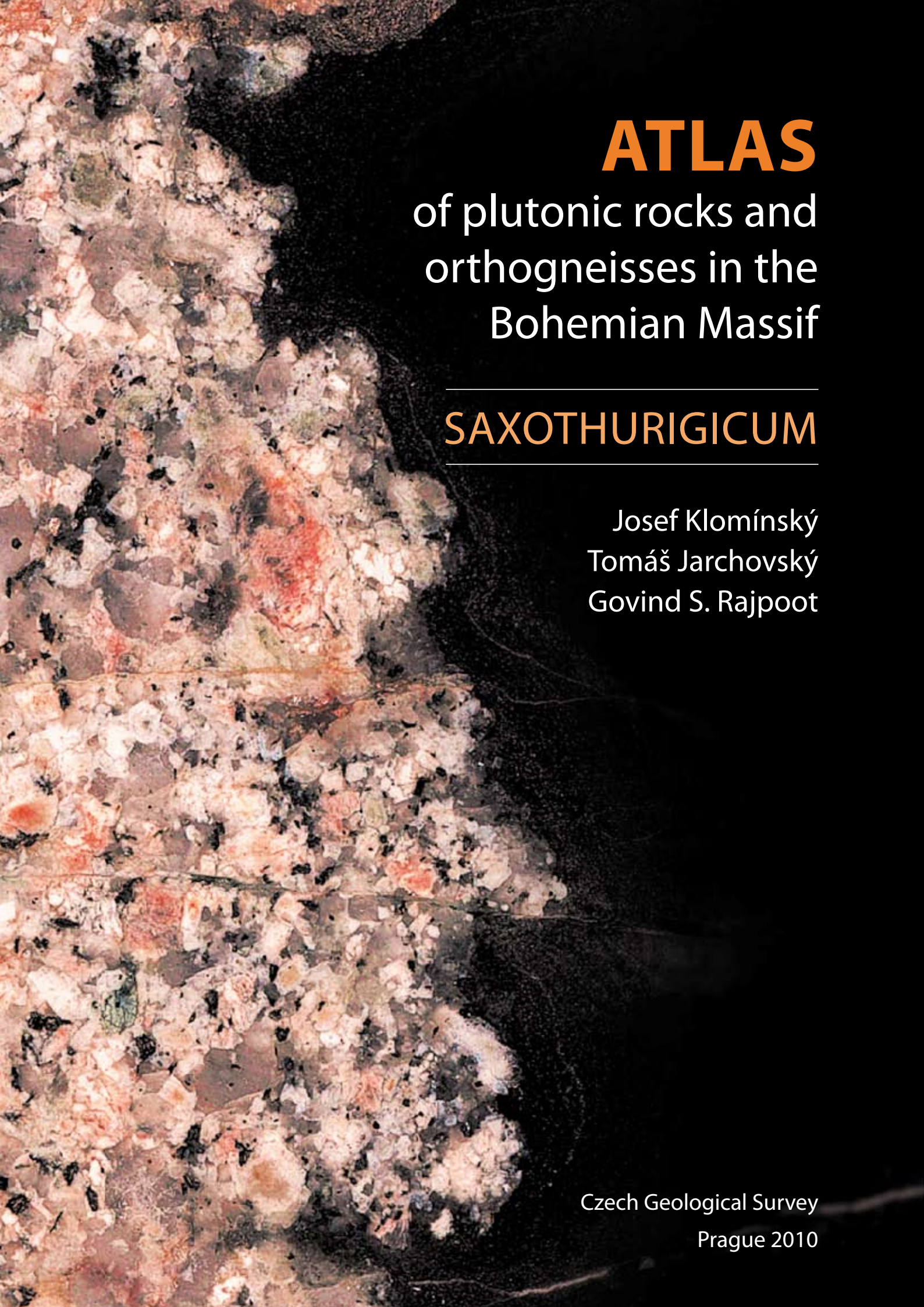

ATLAS

of plutonic rocks and orthogneisses in the Bohemian Massif

SAXOTHURIGICUM

Josef Klomínský
Tomáš Jarchovský
Govind S. Rajpoot

Czech Geological Survey
Prague 2010

CZECH GEOLOGICAL SURVEY

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3. SAXOTHURINGICUM

Compiled by

Josef Klomínský
Tomáš Jarchovský
Govind S. Rajpoot

The **Saxothuringicum** is a part of the **Atlas of plutonic rocks and orthogneisses in the Bohemian Massif** which consists of six chapters:

INTRODUCTION
1. BOHEMICUM
2. MOLDANUBICUM
3. SAXOTHORINGICUM
4. LUGICUM
5. BRUNOVISTULICUM AND MORAVOSILESICUM

In the Introduction volume are summarized general characteristics of the plutonic rocks and orthogneisses from point of view of their composition, age, 3-D shape, zonation, metallogeny and spatial distribution.
The territorial sections 1–5 comprise structured geological parameters of the plutonic rocks and orthogneisses located within boundaries of the principal geological zones in the Bohemian Massif.
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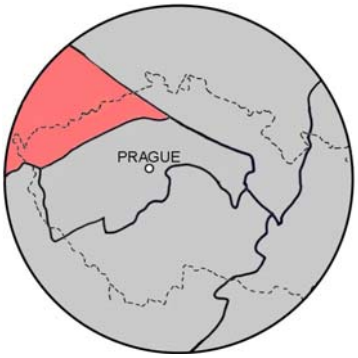
THE ATLAS OF PLUTONIC ROCKS AND ORTHOGNEISSES IN THE BOHEMIAN MASSIF



3. SAXOTHURINGICUM

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The locality map of the plutonic rocks and orthogneisses in the Bohemian Massif (folded)

FOREWORD

Saxothuringicum comprises the Proterozoic and Palaeozoic phyllite to mica schist to gneiss sequences within which three principal groups of granitic intrusions have been recognized by Tischendorf et al. (1995):

3.1. Late Carboniferous-Early Permian silicic plutonic rocks of the Smrčiny-Krušné hory Mts. (Fichtelgebirge-Erzgebirge) Batholith.

3.2. Cadomian orthogneisses (metamorphosed granitoids)

Cambrian-Early Ordovician (meta)granodiorites – (meta)monzogranites represented by small, high-level, epizonally altered S-type granites, sometimes sheet-like, within the Berga anticlinal zone at the southwestern margin of the Elbe Lineament.

Neo-Proterozoic to Ordovician orthogneisses (e.g. Grey Orthogneiss, Red Orthogneiss, Selb Orthogneiss).

Cadomian gneisses and metagranitoids (the Grey and Red Orthogneisses) were intruded by the Smrčiny-Krušné hory Mts. (Fichtelgebirge-Erzgebirge Mts.) postkinematic Batholith of the Variscan age.

3.1. SMRČINY-KRUŠNÉ HORY MTS. (FICHTELGEBIRGE-ERZGEBIRGE) BATHOLITH

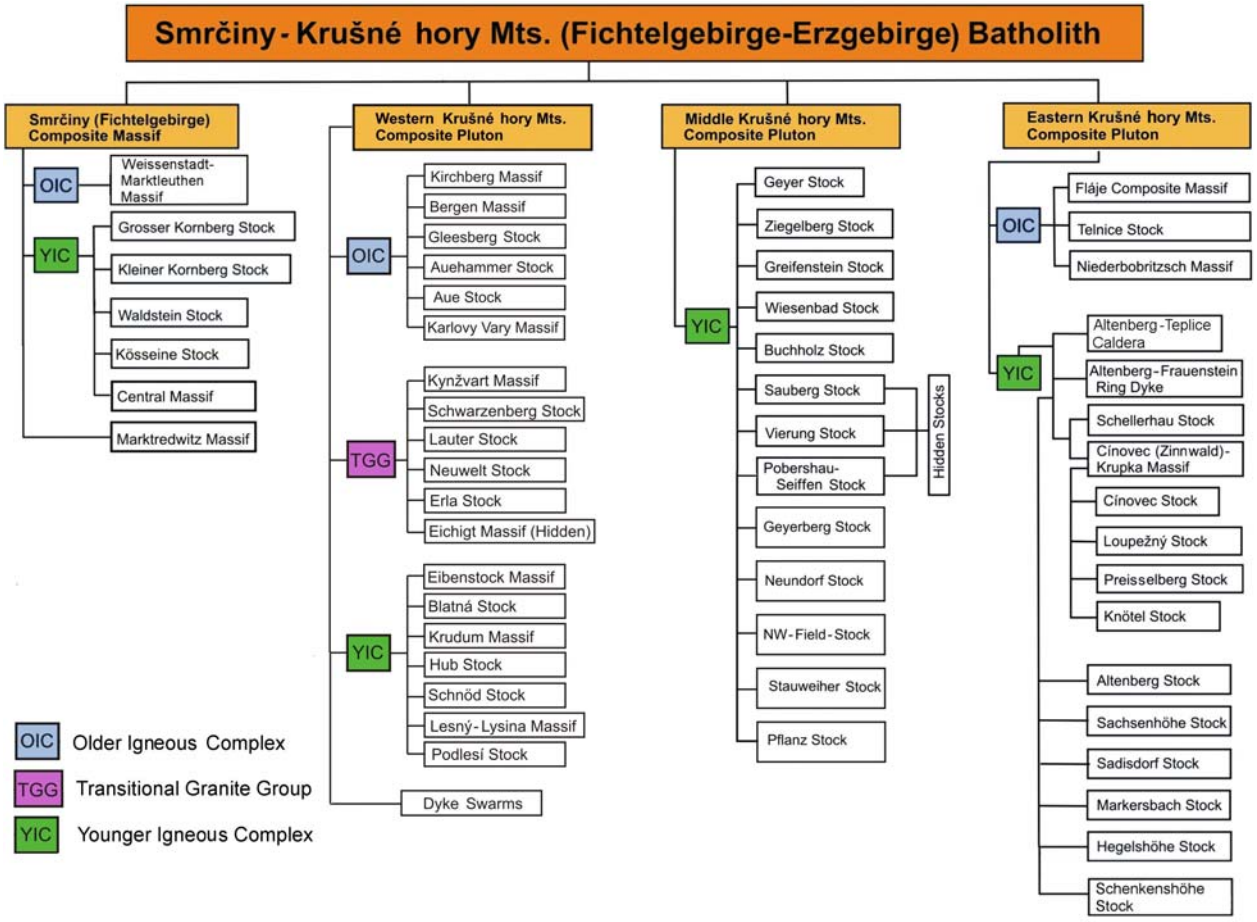

Fig. 3.1. *Smrčiny-Krušné hory Mts. (Fichtelgebirge-Erzgebirge) Batholith hierarchical scheme according to plutons, massifs, stocks and dyke swarms.*

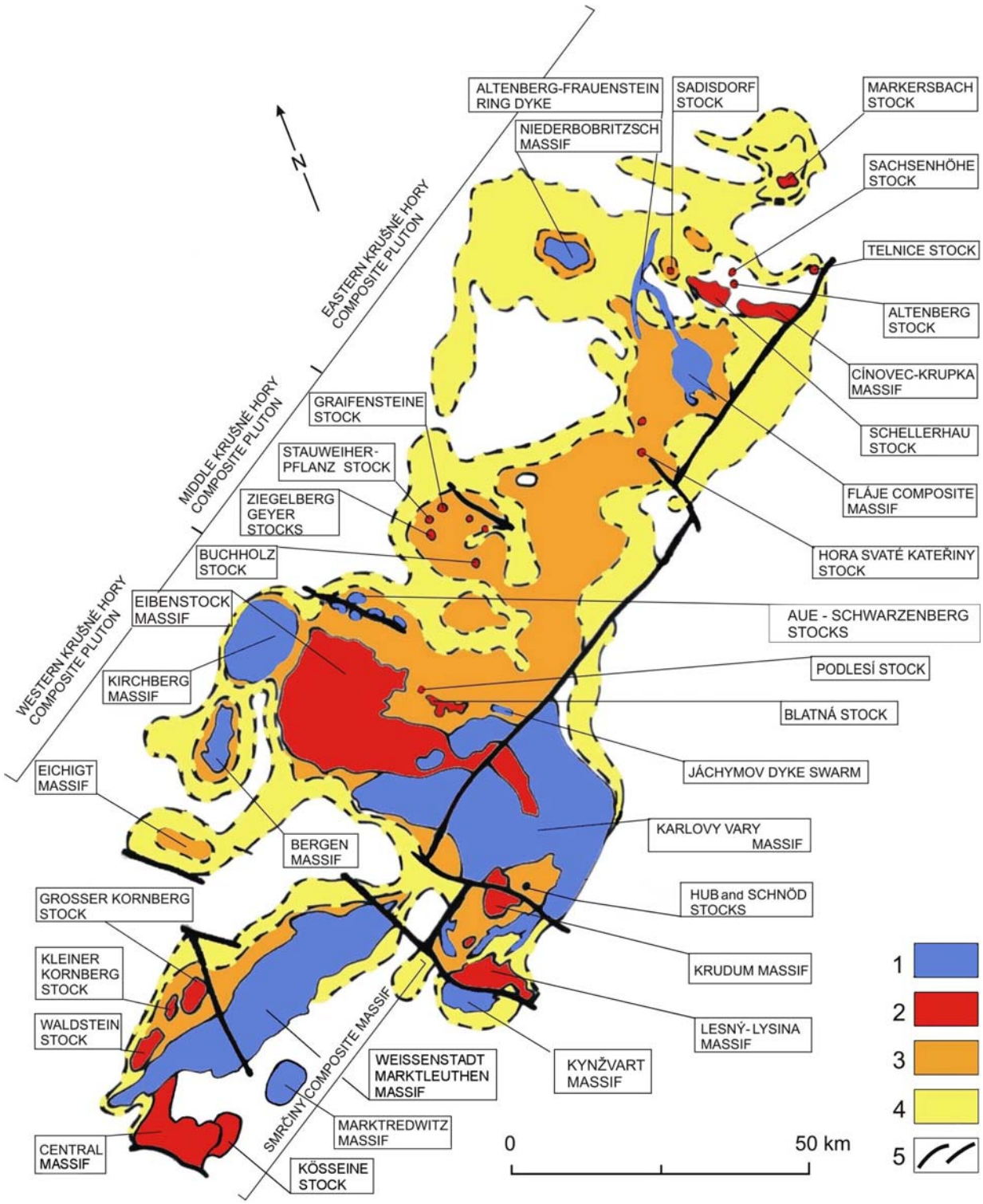

Fig. 3.2. *Topography of the Smrčiny-Krušné hory Mts. (Fichtelgebirge-Erzgebirge) Batholith (adapted after Rajpoot and Klomínský 1994). 1 – Older Igneous Complex (OIC) 2 – Younger Igneous Complex (YIC) and Transitional Granite Group (TGG), 3 – areal extent at depth 0 m, 4 – areal extent at depth of –1000 m, 5 – faults.*

Regional position: The batholith consists of four plutonic units:

Smrčiny-Fichtelgebirge Composite Massif,
Western Krušné hory Mts. Composite Pluton,
Middle Krušné hory Mts.Composite Pluton,
Eastern Krušné hory Mts. Composite Pluton.

Drilling as well as gravity measurements proves the subsurface continuity of the individual granitic intrusions. They are outlined and segmented by the NW-SE trending post-emplacement faults.

Rock types:

Biotite granites (formerly the Older Intrusive Complex – OIC and/or Gebirgs Granites)

Two-mica granites (corresponding to the Transitional Group)

Li-mica granites (formerly the Younger Intrusive Complex – YIC and/or Erzgebirges Granites)

Detailed typology of the Smrčiny-Krušné hory Mts. (Fichtelgebirge-Erzgebirge Batholith) after Rajpoot and Klomínský (1994):

Group 1 (G1) granites – porphyritic biotite, coarse-grained, undifferentiated, late-orogenic, tin-barren, peraluminous monzogranite (e.g. *Loket Granite, Fláje Granite, Weissenstadt Granite).*

Group 2 (G2) granites – two-mica or biotite ± muscovite, coarse- to medium-grained, poorly differentiated, post-tectonic, tin-barren, per-aluminous monzo-syenogranite (e.g. *Nejdek Granite, Waldstein Granite, Telnice Granite).*

Group 3 (G3) granites – two-mica coarse- or medium-grained, moderately differentiated, post-orogenic, stanniferous, highly peraluminous, alkali-feldspar syenogranite (e.g. *Eibenstock Granite, Kornberg Granite, Rand- and Kerngranite, Kynžvart Granite).*

Group 4 (G4) granites – generally two-mica medium- or fine-grained, strongly differentiated, post-orogenic, stanniferous, highly peraluminous, syenogranite *(Blauenthal Granite, Cínovec Granite, Milíře Granite).*

Group 5 (G5) granites – Li-mica and topaz-bearing leucocratic, medium- or fine-grained, alkali-rich, moderate to strongly differentiated, post-orogenic, stanniferous, highly peraluminous, alkali-feldspar syeno-monzogranite (e.g. *Čistá Granite, Tin Granite-Zinngranite, Lithium Granite, Pila Granite).*

A classification of Erzgebirge granitic bodies (Förster et al. 1999) is based on petrologic interpretation of geochemical and mineralogical relationships (micas, F- and P- whole rock contents). The subdivision of German massifs involves low-F biotite granites, low-F two-mica granites, high-F, high-P Li-mica granite, high-F, low-P Li-mica granite and a high-F, low-P biotite granite subtypes.

Size and shape (on erosion level): The area of exposed granites is about 1,883 km^2. The total subsurface area of the batholith is estimated at about 7,500 km^2 at depth of 0 m a.s.l. The total volume of the batholith is estimated at about 40,000 km^3 to a depth of 6 km. Wedge-like shape of the batholith (up to 15 km thick on south) is thinning towards the NW (Polanský 1993). The roof of the batholith forms several large domes corresponding to the individual composite massifs and plutons. Each dome shows complicated morphology consisting of a series of local cupolas (stocks) and depressions. The batholith is NE-SW trending ridge where the present surface almost copies the original roof of the batholith. The depth of OIC magma solidification is about 5–7 km and 2.5 km of the YIC (Dudek et al. 1991).

The extent of post-Carboniferous denudation of the Krušné hory (Erzgebirge) Batholith was estimated by Sattran (1957) according to the material removal in the Krušné hory crystalline complex at the maximum of 1,500 m.

The laccolitic shape is the most probable form of Variscan granites in the Erzgebirge.

Age and isotopic data: The Smrčiny-Krušné hory Mts. (Fichtelgebirge-Erzgebirge) Batholith originated from repeated melting events encompassing a time span of about 40 Ma.

Biotite granites (OIC) are of Upper Visean – Lower Namurian age, from about 330 Ma down to 320 Ma.

Two-mica granites (Transitional Group) are of the Westphalian age (~ 315 Ma).

Li-mica granites (YIC) are of the Upper Westphalian-Stephanian age (295 Ma), from 315 Ma to 290 Ma.

G1 and G2 Granites 325 ± 11 and 318 ± 5 Ma, 324 ±12, 317± 4 Ma (Rb-Sr whole rock), *G2 Granite* in Smrčiny Massif 290 to 280 Ma (Rb-Sr whole rock),

G3 Granite – 288 to 275 Ma (Rb-Sr whole rock), *G4 Granite and G5 Granite* 285 to 268 Ma, 321 ± 12 Ma, 313 ± 5 Ma, 318 ± 4 Ma, 305 ± 4 Ma (Rb-Sr whole rock), *lamprophyre* 305 ± 4 Ma (K-Ar), 286 ± 7 to 260 ± 7 (K-Ar) Ma.

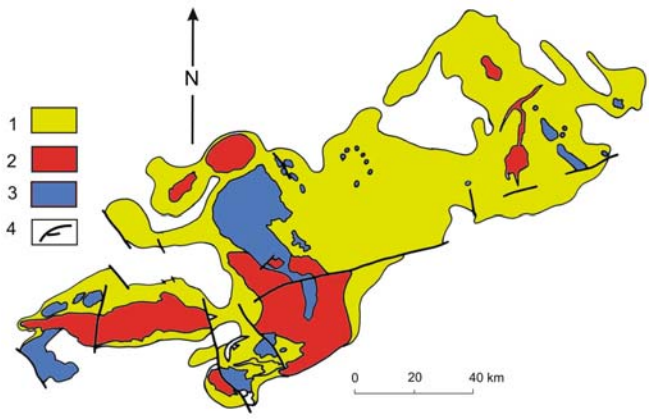

Fig. 3.3. Smrčiny-Krušné hory Mts. (Fichtelgebirge-Erzgebirge) Batholith geological (after Hoth, Tischendorf, Berger 1995). 1 – areal extent at depth of –1000 m, 2 – Older Igneous Complex, 3 – Younger Igneous Complex, 4 – faults.

Geological environment: Proterozoic monotonous group, paragneisses, quartzites and metabasites and orthogneisses (the Red and Grey Orthogneisses). Cambrian metagreywackes, graphitic mica-schists, paragneisses, quartzites and metabasites. Ordovician and Silurian quartzite, phyllite and graphitic schists. Devonian volcano-sedimentary units and diabase.

Contact aureole: the contact aureole discordant to isograds of the regional metamorphism. Broad aureole in the Devonian, Silurian and Ordovician strata, narrow aureole in the Upper Proterozoic strata. The thermal aureole and interaction within the OIC produced by YIC granites. Ghost stratigraphy within the granite outcrops as an effect of the partial melting of the country rocks.

Hydrothermal alterations: tourmalinization, greisenization, skarnization, chloritization, sericitization, argillitization, kaolinization.

Zoning: OIC is intruded by YIC after the time age maximum of 50 Ma. With a few exceptions, YIC is emplaced in the internal part of the batholith. OIC is eroded to a deeper level and the YIC is not yet fully exposed. YIC granites are intruded into their own volcanic ejecta (Teplice Volcanic Caldera).

Origin of granites: 20–25 km depth for magma formation. Base of older granites at the depth of 4–6 km. Base of younger granites lying at the depth of 14–15 km. The intrusion level of about 7 km for older granites and about 3 km for the younger granites is suggested (Tischendorf 1989).

Mineralization: boron-poor and fluorine-rich metallogenic province of Sn-W, U-Ag-Ni-Co-Bi, Pb-Zn-Cu-Fe, F-Ba associations. Genetic relationship to Sn-W mineralization (greisens, quartz veins and skarns).

Style of mineralization: breccias, stockworks, vein and strata bound systems.

Major economic ore Deposits: Jáchymov, Cínovec, Krupka, Freiberg, Horní Slavkov, Altenberg, Ehrenfriedersdorf, Aue-Oberschlema.

Heat production (μWm^{-3}): The average heat production of the batholith is 3.5. The younger granites appear to have higher heat production than the older granites. The highest heat production of 6.0 show the Zinngranite (Smrčiny Composite Massif), Eibenstock Granite (Karlovy Vary Massif) and Cínovec Granite (Eastern Krušné hory Mts. Pluton). Smrčiny Composite Massif 2.82–5.32, Kirchberg Massif 5.7–7.3, Loket Granite 3.74, Nejdek Granite 3.25, Kynžvart and Kfely Granites 3.3–4.39, Karlovy Vary Massif 0.4–9.6, Eibenstock Granite 5.36, Čistá Granite 3.76, Fláje Granite 2.5–4.8.

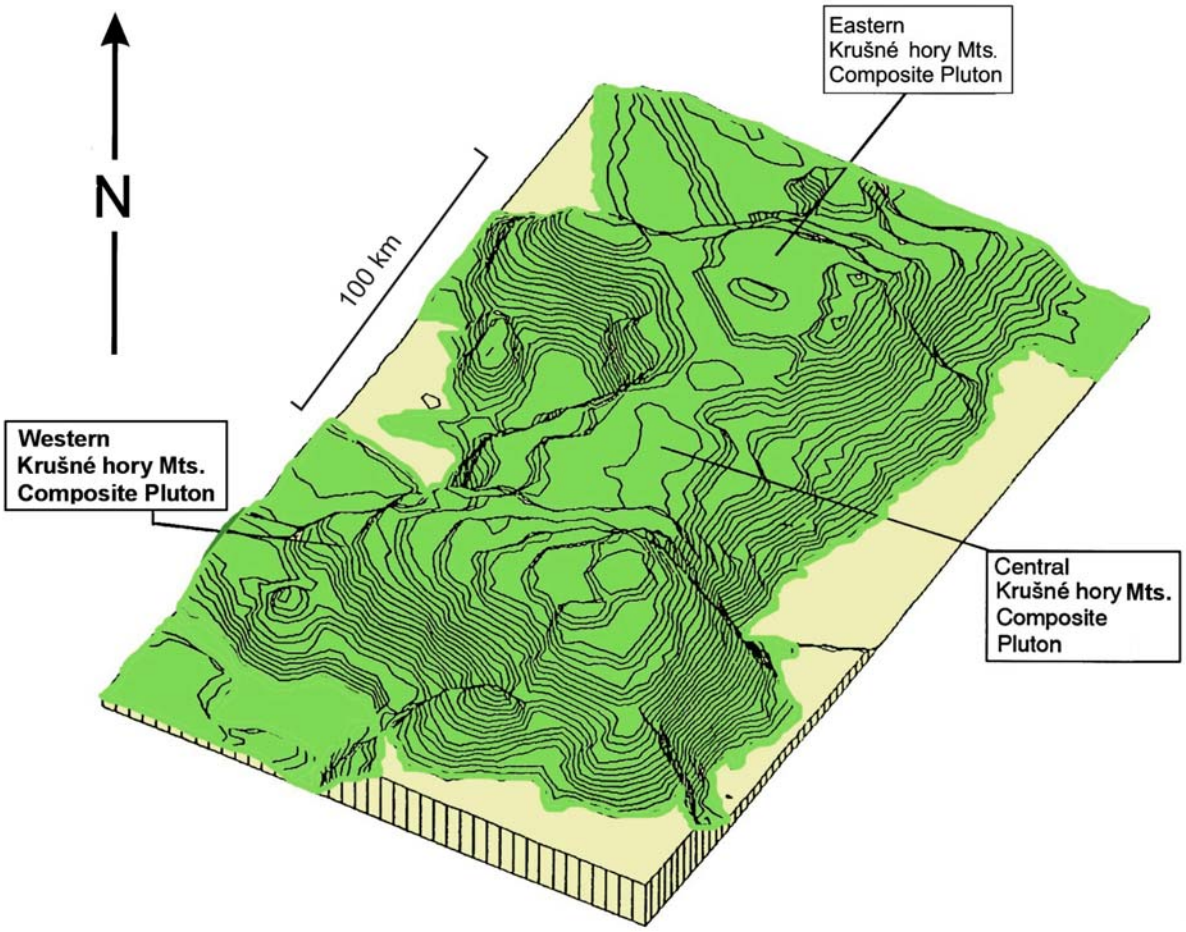

Fig. 3.4. *Smrčiny-Krušné hory Mts. (Fichtelgebirge-Erzgebirge) Batholith (the Krušné hory Mts.-Erzgebirge part) 3D morphology (according to the Bouguer gravity field).*

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3.1.1. SMRČINY (FICHTELGEBIRGE) COMPOSITE MASSIF (SCM)

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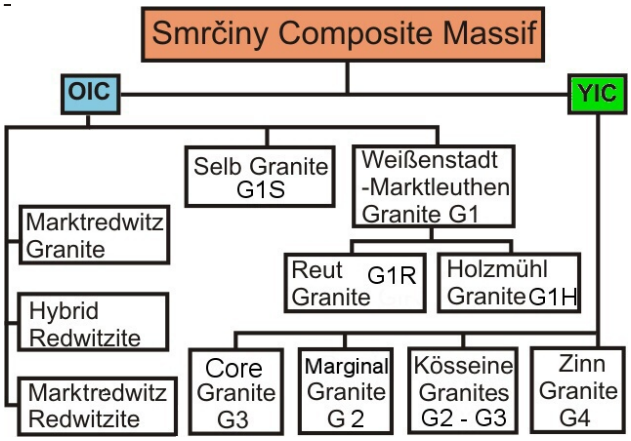

Fig. 3.5. *Smrčiny (Fichtelgebirge) Composite Massif hierarchic scheme according to rock types.*

Regional position: member of the the Smrčiny-Krušné hory Mts. (Erzgebirge) Batholith. The SCM consists of the Weissenstadt-Markleuthen Massif, Central Massif, Kösseine Stock and in the periphery is accompanied by the Kleiner Kornberg Stock, the Waldstein Stock, the Grosser Kornberg Stock and the Marktredwitz Massif (see Figs. 3.1. and 3.2.).

Rock types:

A. OLDER INTRUSIVE COMPLEX (OIC):

1. *Weissenstadt-Marktleuthen Granite* (G1W) – porphyritic biotite-muscovite granodiorite.
2. *Reut Granite* (G1R) – biotite-muscovite granite.
3. *Selb Granite* (G1S) – porphyritic biotite-muscovite granodiorite (close to transitional granites G2).
4. *Holzmühl Granite* (G1H)
5. *Marktredwitz Granite* (G1) – porphyritic biotite granite
6. *Hybrid Redwitzite* – amphibole-biotite and biotite granodiorites (contain subordinate K-feldspar and quartz). Both types (1 and 2) are intruded by the Marktredwitz Granite.
7. *Marktredwitz Redwitzite* comprises basic (noritic) biotite-hornblende variety of redwitzite – medium- to coarse-grained quartzdiorite with typical skeletal-biotite structure.

B. YOUNGER INTRUSIVE COMPLEX (YIC):

8. *Marginal (Randgranit) Granite* (G2) – porphyritic fine-grained muscovite-biotite granite (also in the Kornberg and Waldstein Stocks.
9. *Core (Kerngranit) Granite* (G3) – medium to coarse-grained muscovite-biotite granite (also in the Kornberg and Waldstein Stocks).
10. *Kösseine Granite (Kerngranit G2K) – (Kösseine Stock)*
    (a) medium- and equigranular facies (G2Ke),
    (b) fine- to medium-grained porphyritic facies (G2Kp-enclaves).
11. *Kösseine Granite* (Randgranit G3K) – medium- to coarse-grained muscovite-biotite granite (Kösseine Stock).
12. *Tin (Zinngranit) Granite* (G4) – medium-grained polymica (biotite-protolithionite-zinnwaldite) alkali-feldspar granite, local variable deuteric alteration.

The Selb, Rand and Kern granites are comparable to Erzgebirge Transition Granite Group.

The Kösseine Granite represents an independent intrusion (stock) among the Fichtelgebirge granites formed by a combination of incomplete restite unmixing, assimilation and probably fractional crystallization in the course of magma formation, ascent and emplacement.

Size and Shape (on erosion level): ca. 460 km^2 (volume estimate of 3,000 km^3), SCM has a cone shape (Vigneresse et al. 1989). Intersection of the two intrusive suites (OIC and YIC) OIC – 53 × 8 km, long elliptical YIC – 38 × 3.5 km semi-circular.

The Grosser Kornberg Stock (10 km^2), the Kleiner Kornberg Stock (2 km^2), the Waldstein Stock (15 km^2). Intrusion depth estimates suggest a crustal uplift of 6–8 km between early and late intrusive pulses. The OIC unit (Wiessenstadt-Marktleuthen Granite) is thin, except on its eastern site (6 km). The average depth of the floor is approximately 2–3 km. In YIC, (the Central Massif) presents a great thickness averaging 6–7 km. The satellite stocks of

the YIC (the Waldstein and Kornberg Stocks) have a restricted thickness of less than 2 km.

The Kösseine granites represent an independent intrusion among the Fichtelgebirge granites formed by a combination of incomplete restite unmixing, assimilation and probably fractional crystallization.

Age and isotopic data: Three distinct episodes of granite emplacement have been discriminated (Förster and Tischendorf 1994): 326 ± 4 Ma (G1W, G1S), 305 ± 4 Ma (G2, G3), and 289 ± 2 Ma (G4).

OIC 310 ± 14 Ma (Rb-Sr whole-rock), YIC 285 ± 6 Ma (Rb-Sr whole-rock) (Richter and Stettner 1979).

Geological environment: Cambrian to Ordovician phyllite, micaschists and orthogneisses, and Upper Proterozoic micaschists and Upper Proterozoic or Lower Palaeozoic orthogneisses.

Contact aureole: Broad contact aureole at northern granite contact.

Zoning: OIC – normal compositional zoning from SW to NE (from biotite granite to two-mica granites),

YIC – reverse and normal zoning, semi-circular arrangement of the individual granite phases.

The general zonation pattern of the OIC and the YIC is the result of a combination of multiple injections of single magma batches and in situ differentiation during magma emplacement.

According to Hecht et al. (1997) the internal zonation patterns of the OIC and YIC are asymmetrical and cannot be simply classified as normal or reverse with respect to the exposed granite outline.

Mineralization: Tin and uranium mineralization within the Zinn Granite.

Heat production (μWm^{-3}): *Selb Granite* 2.82, *Weissenstadt Granite* 3.86, *Reut Granite* 3.98, *Rand Granite* 3.51, *Kern Granite* 3.98, Tin Granite (Zinngranite) 5.32. Smrčiny Composite Massif 0.9–6.3 (Vaňková et al. 1979).

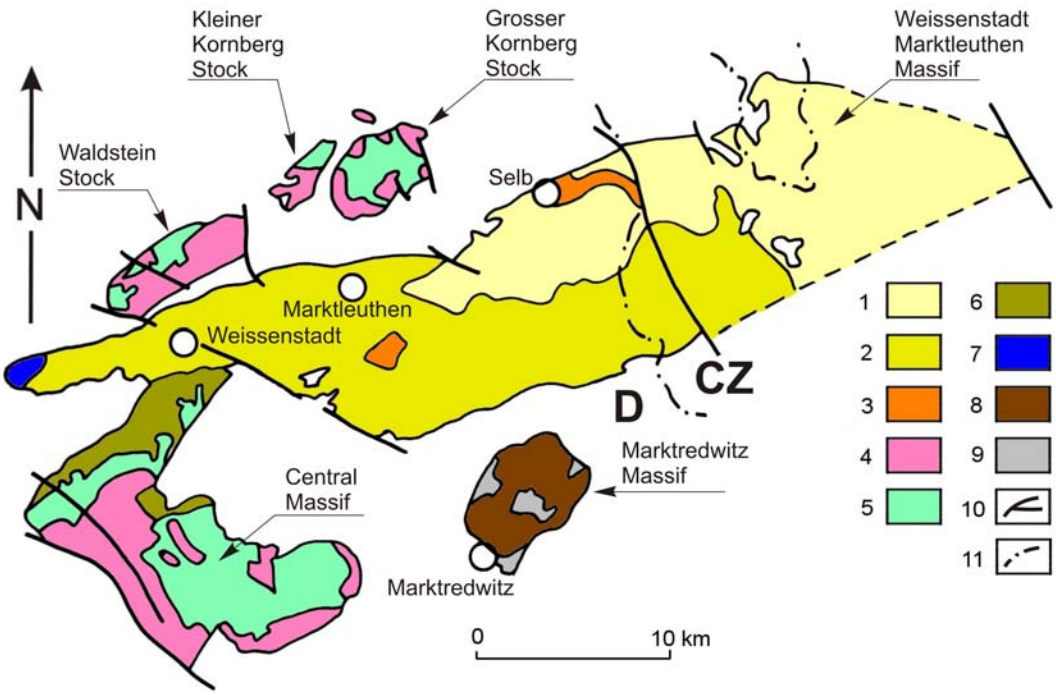

Fig. 3.6. *Smrčiny (Fichtelgebirge) Composite Massif geological sketch-map (altered after Weber and Vollbrecht, 1986). 1 – Selb Granite, 2 – Weissenstadt-Marktleuthen Granite, 3 – Holzmühl Granite, 4 – Marginal (Randgranit) Granite, 5 – Core (Kerngranit) and Kösseine Granites, 6 – Tin (Zinngranit) Granite, 7 – Reut Granite (G1), 8 – Redwitzite, 9 – Marktredwitz Granite, 10 – faults, 11 – state border.*

Weissenstadt-Marktleuthen Granite (G1W)

Quartz normal, sodic-potassic, peraluminous, mesocratic, S-type, I-M-series, granodiorite to granite

n = 9	Med.	Min	Max	QU1	QU3
SiO_2	67.70	66.80	69.80	67.50	68.40
TiO_2	0.68	0.56	0.75	0.68	0.73
Al_2O_3	14.90	14.60	15.70	14.70	15.20
Fe_2O_3	0.70	0.39	1.28	0.55	0.75
FeO	2.90	2.50	3.20	2.70	3.10
MnO	0.06	0.05	0.07	0.06	0.07
MgO	1.32	1.15	1.35	1.23	1.32
CaO	2.21	1.81	2.75	2.09	2.41
Li_2O	0.01	n.d.	0.03	0.00	0.02
Na_2O	3.20	3.00	3.60	3.10	3.20
K_2O	4.45	4.01	4.89	4.29	4.63
P_2O_5	0.31	0.27	0.38	0.29	0.36
Mg/(Mg+Fe)	0.39	0.36	0.41	0.38	0.40
K/(K+Na)	0.48	0.42	0.51	0.46	0.49
Nor.Or	27.67	25.09	30.55	26.88	28.69
Nor.Ab	30.13	28.78	34.15	29.29	30.29
Nor.An	9.08	7.02	12.40	8.75	10.33
Nor.Q	24.00	22.43	26.56	23.38	25.15
Na+K	200.72	185.18	203.86	197.75	201.52
*Si	150.52	143.36	164.15	147.37	156.48
K-(Na+Ca)	-47.89	-70.22	-26.68	-61.60	-37.23
Fe+Mg+Ti	90.81	76.64	94.96	88.24	92.68
Al-(Na+K+2Ca)	15.57	6.37	26.48	13.49	21.87
(Na+K)/Ca	5.11	3.78	6.25	4.67	5.42
A/CNK	1.08	1.05	1.13	1.07	1.11

Trace elements (mean values in ppm): Weissenstadt-Marktleuthen Granite – ***Ba*** *930,* ***Be*** *4.6,* ***Cs*** *99,* ***Ga*** *20,* ***F*** *602,* ***Li*** *60,* ***Nb*** *15,* ***Pb*** *35,* ***Rb*** *211,* ***Sn*** *8,* ***Sr*** *251,* ***Th*** *34,* ***U*** *4,* ***Y*** *18,* ***Zn*** *62,* ***Zr*** *267,* ***W*** *1.29,* ***Ce*** *99 (Richter and Stettner 1979).*
Selb Granite – ***Ba*** *344,* ***Be*** *9,1,* ***Cs*** *19,* ***Ga*** *23,* ***F*** *480,* ***Li*** *123,* ***Nb*** *9,* ***Pb*** *35,* ***Rb*** *321,* ***Sn*** *14,* ***Sr*** *74,* ***Th*** *12,* ***U*** *6,* ***Y*** *11,* ***Zn*** *47,* ***Zr*** *87,* ***W*** *2.61,* ***Ce*** *29 (Richter and Stettner 1979).*

Marginal (Randgranit) Granite (G2)

Quartz-rich, potassic, peraluminous, leucocratic, S-type, I-series, leucocratic granite

n = 14	Med.	Min	Max	QU1	QU3
SiO_2	73.90	72.50	75.70	73.30	74.50
TiO_2	0.23	0.12	0.36	0.16	0.31
Al_2O_3	13.30	12.30	14.40	13.10	13.60
Fe_2O_3	0.24	0.05	0.36	0.20	0.27
FeO	1.70	1.20	2.30	1.40	1.90
MnO	0.04	0.02	0.04	0.03	0.04
MgO	0.30	0.00	0.48	0.20	0.35
CaO	0.64	0.47	1.12	0.58	0.87
Li_2O	0.03	0.02	0.04	0.02	0.03
Na_2O	2.90	2.40	3.50	2.80	3.00
K_2O	5.43	4.85	6.36	5.18	5.47
P_2O_5	0.18	0.15	0.26	0.17	0.20
Mg/(Mg+Fe)	0.22	0.00	0.25	0.18	0.22

K/(K+Na)	0.55	0.49	0.60	0.54	0.55
Nor.Or	33.51	29.31	38.75	31.69	33.56
Nor.Ab	27.09	22.56	32.24	26.18	28.09
Nor.An	2.08	0.84	4.69	1.52	3.31
Nor.Q	31.99	27.34	37.47	30.24	34.11
Na+K	208.87	192.53	231.85	203.78	214.44
*Si	189.38	162.76	220.31	181.32	201.15
K-(Na+Ca)	5.39	-15.45	26.93	4.06	7.87
Fe+Mg+Ti	35.74	22.49	51.21	28.08	43.18
Al-(Na+K+2Ca)	27.62	8.98	46.54	15.04	31.32
(Na+K)/Ca	15.20	10.32	24.31	13.65	19.68
A/CNK	1.13	1.05	1.24	1.08	1.16

Trace elements (mean values in ppm): *Rand Granite* – **B** 7.7, B**a** 270, **Be** 8.6, **Cr** 8, **Cs** 26, **Cu** 4, **Ga** 22, **F** 1644, **Li** 135, **Ni** 4, **Nb** 12, **Pb** 29, **Rb** 411, **Sn** 13, **Sr** 41, **Th** 24, **U** 6, **Y** 28, **Zn** 44, **Zr** 95, **La** 49, **Ce** 64 (Richter and Stettner 1979).

Core (Kerngranit) **Granite** (G3)

Quartz-rich, potassic, strongly peraluminous, mesocratic, S-type, I-series, granite

n = 23	**Med.**	**Min**	**Max**	**QU1**	**QU3**
SiO_2	75.70	73.00	77.20	74.40	76.40
TiO_2	0.16	0.08	0.27	0.15	0.19
Al_2O_3	13.00	12.00	14.80	12.80	13.50
Fe_2O_3	0.19	0.03	0.65	0.07	0.29
FeO	1.50	1.00	1.90	1.40	1.60
MnO	0.03	0.02	0.07	0.03	0.04
MgO	0.17	0.02	0.34	0.08	0.20
CaO	0.56	0.30	0.90	0.50	0.59
Li_2O	0.03	0.01	0.06	0.03	0.04
Na_2O	3.10	2.70	3.70	2.80	3.20
K_2O	4.90	4.50	6.33	4.82	5.07
P_2O_5	0.19	0.13	0.27	0.16	0.21
Mg/(Mg+Fe)	0.17	0.02	0.21	0.07	0.18
K/(K+Na)	0.52	0.48	0.61	0.50	0.54
Nor.Or	29.91	27.63	38.54	29.35	30.96
Nor.Ab	28.76	24.98	33.85	26.02	29.51
Nor.An	1.55	-0.30	3.62	1.19	2.01
Nor.Q	35.64	26.61	39.03	33.63	36.08
Na+K	202.80	189.89	249.76	196.30	207.68
*Si	211.75	157.37	228.57	200.63	214.75
K-(Na+Ca)	-2.37	-16.01	37.11	-10.82	5.22
Fe+Mg+Ti	30.12	20.78	41.79	26.73	31.85
Al-(Na+K+2Ca)	33.24	6.61	69.74	21.72	39.57
(Na+K)/Ca	20.61	13.17	46.69	17.44	22.44
A/CNK	1.17	1.05	1.34	1.11	1.20

Trace elements (mean values in ppm): Core Granite – B 17.5, Ba 134, Be 9.8, ***Cr*** *6,* ***Cs*** *33,* ***Cu*** *5,* ***Ga*** *21,* ***F*** *1244,* ***Li*** *158,* ***Ni*** *4,* ***Nb*** *11,* ***Pb*** *35,* ***Rb*** *425,* ***Sn*** *15,* ***Sr*** *30,* ***Th*** *12.5,* ***U*** *10,* ***Y*** *25,* ***Zn*** *43,* ***Zr*** *81,* ***La*** *32,* ***Ce*** *30 (Richter and Stettner 1979).*

Tin (Zinngranit) **Granite** (G4)

Quartz-rich, sodic to potassic, strongly peraluminous, leucocratic, S-type, I-series, granite

n = 12	Med.	Min	Max	QU1	QU3
SiO_2	74.80	73.50	76.40	74.40	75.40
TiO_2	0.05	0.02	0.40	0.03	0.08
Al_2O_3	13.90	12.80	15.20	13.50	14.50
Fe_2O_3	0.08	0.04	1.01	0.05	0.11
FeO	1.20	1.00	1.50	1.10	1.20
MnO	0.03	0.03	0.05	0.03	0.03
MgO	0.01	0.01	0.07	0.01	0.06
CaO	0.30	0.26	0.43	0.28	0.39
Li_2O	0.06	0.03	0.10	0.05	0.08
Na_2O	3.70	3.20	4.20	3.50	4.00
K_2O	4.55	4.32	5.55	4.32	4.77
P_2O_5	0.26	0.19	0.31	0.20	0.29
Mg/(Mg+Fe)	0.02	0.01	0.08	0.01	0.05
K/(K+Na)	0.45	0.40	0.50	0.41	0.47
Nor.Or	27.33	25.87	33.07	26.06	28.91
Nor.Ab	34.08	29.63	38.44	31.68	36.53
Nor.An	-0.34	-0.63	0.71	-0.40	0.47
Nor.Q	32.75	26.48	35.87	31.42	33.88
Na+K	216.68	206.66	246.92	212.99	224.03
*Si	190.60	157.40	212.55	184.15	199.17
K-(Na+Ca)	-27.96	-49.16	-6.82	-45.57	-19.01
Fe+Mg+Ti	18.46	16.95	31.73	18.19	21.96
Al-(Na+K+2Ca)	40.92	25.00	60.37	40.04	44.87
(Na+K)/Ca	37.97	27.78	49.02	30.00	44.87
A/CNK	1.21	1.14	1.29	1.19	1.23

Trace elements (mean values in ppm): Zinn Granite – B 19, Ba 11, Be 16.9, Cr 6, **Cs** 63, **Cu** 4, **Ga** 42, **F** 2313, **Li** 324, **Ni** 3.6, **Nb** 16, **Pb** 20, **Rb** 830, **Sn** 25, **Sr** 5, ***Th*** *7,* ***U*** *14,* ***Y*** *14,* ***Zn*** *47,* ***Zr*** *26,* ***La*** *42,* ***Ce*** *20 (Richter and Stettner 1979).*

Kösseine Stock

Kösseine Granite (Kerngranit *G3K*) – quartz-rich, potassic, peraluminous, mesocratic, S-type granite

Kösseine Granite (Randgranit *G2K)* – quartz-rich, potassic, peraluminous, leucocratic, S-type granite

	Kösseine Granite-Kerngranit			**Kösseine Granite–Randgranit**		
	G3149	G335	G3237a	G2215	G2204	G2236
SiO_2	72.10	69.80	74.10	74.60	74.90	74.00
TiO_2	0.46	0.52	0.65	0.28	0.21	0.24
Al_2O_3	13.90	14.30	11.40	13.60	13.10	13.70
Fe_2O_3	0.23	0.98	1.19	0.13	0.15	0.49
FeO	3.00	3.40	4.60	1.90	1.60	1.40
MnO	0.05	0.05	0.05	0.04	0.03	0.03
MgO	0.61	0.68	1.32	0.40	0.26	0.30
CaO	1.22	1.40	0.40	0.61	0.57	0.74
Na_2O	2.90	2.70	1.06	2.50	3.00	2.90
K_2O	5.58	5.00	4.26	5.63	5.10	4.95
P_2O_5	0.21	0.27	0.13	0.23	0.22	0.17

Li_2O	0.02	0.02	0.03	0.03	0.03	0.03
Mg/(Mg+Fe)	0.25	0.22	0.29	0.26	0.21	0.22
K/(K+Na)	0.56	0.55	0.73	0.60	0.53	0.53
Nor.Or	34.33	31.30	27.76	34.50	31.29	30.37
Nor.Q	27.81	29.03	47.21	34.49	34.43	34.44
Nor.Ab	27.12	25.69	10.50	23.28	27.97	27.04
Nor.An	4.86	5.47	1.24	1.57	1.43	2.65
Na+K	212.06	193.29	124.66	200.21	205.09	198.68
*Si	173.43	177.30	281.68	206.40	203.66	203.06
K-(Na+Ca)	3.14	-5.93	49.11	27.99	1.31	-1.68
Fe+Mg+Ti	65.56	83.02	119.87	41.52	33.24	36.09
Al-(Na+K+2Ca)	17.40	37.60	84.95	45.11	31.83	43.97
(Na+K)/Ca	9.75	7.74	17.48	18.41	20.18	15.06
A/CNK	1.09	1.18	1.65	1.23	1.17	1.22

Trace elements (mean values in ppm): *Kösseine Granite (Kerngranit G3K)* – **Ba** 842, **Ce** 86,**Cr** 12, **Cs** 12,**Ga** 16, **La** 56, **Nb** 13, **Ni** 6, **Pb** 27, **Rb** 243, **Sc** 9, **Sn** 5, **Sr** 92, **Th** 19, **U** 3, **V** 31, **Y** 26, **Zn** 57, **Zr** 257. (Richter and Stettner 1979).

Kösseine Granite (Randgranit G2K) – **Ba** 283, **Ce** 33,Cr **11**, Cs **22**,Ga **21**,La **35**,Nb **11**, **Ni** 10, **Nb** 27, **Rb** 371, **Sn** 11, **Sr** 60, **Th** 11, **U** 5, **V** 13, **Y** 21, **Zn** 44, **Zr** 108. (Richter and Stettner 1979).

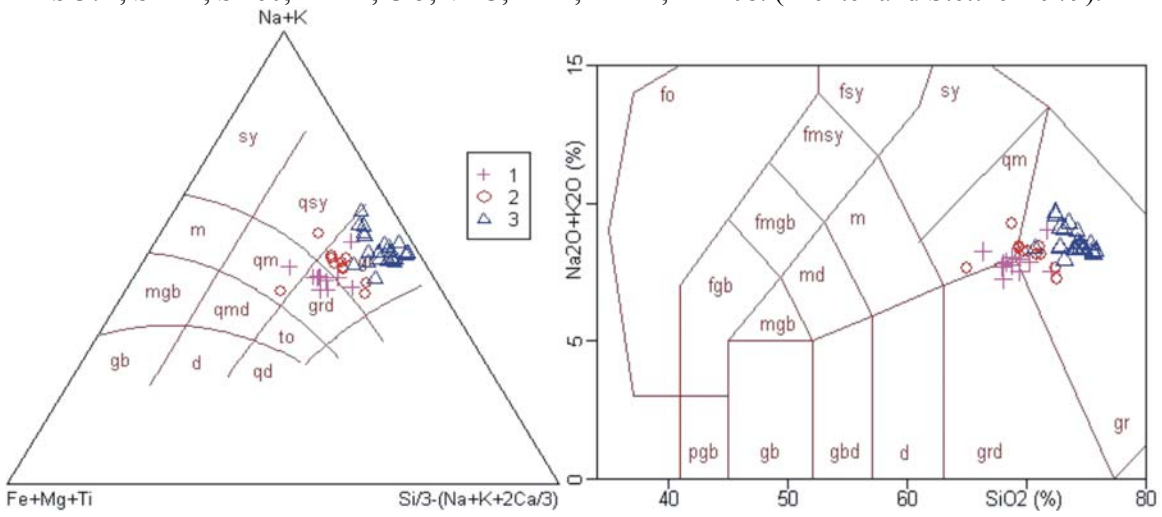

Fig. 3.7. *Weissenstadt-Marktleuthen Granite ABQ and TAS diagrams: 1 – Weissenstadt-Marktleuthen Granite (G1W), 2 – Reut Granite (G1R), 3 – Selb Granite (G1S).*

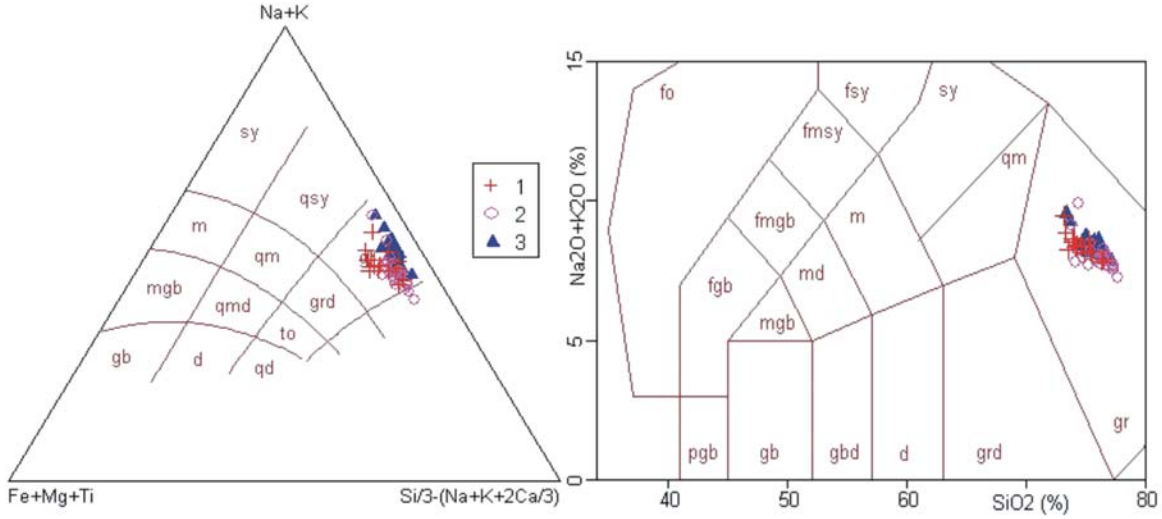

Fig. 3.8. *Fichtelgebirge/Smrčiny Massif ABQ and TAS diagrams. Younger Granite: 1 – Marginal Granite (G2 + Kornberg and Waldstein Stocks), 2 – Core Granite (G3) + Kornberg and Waldstein Stocks, 3 – Zinngranite (G4).*

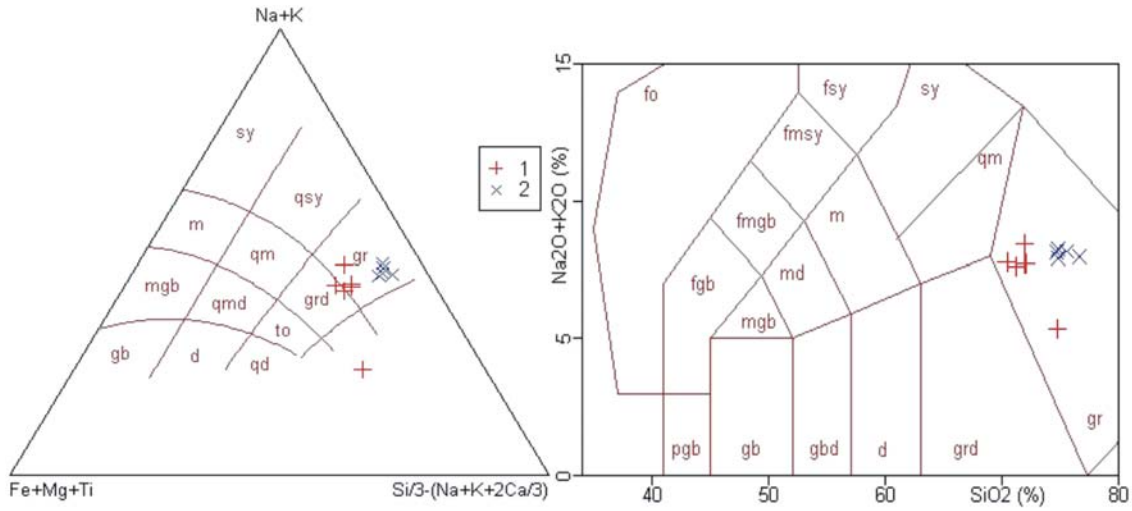

Fig. 3.9. Fichtelgebirge/Smrčiny Massif ABQ and TAS diagrams. 1 – Kösseine (Kern) Granite (G3K), 2 – Kösseine (Rand) Granite (G2K).

3.1.1.1. MARKTREDWITZ MASSIF

Regional position: Saxothuringicum – basic to intermediate rocks belong to the basic precursor series of postmetamorphic granites.

Rock types:

Marktredwitz Granite (G1) – porphyritic biotite granite.

Hybrid Redwitzite – amphibole-biotite and biotite (Marktredwitz) granodiorites (contain subordinate K- feldspar and quartz). Both types (1 and 2) are intruded by the Marktredwitz Granite.

Marktredwitz Redwitzite – comprises basic (noritic) biotite-hornblende variety of redwitzite – medium- to coarse-grained redwitzites with typical skeletal biotite structure.

Size and shape (on erosion level): 23 km^2, oval, and SW-NE oriented shape 7 × 4 km.

Age and isotopic data*: Marktredwitz Granite* 324 ± 4.2 Ma (Pb-Pb zircon), Marktredwitz *Redwitzite* 316–323 Ma (U-Pb titanite), 545–415 (Rb-Sr whole rock), 318–325 Ma (Pb-Pb zircon).

Contact aureole: andalusite in mica-schists.

Geological environment: Saxothuringian mica-schists of the Arzberg series.

Zoning: complex mineral composition and structure partly altered by Post-Sudetic faulting.

Mineralization: not reported.

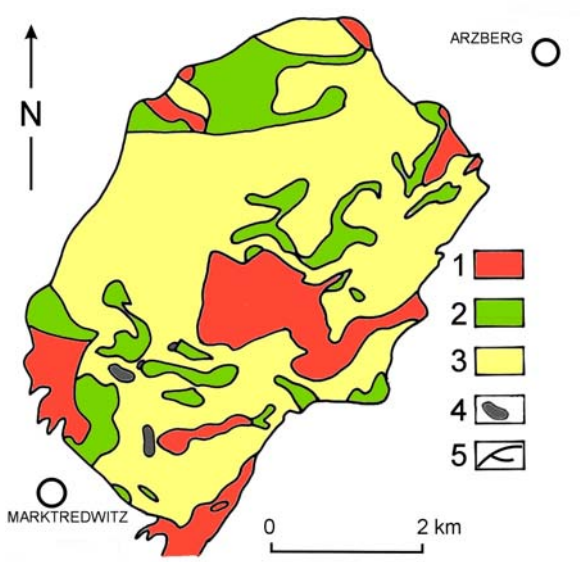

Fig. 3.10. Marktredwitz Massif geological (after Troll 1968). 1 – Marktredwitz Granite, 2 – Hybrid Redwitzite, 3 – Marktredwitz Redwitzite, 4 – Basic Redwitzite, 5 – faults.

Marktredwitz Redwitzite

Quartz-normal, sodic, metaluminous, melanocratic monzodiorite

	baz5732	baz5864	re5654	re5875
	basic redwitzite		**biotite redwitzite**	
SiO_2	48.66	48.62	54.68	53.94
TiO_2	0.85	0.82	1.17	1.30
Al_2O_3	11.73	13.93	18.19	18.66
Fe_2O_3	2.17	2.64	1.69	1.55
FeO	6.98	5.77	5.25	5.30
MnO	0.14	0.11	0.13	0.12
MgO	16.23	13.26	5.34	3.68
CaO	6.59	8.20	6.45	7.29
Na_2O	1.71	1.67	2.97	3.00
K_2O	1.80	1.73	2.56	2.52
P_2O_5	0.33	0.33	0.47	0.55
Mg/(Mg+Fe)	0.76	0.74	0.58	0.49
K/(K+Na)	0.41	0.41	0.36	0.36
Nor.Or	12.87	12.10	16.98	16.58
Nor.Ab	18.58	17.75	29.95	29.99
Nor.An	36.93	45.59	32.46	36.23
Nor.Q	0.00	0.00	4.34	4.47
Na+K	93.40	90.62	150.20	150.31
*Si	98.21	81.63	76.48	62.27
K-(Na+Ca)	-134.48	-163.38	-156.50	-173.30
Fe+Mg+Ti	537.74	452.71	241.44	200.83
Al-(Na+K+2Ca)	-98.07	-109.51	-23.01	-43.86
(Na+K)/Ca	0.79	0.62	1.31	1.16
A/CNK	0.72	0.73	0.97	0.92

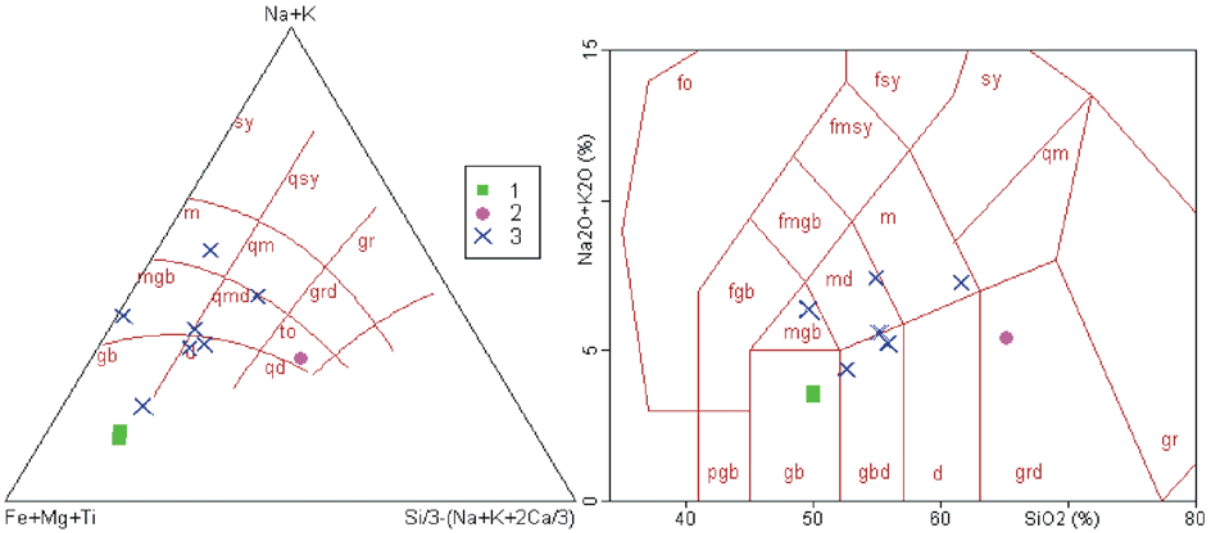

***Fig. 3.11**. Marktredwitz Massif ABQ and TAS diagrams: 1 – Marktredwitz Redwitzite, 2 – Hybrid Redwitzite, 3 – Marktredwitz Granodiorite.*

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3.1.2. WESTERN KRUŠNÉ HORY MTS. COMPOSITE PLUTON

Regional position: western part of the Krušné hory Mts.-Smrčiny Batholith in the Saxothuringian Zone. The pluton comprises the Eibenstock-Karlovy Vary Composite Massif, and following satellite intrusions and the dyke swarms: Kirchberg Massif, Bergen Massif, Eichigt Massif, Lesný-Lysina-Kynžvart Composite Massif, Aue-Schwarzenberg Stocks, the Blatná Stock, Podlesí Stock, Krudum Massif (Koník, Čistá, Výsoký Kámen, Hub and Schnöd Stocks), Jáchymov Dyke Swarm and Subvolcanic Rhyolite Dykes.

Rock types:

A. OLDER INTRUSIVE COMPLEX (OIC)

Redwitzites – enclaves of hybrid granodiorite, quartz diorite and gabbroids (mafics).

Kirchberg Granite (G1) – biotite granite (the Kirchberg Massif).

Loket Granite (G1) – porphyritic biotite granodiorite.

Bečov-Prameny Granite (G1) – medium-grained biotite granite.
Nejdek Granite (G2) – porphyritic biotite monzogranite, also in the Kirchberg Massif.
Burkersdorf Granite – medium- to coarse-grained, weakly porphyritic biotite granite.
Bernbach Granite – medium-grained, weakly porphyritic biotite granite.
Beierfeld Granite – fine-grained equigranular biotite granite.
Aue Granite – medium to coarse-grained to weakly porphyritic seriate biotite granite.

B. TRANSITIONAL GRANITES GROUP (TGG)

Bergen Granite (G2) – two-mica granite.
Kynžvart-Žandov Granite (G2) – two-mica granite
Kfely Granite (G2) – two-mica granite.
Ovčák Granite – occurs in three facies.
Ovčák I Granite – porphyritic medium-grained biotite granite.
Ovčák II Granite – medium-grained two-mica granite.
Ovčák III Granite – porphyritic fine-grained biotite granite.
Podlesí Granite Porphyry (autometamorphosed).
Třídomí Granite – porphyritic fine-grained biotite granite and its facies *Svárov-Polom Granite* – porphyritic medium-grained biotite granite.
Bílé Skály, Wallfischkopf and Krinitzberg Granites – porphyritic biotite granite represents small bodies (enclaves ?).
Lauter Granite – medium- to fine-grained equigranular two-mica granite.
Schwarzenberg Granite – medium- to coarse-grained equigranular two-mica granite.

C. YOUNGER INTRUSIVE COMPLEX (YIC)

Eibenstock (Karlovy Vary) Granite (G3) – porphyritic coarse-grained granite.
Blauenthal Granite (G4) – medium-grained polymica (Li-micas) granite.
Milíře Granite (G4) – medium-grained two-mica granite and its marginal facies "Na *Jeleni" Granite* (Krudum Massif).
Čistá Granite (G5) – zinnwaldite-topaz-alkali-feldspar granite (Krudum, Lesný-Lysina Massifs).
Šibeník Granite (G5?) – fine-grained muscovite alkali-feldspar granite.
Hřebečná Granite (G3) – coarse-grained, tourmaline-bearing ± topaz-biotite granite.
Blatenský vrch Granite (G3) – coarse-grained, tourmaline-bearing ± topaz-biotite granite.
Luhy Granite (G3) – coarse-grained, tourmaline-bearing ± topaz biotite granite.
Jelení vrch Granite (G4) – porphyritic fine-grained biotite granite.
Lithium Granite (G5) – Li-mica topaz-bearing medium-grained alkali-feldspar granite, similar to the Podlesí Stock and Pernink Stock).
Lesný-Lysina Granite – lithionite-topaz alkali-feldspar granite.
Jelení Granite – porphyritic alkali-feldspar granite.
Kladská Granite – fine-grained muscovite granite.
Hájek-Steinbruch Granite – small stock of partly greisenized alkali-feldspar granite.
Stock Granite – albite-protolithionite-topaz granite (the Podlesí Stock).

D. SUBVOLCANIC RHYOLITIC DYKES

<u>Group I Rhyolites:</u>
Jungfernsprung Rhyolite – porphyritic (quartz and feldspar) rhyolite.
Mahnbrück Rhyolite – porphyritic (quartz and feldspar) rhyolite.

<u>Group II Rhyolites:</u> (poor in phenocrysts, and different textures).
Saupersdorf Rhyolite – crypto- to microcrystalline granular incompletely altered rhyolite.
Weissbach Rhyolite – porphyritic crypto- to microcrystalline granular rhyolite.
Burkerdorf Rhyolite – crypto- to microcrystalline granular rhyolite.
Group III Rhyolites:
Morgenröthe Rhyolite – strongly porphyritic microcrystalline rhyolite.
Hahnewald Rhyolite – porphyritic cryptocrystalline rhyolite.
Gottesberg Rhyolite – porphyritic biotite rhyolite and porphyritic microgranite.

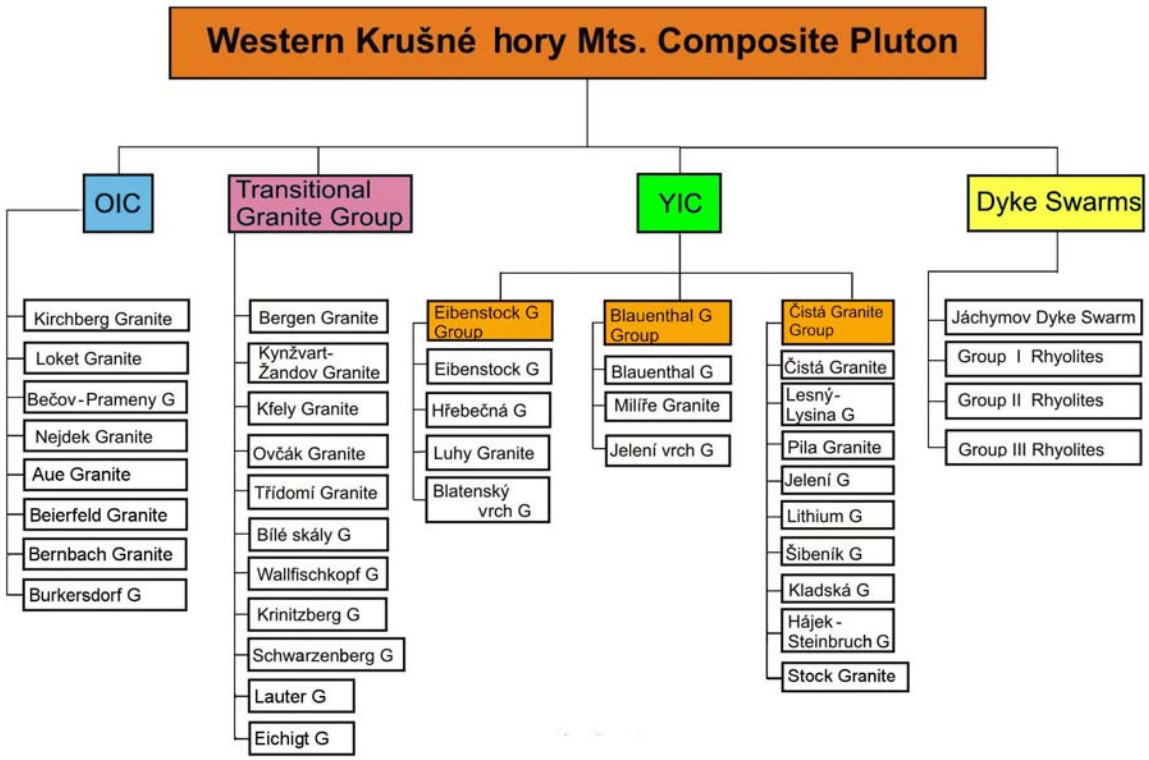

Fig. 3.12. *Western Krušné hory Mts. (Erzgebirge) Composite Pluton hierarchical scheme according to rock groups and rock types.*

Size and shape (on erosion level): the Eibenstock-Karlovy Vary Composite Massif, 1,500 km^2 (63 × 25 km), S-shape elongated oval tectonically outlined in the south with several semicircular massifs and stocks comprising two intrusive suites, OIC ~ 600 km^2 and YIC 900 km^2. The pluton root is at up to 8–15 km depths in the south. Satellite massifs and stocks: the Kirchberg Massif (140 km^2), the Bergen Massif (33 km^2), the Kynžvart Massif (the Lesný-Lysina-Kynžvart Composite Massif) 85 km^2, the Schwarzenberg Stocks (12 km^2), the Blatná Stock (7 km^2), the Krudum Massif (Hub and Schnöd Stocks) 30 km^2.

Suite of the subvolcanic rhyolitic dykes forms dykes between a few and some tens of meters in width, though their thickness and length is difficult to determine precisely owing to poor exposure.

Age and isotopic data: OIC and TGG: 332 ± 5, 323 ± 4 Ma (Rb-Sr whole rock), 324 ± 12, *Bergen Granite* 312.8 Ma ± 7 Ma (Rb-Sr whole rock), 323.6 ±2.6 Ma (K-Ar biotite), *Kirchberg Granite* 309.4 ± 3.8 Ma (Rb-Sr whole rock), 320.9 ± 2.9 Ma (K-Ar biotite), 307 ± 4, 315 ± 6 Ma (Rb-Sr whole rock). *Redwitzite* 322.8 ± 3.5 Ma, 323 ± 4.4 Ma (Pb-Pb zircon).

YIC: 275 Ma (K-Ar biotite), 325 ± 7 Ma, (0.7025, Rb-Sr whole rock) 313 ± 5, 321 ± 12 Ma (Rb-Sr whole rock), 305 ± 2, 299 ± 3 Ma (Rb-Sr whole rock), *Eibenstock Granite* 305 ± 4 Ma (Rb-Sr whole rock), 303 ± 8 Ma (Rb-Sr biotite).

Dyke Swarms: *Gottesberg Rhyolite* 290 ± 15 Ma (U-Th-Pb monazite), *Jungfernsprung Rhyolite* 295 ± 20 Ma (U-Th-Pb monazite), *Mahnbrück Rhyolite* 291 ±11 Ma (U-Th-Pb monazite), *Gottesberg Microgranite* 304 ± 2.5 Ma (K-Ar biotite cooling-age), Kersantite crossing the Kirchberg Massif 295 ± 6 Ma (Ar-Ar biotite).

Suite of the subvolcanic rhyolitic dykes are probably intermediate in age between the oldest and youngest Variscan subvolcanic/volcanic activity related to the Western Krušné hory Mts. Composite Pluton

Geological environment: Cambrian to Ordovician phyllite and the Upper Proterozoic mica-schists, orthogneisses, and Mariánské Lázně Metabasite Complex.

One part of the suite subvolcanic rhyolitic dykes (Mahnbrück, Weissbach, Burkersdorf) is located in the granite exocontact (Bergen and Kirchberg Massifs). The Saupersdorf, Jungfernsprung, Morgenröthe, Hahnewald and Gottesberg are emplaced within and/or the endocontact of the Kirchberg and Eibenstock Massifs.

Contact aureole: Broad aureole of YIC and OIC in the Ordovician sediments, narrow aureole of OIC in the Upper Proterozoic mica-schists.

Zoning: Complex zonation, weak and/or strong vertical compositional zoning in both plutonic suites. YIC is intruded into OIC. The pluton shows multistage emplacement, normal felsic inward concentric zoning (OIC – marginal, YIC – central part of the pluton with sharp contacts). In the Krudum Massif marginal greisen and feldspatites are located in apical parts of zinnwaldite granites (G5).

Mineralization: Tin and tungsten greisen Deposits in endo- and exocontact (Sm-Nd 287 ± 28 Ma), quartz-wolframite veins (in the Kirchberg Granite), uranium, Ni-Co-Bi and Ag (e.g. Jáchymov and Aue-Oberschlema Deposits).

Heat production (μWm^3): (OIC): Kirchberg Granite 5.7–7.3, Loket Granite 3.74, Nejdek Granite 3.25,

(TGG): *Kynžvart and Kfely Granite* 3.3–4.39,

(YIC): Eibenstock Granite 5.36, Čistá Granite 3.76, (Vaňková et al. 1979).

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3.1.2.1. KARLOVY VARY-EIBENSTOCK COMPOSITE MASSIF

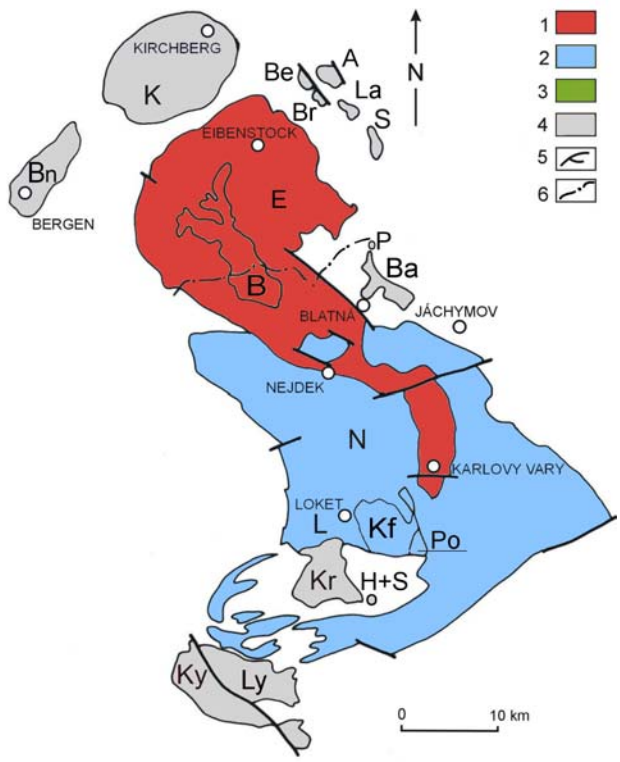

Fig. 3.13. *Western Krušné hory Mts. (Erzgebirge) Composite Pluton geological (adapted after Fusán et al. 1967). 1 – Eibenstock Massif (E), Blauenthal Granite (B), 2 – Karlovy Vary Massif: Nejdek Granite (N), Loket Granite (L), Kfely Granite (Kf), Granite Porphyry, 3 – Bernbach Stock (Be), Schwarzenberg Stock (S), Aue Stock (A), Beierfeld Stock (Be), Burkendorf Stock (Br) Lauter Stock (La), Kirchberg Massif (K), Bergen Massif (Bn), Kynžvart Massif (Ky), Krudum Massif (Kr), Blatná Stock (Ba), Podlesí Stock (P), Lesný-Lysina Massif (Ly), Hub and Schnöd Stocks (H + S), 4 – faults, 5 – state border.*

Regional position: Central part of the Western Krušné hory (Erzgebirge) Composite Pluton. The Karlovy Vary-Eibenstock Composite Massif is surrounded by Kirchberg Massif, Bergen Massif, Lesný-Lysina-Kynžvart Composite Massif, Blatná Stock, Jáchymov Dyke Swarm, Krudum Massif and minute (mostly hidden) Podlesí, Aue-Schwarzenberg, Hub and Schnöd Stocks.

Rock types:

A. OLDER INTRUSIVE COMPLEX (OIC)

Redwitzites – Enclaves of hybrid granodiorite, quartz diorite and gabbroids (mafics) – not shown in the map (the Abertamy body).

Loket Granite (G1) – porphyritic biotite granodiorite.

Bečov-Prameny Granite (G1) – medium-grained biotite granite – not shown in the map.

Nejdek Granite (G2) – porphyritic biotite granite (monzogranite).

B. TRANSITIONAL GRANITE GROUP (TGG)

Kfely Granite (G2) – two-mica granite.

Bílé Skály, Wallfischkopf and Krinitzberg Granites are represented by small bodies of the porphyritic biotite granite.

C. YOUNGER INTRUSIVE COMPLEX (YIC)

Eibenstock (Karlovy Vary) Granite (G3) – porphyritic coarse-grained granite.

Blauenthal Granite (G4) – medium-grained polymica (Li micas) granite.

Size and shape (on erosion level)*:* 1,500 km^2 (63 × 25 km), elongated S shape oval (tectonically outlined in the south. The Abertamy Redwitzite is about 1000 m thick. The main granite is interpreted according to gravity profiles as a continuous desk whose floor is horizontal (or subhorizontal) and varies along its whole extention about a depth of 10 km (saw-like floor, interfingering pattern between the granite and gneiss). The near surface upper contact of the granite body is midly inclined, and outward dipping.

Age and isotopic data:

OIC: Rb/Sr 332 ± 5, 323 ± 4, 320 ± 6 Ma, 324 ± 12 Ma (Rb-Sr WR). 320 ± 9 Ma (Pb-Pb zircon). *Redwitzite* 322.8 ± 3.5 Ma (Pb-Pb zircon).

YIC: *Eibenstock 1 Granite* 305 ± 4 Ma (Rb-Sr whole rock), 303 ± 8, *Eibenstock 2 Granite* 299 ± 6 (Rb-Sr biotite), 316 ± 3 Ma (U-Pb chemical monazite + xenotime + uraninite), 311 ± 5 Ma (Ar-Ar muscovite, biotite), 305 ± 4, 325 ± 7, 323 ± 1 Ma (Rb-Sr whole rock), 303 ± 8 Ma (Rb-Sr biotite).

Geological environment: Cambrian to Ordovician phyllite and Upper Proterozoic mica-schists,

Contact aureole: Broad thermal aureole of YIC and OIC in the Ordovician sediments, narrow aureole of OIC in the Upper Proterozoic mica schists.

Zoning: Complex zonation, weak and/or strong vertical compositional zoning in both plutonic suites. YIC is intruded into OIC. The pluton shows multistage emplacement, normal felsic inward concentric zoning (OIC – marginal, YIC – central part of the massif with sharp contacts). The YIC granites tend to higher positions and occur close to the centres of the OIC granites.

Mineralization: Tin and tungsten greisen Deposits in endo- and exocontact quartz-wolframite veins and stock works (the Rotava Deposit), uranium, Ni-Co-Bi and Ag veins (Jáchymov District and Aue-Oberschlema).

Heat production (μWm^{-3}): Loket Granite 3.74, Nejdek Granite 3.25, Eibenstock Granite 5.36.

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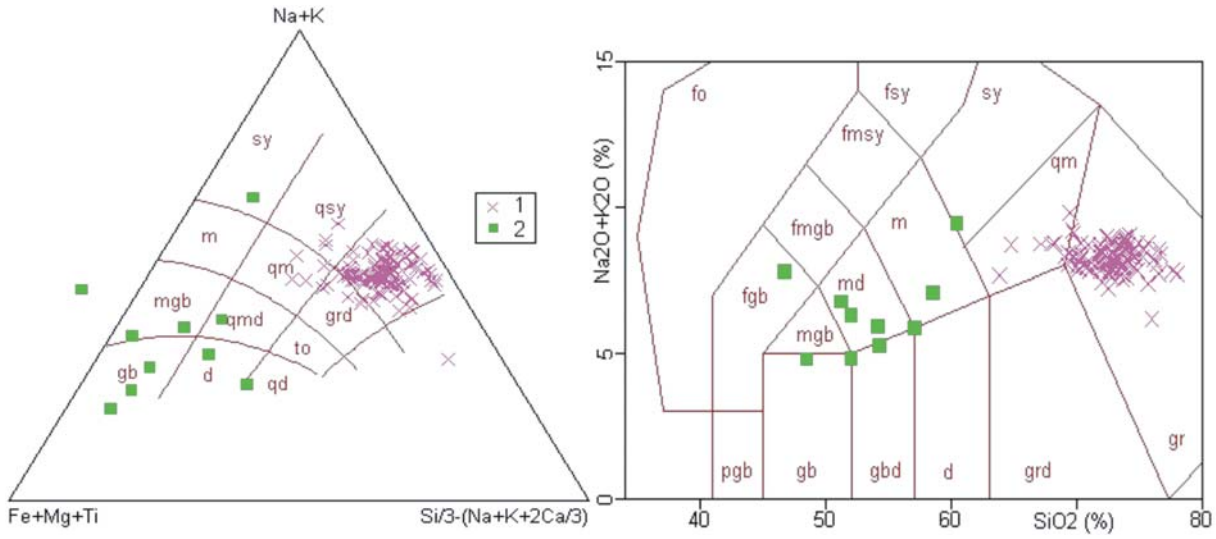

Fig. 3.14. *Karlovy Vary-Eibenstock Composite Massif ABQ and TAS diagrams. 1 – OIC granites, 2 – mafic rocks (enclaves).*

Nejdek Granite

Quartz-normal, sodic to potassic, peraluminous, mesocratic, S-type, I- and M-series, granite to granodiorite

n = 56	Median	Min	Max	QU1	QU3
SiO_2	70.84	67.60	74.12	69.38	71.90
TiO_2	0.36	0.13	0.71	0.23	0.43
Al_2O_3	14.35	13.37	16.07	14.09	14.87
Fe_2O_3	0.65	0.10	1.19	0.54	0.73
FeO	1.86	0.12	3.48	1.36	2.22
MnO	0.00	0.00	0.08	0.00	0.00
MgO	0.78	0.19	2.43	0.56	0.94
CaO	1.14	0.10	2.05	0.84	1.51
Na_2O	3.40	0.26	4.54	3.19	3.57
K_2O	4.63	2.23	5.42	4.40	4.97
P_2O_5	0.18	0.01	0.36	0.14	0.21
Li_2O	0.030	0.010	0.170	0.025	0.050
Mg/(Mg+Fe)	0.36	0.20	0.58	0.32	0.43
K/(K+Na)	0.47	0.32	0.93	0.45	0.49
Nor.Or	28.74	14.23	33.72	27.33	30.29
Nor.Ab	31.85	2.55	42.07	30.35	33.49
Nor.An	4.85	0.47	9.68	3.14	6.63
Nor.Q	28.17	14.03	50.64	25.96	30.05
Na+K	207.44	116.67	252.43	202.73	215.21
*Si	169.93	104.02	279.58	157.50	182.37
K-(Na+Ca)	-31.68	-76.72	98.11	-48.97	-22.38
Fe+Mg+Ti	55.52	27.59	114.70	45.99	68.54
Al-(Na+K+2Ca)	33.93	-33.44	195.34	20.38	42.88
(Na+K)/Ca	9.86	5.64	65.43	7.88	14.25
A/CNK	1.16	0.91	2.63	1.09	1.20

Trace elements (mean values in ppm): *Older granites (OIC)* – **Ba** 472, **Cs** 20, **Ga** 20, **Hf** 4.9, **Li** 125, **Nb** 13, **Pb** 33, **Rb** 242, **Sc** 6.1, **Sr** 151, **Th** 25, **U** 4, **Y** 23, **Zn** 56, **Zr** 140, **La** 42, **Ce** 72, **Sm** 5.2, **Eu** 0.82, **Yb** 1.74, **Lu** 0.26 (Breiter, Sokolová and Sokol 1991).

Loket Granite – **Ba** 1281, **Cs** 9, **Ga** 33, **Hf** 10.7, **Li** 60, **Nb** 19, **Pb** 45, **Rb** 171, **Sc** 10.8, **Sr** 376, **Th** 32, **U** 4, **Y** 28, **Zn** 74, **Zr** 341, **La** 74, **Ce** 128, **Sm** 7.8, **Eu** 1.53, **Yb** 2.15, **Lu** 0.3 (Breiter, Sokolová and Sokol 1991).
Younger granites (YIC) – **Ba** 52, **Cs** 67, **Ga** 29, **Hf** 2.9, **Li** 353, **Nb** 21, **Pb** 15, **Rb** 702, **Sc** 3.6, **Sr** 15, **Th** 11, **U** 16, **Y** 25, **Zn** 50, **Zr** 72, **La** 12, **Ce** 26, **Sm** 2.8, **Eu** 0.13, **Yb** 2.12, **Lu** 0.18 (Breiter, Sokolová and Sokol 1991).
Li-mica granites – **Ba** 37, **Cs** 102, **Ga** 39, **Hf** 1.9, **Li** 943, **Nb** 37, **Pb** 7, **Rb** 1428, **Sc** 3.5, **Sr** 24, **Th** 4.8, **U** 11.8, **Y** 33, **Zn** 103, **Zr** 18, **La** 2, **Ce** 8, **Sm** 1.3, **Eu** 0.1, **Yb** 21.9, **Lu** 0.15 (Breiter, Sokolová and Sokol 1991).

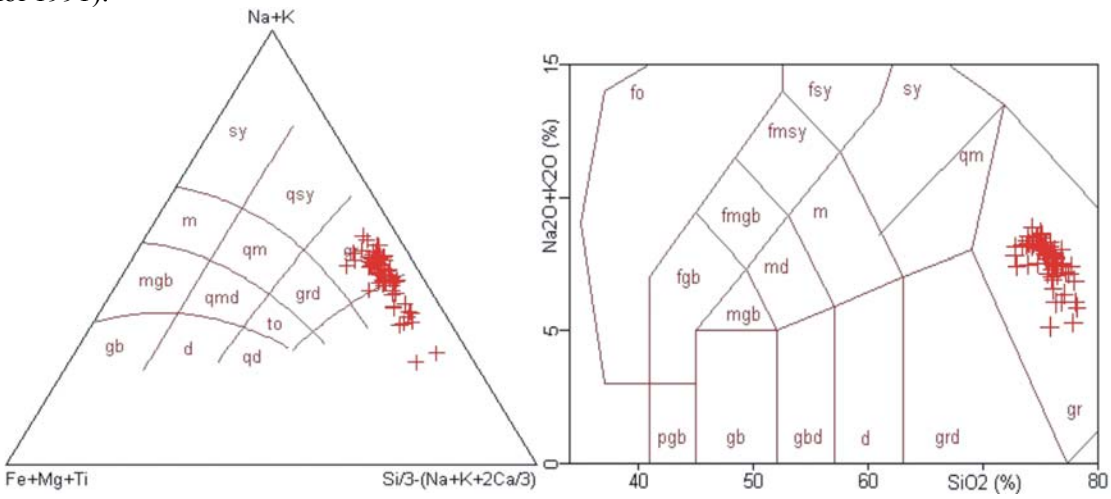

Fig. 3.15. *Karlovy Vary-Eibenstock Composite Massif ABQ and TAS diagrams. YIC-granites.*

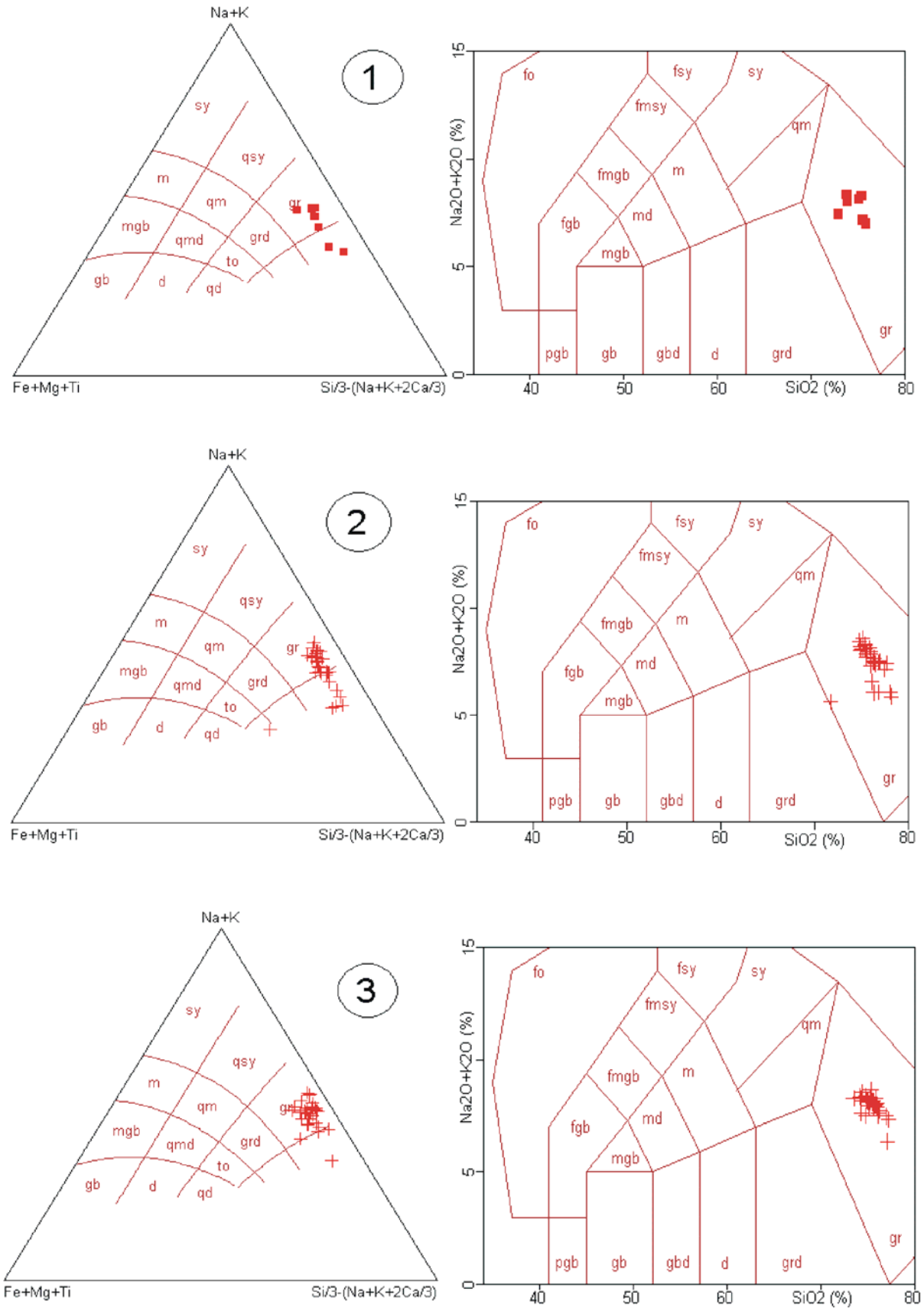

Fig. 3.16. *Karlovy Vary-Eibenstock Massif ABQ and TAS diagrams: 1 – Bílé Skály (Wallfischkopf type) Granite, 2 – Eibenstock (Karlovy Vary) Granite, 3 – Blauenthal Granite.*

Eibenstock (Karlovy Vary) Granite

Quartz-rich, potassic, peraluminous, leucocratic, S-type, granite

n = 30	Median	Min	Max	QU1	QU3
SiO_2	74.40	72.81	77.05	74.02	75.02
TiO_2	0.11	0.06	0.17	0.09	0.13
Al_2O_3	13.59	12.00	14.62	12.95	13.82
Fe_2O_3	0.49	0.21	14.02	0.43	0.63
FeO	1.20	0.43	1.94	0.96	1.36
MnO	0.00	0.00	0.00	0.00	0.00
MgO	0.18	0.10	0.36	0.14	0.21
CaO	0.37	0.19	0.82	0.29	0.42
Na_2O	2.83	1.75	3.36	2.70	3.04
K_2O	4.71	3.19	5.22	4.46	4.90
P_2O_5	0.21	0.07	0.32	0.14	0.25
Li_2O	0.065	0.030	0.110	0.058	0.075
Mg/(Mg+Fe)	0.16	0.03	0.24	0.14	0.18
K/(K+Na)	0.52	0.43	0.64	0.50	0.53
Nor.Or	29.08	19.88	32.30	27.34	30.18
Nor.Ab	26.67	16.76	31.25	25.49	28.40
Nor.An	0.39	-0.55	3.25	-0.01	0.84
Nor.Q	37.36	32.92	46.98	34.99	39.47
Na+K	190.23	144.17	215.86	184.55	199.24
*Si	218.11	189.80	268.20	201.75	227.83
K-(Na+Ca)	0.43	-37.43	42.02	-6.15	5.70
Fe+Mg+Ti	28.87	20.20	195.12	25.32	32.72
Al-(Na+K+2Ca)	54.67	32.29	119.02	50.32	70.83
(Na+K)/Ca	29.50	10.18	54.47	24.66	35.91
A/CNK	1.30	1.17	1.72	1.26	1.39

Trace elements (mean values in ppm)*: Eibenstock-Karlovy Vary Granite* – **Li** 465, **Rb** 705, **Ga** 39, **Sn** 39, **Be** 15, **Zr** 52, **Ba** 50, **Sr** 24, **V** 5, **U** 12.7, **Th** 13.8 (Klomínský and Absolonová 1974).

Bílé Skály (Wallfischkopf) Granite

Quartz-rich, potassic, peraluminous, leucocratic, S-type, granite

n = 7	Median	Min	Max	QU1	QU3
SiO_2	73.91	70.13	74.76	73.40	73.92
TiO_2	0.25	0.13	0.40	0.16	0.25
Al_2O_3	13.90	13.05	16.01	13.41	14.75
Fe_2O_3	0.86	0.52	1.32	0.61	0.98
FeO	1.01	0.47	1.98	0.64	1.06
MnO	0.00	0.00	0.00	0.00	0.00
MgO	0.24	0.18	0.40	0.20	0.25
CaO	0.52	0.11	0.80	0.11	0.56
Na_2O	3.06	0.32	3.68	0.37	3.18
K_2O	5.10	3.20	6.82	4.75	5.52
P_2O_5	0.19	0.07	0.30	0.12	0.21
Li_2O	0.063	0.039	0.106	0.043	0.065
Mg/(Mg+Fe)	0.20	0.15	0.22	0.17	0.20
K/(K+Na)	0.52	0.36	0.93	0.49	0.59
Nor.Or	31.26	19.57	43.45	29.06	33.33
Nor.Ab	28.68	3.10	34.20	3.53	29.62
Nor.An	0.76	-0.26	3.15	0.09	1.59

Nor.Q	35.54	31.53	45.20	34.00	37.77
Na+K	198.20	152.07	210.90	155.13	205.73
*Si	205.66	188.82	255.32	197.25	218.55
K-(Na+Ca)	-1.30	-65.07	132.52	-12.58	26.93
Fe+Mg+Ti	33.91	26.92	48.52	27.42	37.00
Al-(Na+K+2Ca)	50.12	30.12	155.35	33.70	75.07
(Na+K)/Ca	21.37	13.09	79.09	18.77	24.04
A/CNK	1.26	1.16	2.01	1.17	1.39

Trace elements (mean values in ppm)*: Bílé Skály Granite* – **Li** 325, **Rb** 645, **Ga** 37, **Sn** 35, **Be** 14, **Zr** 59, **Ba** 71, **Sr** 27, **V** 6, **U** 13.4, **Th** 12.7 (Klomínský and Absolonová 1974).

Blauenthal Granite

Quartz–rich, potassic, peraluminous, leucocratic, S-type, granite

n = 13	**Median**	**Min**	**Max**	**QU1**	**QU3**
SiO_2	74.60	72.24	75.95	74.17	75.06
TiO_2	0.10	0.07	0.15	0.08	0.11
Al_2O_3	13.16	12.54	14.18	12.79	13.57
Fe_2O_3	0.56	0.19	0.91	0.45	0.69
FeO	1.29	0.94	2.81	1.19	1.44
MnO	0.00	0.00	0.00	0.00	0.00
MgO	0.18	0.10	0.31	0.14	0.26
CaO	0.42	0.15	0.97	0.32	0.48
Na_2O	3.12	1.78	3.39	2.77	3.32
K_2O	4.60	4.00	5.30	4.53	4.81
P_2O_5	0.17	0.08	0.29	0.11	0.26
Li_2O	0.080	0.060	0.430	0.067	0.086
Mg/(Mg+Fe)	0.15	0.05	0.22	0.12	0.21
K/(K+Na)	0.51	0.44	0.62	0.48	0.52
Nor.Or	28.64	24.65	32.30	28.24	30.72
Nor.Ab	29.21	17.01	31.67	26.24	30.78
Nor.An	0.48	-0.23	4.20	0.30	1.84
Nor.Q	35.75	31.43	45.83	34.45	37.32
Na+K	196.81	151.71	220.96	188.02	207.06
*Si	209.17	189.75	261.69	200.09	217.48
K-(Na+Ca)	-4.20	-41.44	31.30	-16.18	1.79
Fe+Mg+Ti	33.25	24.05	51.91	28.25	34.51
Al-(Na+K+2Ca)	50.45	13.09	100.58	34.26	59.28
(Na+K)/Ca	27.44	11.22	67.86	24.20	33.97
A/CNK	1.27	1.06	1.66	1.17	1.31

Trace elements (mean values in ppm)*: Blauenthal Granite* – **Li** 465, **Rb** 793, **Ga** 43, **Sn** 44, **Be** 13, **Zr** 21, **Ba** 26, **Sr** 25, **V** 3, **U** 9.9, **Th** 8.9 (Klomínský and Absolonová 1974).

3.1.2.2. BERGEN MASSIF

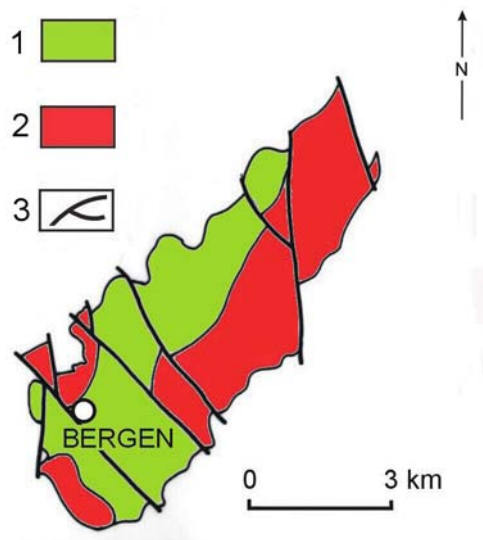

Fig. 3.17. Bergen Massif geological sketch-map (after Hoth, Tischendorf, and Berger 1995). 1 – Kirchberg Granite (G1), 2 – Bergen Granite (G2), 3 – faults.

Regional position: member of the Western Krušné hory (Erzgebirge) Composite Pluton. Isolated body in Vogtland area at the northern periphery of the Eibenstock-Karlovy Vary Composite Massif.

Rock types:

1. *Kirchberg Granite (G1)* – porphyritic coarse-grained biotite monzogranite.
2. *Bergen Granite (G2)* – porphyritic two-mica (transitional) monzogranite (low F), and aplitic marginal facies.

Size and shape (on erosion level): smaller intrusion elongated in NE direction, 10 × 3 km (26 km^2).

Age and isotopic data: 312.8 Ma ± 7 Ma (Rb-Sr whole rock), 323.6 ± 2.6 Ma (K-Ar biotite), 318.2 ± 3.1 Ma (K-Ar muscovite), 330 Ma (SHRIMP U-Pb-Th zircon).

Geological environment: Lower Ordovician phyllitic schists, Phycoden schists.

Contact aureole: distinct contact metamorphic (thermal) phenomena.

Zoning: not described.

Mineralization: quartz-wolframite veins in the contact aureole.

Heat production (μWm^{-3}): Bergen Granite 5.46.

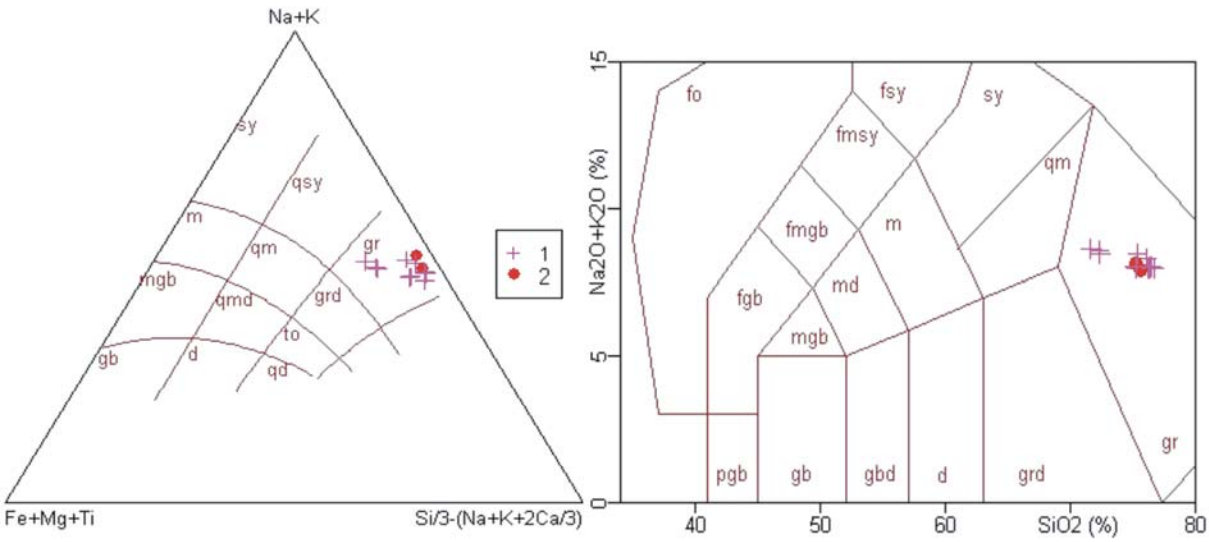

Fig. 3.18. Bergen Massif ABQ and TAS diagrams. 1 – Bergen Granite, 2 – Aplitic marginal facies.

Bergen Granite

Quartz-rich, sodic/potassic, peraluminous, leucocratic, S-type, granite

n = 13	Median	Min	Max	QU1	QU3
SiO_2	74.80	70.60	75.80	74.20	75.30
TiO_2	0.09	0.04	0.37	0.06	0.18
Al_2O_3	14.10	13.50	14.60	14.00	14.50
Fe_2O_3	0.91	0.69	2.25	0.73	1.29

FeO	0.05	0.01	0.06	0.05	0.06
MnO	0.20	0.03	0.82	0.13	0.34
MgO	0.49	0.34	1.14	0.37	0.57
CaO	3.65	3.01	4.25	3.50	3.88
Na_2O	4.36	3.80	5.47	4.17	4.49
K_2O	0.20	0.15	0.50	0.18	0.24
P_2O_5	0.030	0.000	0.083	0.019	0.040
Mg/(Mg+Fe)	0.31	0.05	0.41	0.25	0.36
K/(K+Na)	0.43	0.37	0.54	0.42	0.46
Nor.Or	26.49	22.83	33.41	25.26	27.00
Nor.Ab	33.49	27.95	38.80	32.28	35.54
Nor.An	1.00	-0.83	4.35	0.46	1.82
Nor.Q	34.17	26.88	36.41	31.98	35.28
Na+K	210.07	204.31	221.51	207.38	217.14
*Si	198.89	158.28	211.81	187.64	204.89
K-(Na+Ca)	-34.25	-65.38	-0.61	-40.58	-29.90
Fe+Mg+Ti	16.10	10.70	53.17	12.94	26.85
Al-(Na+K+2Ca)	48.45	26.93	62.74	35.95	52.17
(Na+K)/Ca	25.35	10.53	34.21	20.28	30.97
A/CNK	1.24	1.13	1.32	1.17	1.26

Trace elements (mean values in ppm): *Bergen Granite* – **Ba** 204, **Co** 3.4, **Cs** 25, **Ga** 21, **Li** 144, **Nb** 18, **Ni** 4, **Pb** 30, **Rb** 365, **Sc** 3, **Sn** 13, **Sr** 49, **Ta** 4, **Th** 9, **U** 9.

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3.1.2.3. KIRCHBERG MASSIF

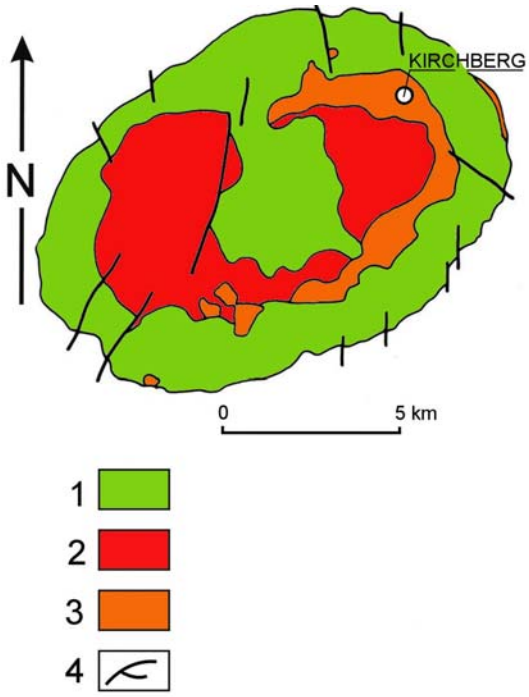

Fig. 3.19. Geological of the Kirchberg Massif (after Hoth, Tischendorf and Berger 1995). 1 – Kirchberg Granite (G1), 2 – Bergen Granite (G2), 3 – fine-grained monzo-syenogranite, 4 – faults.

Regional position: member of the Western Krušné hory (Erzgebirge) Composite Pluton. Isolated body at the northern margin of the Eibenstock-Karlovy Vary Composite Massif. A member of the Western

Rock types:

Kirchberg Granite (G1) – variable texture equigranular to porphyritic, low F, biotite monzogranite (OIC).

Bergen Granite (G2) – coarse-grained biotite and muscovite-biotite monzo-syenogranite.

Fine-grained Granite – biotite and muscovite-biotite monzo-syenogranite.

Size and shape (on erosion level)*:* oval shape, 14 × 9 km (110 km^2).

Age and isotopic data: *Kirchberg and Bergen Granite:* 307 ± 4, 315 ± 6, 309.4 ± 8, 323 ± 6, 323 ± 4, Ma (Rb-Sr whole rock), 316 ± 8 Ma (Rb-Sr dark mica), 328 ± 1 Ma (WR, feldspar, mica), 320.9 ± 2.9 Ma (K/Ar biotite), 318.1 ± 1.3 Ma (Ar-Ar biotite), 330 ± 5 Ma (U-Pb chemical uraninite), 322.7 ± 3.5 Ma (Th-U-total Pb uraninite).

Geological environment: Lower Ordovician phyllitic schists.

Contact aureole: distinct.

Zoning: approximately concentric zoning, medium-grained and fine-grained granite facies around the centre.

Mineralization: W-Mo vein mineralization within granite.

Heat production (μWm^{-3}): *Kirchberg Granite* 4.47.

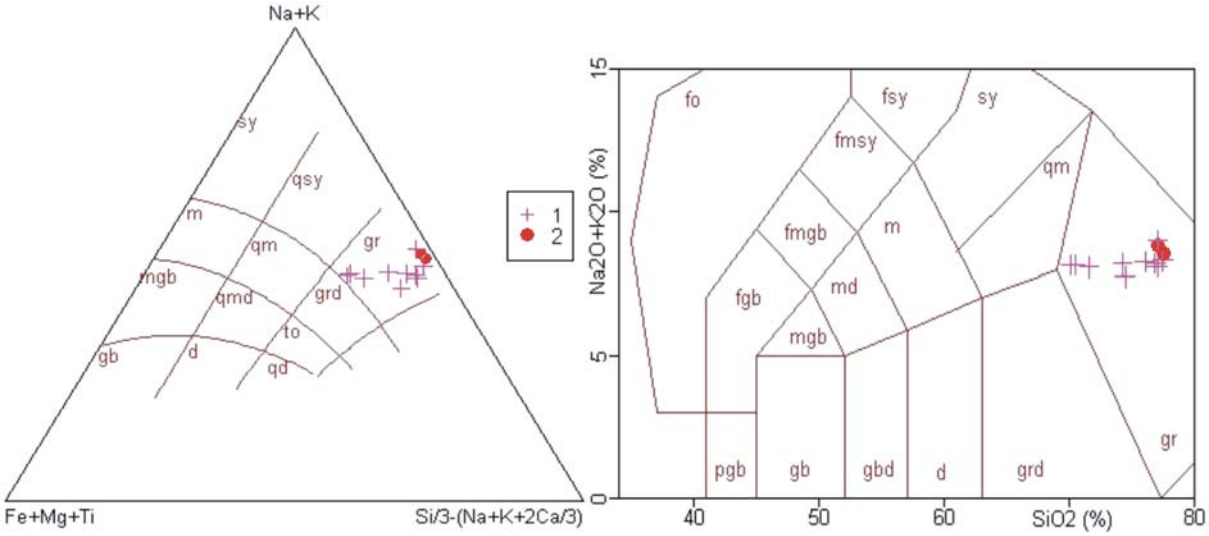

Fig. 3.20. Kirchberg assif ABQ and TAS diagrams. 1 – Kirchberg Granite, 2 – Aplitic facies.

Kirchberg Granite

Quartz-rich, sodic/potassic, peraluminous, leucocratic, S-type, granite

n = 10	Median	Min	Max	QU1	QU3
SiO_2	76.19	70.80	77.10	73.60	76.80
TiO_2	0.13	0.05	0.48	0.05	0.20
Al_2O_3	12.82	12.60	14.10	12.80	13.00
Fe_2O_{3tot}	1.07	0.43	2.77	0.59	1.40
FeO	0.04	0.01	0.08	0.02	0.04
MnO	0.28	0.04	0.88	0.07	0.36
MgO	0.49	0.36	1.62	0.37	0.67
CaO	3.41	3.14	3.65	3.31	3.53
Na_2O	4.71	4.49	5.34	4.60	4.82
K_2O	0.05	0.02	0.21	0.02	0.08
P_2O_5	0.006	0.000	0.041	0.000	0.016
Mg/(Mg+Fe)	0.33	0.12	0.38	0.18	0.34
K/(K+Na)	0.48	0.45	0.50	0.47	0.48
Nor.Or	28.60	27.45	31.92	27.82	29.09
Nor.Ab	31.40	29.18	33.34	30.88	32.66
Nor.An	2.16	1.46	6.91	1.70	3.07
Nor.Q	33.81	28.41	35.52	32.35	34.55
Na+K	210.94	196.66	230.20	207.76	215.45
*Si	198.93	167.77	210.03	191.76	203.22
K-(Na+Ca)	-20.76	-36.76	-5.33	-27.60	-18.68
Fe+Mg+Ti	22.11	7.13	62.56	9.76	28.98
Al-(Na+K+2Ca)	16.50	8.72	47.17	13.36	20.02
(Na+K)/Ca	17.92	7.12	35.86	12.97	28.77
A/CNK	1.08	1.04	1.22	1.07	1.09

Trace elements (mean values in ppm): *Kirchberg Granite –* ***Ba*** *255,* ***Be*** *8.7,* ***Bi*** *0.10,* ***Co*** *5.0,* ***Cs*** *23.8,* ***Ga*** *19,* ***Hf*** *5.3,* ***Li*** *113,* ***Mo*** *0.64,* ***Ni*** *4.8,* ***Nb*** *26,* ***Pb*** *41,* ***Rb*** *334,* ***Sb*** *0.16,* ***Sc*** *5,* ***Sn*** *11.8,* ***Sr*** *105,* ***Ta*** *4.0,* ***Th*** *34.4,* ***Tl*** *1.9,* ***U*** *17.1,* ***W*** *3.7,* ***Y*** *35.2,* ***Zn*** *56,* ***Zr*** *171,* ***La*** *34.0,* ***Ce*** *71.2,* ***Pr*** *8.38,* ***Nd*** *32.7,* ***Sm*** *6.11,* ***Eu*** *0.64,* ***Gd*** *5.49,* ***Tb*** *0.93,* ***Dy*** *5.63,* ***Ho*** *1.12,* ***Er*** *3.47,* ***Tm*** *0.55,* ***Yb*** *3.84,* ***Lu*** *0.55.*

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3.1.2.4. JÁCHYMOV DYKE SWARM (JDS)

Regional position: member of the Western Krušné hory (Erzgebirge) Composite Pluton. JDS is related to the Jáchymov – Gera deep-seated tectonic zone at the exocontact of the Eibenstock-Karlovy Vary Composite Massif.

Rock types:

Granite to granodiorite porphyries.

Syenite to granite porphyries.

Lamprophyres (spessartite, kersantite and minette).

Aplites (some of them with topaz and Li-micas) not shown in the map.

Alkali basalts of the Tertiary age.

Size and shape (on erosion level): complex network of rock dykes (within the area of 15 × 5 km) of different composition, age and origin is developed along the exocontact of the Karlovy Vary Massif between Jáchymov and Johanngeorgenstadt. The largest granite porphyry dyke is over 8 km long and about 200 metres wide; the largest syenite dyke is over 8 km long and 20–50 metres wide.

Age and isotopic data*:* two generations of granite porphyries, lamprophyres and aplites (OIC and YIC), e.g. the younger granite porphyries cuts the older granite porphyries. Rhyolite dykes cutting the Eibenstock Granite 290 ± 5 Ma (Pb-Pb zircon evaporation), 297 ± 8 Ma (U-Pb zircon SHRIMP). The significant time gap of at least 20 Ma between granite intrusion (320 ± 8 Ma) and rhyolite formation (297 ± 8 Ma) in the endo- and exo-contact of the Eibenstock granite, the Eibenstock-Karlovy Vary Composite Massif, has been found by Kempe et al. (2004). According to Förster et al. (2007) a suite of rhyolite dykes (305–295 Ma) in the western Erzgebirge is about 10 Ma younger than the major granite magmatism (325–318 Ma).

Geological environment: NE exocontact of the Eibenstock-Karlovy Vary Composite Massif. Precambrian mica-schists and gneisess.

Zoning: composite granite porphyry dykes with rims of kersantite.

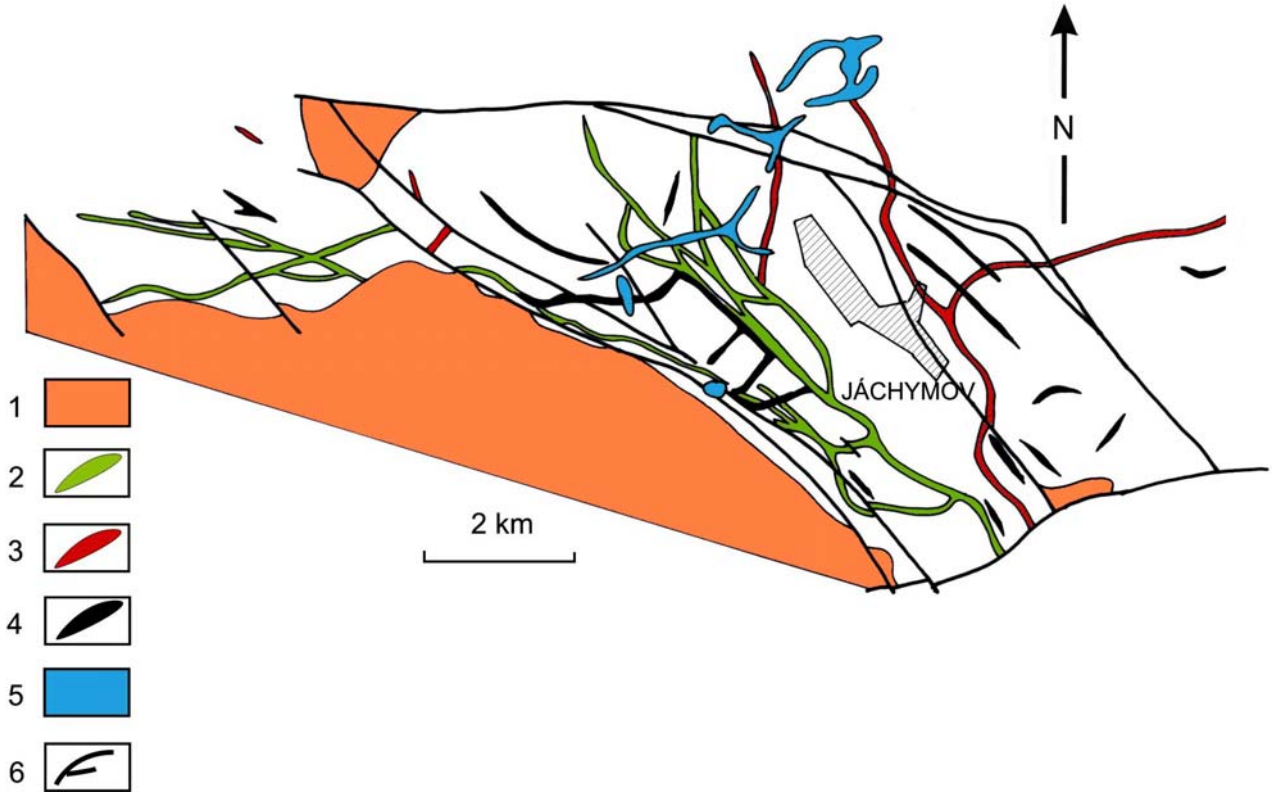

Fig. 3.21. *Jáchymov Dyke Swarm geological (after Hoth, Tischendorf, Berger 1995). 1 – Eibenstock-Karlovy Vary Composite Massif, 2 – granite to granodiorite porphyry, 3 – granite porphyry and syenite porphyry, 4 – lamprophyre, 5 – Tertiary basaltoids, 6 – faults.*

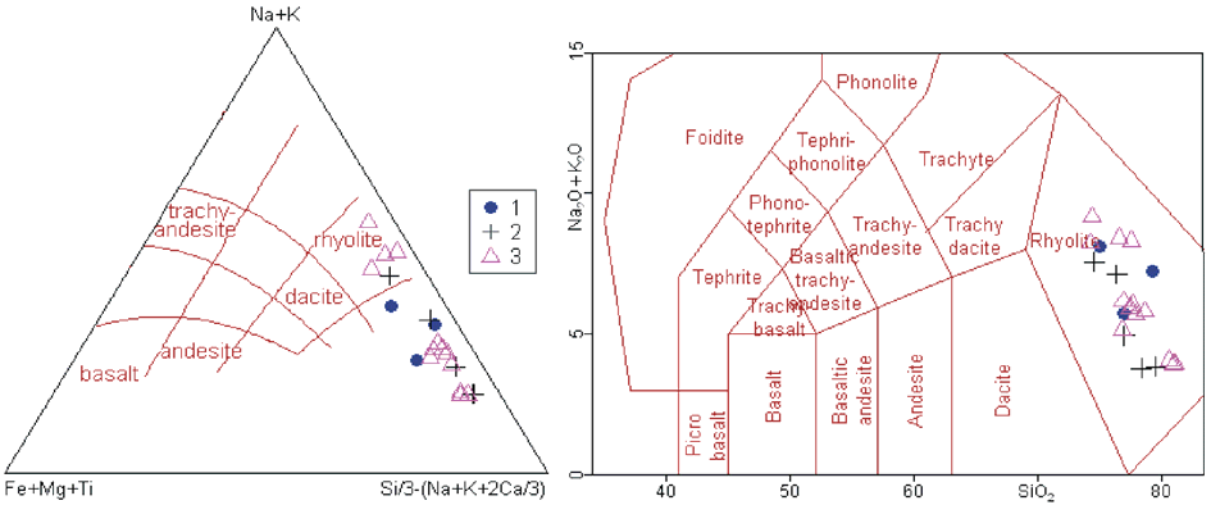

Fig. 3.22. *Rhyolite ABQ and TAS diagrams: 1 –Rhyolite I, 2 – Rhyolite II, 3 – Rhyolite III.*

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Jáchymov Porphyry

Quartz-normal, sodic/potassic, metaluminous/peraluminous, mesocratic, I-S type granite

	porf12	**porf13**	**porf14**
	Grd.porphyry	Alk.-felds.granite porphyry	
SiO_2	68.42	73.55	73.15
TiO_2	0.42	0.06	0.06
Al_2O_3	14.07	15.79	14.78
Fe_2O_3	0.90	0.70	0.60
FeO	2.61	0.94	1.60
MnO	0.11	0.04	0.03
MgO	1.09	0.50	0.52
CaO	0.93	0.42	0.37
Na_2O	4.00	4.02	3.24
K_2O	5.70	2.58	4.77

P_2O_5	0.20	0.22	0.12
Li_2O	0.02	n.d.	n.d.
Mg/(Mg+Fe)	0.35	0.36	0.30
K/(K+Na)	0.48	0.30	0.49
Nor.Or	35.35	15.71	29.19
Nor.Ab	37.70	37.19	30.14
Nor.An	3.46	0.65	1.08
Nor.Q	18.15	36.99	32.36
Na+K	250.10	184.50	205.83
*Si	118.42	218.54	195.59
K-(Na+Ca)	-24.64	-82.43	-9.87
Fe+Mg+Ti	79.93	35.02	43.45
Al-(Na+K+2Ca)	-6.96	110.60	71.20
(Na+K)/Ca	15.08	24.64	31.20
A/CNK	0.99	1.59	1.34

Rhyolite I

Quartz-rich, strongly potassic, peraluminous, leuco/mesocratic, S-type rhyolite

	MAH1228	**JFS1208**	**JFS1209**
SiO_2	77.10	74.60	73.20
TiO_2	0.17	0.33	0.35
Al_2O_3	11.90	12.70	12.90
Fe_2O_3tot	0.83	3.36	2.80
MnO	0.01	0.01	n.d.
MgO	0.23	0.25	0.23
CaO	0.06	0.10	0.12
Na_2O	0.05	0.05	0.05
K_2O	6.94	5.48	7.85
P_2O_5	0.03	0.12	0.11
Mg/(Mg+Fe)	0.35	0.13	0.14
K/(K+Na)	0.99	0.99	0.99
Nor.Q	49.46	53.40	42.22
Nor.Or	43.91	35.16	49.64
Nor.Ab	0.48	0.49	0.48
Nor.An	0.11	-0.32	-0.14
Na+K	148.97	117.97	168.29
*Si	278.06	294.71	236.38
K-(Na+Ca)	144.67	112.96	162.92
Fe+Mg+Ti	18.24	52.44	45.17
Al-(Na+K+2Ca)	82.59	127.87	80.76
(Na+K)/Ca	139.23	66.15	78.64
A/CNK	1.55	2.05	1.47

Trace elements (in ppm): *Rhyolite I* – **Li** 30, **Be** 4, **Sc** 4, **Ni** 1.6, **Cu** 3.2, **Zn** 32, **Ga** 18, **Rb** 473, **Sr** 27, **Y** 36, **Zr** 16.6, **Nb** 17, **Sn** 14, **Cs** 29, **Ba** 360, **Ta** 2.2, **W** 16, **Pb** 12, **Th** 2.7, **U** 7.3.

Rhyolite II

Quartz-rich, strongly potassic, peraluminous, leucocratic, S-type rhyolite

	SAU1210	**SAU1211**	**WEI1212**	**WEI1213**	**BUR988**
SiO_2	74.30	74.50	75.40	76.90	72.90
TiO_2	0.05	0.05	0.06	0.05	0.15

Al_2O_3	14.30	14.90	15.20	14.10	14.50
Fe_2O_3tot	1.00	1.14	1.41	1.35	1.12
MnO	0.06	0.07	0.02	0.02	0.06
MgO	0.22	0.24	0.14	0.13	0.54
CaO	0.26	0.62	0.17	0.22	0.82
Na_2O	0.05	0.05	0.05	0.05	2.82
K_2O	6.86	4.71	3.58	3.64	4.54
P_2O_5	0.20	0.49	0.17	0.23	0.36
Mg/(Mg+Fe)	0.29	0.28	0.16	0.16	0.47
K/(K+Na)	0.99	0.98	0.98	0.98	0.51
Nor.Q	46.83	55.77	61.68	62.82	36.35
Nor.Or	43.19	29.98	22.97	23.27	28.01
Nor.Ab	0.48	0.48	0.49	0.49	26.44
Nor.An	-0.03	-0.17	-0.30	-0.46	1.77
Na+K	147.27	101.62	77.63	78.90	187.39
*Si	261.84	304.32	338.66	345.11	207.29
K-(Na+Ca)	139.40	87.33	71.37	71.75	-9.23
Fe+Mg+Ti	18.61	20.86	21.89	20.77	29.31
Al-(Na+K+2Ca)	124.28	168.87	214.81	190.15	68.11
(Na+K)/Ca	31.76	9.19	25.61	20.11	12.82
A/CNK	1.79	2.36	3.56	3.19	1.31

Trace elements (in ppm): *Rhyolite II* – **Li** 90, **Be** 3.9, **Sc** 4.5, **Ni** 0.8, **Cu** 2.5, **Zn** 40, **Ga** 2.8, **Rb** 600, **Sr** 51, **Y** 7.6, **Zr** 32, **Nb** 44, **Sn** 38, **Cs** 32, **Ba** 61, **Ta** 9, **W** 16, **Pb** 7, **Th** 1.5, **U** 9.

Rhyolite III

Quartz-rich, potassic, peraluminous, leucocratic, S-type rhyolite

n=10	Median	Min	Max	QU1	QU3
SiO_2	75.60	72.70	78.90	74.50	76.40
TiO_2	0.07	0.03	0.19	0.03	0.08
Al_2O3	12.60	11.90	15.40	12.50	13.30
Fe_2O_3tot	1.55	0.41	2.52	1.31	1.62
MnO	0.09	0.02	0.29	0.04	0.09
MgO	0.17	0.09	0.29	0.14	0.23
CaO	0.04	0.03	0.77	0.03	0.51
Na_2O	0.05	0.05	3.93	0.05	2.69
K_2O	4.81	3.74	5.93	3.88	5.08
P_2O_5	0.04	0.02	0.12	0.02	0.04
Mg/(Mg+Fe)	0.16	0.07	0.51	0.14	0.21
K/(K+Na)	0.98	0.46	0.99	0.48	0.98
Nor.Q	51.12	27.80	64.10	34.18	54.81
Nor.Or	29.22	23.94	37.52	24.93	31.31
Nor.Ab	0.49	0.48	36.05	0.48	25.28
Nor.An	0.07	-0.12	3.50	-0.12	2.19
Na+K	119.67	81.02	234.68	83.99	199.76
*Si	287.10	163.37	355.49	199.25	306.55
K-(Na+Ca)	77.26	-32.69	123.76	-18.94	80.23
Fe+Mg+Ti	24.26	11.85	41.15	22.74	26.88
Al-(Na+K+2Ca)	140.09	8.89	194.71	13.18	152.55
(Na+K)/Ca	149.01	17.09	238.38	17.51	153.04
A/CNK	2.15	1.04	3.01	1.06	2.79

Trace elements (in ppm): *Rhyolite III* – **Li** 121, **Be** 7.6, **Sc** 2.5, **Ni** 1.3, **Cu** 6.4, **Zn** 52, **Ga** 30, **Rb** 681, **Sr** 15, **Y** 50, **Zr** 125, **Nb** 57, **Sn** 56, **Cs** 40, **Ba** 53, **Ta** 15, **W** 9, **Pb** 32, **Th** 44.8, **U** 59.2.

3.1.2.5. BLATNÁ STOCK

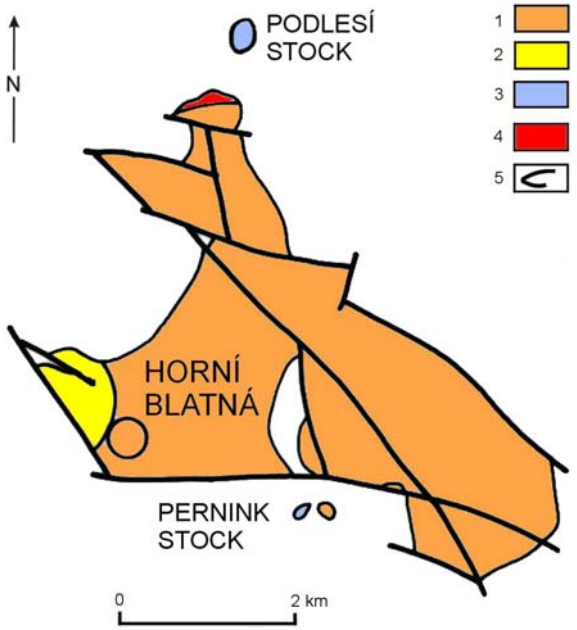

Fig. 3.23. Blatná, Podlesí and Pernink Stocks geological (after Breiter 2001. 1 – Hřebečná and Luhy Granites, 2 – Jelení vrch Granite, 3 – Lithium Granite, 4 – Blatenský vrch Granite, 5 – faults.

Regional position: member of the Western Krušné hory (Erzgebirge) Composite Pluton. A satellite body at the eastern contact of the Karlovy Vary-Eibenstock Composite Massif, separated by faults.

Rock types:

1. *Hřebečná Granite (G3)* – coarse-grained, tourmaline-bearing ± topaz-biotite granite (prevailing rock type).
2. *Blatenský vrch Granite (G3)* – coarse-grained, tourmaline-bearing ± topaz-biotite granite.
3. *Luhy Granite (G3)* – coarse-grained, tourmaline-bearing ± topaz-biotite granite.
4. *Jelení vrch Granite (G4)* – porphyritic fine-grained biotite granite.
5. *Lithium Granite (G5)* – Li-mica topaz-bearing medium-grained alkali-feldspar granite (Podlesí Stock and Pernink Stock).

Size and shape (on erosion level): outcrop about 12 km^2, irregular shape 6 × 2.5 km.

Age and isotopic data: corresponds to the age of YIC granites, (for an age dating of the closest body see the Podlesí Stock). The Lithium Granite (G5) is an independent intrusion, younger than 1–3 types (G3), Blatenský vrch Granite 313.2 ± 2 Ma (Ar-Ar mica).

Geological environment: Early Palaeozoic phyllites and phyllitic schists.

Contact aureole: tourmalinization of phyllites at the exocontact.

Zoning: not defined.

Mineralization: greisen zones carrying sub-economic Sn-mineralization.

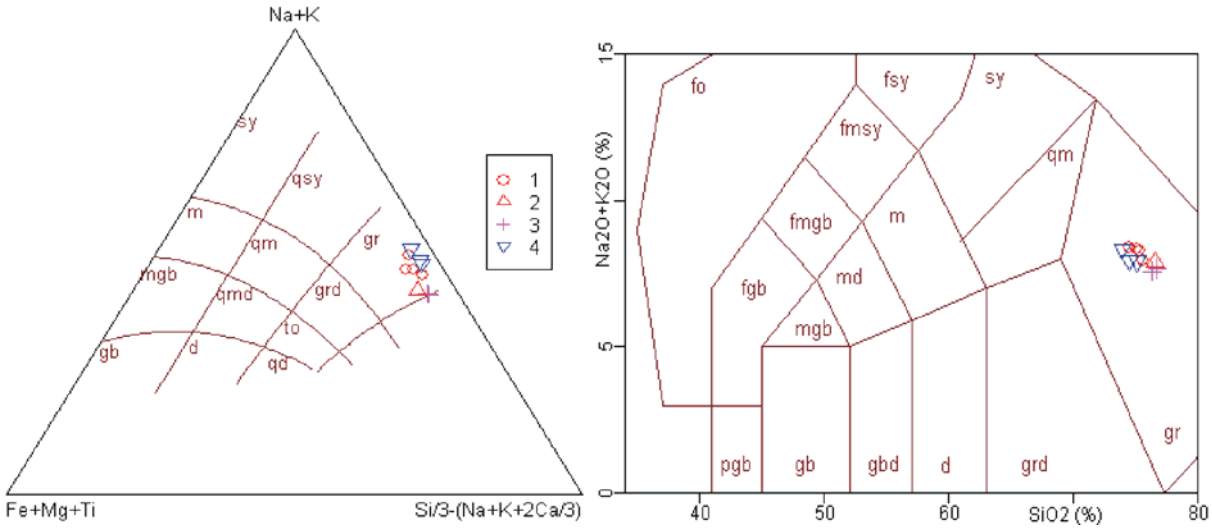

Fig. 3.24. Blatná Stock ABQ and TAS diagrams: 1 – Hřebečná Granite, 2 – Blatenský vrch and Luhy Granite, 3 – Jelení vrch Granite, 4 – Lithium Granite.

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Blatná Stock (Hřebečná and Luhy Granite, Jelení vrch Granite, Lithium Granite and Blatenský vrch Granite)

Quartz-rich, potassic, strongly peraluminous, leucocratic, S-type, alkali-feldspar granite

n = 8	Median	Min	Max	QU1	QU3
SiO_2	74.25	71.90	75.18	73.10	74.78
TiO_2	0.06	0.04	0.15	0.04	0.08
Al_2O_3	13.81	12.60	15.57	13.10	14.60
Fe_2O_3	0.34	0.04	0.63	0.15	0.42
FeO	0.97	0.66	1.12	0.82	0.99
MnO	0.03	0.02	0.04	0.02	0.03
MgO	0.07	0.05	0.25	0.05	0.11
CaO	0.23	0.20	0.44	0.20	0.31
Na_2O	3.20	2.63	4.00	2.65	3.70
K_2O	4.53	3.97	5.02	4.12	4.89
P_2O_5	0.26	0.22	0.45	0.24	0.43
Li_2O	0.098	0.044	0.280	0.046	0.120
Mg/(Mg+Fe)	0.10	0.07	0.22	0.09	0.12
K/(K+Na)	0.47	0.40	0.55	0.41	0.55
Nor.Or	27.67	24.23	31.11	25.26	30.31
Nor.Ab	29.70	24.75	37.28	24.77	34.35
Nor.An	-1.02	-1.90	0.48	-1.54	-0.62
Nor.Q	34.73	31.63	39.37	32.43	38.04
Na+K	202.25	188.07	216.56	188.69	209.85
*Si	197.70	179.60	226.52	185.45	218.00
K-(Na+Ca)	-14.30	-45.70	15.39	-43.47	13.29
Fe+Mg+Ti	19.27	12.81	29.48	13.66	23.46
Al-(Na+K+2Ca)	61.43	43.20	81.00	44.68	75.64
(Na+K)/Ca	43.04	26.75	56.71	31.81	52.80
A/CNK	1.35	1.23	1.43	1.24	1.42

3.1.2.6. PODLESÍ STOCK

***Regional position*:** member of the Western Krušné hory (Erzgebirge) Composite Pluton. The largest outcrop of phosphorus-rich Li-mica granite at the eastern exocontact of the Eibenstock-Karlovy Vary Composite Massif, satellite stock of the Blatná Stock.

Rock types:

1. Podlesí Granite (Stock Granite) – albite-protolithionite (lithium)-topaz alkali-feldspar granite.

a. *"Upper facies"* – fine-grained porphyritic granite (the uppermost 30–40 m of the stock).

b. *"Lower facies"* – medium-grained, non-porphyritic alkali-feldspar granite (main part of the stock).

2. *Podlesí Dyke Granite* – fine-grained topaz – zinnwaldite alkali-feldspar granite.

3. *Biotite Granite.*

Size and shape (on erosion level): tongue-like, steep dipping granite layer about 250–150 m thick.

Age and isotopic data: Podlesí Granite 312 ± 1.8 Ma (Ar-Ar mica), 315 ± 2 Ma (Rb-Sr whole rock), 321.5 ± 2.7 Ma (U-Pb, uraninite), 316.5 ± 8.4 Ma (U-Pb, monazite), Dyke Granite 311.2 ± 1.8 Ma (Ar-Ar mica).

Geological environment: contact metamorphosed Lower Palaeozoic phyllites.

Contact aureole: phyllites are strongly altered into protolithionite-topaz hornfelses. This alteration is accompanied by tourmalinization.

Zoning: prominent manifestation of layering. A steep AMS foliations and subhorizontal magnetic lineation.

Mineralization: greisen zones carrying sub-economic Sn-mineralization.

Heat production (μWm^{-3}): *Podlesí Granite* 9.68, the Podlesí Stock is one of the most radioactive bodies in the Bohemian Massif (34 ppm U and 6.4 ppm Th in the *Stock Granite*).

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Podlesí Granite (upper and lower facies)

Quartz-rich, sodic, strongly peraluminous, leucocratic, S-type, I-series, alkali-feldspar granite

n = 29	Med.	Min	Max	QU1	QU3
SiO_2	73.08	71.52	74.78	72.55	73.78
TiO_2	0.04	0.02	0.07	0.04	0.05
Al_2O_3	14.59	13.79	15.57	14.21	14.84
Fe_2O_3	0.23	0.12	0.66	0.20	0.30
FeO	0.69	0.45	0.92	0.65	0.82
MnO	0.03	0.01	0.07	0.03	0.04
MgO	0.05	0.02	0.14	0.04	0.05
CaO	0.44	0.32	0.82	0.39	0.52
Na_2O	3.84	3.19	4.17	3.54	3.96
K_2O	4.29	3.88	4.46	4.20	4.36
P_2O_5	0.50	0.38	0.70	0.44	0.54
Li_2O	0.190	0.033	0.264	0.163	0.209

Mg/(Mg+Fe)	0.08	0.04	0.17	0.06	0.09
K/(K+Na)	0.43	0.39	0.48	0.41	0.45
Nor.Or	26.33	23.63	27.54	25.56	26.72
Nor.Ab	35.61	29.72	38.68	32.83	36.67
Nor.An	-0.96	-1.93	-0.07	-1.24	-0.63
Nor.Q	33.22	31.29	36.29	32.29	34.31
Na+K	213.50	197.36	221.83	205.83	217.14
*Si	186.46	174.31	207.15	182.11	192.10
K-(Na+Ca)	-38.61	-59.39	-15.20	-45.08	-34.00
Fe+Mg+Ti	14.53	11.39	20.53	13.15	16.65
Al-(Na+K+2Ca)	60.40	33.09	85.66	49.68	65.51
(Na+K)/Ca	26.23	13.56	37.11	22.62	29.67
A/CNK	1.33	1.18	1.49	1.28	1.36

Trace elements (mean values in ppm)*: Podlesí Granite* – **Ba** 7, **Cs** 124.5, **Nb** 35, **Rb** 1357, **Sn** 37, **Sr** 22, **Ta** 13.8, **Th** 6.48, **U** 37.3, **W** 40, **Zr** 52, **Y** 8.8, **Pb** 4.4, **Zn** 39.5.
Podlesí Dyke Granite – **Ba** 19, **Cs** 121, **Nb** 69, **Rb**1798, **Sn** 16.7, **Sr** 16.3, **Ta** 39.6, **Th** 5.3, **U** 25.4, **W** 50, **Zr** 21, **Y** 2.7, **Pb** 2.5, **Zn** 72.

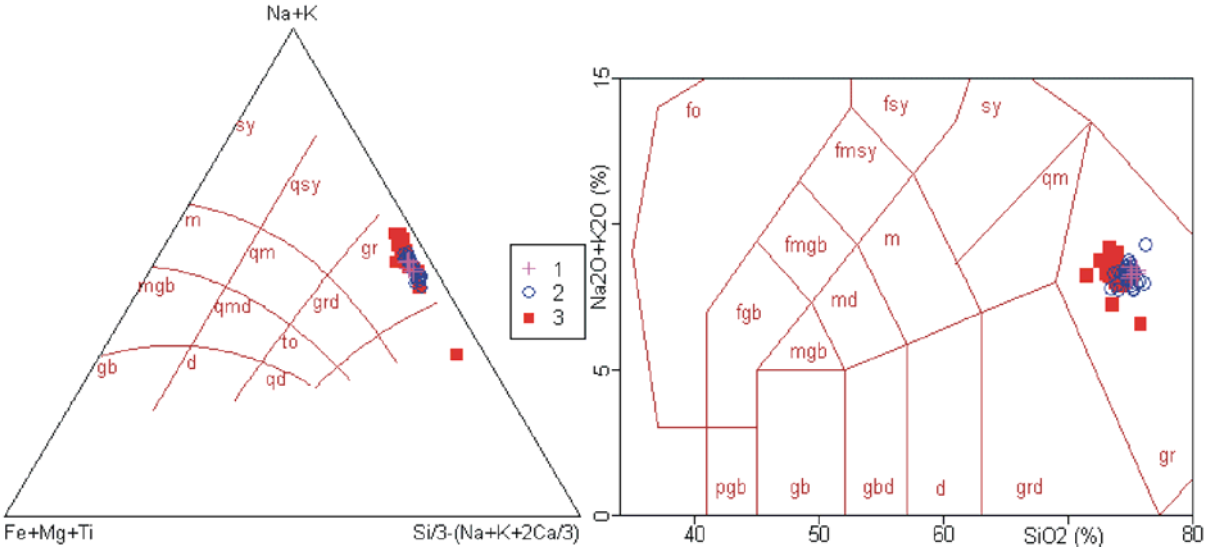

Fig. 3.25. *Podlesí Stock ABQ and TAS diagrams. 1 – Podlesí Dyke Granite, 2 – Podlesí Granite, 3 – Biotite Granite.*

3.1.2.7. KRUDUM MASSIF

Regional position: member of the Western Krušné hory (Erzgebirge) Composite Pluton. Independent magmatic body in the SW margin the Eibenstock-Karlovy Vary Composite Massif.

Rock types:

A. OLDER IGNEOUS COMPLEX

1. Gabbrodiorite and diorite (redwitzite) – medium-to coarse-grained amphibole biotite diorite to pyroxene-biotite gabbrodiorite. Gravity measurement outlined extent of mafic rocks in the depth.

B. TRANSITIONAL GRANITE GROUP

2. Třídomí Granite – porphyritic fine-grained biotite granite and its facies of the *Svárov-Polom Granite* – porphyritic medium-grained biotite granite.

3. Milíře Granite – two-mica granite and its marginal facies "Na Jeleni"Granite.

C. YOUNGER IGNEOUS COMPLEX

4. Čistá Granite – fine-grained Li-mica topaz bearing alkali-feldspar granite.

5. Šibeník Granite – fine-grained muscovite alkali-feldspar granite.

6. Li-mica topaz-bearing Granite.

7. Granite Porphyry.

Size and shape (on erosion level): an approximately triangular shape – 34 km^2 (6 × 6 km). Its eastern and southeastern continuation is hidden under gneiss roof, forming several partly mineralised cupolas (e.g. Koník, Čistá, Vysoký Kámen, Hub and Schnöd Stocks). Redwitzite rafts up to 500 × 250 m in size.

Age and isotopic data: Třídomí Granite 313 Ma, Milíře Granite 343 Ma, Čistá Granite 269 Ma, Šibeník Granite 291 Ma (K/Ar whole rock), Redwitzite 323 ± 4.4 Ma (Pb-Pb zircon).

Geological environment: Biotite-gneisses of the Slavkov gneiss block, and biotite-granites (OIC) of the Eibenstock-Karlovy Vary Composite Massif.

Contact aureole: extensive greisenization at the exocontact.

Zoning: Třídomí Granite in the core, the youngest Čistá Granite at the margin.

Mineralization: Sn-W accumulated mainly at the top of hidden stocks (near-contact greisens) and U mineralization in gneisses.

Heat production (μWm^{-3}): Milíře Granite 4.78, Čistá Granite 3.14.

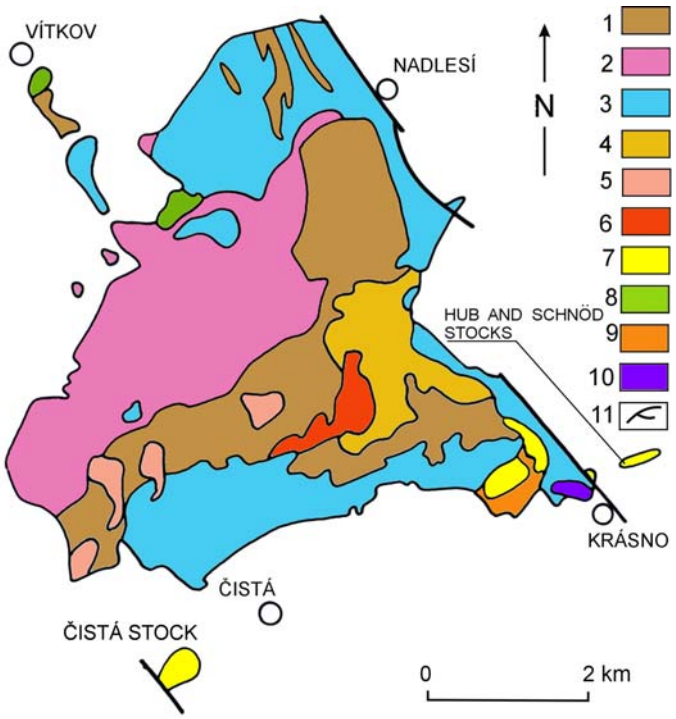

Fig. 3.26. *Krudum Massif geological (adapted after the geological map 1 : 50,000). 1 – Třídomí Granite, 2 – Milíře Granite, 3 – Čistá Granite, 4 – Svárov-Polom Granite, 5 – Granite porphyry, 6 – "Na Jelení" Granite, 7 – Li-mica topaz-bearing Granite, 8 – gabbrodiorite and diorite, 9 – Šibeník Granite, 10 – greisen, 11 – faults.*

Třídomí, Milíře and Čistá Granites

Quartz rich, sodic/potassic, moderate peraluminous, leucocratic, S-type, I-series, *Třídomí* (1), and *Milíře Granites* (2–4) – potassic granites, *Čistá Granite* (5) – sodic-potassic granite

	(1)Tri	(2)Mil	(3)Mil	(4)Mil	(5)Ct
SiO_2	72.96	74.32	73.51	71.99	73.26
TiO_2	0.26	0.14	0.09	0.09	0.03
Al_2O_3	13.50	13.57	14.58	15.71	14.67
Fe_2O_3	0.20	0.25	0.28	0.24	0.24
FeO	1.80	1.26	1.04	1.14	0.83
MnO	0.06	0.06	0.05	0.05	0.07
MgO	0.25	0.19	0.17	0.19	0.10
CaO	0.79	0.59	0.39	0.42	0.38
Na_2O	0.04	0.06	0.09	0.11	0.20
K_2O	2.96	3.18	3.78	3.74	3.13
P_2O_5	5.02	4.68	4.27	4.83	4.69
Li_2O	0.17	0.21	0.29	0.30	0.33

Mg/(Mg+Fe)	0.18	0.18	0.18	0.19	0.14
K/(K+Na)	0.53	0.49	0.43	0.46	0.50
Nor.Or	31.20	28.77	26.04	29.33	28.87
Nor.Ab	27.96	29.71	35.03	34.51	29.28
Nor.An	2.94	1.61	0.02	0.11	-0.30
Nor.Q	32.80	34.75	32.67	29.11	35.17
Na+K	202.10	201.98	212.64	223.24	200.58
*Si	193.27	203.31	190.54	171.15	201.33
K-(Na+Ca)	-3.02	-13.77	-38.27	-25.63	-8.20
Fe+Mg+Ti	37.03	27.15	23.34	24.73	17.42
Al-(Na+K+2Ca)	34.83	43.46	59.77	70.29	73.95
(Na+K)/Ca	14.35	19.20	30.58	29.81	29.60
A/CNK	1.17	1.22	1.30	1.33	1.39

Trace elements (mean values in ppm): *Třídomí Granite* – **Ba** 328, **Cs** 26.9, **Ga** 33, **Hf** 4.3, **Nb** 20, **Pb** 44, **Rb** 467, **Sc** 4.1, **Sn** 13, **Sr** 49, **Th** 26, **U** 9.9, **Y** 19, **Zn** 46, **Zr** 164 (Breiter, Sokolová and Sokol 1991). *Milíře Granite* – **U** 11.9, **Th** 17.9, **Ba** 334, **Rb** 408, **Sr** 57, **Zr** 130. *Čistá Granite* – **U** 9.0, **Th** 6.5, **Ba** 45, **Rb** 1004, **Sr** 75, **Zr** 98.

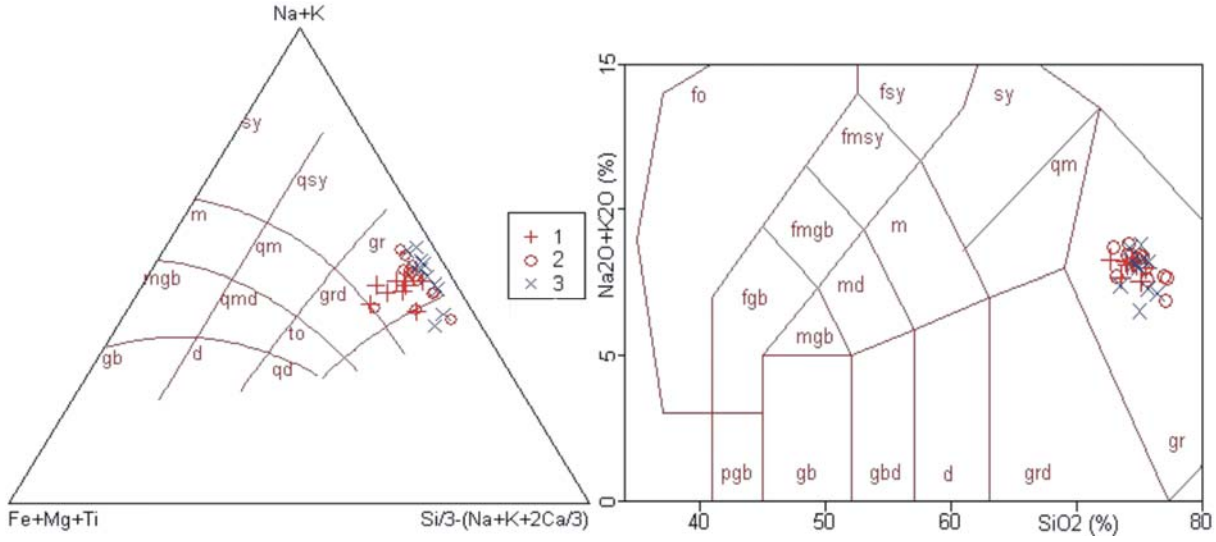

Fig. 3.27. *Krudum Massif ABQ and TAS diagrams. 1 – Třídomí Granite, 2 - Milíře Granite, 3 - Čistá Granite.*

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3.1.2.8. LESNÝ-LYSINA-KYNŽVART COMPOSITE MASSIF

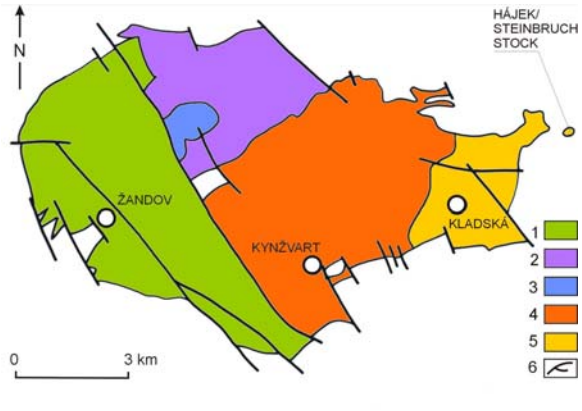

Fig. 3.28. *Lesný-Lysina-Kynžvart Composite Massif geological sketch-map (adapted after geological map 1 : 50,000, CGS). Transitional Granite Group: 1 – Kynžvart-Žandov Granite, 2 – Ovčák Granite, 3 – Granite Porphyry. Younger Intrusive Complex: 4 – Lesný-Lysina Granite, 5 – Kladská Granite, 6 – faults.*

Regional position: member of the Western Krušné hory (Erzgebirge) Composite Pluton. Independent magmatic body in the SW periphery the Eibenstock-Karlovy Vary Composite Massif. The Lesný-Lysina-Kynžvart Composite Massif consists of the Kynžvart Massif and the Lesný-Lysina Massif. Both intrusions are separated by regional fault zone.

Rock types:

TRANSITIONAL GRANITE GROUP

1. *Kynžvart-Žandov Granite* – porphyritic two-mica granite.
2. *Ovčák Granite* – occurs in three facies:
   a. *Ovčák I facies* – porphyritic medium-grained biotite granite,
   b. *Ovčák II facies* – medium-grained two-mica granite,
   c. *Ovčák III facies* – porphyritic fine-grained biotite granite.

YOUNGER IGNEOUS COMPLEX

3. Granite Porphyry (autometamorphosed).
4. *Lesný-Lysina Granite* – lithionite-topaz alkali-feldspar granite (main type).
5. *Jelení Granite* – porphyritic alkali-feldspar granite (not shown in the map).
6. *Kladská Granite* – fine-grained muscovite alkali-feldspar granite.
7. *Hájek-Steinbruch Granite* – small stock of partly greisenized alkali-feldspar granite.

Size and shape (on erosion level): Elliptical shape in size of 75 km^2 (9 × 13 km). The Lesný-Lysina is 3–4 km thick (according to gravity profiles).

Age and isotopic data: Corresponds to the isotopic data of YIC granites.

Geological environment: migmatitized gneisses and tectonic boundary to the Kynžvart Massif.

Contact aureole: Not observed.

Zoning: not defined.

Mineralization: scarce greisen veins with sub-economic mineralization.

Heat production (μWm^{-3}): Milíře Granite 4.78, Čistá Granite 3.19.

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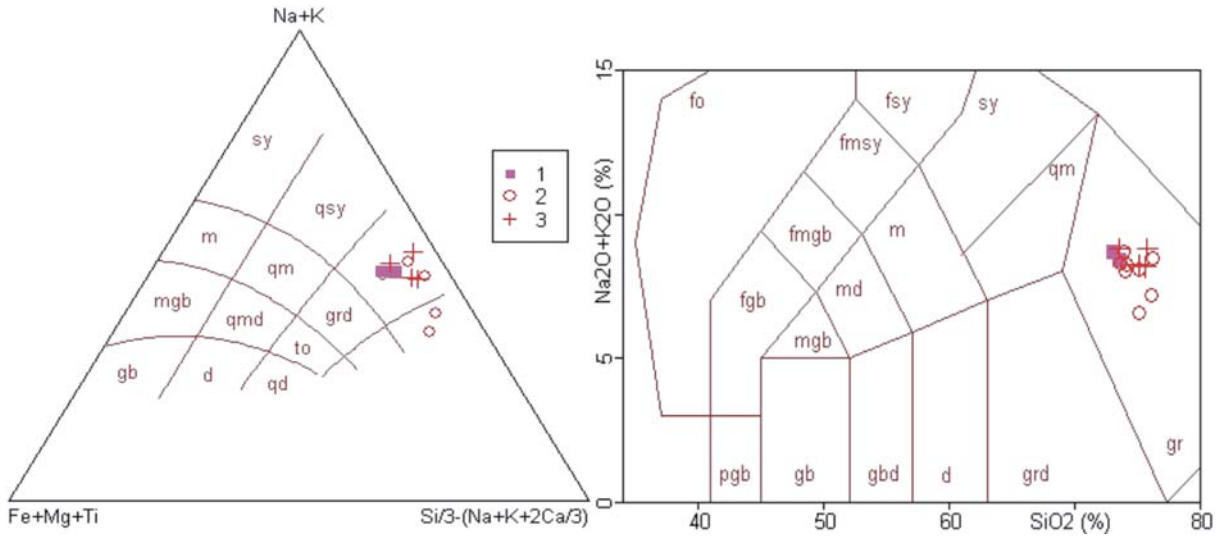

Fig. 3.29. *Lesný-Lysina Massif ABQ and TAS diagrams. 1 – Ovčák Granite, 2 – Lesný-Lysina Granite, 3 – Kynžvart-Žandov Granite.*

Lesný-Lysina Granite

Quartz normal to quartz-rich, sodic, peraluminous, leucocratic, S-type, syenogranite to alkali-feldspar granite

	Les55-5	**Les56-3**	**Les57-5**	**Lys58-3**
SiO_2	73.15	72.56	72.19	73.80
TiO_2	n.d.	n.d.	n.d.	n.d.
Al_2O_3	14.20	14.49	14.45	12.16
Fe_2O_3	0.24	0.52	0.79	0.60
FeO	1.04	1.50	1.05	1.00
MnO	0.06	0.08	0.03	0.09
MgO	0.05	0.03	0.10	0.23
CaO	1.31	0.28	0.67	0.42
Na_2O	4.02	3.83	3.52	4.12
K_2O	4.60	4.24	4.33	4.06
P_2O_5	0.39	0.28	0.39	0.39
Li_2O	0.14	0.19	0.03	0.23
Mg/(Mg+Fe)	0.06	0.03	0.09	0.20
K/(K+Na)	0.43	0.42	0.45	0.39
Nor.Or	27.79	26.10	26.68	25.20
Nor.Ab	36.91	35.83	32.96	38.86
Nor.An	4.02	-0.48	0.79	-0.51
Nor.Q	28.00	31.93	32.90	32.57
Na+K	227.39	213.62	205.52	219.15
*Si	162.86	185.60	187.01	185.28
K-(Na+Ca)	-55.41	-38.56	-33.60	-54.24
Fe+Mg+Ti	18.73	28.15	27.00	27.15
Al-(Na+K+2Ca)	4.75	60.95	54.35	4.66
(Na+K)/Ca	9.73	42.78	17.20	29.26
A/CNK	1.05	1.31	1.29	1.06

Ovčák Granite

Ouartz-rich, potassic, peraluminous, mesocratic, S-type granite

	113Ovčák	**3829Ovčák**
SiO_2	72.03	71.98
TiO_2	0.25	0.05
Al_2O_3	13.75	14.03
Fe_2O_3	0.12	0.77
FeO	2.49	1.50
MnO	0.05	0.08
MgO	0.41	0.33
CaO	0.65	0.70
Na_2O	2.99	3.18
K_2O	5.56	5.00
P_2O_5	0.25	0.23
Li_2O	0.04	0.05
Mg/(Mg+Fe)	0.22	0.21
K/(K+Na)	0.55	0.51
Nor.Q	29.42	31.09
Nor.Or	34.58	30.97
Nor.Ab	28.26	29.94
Nor.An	1.66	2.05
Na+K	214.54	208.78
*Si	177.34	182.23
K-(Na+Ca)	9.98	-8.94
Fe+Mg+Ti	49.49	39.35
Al-(Na+K+2Ca)	32.30	41.78
(Na+K)/Ca	18.51	16.73
A/CNK	1.16	1.21

Kynžvart-Žandov Granite

Quartz-rich, sodic/potassic, peraluminous, leucocratic, S-type granite

	Kyn25-5	**Kyn26-5**	**Kyn27-7**
SiO_2	72.81	75.08	75.41
TiO_2	0.23	0.11	0.21
Al_2O_3	13.35	13.23	13.34
Fe_2O_3	1.13	0.33	0.51
FeO	1.28	0.79	1.15
MnO	0.03	0.01	0.02
MgO	0.17	n.d.	0.05
CaO	1.08	0.67	0.69
Na_2O	2.96	3.67	2.97
K_2O	5.75	5.05	5.17
P_2O_5	0.1	0.11	0.11
Li_2O	0.01	0.01	0
Mg/(Mg+Fe)	0.11	0	0.05
K/(K+Na)	0.56	0.47	0.53
Nor.Or	35.08	30.49	31.32
Nor.Ab	27.44	33.68	27.34

Nor.An	4.78	2.58	2.75
Nor.Q	29.49	31.09	34.65
Na+K	217.6	225.65	205.61
*Si	173.54	182.91	204.48
K-(Na+Ca)	7.3	-23.16	1.44
Fe+Mg+Ti	39.47	16.64	26.66
Al-(Na+K+2Ca)	6.04	10.45	31.39
(Na+K)/Ca	11.29	18.88	16.47
A/CNK	1.03	1.05	1.14

3.1.2.9. AUE-SCHWARZENBERG STOCKS (ASS)

Regional position: members of the Western Krušné hory (Erzgebirge) Composite Pluton. ASS consists of the Aue-Schwarzenberg Granite Zone (Aue Suite and Schwarzenberg Suite)as a part of the Western Krušné hory Mts. (Erzgebirge) Composite Pluton. Aue-Schwarzenberg Stocks are located within the deep-reaching Gera-Jachymov fault zone, intruded early-Variscan metamorphosed sediments of Palaezoic age.

ASS forms a cluster of smaller sized, shallowly intruded (partly buried) satellite stocks od the periphery of the Eibenstock-Karlovy Vary Composite Massif. The Aue suite consists of the Gleesberg Stock, Auerhammer Stock and Aue Stock. The Schwarzenberg Suite comprises the Lauter Stock, Neuwelt Stock, Schwarzenberg Stock and Erla Stock.

Rock types:

Biotite granite group (OIC – Older Igneous Complex): *Burkersdorf Granite* – medium- to coarse-grained, weakly porphyritic biotite granite.

Bernbach Granite – medium-grained, weakly porphyritic biotite granite.

Beierfeld Granite – fine-grained equigranular biotite granite.

Aue Granite – medium to coarse-grained to weakly porphyritic seriate biotite granite.

Two-mica granite group (TGG – Transitional Granite Group):

Lauter Granite – medium- to fine-grained equigranular two-mica granite.

Schwarzenberg Granite – medium- to coarse-grained equigranular two-mica granite.

Size and shape (on erosion level): small size apical outcrops of the shallow multistage intrusion forming large subsurface NE extention (200–300 km^2) of the Western Krušné hory Mts. (Erzgebirge) Composite Pluton.

Age and isotopic data: *Aue Granite* (suite) 324.3 ± 3.1 Ma (Th-U-total U uraninite), *Beierfeld Granite* 323.7 ± 3.1 Ma (Th-U-total U uraninite), *Bernsbach Granite* 320.7 ± 2.9 Ma (Th-U-total U uraninite), *Schwarzenberg Granite* 323.3 ± 2.4 Ma (Th-U-total U uraninite).

Geological environment: low-grade garnet phyllites and medium-grade mica schists formed during an amphibolite-facies of the Barrow-type metamorphism.

The Aue-Schwarzenberg Granite Zone is associated with the Gera-Jáchymov lineament zone and lamprophyric dykes.

Contact aureole: not reported.

Mineralization: spatially associated ore deposits (Sn, W, Mo, Pb, Zn, Bi, Co, Ni) In particular Aue Granite suite should served as major source for U accumulated in important post-granitic deposits of Schneeberg and Schlema-Alberoda.

Heat production (μWm^{-3}): Aue Granite 2.8–8.8, Burkerdorf Granite 4.9–7.5, Beierfeld Granite 9.5, Lauter Granite 1.4–2.6, Bernbach Granite 5.7-6.5, Schwarzenberg Granite 3.0–6.8.

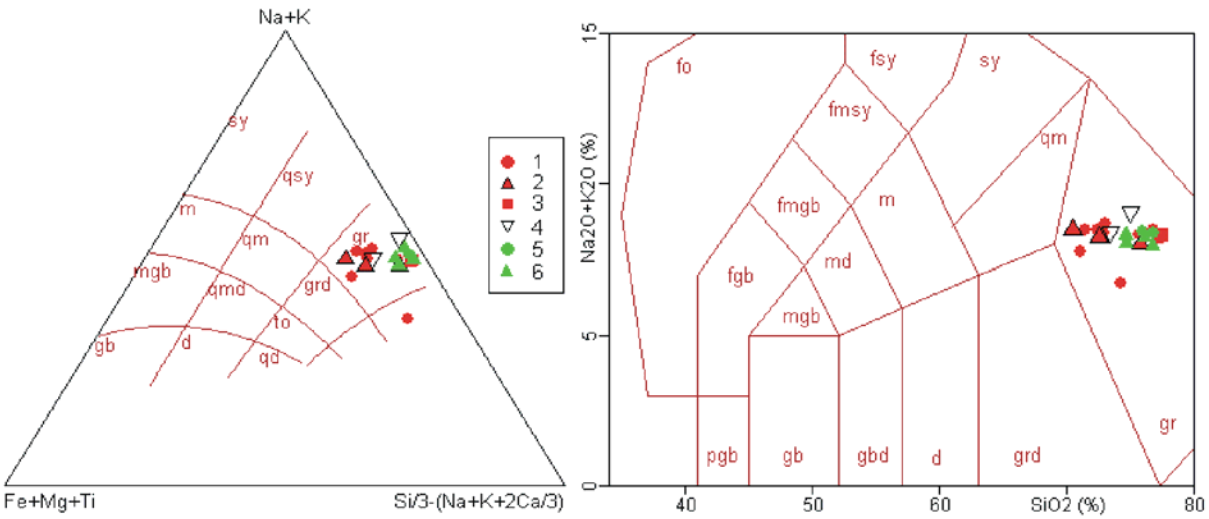

Fig. 3.30. *Aue-Schwarzenberg Stocks. Aue Suite:1 – Aue Granite, 2 – Burhersdorf Granite, 3 – Bernbach Granite, 4 – Beierfeld Granite, Two-mica Suite: 5 – Lauter Granite, 6 – Schwarzenberg Granite.*

Aue Granite

Quartz-normal, sodic/potassic, peraluminous, mesocratic, S-type granite

n=8	Median	Min	Max	QU1	QU3
SiO_2	71.70	70.10	76.20	70.50	72.20
TiO_2	0.28	0.09	0.49	0.16	0.31
Al_2O_3	14.30	13.30	14.90	13.40	14.60
Fe_2O_{3tot}	1.83	0.53	2.84	1.08	2.07
MnO	0.04	0.03	0.06	0.04	0.04
MgO	0.56	0.16	0.93	0.26	0.60
CaO	1.09	0.37	1.72	0.73	1.27
Na_2O	3.46	1.73	3.65	3.33	3.50
K_2O	4.75	4.33	5.08	4.72	4.94
P_2O_5	0.21	0.11	0.31	0.14	0.26
Mg/(Mg+Fe)	0.36	0.32	0.39	0.36	0.38
K/(K+Na)	0.47	0.46	0.64	0.46	0.49
Nor.Q	29.15	26.81	40.40	28.42	33.30
Nor.Or	29.18	26.66	30.62	28.72	30.00
Nor.Ab	31.93	16.64	33.83	30.69	32.40
Nor.An	4.15	1.13	7.04	2.54	4.72
Na+K	214.65	156.47	220.60	199.39	216.54
*Si	169.13	157.07	227.76	166.14	194.81
K-(Na+Ca)	-29.41	-46.19	24.49	-41.64	-22.80
Fe+Mg+Ti	41.20	11.74	64.80	21.99	44.33
Al-(Na+K+2Ca)	25.98	23.96	83.70	24.88	31.70
(Na+K)/Ca	9.56	6.50	32.73	7.70	13.59
A/CNK	1.12	1.11	1.46	1.12	1.15

Aue-Schwarzenberg Stocks

Burkersdorf Granite – quartz-normal, potassic, peraluminous, mesocratic, S-type granite
Lauter Granite – quartz-rich, sodic/potassic, peraluminous, leucocratic, S-type granite
Schwarzenberg Granite – quartz-rich, sodic, strongly peraluminous, leucocratic, S-type granite

	BurkersdorfGranite		**LauterGranite**		**SchwarzenbergGranite**	
	BUR991	BUR996	LAU806	LAU806a	SGS8002	SGS803
SiO_2	69.10	71.60	76.00	74.80	73.70	76.00
TiO_2	0.46	0.39	0.09	0.06	0.13	0.06
Al_2O_3	14.90	14.20	13.50	14.10	14.40	13.90
$Fe2O_{3tot}$	2.54	2.05	0.50	0.54	1.12	0.59
MnO	0.06	0.04	0.02	0.03	0.03	0.03
MgO	0.96	0.74	0.13	0.10	0.30	0.07
CaO	1.46	1.37	0.27	0.34	0.51	0.28
Na_2O	3.18	3.16	3.72	3.37	3.46	4.06
K_2O	5.16	4.98	4.57	4.90	4.72	3.80
P_2O_5	0.22	0.17	0.09	0.20	0.26	0.18
Mg/(Mg+Fe)	0.42	0.41	0.33	0.26	0.34	0.18
K/(K+Na)	0.52	0.51	0.45	0.49	0.47	0.38
Nor.Q	26.09	29.41	34.38	34.35	33.03	35.50
Nor.Or	31.89	30.53	27.57	29.71	28.65	22.85
Nor.Ab	29.87	29.44	34.11	31.05	31.92	37.11
Nor.An	6.06	5.89	0.76	0.38	0.84	0.21
Na+K	212.18	207.71	217.07	212.79	211.87	211.70
*Si	153.82	173.23	201.35	198.15	190.94	206.61
K-(Na+Ca)	-19.09	-20.66	-27.83	-10.77	-20.53	-55.32
Fe+Mg+Ti	61.41	48.93	10.62	10.00	23.11	9.88
Al-(Na+K+2Ca)	28.36	22.29	38.41	51.98	52.73	51.28
(Na+K)/Ca	8.15	8.50	45.09	35.10	23.30	42.40
A/CNK	1.13	1.10	1.18	1.26	1.26	1.25

Trace elements (in ppm)*: Aue Granite* – **Li** 94, **Be** 8.9, **Sc** 3.7, **Co** 2.3, **Ni** 2.2, **Zn** 45, **Ga** 19, **Rb** 279**, Sr** 129, **Y** 15, **Zr** 134, **Nb** 16, **Mo** 0.4, **Sn** 8.6, **Cs** 18, **Ba** 352, **Hf** 11, **Ta** 2.5, **W** 2, **Pb** 34, **Th** 18, **U** 16 (Förster et al. 2009).
Burkersdorf Granite – **Li** 74, **Be** 4.9, **Sc** 5.8, **Co** 3.2, **Ni** 4, **Zn** 32, **Ga** 17, **Rb** 255, **Sr** 147, **Y** 21, **Zr** 189, **Nb** 19, **Mo** 6.3, **Sn** 6.8, **Cs** 17.9, **Ba** 453, **Hf** 5.2, **Ta** 2.1, **W** 2, **Pb** 37, **Th** 23, U **14** (Förster et al. 2009).
Lauter Granite – **Li** 75, **Be** 12, **Sc** 33, **Co** 0.5, **Ni** 1.5, **Zn** 27, **Ga** 22, **Rb** 507**, Sr** 11, **Y** 11**, Zr** 31, **Nb** 22, **Mo** 0.26, **Sn** 27, **Cs** 28, **Ba** 40, **Hf** 1.85, **Ta** 5.2, **W** 6.7, **Pb** 19, **Th** 5.5, **U** 4.7 (Förster et al. 2009).
Schwarzenberg Granite – **Li** 68, **Be** 13, **Sc** 3.1, **Co** 1.2, **Ni** 1.9, **Zn** 33, **Ga** 21, **Rb** 405, **Sr** 35, **Y** 10, **Zr** 51, **Nb** 18, **Mo** 0.7, **Sn** 16, **Cs** 29, **Ba** 123, **Hf** 1.9, **Ta** 4, **W** 6.3, **Pb** 17, **Th** 5.4**, U** 9.4 (Förster et al. 2009)

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3.1.3. MIDDLE KRUŠNÉ HORY MTS. COMPOSITE PLUTON

Regional position: Central section of the Krušné hory Mts.-Smrčiny Batholith in the Saxothuringian Zone. Mostly hidden polyphase granite pluton with numerous small stocks in its roof. Several mineralised cupolas and their exocontacts have been explored and mined for tin and tungsten mainly in ore district Ehrenfriedersdorf (e.g Sauberg, Vierung) and Pobershau-Seiffen Stocks. Only a small number of stocks crops out in crystalline rocks: partly mineralised Geyer, Ziegelberg and Greifensteine stocks and barren (unexplored) Stauweiher, Pflanzgarten, Wiesenbad, Buchholz, NW-Field, Neudorf and Svatá Kateřina stocks.

Rock types:

Four granite phases of the Ehrenfriedersdorf Granite (YIC):

A – fine-grained porphyritic granite,

B – medium-grained porphyritic granite,

C–D – mostly medium-grained Li-mica alkali-feldspar granites). Zinwaldite alkali-feldspar granite – single outcrop and a small outcrop of YIC biotite granite near Hora Sv. Kateřiny (Lesná Stock, 0.35 km^2).

Prevailing granite phase C (called "*Normal granite"*) is fine- to medium-grained monzogranite.

Size and shape: approx. 1,000 km^2 (50 × 20 km) in depth of – 1,000 m a large oval shape, W-E oriented pluton with a series of hidden stocks (about or less than 1km^2, 6 km^2 total area of outcrops) in the roof of the Pobershau-Seiffen hidden granite ridge, 75 km^2 in depth of –500 m a.s.l. (contains mineralised greisen bodies).

Age and isotopic data: Westphalian-Permian. YIC granite 328–326 Ma (Rb-Sr whole rock), two maxima 354–336 Ma and 311–300 Ma (K-Ar Li-mica), Ehrenfriedersdorf Granite 316 ± 10, 327 ± 5. 317.2 ± 4.2, 291.3 ± 2.3 Ma (Rb-Sr whole rock), 323.9 ± 3.5, 320.6 ± 1.9, 319.7 ± 3.4 Ma (U-Pb uraninite).

Seiffen Granite 302 ± 4 Ma (U-Pb chemical monazite), 301 ± 5 Ma (K-Ar biotite).

Geological environment: gneisses and orthogneisses of the Annaberg-Marienberg anticline.

Contact aureole: poorly defined by mineralised quartz-vein stockworks.

Mineralization: Sn-greisen and quartz-vein stockworks at the endo- and exo-contacts of the granite stocks, U and Fe-Zn-Pb mineralization in exocontact of calc-silicate rocks.

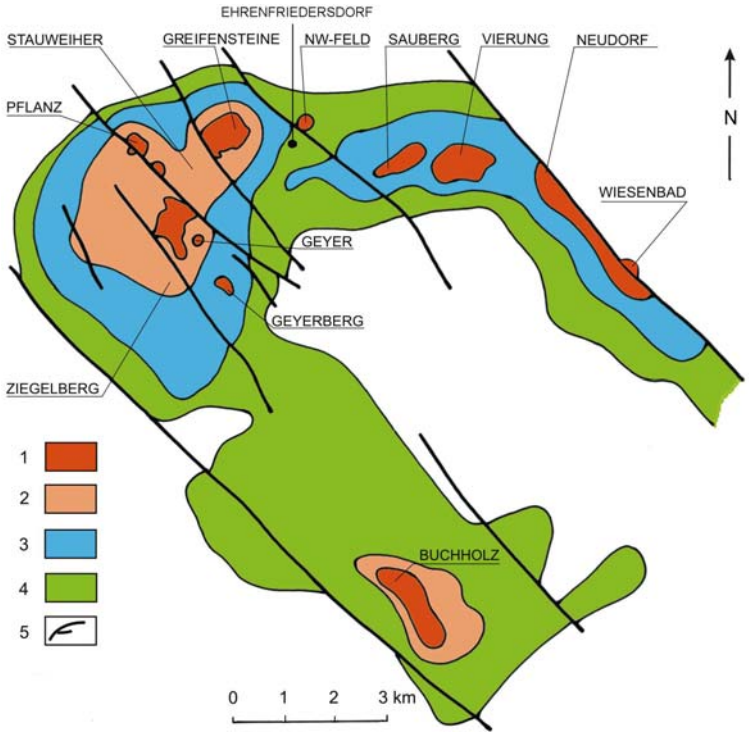

Fig. 3.31. *Middle Krušné hory Mts. Composite Pluton geological sketch-map (after Hoth, Tischendorf and Berger 1995). 1 – Granite stocks (contours and/or sub outcrops), 2 – +500 m a.s.l. isohyps, 3 – ± 0 m a.s.l. isohyps, 4 – –500 m a.s.l. isohyps, 5 – faults.*

Ehrenfriedersdorf Granite (C-phase)

Quartz-normal, sodic, moderately peraluminous, leucocratic, S-type, I-series, alkali-feldspar granite

n = 10	Med.	Min	Max	QU1	QU3
SiO_2	73.70	67.14	74.81	72.60	74.20
TiO_2	0.03	0.01	0.12	0.01	0.04
Al_2O_3	15.03	13.15	18.73	14.60	15.40
Fe_2O_{3tot}	0.90	0.01	1.35	0.45	0.98
FeO	n.d.	n.d.	1.04	n.d.	n.d.
MnO	0.03	0.02	0.05	0.03	0.03
MgO	0.08	0.04	0.28	0.05	0.11
CaO	0.51	0.27	0.72	0.43	0.59
Na_2O	3.80	1.78	5.68	3.70	3.97
K_2O	3.96	3.18	5.37	3.54	4.26
P_2O_5	0.51	0.27	0.76	0.41	0.56
Mg/(Mg+Fe)	0.10	0.06	0.26	0.10	0.18
K/(K+Na)	0.40	0.32	0.65	0.38	0.41
Nor.Or	23.93	19.24	31.40	21.29	25.80
Nor.Ab	34.74	17.00	50.47	33.88	36.54
Nor.An	-0.53	-3.11	0.38	-1.80	-0.26
Nor.Q	33.15	13.16	43.61	32.74	34.59
Na+K	209.85	162.75	297.31	200.52	212.62
*Si	189.07	68.04	247.17	182.99	198.90
K-(Na+Ca)	-55.90	-84.99	40.20	-79.97	-44.61
Fe+Mg+Ti	15.24	12.62	28.57	14.39	17.16
Al-(Na+K+2Ca)	65.52	49.11	82.16	61.94	69.95
(Na+K)/Ca	21.75	16.45	45.38	19.91	26.75
A/CNK	1.35	1.22	1.50	1.32	1.38

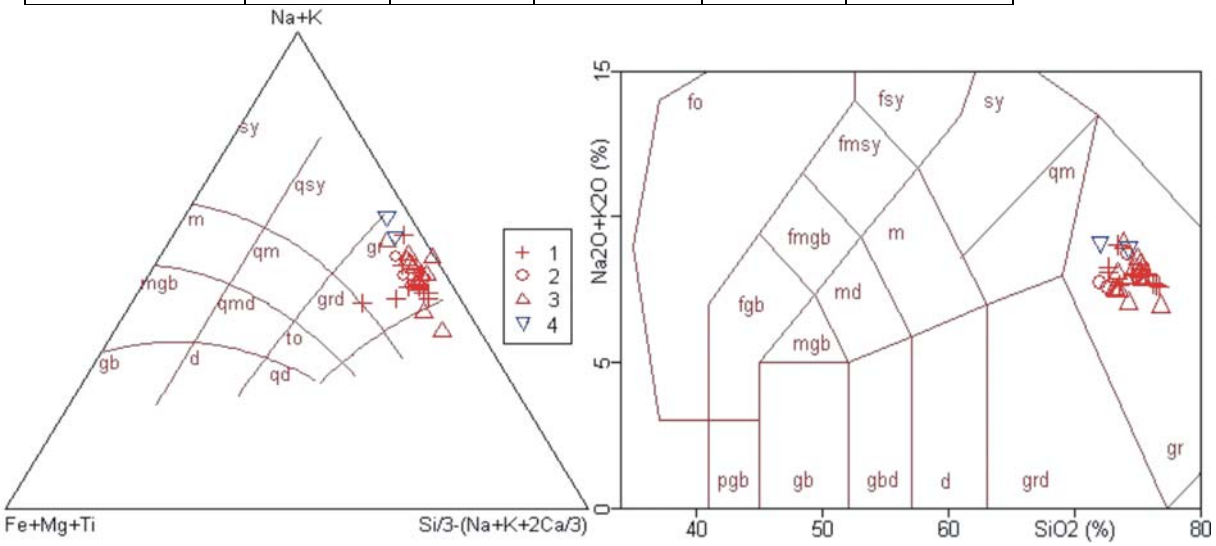

Fig. 3.32. Middle Krušné hory Mts. Composite Pluton YIC Granites ABQ and TAS diagrams. 1 – fine-grained porphyritic granite (A-phase), 2 – medium-grained granite (B-phase), 3 – medium-grained granite (C-phase is prevailing granite), 4 – medium-grained granite (D-phase).

Svatá Kateřina (Lesná) Stock

Quartz-rich, sodic, weakly peraluminous, leucocratic, I-type, granite

	1389	1390	3644	4554	4475
SiO_2	76.11	75.83	76.03	75.50	82.71
TiO_2	0.03	0.01	0.02	0.01	0.02
Al_2O_3	12.78	12.63	12.84	12.61	9.16
Fe_2O_3	0.35	0.07	0.34	1.02	0.56
FeO	0.82	0.81	0.63	n.d.	n.d.
MnO	0.04	0.03	0.04	0.04	0.02
MgO	n.d.	n.d.	0.02	0.04	0.03
CaO	0.41	0.23	0.35	0.20	0.10
Na_2O	4.00	4.58	4.15	4.42	2.75
K_2O	4.36	3.98	4.29	4.36	3.90
P_2O_5	0.02	0.01	0.02	0.09	0.10
Li_2O	0.11	0.14	n.d.	0.15	0.01
Mg/(Mg+Fe)	0.00	0.00	0.04	0.07	0.09
K/(K+Na)	0.42	0.36	0.40	0.39	0.48
Nor.Or	26.38	24.17	25.94	26.34	23.81
Nor.Ab	36.79	42.27	38.13	40.58	25.52
Nor.An	1.95	1.11	1.66	0.40	-0.14
Nor.Q	32.99	31.25	32.54	31.13	49.59
Na+K	221.65	232.30	225.01	235.20	171.55
*Si	195.72	185.66	192.64	181.28	286.12
K-(Na+Ca)	-43.82	-67.39	-49.06	-53.62	-7.72
Fe+Mg+Ti	16.18	12.28	13.79	13.90	8.01
Al-(Na+K+2Ca)	14.70	7.52	14.70	5.30	4.77
(Na+K)/Ca	30.32	56.64	36.15	65.95	96.20
A/CNK	1.06	1.03	1.06	1.03	1.04

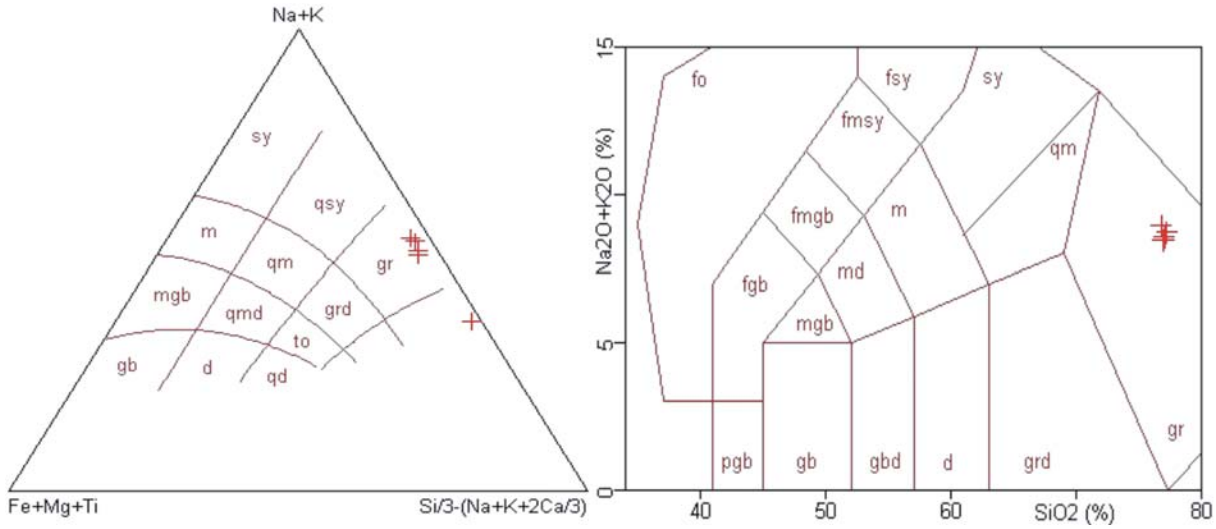

Fig. 3.33. *Lesná Stock ABQ and TAS diagrams. Lesná Granite.*

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3.1.4. EASTERN KRUŠNÉ HORY MTS. COMPOSITE PLUTON

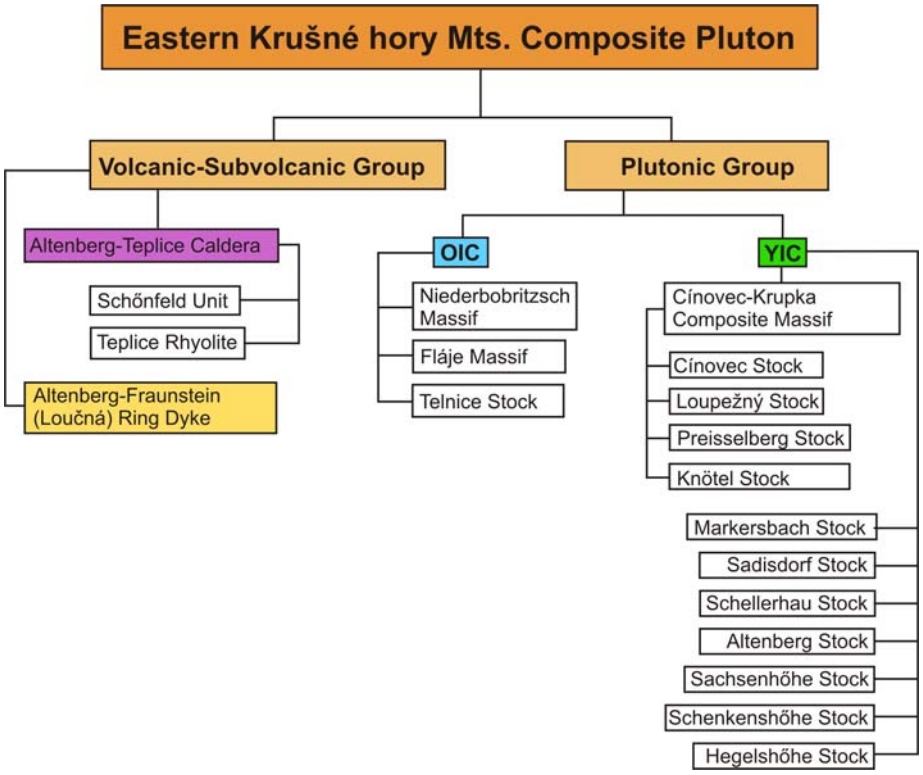

Fig. 3.34. *Eastern Krušné hory Mts. (Erzgebirge) Composite Pluton hierarchical scheme according to rock groups, rock types, massifs, stocks and ring dyke.*

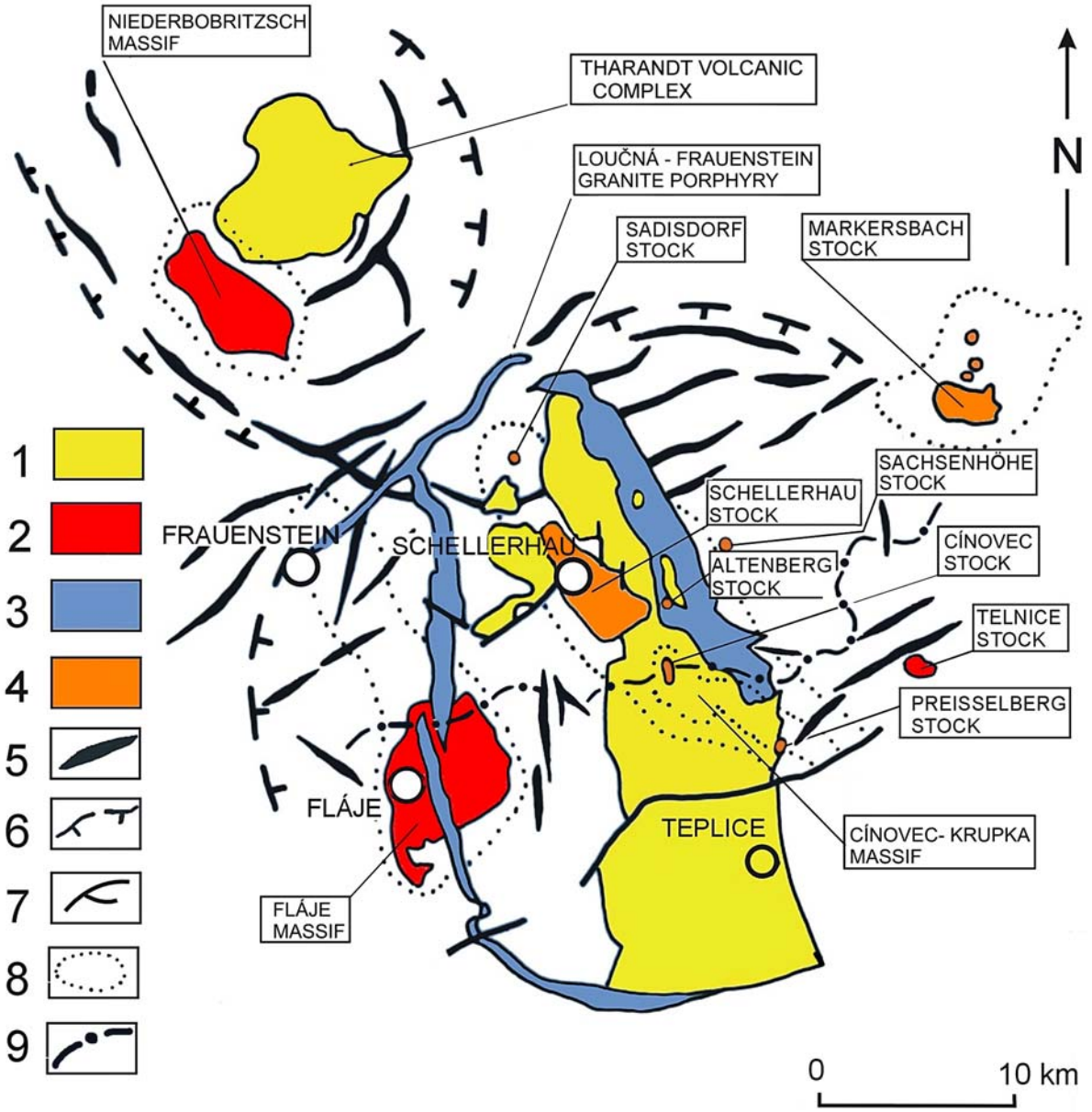

Fig. 3.35. *Eastern Krušné hory Mts. (Erzgebirge) Composite Pluton geological sketch-map (after Hoth, Tischendorf, and Berger 1995, adapted according to Müller and Seltmann 2002). 1 – Teplice Rhyolite and Tharandt Volcanic Complex, 2 – OIC: Niederbobritzsch, Fláje, Telnice granites, 3 – Loučná-Frauenstein and Altenberg Granite Porphyry (Altenberg-Frauenstein Ring Dyke), 4 – YIC: Schellerhau-Altenberg, Zinnwald-Cínovec, Krupka (Preisselberg), Markersbach granites, 5 – Rhyolite Dykes, 6 – outline of the cauldron subsidence, 7 – faults, 8 – subsurface outline of granite intrusions, 9 – state border.*

Regional position: Eastern section of the Krušné hory-Smrčiny Batholith in the Saxothuringian Zone. Partly hidden polyphase granite pluton comprising the Volcanic-Subvolcanic Group and Plutonic Group of igneous rocks. The Volcanic-Subvolcanic Group consists of the Altenberg-Teplice Volcanic Caldera and Altenberg-Frauenstein Ring Dyke. The Plutonic Group is represented by the Fláje Composite Massif, the Telnice Stock, the Niederbobritzsch Massif, the Markersbach Stock, including the Schellerhau Stock, Cínovec (Zinnwald)-Krupka Composite Massif and several five mini-satellite stocks (the Sadisdorf Stock, the Sachsenhöhe Stock, the Altenberg Stock, the Hegelshöhe Stock, the Schenkenshöhe Stock). Presence of volcanic suites in the roof of the Plutonic Group intrusions. OIC granites occur in the marginal parts of the area, the YIC granites occupy its centre.

Rock types:

VOLCANIC-SUBVOLCANIC GROUP

Altenberg-Teplice Volcanic Caldera

Schönfeld Unit

Teplice Rhyolite

Altenberg-Frauenstein Ring Dyke
Loučná Granite Porphyry.

PLUTONIC GROUP
A. OLDER IGNEOUS COMPLEX (OIC):
Niederbobritzsch Granite,
Fláje Granite,
Telnice Granite.

B. YOUNGER IGNEOUS COMPLEX (YIC):
Sadisdorf Granite,
Schellerhau Granite,
Altenberg Granite,
Zinnwald-Cínovec Granite,
Krupka (Preisselberg) Granite,
Knötel Granite,
Markersbach Granite.

Size and shape: 2400 km^2 in depth of –1000 a. s. l., a large subsurface elliptical NW-SE oriented pluton of a domal shape (YIC ~ 20 × 10 km) with local protuberances in its roof. The Teplice subsidence volcanic caldera (approx. 50 km in diameter) is intruded by the Schellerhau Stock and Cínovec (Zinnwald)-Krupka Composite Massif.

Age and isotopic data: Viséan-Permian, OIC granites (311 ± 2 Ma) are clearly older then Westphalian B/C. Niederbobritzsch Granite 315 ± 6 Ma, 320 ± 6 (Pb-Pb zircon), YIC granites are younger than the Teplice Rhyolite, which extruded during Westphalian C/D (311 ± 2 Ma), Altenberg Granite 293 Ma (Rb-Sr whole rock), 290 ± 5 Ma (Pb-Pb zircon evaporation), 297 ± 13 Ma (K-Ar amphibole).

Geological environment: Neoproterozoic orthogneisses, migmatites and paragneisses.

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3.1.4.1. FLÁJE COMPOSITE MASSIF

Regional position: member of the OIC Plutonic Group in the Eastern Erzgebirge-Krušné hory Mts. Composite Pluton.

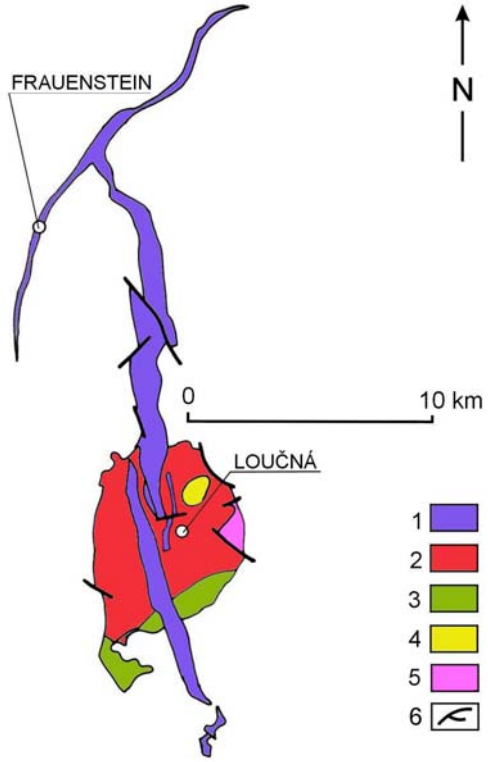

Fig. 3.36. *Fláje Massif geological (after Hoth, Tischendorf and Berger 1995). 1 – Loučná-Frauenstein Granite Porphyry (Frauenstein Porphyritic Microgranite), 2 – Fláje Granite – a facies, 3 – Fláje Granite – b facies, 4 – Fláje Granite – c facies, 5 – Fláje Granite – d facies, 6 – faults.*

Rock types:

1. *Fláje Granite:* four facies
   a. porphyritic coarse-grained biotite monzogranite,
   b. porphyritic medium-grained biotite monzogranite,
   c. porphyritic fine-grained muscovite-biotite monzogranite (transitional relationship between a–d facies),
   d. porphyritic fine-grained biotite monzogranite.
2. *Loučná (Fláje-Frauenstein) Granite Porphyry (*Frauenstein porphyritic Microgranite)*:* three facies –
   a. hornblende-biotite granodiorite porphyry,
   b. biotite granodiorite porphyry,
   c. biotite granite porphyry.
3. *Moldava Granite* – leucocratic biotite granite (YIC?) intruding the Fláje Granite and the Loučná Granite Porphyry at depth of less than 1 km.

Size and shape (on erosion level): 50 km^2, elliptical (Fláje Granite), Loučná Granite Porphyry – up to 1 km thick and 60 km long dyke (ca. 30 km^2).

Age and isotopic data: Upper Carboniferous. No isotopic data.

Geological environment: Migmatized two mica and biotitic paragneisses, mica-schists and orthogneisses.

Contact aureole: narrow zone.

Zoning: The Fláje Granite shows distinct compositional asymmetric zoning with decrease of basicity and biotite content from south to north. Anomalous magnetization of the intrusion. Loučná Porphyry – compositional zoning – decrease of basicity towards north (from granodiorite porphyry to granite porphyry).

Mineralization: Fluorite-barite hydrothermal Deposits (Moldava Deposit), greisen indices.

Heat production (μWm^{-3}): Fláje Granite 2.5, 4.8

Fláje Granite (a–c facies)

Quartz-normal to quartz-rich, sodic, weakly peraluminous, mesocratic, S-type, M-series, biotite granodiorite, the *Fláje Granite* – facies (Fl-4, Fl-5*)* are more evolved variety, quartz-rich, potassic, weakly peraluminous, leucocratic granite

	477Fl	Fl-2	Fl-1	478Fl	Fl-4	Fl-5
SiO_2	67.07	66.54	68.34	68.21	73.85	73.54
TiO_2	0.58	0.54	0.47	0.35	0.20	0.18
Al_2O_3	16.45	15.10	14.94	13.89	12.82	14.10
Fe_2O_3	0.78	1.11	1.32	3.81	0.13	0.66
FeO	2.02	1.96	1.39	1.16	0.55	0.48
MnO	0.05	0.04	0.05	n.d.	0.02	0.02
MgO	1.41	1.82	1.49	0.54	0.27	0.45

CaO	2.50	2.22	2.49	2.90	0.94	0.74
Na_2O	3.52	3.39	3.60	3.38	3.08	3.59
K_2O	3.70	3.95	3.96	3.68	5.12	4.52
P_2O_5	0.24	0.25	0.21	0.80	0.22	0.10
Mg/(Mg+Fe)	0.48	0.52	0.50	0.17	0.41	0.42
K/(K+Na)	0.41	0.43	0.42	0.42	0.52	0.45
Nor.Or	22.99	25.04	24.53	22.71	31.63	27.54
Nor.Ab	33.24	32.66	33.89	31.69	28.92	33.24
Nor.An	11.38	10.05	11.50	9.52	3.36	3.11
Nor.Q	24.02	23.94	24.56	28.75	33.20	31.89
Na+K	192.15	193.26	200.25	187.21	208.10	211.82
*Si	150.22	149.50	149.28	156.73	190.43	187.37
K-(Na+Ca)	-79.61	-65.11	-76.49	-82.65	-7.44	-33.07
Fe+Mg+Ti	80.16	93.13	78.75	81.68	18.49	28.37
Al-(Na+K+2Ca)	41.73	24.10	4.34	-17.86	10.13	38.69
(Na+K)/Ca	4.31	4.88	4.51	3.62	12.41	16.05
A/CNK	1.17	1.11	1.03	1.00	1.06	1.17

Trace elements (mean values in ppm): *Fláje Granite* – **Ba** 704, **Cs** 12.2, **Ga** 20, **Hf** 5.5, **Li** 125, **Nb** 12, **Pb** 40, **Rb** 162, **Sc** 7.3, **Sn** 5, **Sr** 292, **Th** 17.9, **U** 3, **Y** 29, **Zn** 54, **Zr** 126, (Breiter, Sokolová and Sokol 1991).

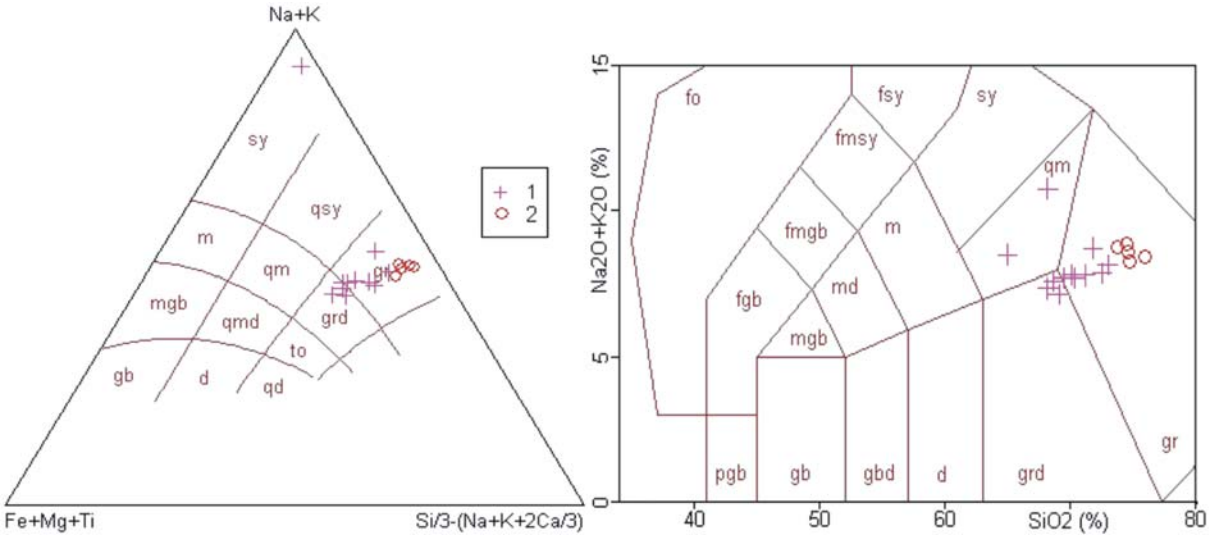

Fig. 3.37. *Fláje Composite Massif ABQ and TAS diagrams. 1 – Fláje Granite, 2 – Moldava Granite.*

Moldava Granite

Quartz-normal, sodic/potassic, peraluminous, meso - leucocratic, S-type granite

	fmo475F	**MOp2**	**Fl4**	**Fl5**	**Fl6**
SiO_2	70.63	71.94	73.84	73.54	72.77
TiO_2	0.37	0.23	0.2	0.18	0.18
Al_2O_3	14.05	14.48	12.81	14.1	13.92
Fe_2O_3	0.47	0.46	0.12	0.66	0.63
FeO	1.51	0.72	0.55	0.47	0.18
MnO	0.03	0.03	0.01	0.02	0.02
MgO	0.98	0.37	0.27	0.44	0.3
CaO	1.47	0.47	0.93	0.74	0.56
Na_2O	3.29	2.92	3.07	3.58	2.39
K_2O	4.36	5.59	5.11	4.51	6.23

P_2O_5	0.18	0.25	0.21	0.1	0.38
Mg/(Mg+Fe)	0.46	0.35	0.41	0.42	0.4
K/(K+Na)	0.46	0.55	0.52	0.45	0.63
Nor.Or	27.31	34.47	31.66	27.53	38.44
Nor.Ab	31.35	27.36	28.95	33.24	22.38
Nor.An	6.46	.69	3.36	3.1	0.26
Nor.Q	29.18	31.35	33.23	31.89	33.26
Na+K	199.27	212.91	208.09	211.81	209.61
*Si	175.14	180.48	190.42	187.36	187.37
K-(Na+Ca)	-39.92	15.9	-7.45	-33.08	45.2
Fe+Mg+Ti	56.25	27.85	18.49	28.37	20.34
Al-(Na+K+2Ca)	24.21	54.51	10.13	38.68	43.41
(Na+K)/Ca	7.6	24.87	12.41	16.05	20.62
A/CNK	1.11	1.26	1.06	1.17	1.23

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3.1.4.2. TELNICE STOCK

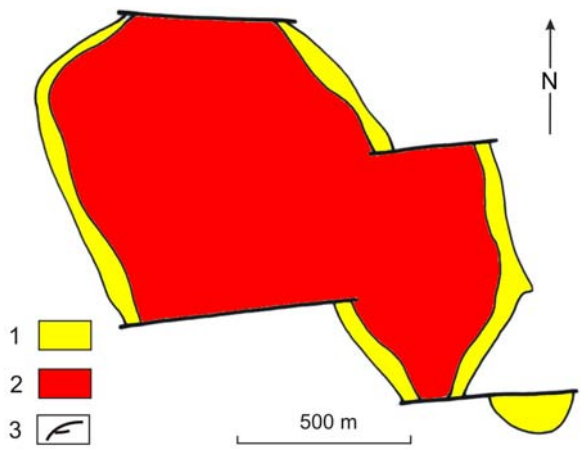

Fig. 3.38. *Telnice Stock geological (after Chrt and Klomínský 1964). 1 – leucocratic granite /marginal facies), 2 – Telnice Granite, 3 – faults.*

Regional position: member of the OIC Plutonic Group in the Eastern Erzgebirge-Krušné hory Mts. Composite Pluton.

Rock types:

Telnice Granite (OIC) – porphyritic biotite syenogranite to monzogranite. A narrow leucocratic marginal facies is enriched in muscovite.

Size and shape (on erosion level): ca. 1 km^2 (1.5 × 0.9 km). A small elliptical stock with moderately dipping contacts.

Age and isotopic data: Upper Carboniferous, 338 Ma (K-Ar biotite).

Geological environment: biotite to two mica Grey Gneiss (Fürstenwald-Lauenstein Gneiss) and migmatites.

Contact aureole: The wall rock is deformed by discordant intrusion.

Zoning: A weak textural and compositional concentric zonation. Central granite is surrounded by narrow zone of the marginal leucocratic granite.

Mineralization: Mo (within the granite intrusion), Bi-Ag, Ba veins (in exocontact).

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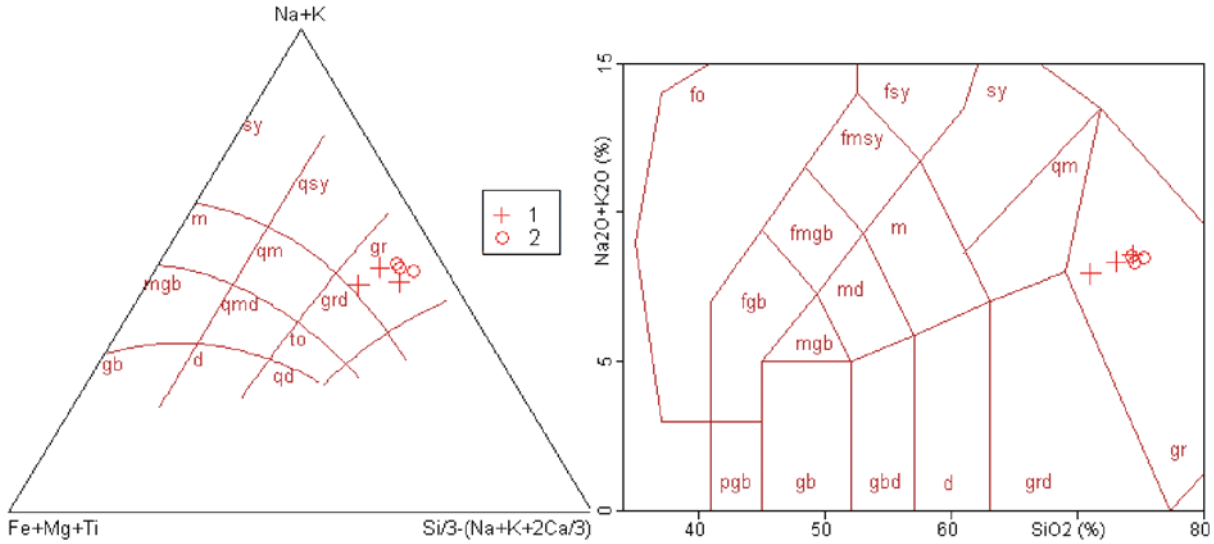

Fig. 3.39. *Telnice Stock ABQ and TAS diagrams. 1 - Telnice Granite, 2 – leucocratic marginal facies.*

Telnice Granite

Porphyritic biotite monzogranite – (more evolved variety 2–3), quartz-normal, sodic, weakly peraluminous to metaluminous, mesocratic, I-type, I-series granite

	1	2	3
	479TELN	**Te-1**	**Te-2**
SiO_2	69.93	71.54	71.49
TiO_2	0.37	0.32	0.37
Al_2O_3	14.26	13.49	13.53
Fe_2O_3	0.77	1.21	0.59
FeO	1.94	0.77	1.26
MnO	0.04	0.03	0.04
MgO	1.26	0.85	0.71
CaO	1.91	1.64	1.59
Na_2O	3.60	3.32	3.78
K_2O	4.22	4.63	4.38
P_2O_5	0.15	0.14	0.15
Mg/(Mg+Fe)	0.46	0.44	0.41
K/(K+Na)	0.44	0.48	0.43
Nor.Or	26.21	28.59	27.01
Nor.Ab	33.98	31.16	35.42
Nor.An	8.92	7.54	7.20
Nor.Q	25.51	29.17	27.18
Na+K	205.77	205.44	214.98
*Si	159.48	171.95	162.73

K-(Na+Ca)	-60.63	-38.07	-57.33
Fe+Mg+Ti	72.56	50.98	47.19
Al-(Na+K+2Ca)	6.15	0.99	-5.98
(Na+K)/Ca	6.04	7.02	7.58
A/CNK	1.03	1.02	0.99

3.1.4.3. NIEDERBOBRITZSCH MASSIF

Regional position: member of the OIC Plutonic Group of the Eastern Erzgebirge-Krušné hory Mts. Composite Pluton.

Rock types:

Niederbobritzsch Normal Granite – fine- to medium-grained biotite monzogranite to granodiorite, least evolved member of the OIC granites. Presence of numerous mafic xenoliths, poorly defined three granitic facies. Low-F biotite granite corresponds to Fláje and Telnice intrusions.

Niederbobritzsch-Sohra Hybrid Granite – granodiorite, hybrid facies (75 % of the outcrop surface) assimilating numerous syenodioritic xenoliths.

Size and shape (on erosion level): 20 km^2 (7.5 × 3 km) an oval body.

Age and isotopic data: 314 ± 5, 325 ± 9 (Rb-Sr whole rock), 309.4 ± 5.2 Ma (Rb-Sr isochrone), 315 ± 6 Ma (K-Ar biotite), 320 ± 6 Ma (Pb-Pb monazite), 324 ± 4 Ma (U-Pb chemical monazite + xenotime + uraninite), 320 ± 6 Ma (Pb-Pb zircon evaporation),

Geological environment: The Freiberg Ortogneiss (Grey Gneiss).

Contact aureole: not observed.

Zoning: not observed.

Mineralization: Molybdenite, sphalerite-pyrite and baryte-fluorite veinlets.

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Niederbobritzsch Normal Granite

Quartz-normal, sodic-potassic, metaluminous, mesocratic, S-type, M-series, granite to granodiorite

n = 8	Med.	Min	Max	Q1	Q3
SiO_2	71.42	66.80	76.20	68.74	74.20
TiO_2	0.33	0.12	0.94	0.25	0.59
Al_2O_3	13.10	11.30	15.61	12.52	14.20
Fe_2O_3	1.51	0.00	3.54	0.61	1.86
FeO	0.00	0.00	4.23	0.00	0.48
MnO	0.00	0.00	0.06	0.00	0.03
MgO	0.45	0.15	1.40	0.30	0.71
CaO	1.24	0.51	3.02	0.65	1.54
Na_2O	3.28	2.89	3.86	3.05	3.57
K_2O	4.88	3.54	5.68	4.39	5.07
P_2O_5	0.18	0.00	0.48	0.03	0.23
Mg/(Mg+Fe)	0.31	0.25	0.43	0.26	0.35
K/(K+Na)	0.48	0.43	0.55	0.45	0.51
Nor.Or	29.33	21.62	34.63	26.98	30.97
Nor.Ab	30.23	26.83	35.50	28.26	33.08
Nor.An	4.18	2.19	15.39	2.39	6.46
Nor.Q	30.00	20.42	34.32	23.62	30.81
Na+K	215.83	168.42	224.78	211.56	219.02
*Si	175.06	125.51	201.06	144.03	191.90
K-(Na+Ca)	-32.73	-73.28	-5.17	-71.95	-7.85
Fe+Mg+Ti	44.05	12.87	97.23	32.73	71.38
Al-(Na+K+2Ca)	4.02	-54.22	32.60	-17.07	15.60
(Na+K)/Ca	9.63	3.13	23.71	4.92	11.78
A/CNK	1.04	0.80	1.14	0.98	1.07

Trace elements (mean values in ppm): *Niederbobritzsch Normal Granite* – **Ba** 655, **Be** 3.5, **Bi** 0.81, **Co** 3.3, **Cs** 5.94, **Ga** 20, **Hf** 5.21, **Li** 58, **Mo** 0.66, **Ni** 5.6, **Nb** 13, **Pb** 32.8, **Rb** 231, **Sb** 0.09, **Sc** 5.0, **Sn** 9, **Sr** 216, **Ta** 1.9, **Th** 20.2, **Tl** 1.52, **U** 11.4, **W** 3.7, **Y** 18.5, **Zn** 50, **Zr** 160, **La** 36.9, **Ce** 72.0, **Pr** 8.59, **Nd** 28.9, **Sm** 5.32, **Eu** 0.91, **Gd** 4.37, **Tb** 0.65, **Dy** 3.56, **Ho** 0.67, **Er** 1.87, **Tm** 0.29, **Yb** 1.85, **Lu** 0.29.

Niederbobritzsch-Sohra hybrid granite

Quartz-normal, sodic/potassic, peraluminous, mesocratic, S-type hybrid granite

	517Sohra	NBZ1Sohra
SiO_2	68.74	66.80
TiO_2	0.82	0.59
Al_2O_3	15.61	15.60
Fe_2O_3	1.07	3.54
FeO	2.16	n.d.
MnO	n.d.	0.06
MgO	0.71	1.40
CaO	1.54	2.46
Na_2O	3.05	3.80
K_2O	5.68	4.39
P_2O_5	0.21	0.23
Mg/(Mg+Fe)	0.29	0.43
K/(K+Na)	0.55	0.43
Nor.Q	23.63	20.42

Nor.Or	34.64	26.98
Nor.Ab	28.27	35.50
Nor.An	6.46	11.12
Na+K	219.02	215.83
*Si	144.03	125.51
K-(Na+Ca)	-5.28	-73.28
Fe+Mg+Ti	71.38	86.48
Al-(Na+K+2Ca)	32.60	2.78
(Na+K)/Ca	7.98	4.92
A/CNK	1.14	1.03

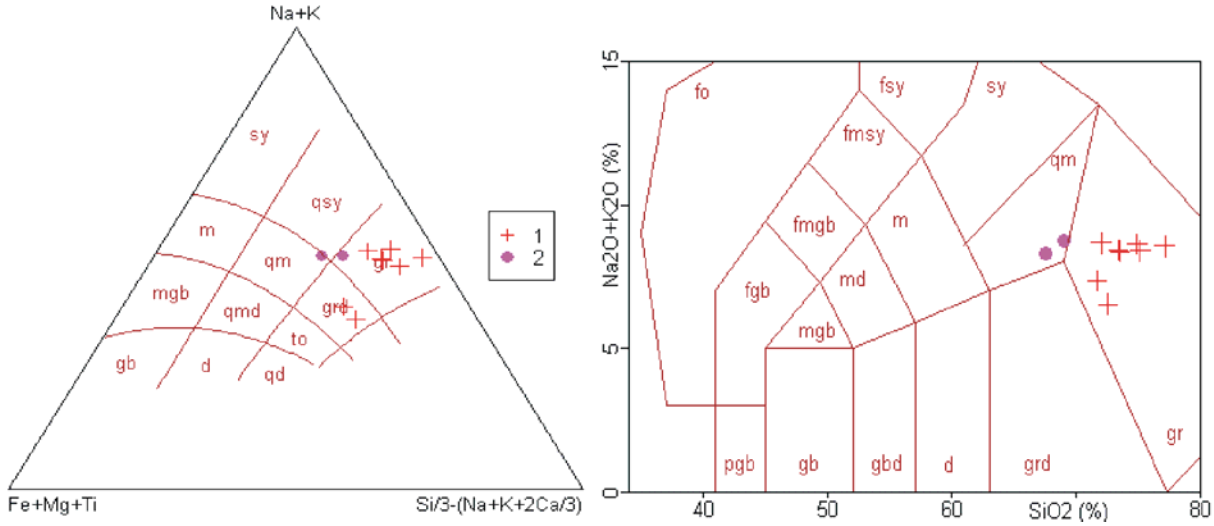

Fig. 3.40. *Niederbobritzsch Massif ABQ and TAS diagrams. 1 – Niederbobritzsch Normal Granite, 2 – Niederbobritzsch Hybrid Granite.*

3.1.4.4. ALTENBERG-FRAUENSTEIN RING DYKE (AFRD)

Regional position: member of the Volcanic-Subvolcanic Group of the Eastern Erzgebirge-Krušné hory Mts. Composite Pluton in the Altenberg-Teplice Caldera (volcanotectonic depression). The Ring Dyke involves two sub-volcanic intrusive stages evolving from acid, more fractionated, to less fractionated rocks.

Rock types:

Granite Porphyry (GPI) – porphyritic biotite microgranite (dominant rock type).

Granite Porphyry (GPII) – porphyritic (granophyric) hornblende microgranite.

In the Fláje Massif the Loučná (Fláje-Frauenstein) Granite Porphyry (Altenberg-Frauenstein RingDyke) consists of three facies:

hornblende-biotite granodiorite porphyry,
biotite granodiorite porphyry,
c. biotite granite porphyry.

Size and shape (on erosion level): N-S elongated, pear-shaped ring dyke, in elliptical radius of 13 × 30 km.

Age and isotopic data: *Teplice Rhyolite* – explosive phase (Westphalian C/D, ca. 308 Ma) was intruded by AFRD, dated at 305 Ma (Pb-Pb zircon).

Mineralization: not studied.

Altenberg -Frauenstein Granite Porphyry

Quartz-normal, potassic, peraluminous, mesocratic, S-type granite

	E10-339	JE97-12	Le127-3
SiO_2	66.96	66.93	70.94
TiO_2	0.68	0.51	0.32
Al_2O_3	14.48	14.91	13.82

Fe_2O_3	2.17	1.80	1.95
FeO	2.15	1.50	0.97
MnO	0.09	0.04	0.02
MgO	0.87	0.28	0.27
CaO	0.98	0.77	0.33
Na_2O	2.17	1.86	0.80
K_2O	6.13	6.76	7.64
P_2O_5	0.28	0.15	0.09
Mg/(Mg+Fe)	0.27	0.14	0.15
K/(K+Na)	0.65	0.71	0.86
Nor.Or	38.83	43.00	48.15
Nor.Ab	20.89	17.98	7.66
Nor.An	3.23	3.05	1.11
Nor.Q	28.08	28.52	35.76
Na+K	200.18	203.55	188.03
*Si	159.65	158.61	201.61
K-(Na+Ca)	42.65	69.78	130.51
Fe+Mg+Ti	87.24	56.78	48.65
Al-(Na+K+2Ca)	49.23	61.79	71.60
(Na+K)/Ca	11.45	14.82	31.95
A/CNK	1.24	1.29	1.37

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3.1.4.5. ALTENBERG-TEPLICE VOLCANIC CALDERA

Regional position: member of the Volcanic-Subvolcanic Group of the Eastern Erzgebirge-Krušné hory Mts. Composite Pluton. Relicts of volcanic and subvolcanic rocks in the volcano-tectonic depression (caldera) in the Eastern Erzgebirge-Krušné hory Mts. Composite Pluton.

The Altenberg-Teplice Caldera is the largest outcrop of the Carboniferous volcanic and subvolcanic suite in the Bohemian Massif covering an area of 650 km^2.

Rock types: *Altenberg-Teplice Volcanic Caldera has been divided into following main phases:*

1. *The 1st volcano-sedimentary phase* (Schönfeld unit) – basal rhyolite tuffs and dacite lava flows. At its base, the unit contains arkoses, sandstones, shales and coal of Westphalian B/C (311 ± 2 Ma) age.
2. *The 2nd volcanic phase* (Teplice Rhyolite – TR) comprises:
   a) An explosive phase (TR1) at the base – rhyolite tuffs and ignimbrites. Plant remains in the sedimentary intercalations were dated as Westphalian C/D (308 Ma),
   b) An explosive-effusive phase (TR2) – lava flows, tuffs and ignimbrites,
   c) An explosive-intrusive phase (TR3) – rhyolitic to rhyodacitic ignimbrites and granite porphyries,
   d) Dyke phase – Altenberg-Frauenstein Granite Porphyry.

Size and shape (on erosion level): The total thickness of the volcanic sequence is nearly 2 km. The preserved volcanic rocks represent more than 250 km^3 of magma. The eruption of this enormous volume from the magma chamber led to the collapse of the Altenberg-Teplice Caldera along the N-S elongated pear-shaped ring fractures, later intruded by YIC granites (the Schellerhau Stock

and Cínovec (Zinnwald)-Krupka Composite Massif).

Age and isotopic data: Teplice Rhyolite 311 ± 2 to 308 Ma (according to the plant fossils of the sedimentary interlayers), Altenberg-Frauenstein Ring Dyke 305 Ma (Pb-Pb zircon), Granite Porphyry 307–309 Ma (Ar-Ar mica).

Zoning: volcano-sedimentary sequence in normal stratigraphic position.

Mineralization: disseminated Sn-greisen stockworks (Komáří Vížka open pit).

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3.1.4.6. CÍNOVEC (ZINNWALD)-KRUPKA COMPOSITE MASSIF (CKCM)

Regional position: member of the YIC Plutonic Group of the Eastern Erzgebirge-Krušné hory Mts. Composite Pluton. Predominantly hidden granite massif intrudes the Teplice Ignimbrite (rhyolite) within the Altenberg-Teplice Volcanic Caldera. The massif consists of four interconnected stocks (Cínovec-Zinnwald, Loupežný, Preisselberg, and Knötel Stocks).

Rock types:

1. Preisselberg Granite – (in the Preisselberg Stock) porphyritic biotite syenogranite with the marginal facies (fine-grained marginal granite).

2. Knötel Granite – fine-grained biotite granite Li-mica alkali-feldspar granite (in the Knötel Stock) and in the deeper parts of the Preisselberg Stock.

3. Cínovec(Zinnwald) Granite – zinnwaldite-albite granite (upper part of the Cínovec-Zinnwald Stock) and porphyritic medium-grained protolithionite granite (lower part of the Cínovec-Zinnwald Stock) with horizontal zones of fine-grained porphyritic granite.

Size and shape: total area at depth of 300 m is about 30 km^2 (11 × 2.5 km, (mostly hidden), individual stocks crop out in the area of an less than 1 km^2. Two main domal structures (Krupka and Cínovec) are elliptical shape (0.5 km^2 and 0.4 km^2 in outcrops, respectively). The Krupka dome consists of the Loupežný and Knötel Stocks). The Preisselberg Stock ca. 3 km^2 of the subsurface area.

Age and isotopic data: 307–270 and 281–286 Ma (K-Ar whole rock), 306–312 Ma (K-Ar mica).

Geological environment: Teplice Ignimbrite (rhyolite), gneiss complex (Grey Gneiss).

Contact aureole: Intense greisenization at the endo- and exocontact of the Cínovec Granite.

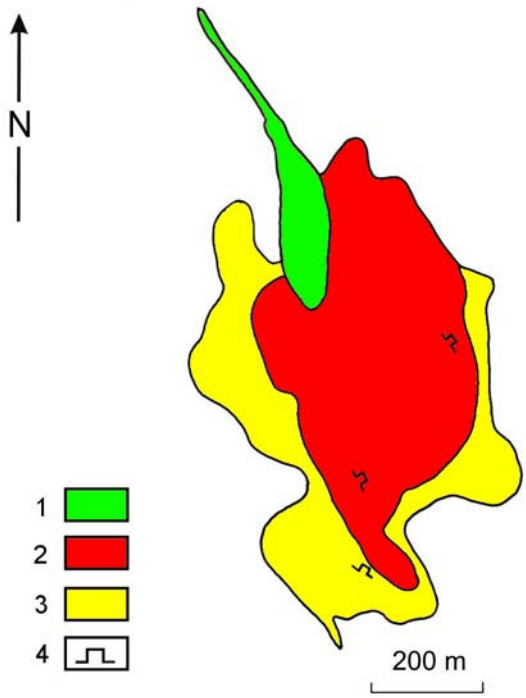

Fig. 3.41. *Preisselberg Stock geological subsurface (adapted according to Štemprok et al. 2003). 1 – granite porphyry, 2 – Preisselberg Granite, 3 – Knötel Granite, 4 – entrances of exploration adits.*

Zoning: Superposition of two granite phases of the YIC. Much larger portion of Li-mica albite granite, representing main volume of the massif, intrudes older biotite monzogranite. Distinct vertical compositional zoning of the albite granite in the Cínovec-Zinnwald Stock. The compositional zoning subparallel to domal shape of the Preisselberg Stock. The Knötel Granite in the deeper part of the Preisselberg Stock intrudes the Preisselberg Granite.

Mineralization: Sn-W, Li, Mo mineralization with Bi, As, Cu, Pb, Zn and fluorite. Greisen type tin Deposits are associated with Li-mica granite stocks along the inclined contacts.

Heat Production (μWm^{-3}): *Preisselberg Granite* 6.68, *Cínovec Granite* up to 13.7.

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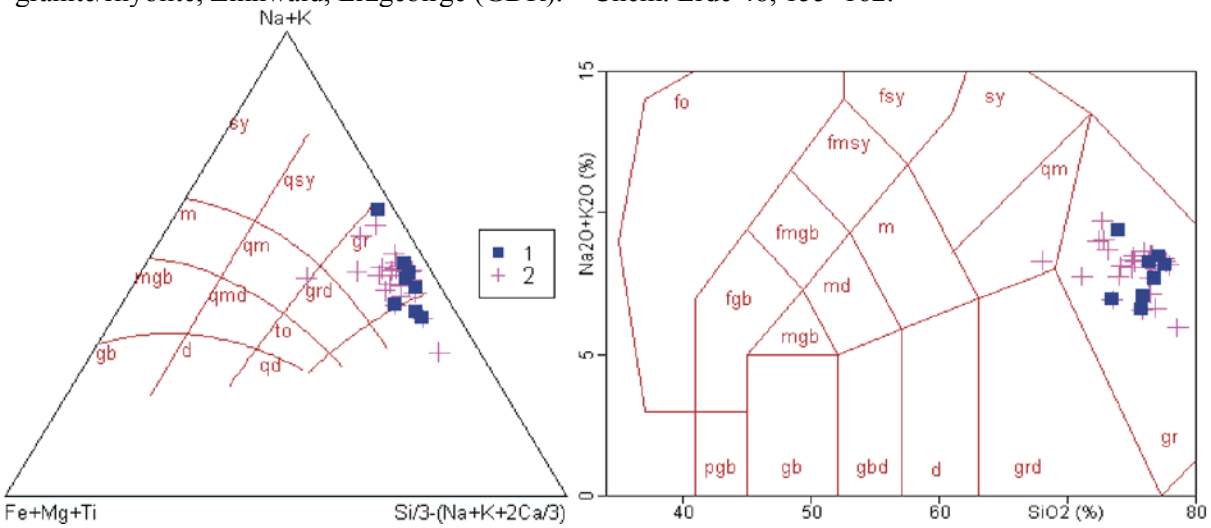

Fig. 3.42. *Preisselberg Stock ABQ and TAS diagrams. 1 – Preisselberg Granite, 2 – Knöttel Granite.*

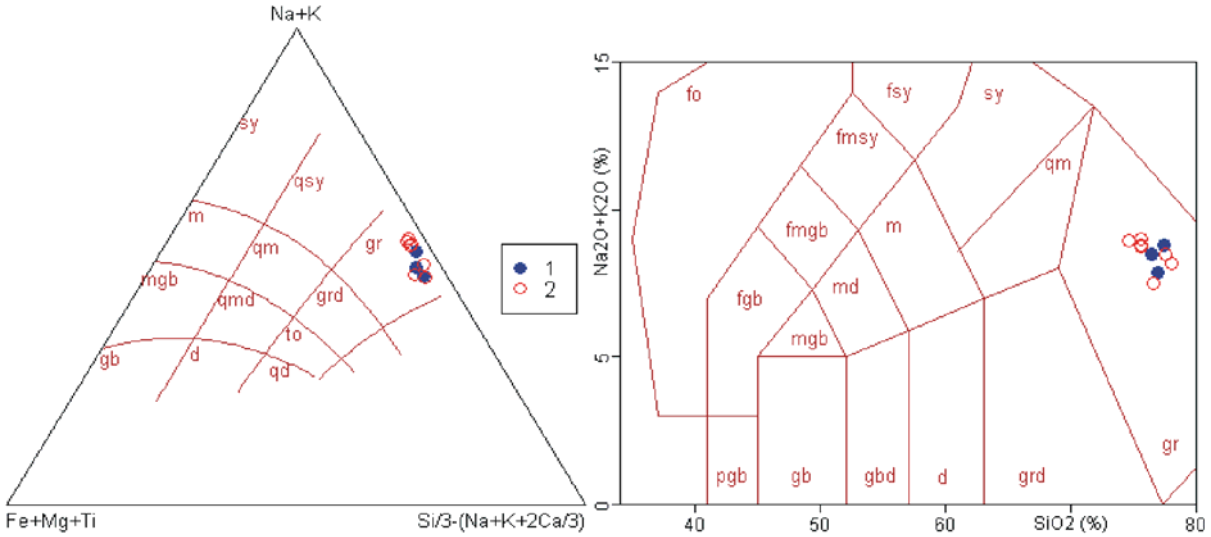

Fig. 3.43. *Cínovec (Zinnwald) Stock ABQ and TAS diagrams. 1 –Cínovec (zinnwaldite) Granite (upper part), 2 – Cínovec (protolithionite) Granite (lower part).*

Cínovec Granite

Quartz-rich, sodic-potassic, weakly peraluminous, leucocratic, S-type, I- and M-series, Li-mica alkali-feldspar granite

DrillholeCS-1		Upper part		Lower part	
Cínovec		**zinnwaldite granite**		**protolithionite granite**	
	Cs126m	Cs410m	Cs668m	Cs1110m	Cs1569m
SiO_2	74.14	76.41	73.87	77.61	77.14
TiO_2	0.20	0.06	0.04	0.08	0.07
Al_2O_3	12.81	12.31	12.66	11.81	12.46
Fe_2O_3	0.65	0.27	0.19	0.30	0.20
FeO	0.36	0.53	1.12	0.71	0.55
MnO	0.11	0.04	0.08	0.03	0.03
MgO	0.04	0.02	0.03	0.08	0.03
CaO	0.50	0.38	0.42	0.67	0.53
Na_2O	3.80	4.13	3.30	3.28	3.55
K_2O	3.78	4.54	4.92	4.88	4.90
P_2O_5	0.02	0.02	0.02	0.02	0.02
Li_2O	0.32	0.13	0.26	0.06	0.05
Mg/(Mg+Fe)	0.06	0.04	0.04	0.12	0.07
K/(K+Na)	0.40	0.42	0.50	0.49	0.48
Nor.Or	23.43	27.43	30.70	29.55	29.52
Nor.Ab	35.80	37.93	31.30	30.19	32.50
Nor.An	2.46	1.79	2.06	3.27	2.55
Na+K	202.88	229.67	210.95	209.4	218.6
*Si	202.49	189.72	193.87	213.1	203.0
K-(Na+Ca)	-51.28	-43.65	-9.52	-14.18	-19.97
Fe+Mg+Ti	16.66	12.01	19.22	16.63	11.79
Al-(Na+K+2Ca)	30.85	-1.48	22.68	-1.43	7.19
(Na+K)/Ca	22.75	33.89	28.17	17.53	23.13
Nor.Q	35.46	32.11	33.31	35.99	34.24
A/CNK	1.14	0.99	1.10	0.99	1.03

Trace elements (mean values in ppm): *Cínovec Granite* – **Ba** 50, **Cs** 31, **Ga** 35, **Hf** 7.6, **Li** 822, **Nb** 68, **Pb** 34, **Rb** 1127, **Sc** 6, **Sr** 9, **Th** 68, **U** 32, **Y** 53, **Zn** 29, **Zr** 100, **La** 30, **Ce** 70, **Sm** 8, **Eu** 0.1, **Yb** 15.2, **Lu** 1.97 (Breiter, Sokolová and Sokol 1991).

Preisselberg Granite

Quartz-rich, sodic-potassic, strongly peraluminous, leucocratic S-type, I- and M-series, granite

	biotite granite			Li-micagranite		
	Pr2	**Pr3**	**Pr4**	**PrLi8**	**PrLi9**	**PrLi10**
SiO_2	73.73	74.89	74.98	71.17	72.68	71.26
TiO_2	0.06	0.13	0.15	n.d.	0.05	0.07
Al_2O_3	13.48	12.59	12.51	15.56	14.09	14.91
Fe_2O_3	1.28	0.81	0.86	0.27	0.01	0.23
FeO	1.16	0.65	0.43	0.95	2.47	2.54
MnO	0.03	0.02	0.02	0.08	0.06	0.10
MgO	0.20	0.02	0.18	0.14	0.06	0.13
CaO	0.20	0.59	0.80	0.67	0.56	0.97
Li_2O	n.d.	0.03	0.03	0.32	0.19	0.35
Na_2O	2.70	3.06	2.39	4.52	3.95	2.96
K_2O	5.46	5.09	5.54	4.30	4.00	3.76
P_2O_5	0.07	0.04	0.05	0.02	0.02	0.01

Mg/(Mg+Fe)	0.13	0.02	0.21	0.16	0.04	0.08
K/(K+Na)	0.57	0.52	0.60	0.38	0.40	0.46
Nor.Or	33.60	31.26	34.19	26.16	24.83	23.79
Nor.Ab	25.26	28.56	22.42	41.80	37.26	28.47
Nor.An	0.55	2.77	3.80	3.29	2.78	5.08
Nor.Q	35.32	35.07	36.80	24.87	30.25	35.06
Na+K	203.06	206.82	194.75	237.16	212.39	175.35
*Si	203.60	201.64	211.71	149.71	184.16	208.45
K-(Na+Ca)	25.23	-1.19	26.24	-66.51	-52.52	-32.98
Fe+Mg+Ti	37.91	21.33	23.11	20.09	36.64	42.36
Al-(Na+K+2Ca)	54.53	19.38	22.39	44.51	44.33	82.86
(Na+K)/Ca	56.94	19.66	13.65	19.85	21.27	10.14
A/CNK	1.27	1.09	1.11	1.17	1.19	1.39

Trace elements (mean values in ppm): *Preisselberg Granite* – **Ba** 63, **Cs** 19, **Ga** 24, **Hf** 7.7, **Li** 121, **Nb** 35, **Pb** 33, **Rb** 514, **Sc** 3, **Sr** 13, **Th** 43, **U** 12, **Y** 51, **Zn** 57, **Zr** 118, **La** 30, **Ce** 70, **Sm** 9.6, **Eu** 0.12, **Yb** 9.05, **Lu** 1.25 (Breiter, Sokolová and Sokol 1991).

3.1.4.7. SCHELLERHAU STOCK

Regional position: member of the YIC Plutonic Group in the Eastern Erzgebirge-Krušné hory Mts. Composite Pluton.

The cupola developed on hidden NW-SE striking granite ridge (Sadisdorf – Schellerhau – Zinnwald-Cínovec – Krupka). The largest outcrop of YIC granites in the Eastern Krušné hory Mts.(Erzgebirge) Composite Pluton.

Rock types:

1. *Schellerhau SG1 Granite* – porphyritic fine-grained biotite syenogranite ("intermediate granite" type).
2. *Schellerhau SG2 Granite* – medium-grained protolithionite topaz-bearing alkali-feldspar monzogranite.
3. *Schellerhau SG3 Granite* – Li-mica alkali-feldspar granite (at depth).

Size and shape: 15 km^2 (7 × 2.5 km), NW-SE elongated outcrop.

Age: Highly evolved Li-F granites, YIC. Granite SG1 found as enclosed blocks in SG2.

Geological environment: Teplice rhyolite in the East and South, gneiss and Schönfeld rhyodacite and tuffs in the West.

Contact aureole: narrow, prevailing magmatic contacts, locally (SE) tectonic margins.

***Zoning*:** not observed.

Mineralization: local greisen zones, Sn-W- and Sn-As mineralization.

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Schellerhau Granite

Quartz-rich to -normal, sodic/potassic, metaluminous/peraluminous, leucocratic, S-type granite

	521-SG1	SG1	SG2	SG2	SG3
SiO_2	73.22	75.13	72.93	71.91	69.29
TiO_2	0.08	0.06	0.09	0.07	0.02
Al_2O_3	13.32	12.60	13.84	14.64	16.97
Fe_2O_3	0.75	0.89	1.69	1.25	0.74
FeO	0.72	n.d.	n.d.	n.d.	0.09
MnO	n.d.	0.02	0.05	0.03	0.02
MgO	0.09	0.06	0.17	0.07	0.02
CaO	1.41	0.50	0.71	0.92	0.11
Na_2O	3.86	3.31	3.47	3.91	6.96
K_2O	4.12	5.33	5.09	4.64	4.09
P_2O_5	1.08	0.02	0.04	0.04	0.03
Li_2O	n.d.	n.d.	0.21	n.d.	0.06
Mg/(Mg+Fe)	0.10	0.12	0.16	0.10	0.04
K/(K+Na)	0.41	0.51	0.49	0.44	0.28
Nor.Q	33.24	32.90	30.21	28.13	11.92
Nor.Or	25.01	32.54	31.03	28.27	23.98
Nor.Ab	35.62	30.72	32.15	36.20	62.02
Nor.An	-0.13	2.43	3.36	4.44	0.35
Na+K	212.04	219.98	220.05	224.69	311.44
*Si	177.41	190.88	176.11	163.31	71.66
K-(Na+Ca)	-62.23	-2.56	-16.56	-44.06	-139.72
Fe+Mg+Ti	22.66	13.39	26.52	18.28	11.27
Al-(Na+K+2Ca)	-0.75	9.62	26.42	30.00	17.90
(Na+K)/Ca	8.43	24.67	17.38	13.70	158.77
A/CNK	1.10	1.04	1.11	1.12	1.06

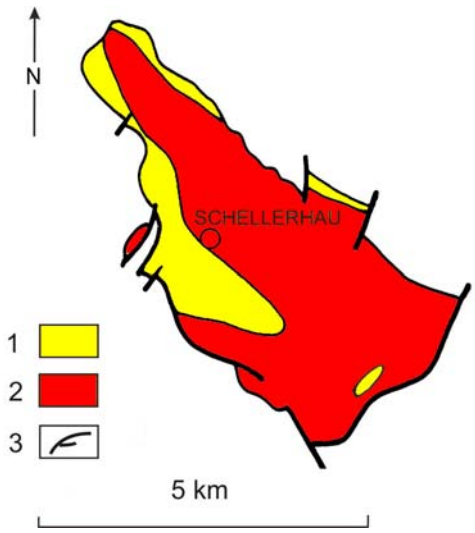

Fig. 3.44. *Schellerhau Stock geological sketch-map (after Hoth, Tischendorf and Berger 1995). 1 – Schellerhau SG2 Granite, 2 – Schellerhau SG1 Granite, 3 – faults.*

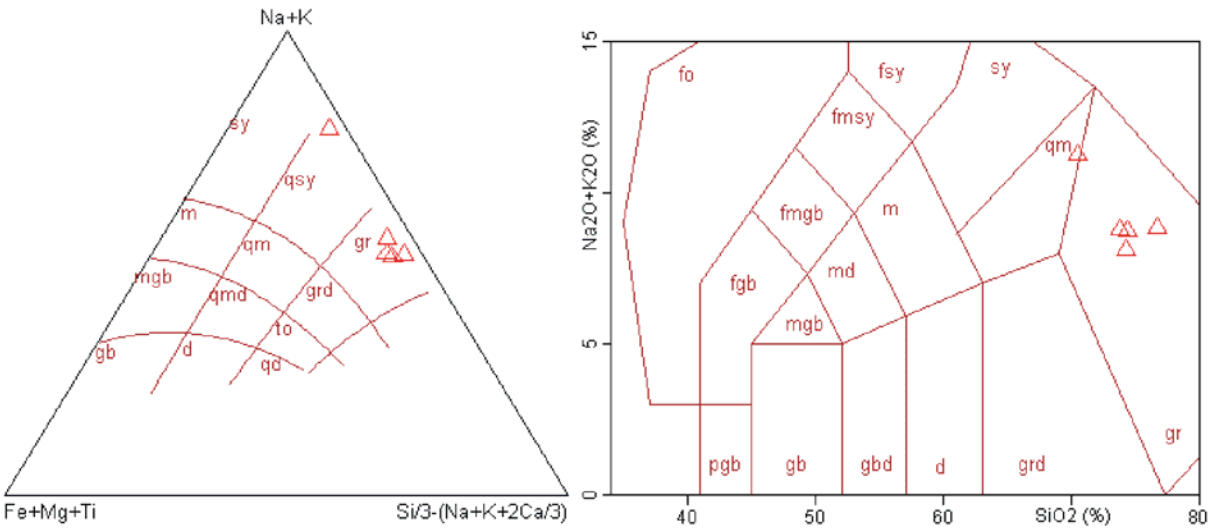

Fig. 3.45. *Schellerhau Massif ABQ and TAS diagrams: Schellerhau Granite (G1 - G3).*

3.1.4.8. SADISDORF STOCK

Regional position: member of the YIC Plutonic Group in the Eastern Erzgebirge-Krušné hory Mts. Composite Pluton.

The stock developed on hidden NW-SE striking granite ridge (Sadisdorf – Schellerhau – Cínovec – Krupka).

Rock types: *Schellerhau Granite (G1)* – biotite granite to Li-mica granite (G4).

Size and shape (on erosion level): 15 km^2 (7 × 2.5 km), NW-SE – elongated outcrop.

Age and isotopic data: Highly evolved Li-F granites, YIC Granite SG1 found as enclosed blocks in SG2 Granite. No isotopic data.

Geological environment: Teplice rhyolite in the East and South, gneiss and Schönfeld rhyodacite and tuffs in the West.

Contact aureole: narrow, prevailing magmatic contacts, locally (SE) tectonic margins.

Zoning: not observed.

Mineralization: local greisen zones, Sn-W and Sn-As mineralizations.

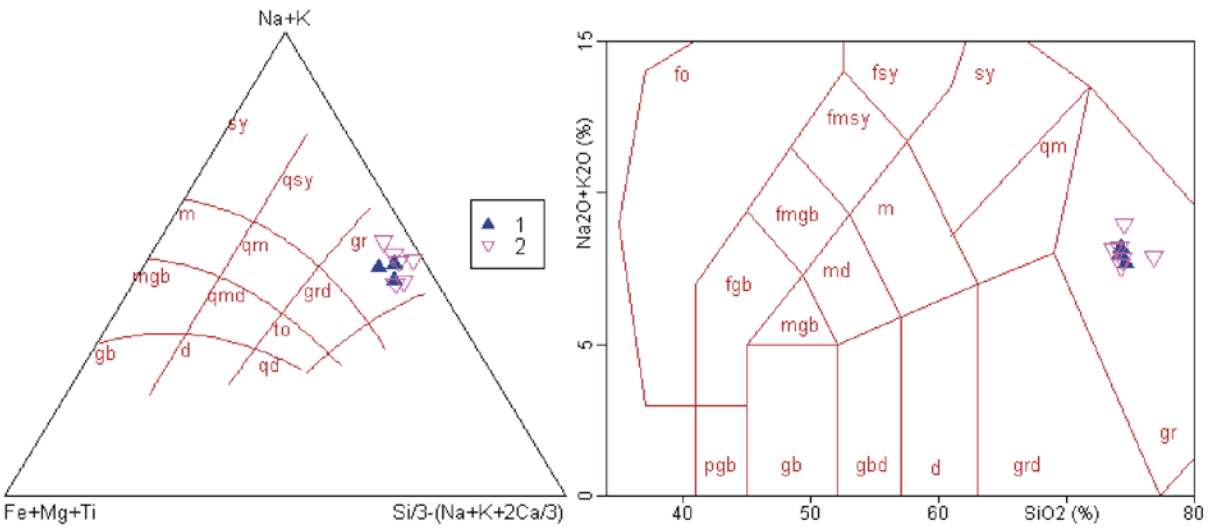

Fig. 3.46. *Altenberg Stock and Sadisdorf Stock ABQ and TAS diagrams: 1 – Altenberg Granite, 2 – Sadisdorf Granite.*

Altenberg Granite

Quartz-rich, sodic/potassic, metaluminous to peraluminous, leucocratic, I/S-type granite

	G1	G2	G3
		outergranite	innergranite
SiO_2	72.60	73.20	72.00
TiO_2	0.40	0.13	0.14
Al_2O_3	13.00	14.00	15.20
Fe_2O_3tot	1.90	1.70	1.50
FeO	n.d.	n.d.	n.d.
MnO	n.d.	n.d.	n.d.
MgO	0.30	0.30	0.10
CaO	1.60	1.20	0.40
Na_2O	3.30	3.30	4.10
K_2O	4.70	4.20	3.60
P_2O5	n.d.	n.d.	n.d.
Li_2O	0.24	0.16	0.32
Mg/(Mg+Fe)	0.24	0.26	0.12
K/(K+Na)	0.48	0.46	0.37
Nor.Q	30.48	33.56	32.07
Nor.Or	28.97	25.75	22.07
Nor.Ab	30.92	30.75	38.21
Nor.An	8.28	6.18	2.06
Na+K	206.28	195.67	208.74
*Si	177.47	196.17	185.94
K-(Na+Ca)	-35.23	-38.71	-63.00
Fe+Mg+Ti	36.26	30.37	23.03
Al-(Na+K+2Ca)	-8.05	36.47	75.49
(Na+K)/Ca	7.23	9.14	29.27
A/CNK	0.97	1.15	1.34

Sadisdorf Granite

Quartz-rich, sodic/potassic, peraluminous, leucocratic, S-type granite

	521(G1)	Se47(G1)	Se4(G2)	Se8(G3)	SP16(G4)	SPO7(G4)
SiO_2	73.30	72.10	72.40	72.70	72.90	75.30
TiO_2	0.18	0.21	0.05	0.05	0.05	0.04
$A_{l2}O_3$	13.90	14.80	15.00	15.20	15.00	13.80
Fe_2O_3	0.93	1.46	1.57	1.28	1.21	0.40
FeO	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
MnO	0.03	0.02	0.08	0.06	0.05	0.04
MgO	0.28	0.42	0.14	0.09	0.09	0.06
CaO	0.83	0.77	0.72	0.57	1.00	0.62
Na_2O	3.83	2.18	3.21	4.11	4.10	4.31
K_2O	4.99	5.77	4.21	3.93	3.56	3.44
P_2O_5	0.15	0.17	0.04	0.05	0.04	0.03
Li_2O	0.06	n.d.	0.80	0.56	n.d.	0.22
Mg/(Mg+Fe)	0.37	0.36	0.14	0.12	0.12	0.21
K/(K+Na)	0.46	0.64	0.46	0.39	0.36	0.34
Nor.Q	28.65	34.43	34.67	30.90	31.62	33.91
Nor.Or	30.24	35.65	25.88	23.80	21.59	20.82
Nor.Ab	35.27	20.47	29.99	37.83	37.79	39.65

Nor.An	3.21	2.82	3.44	2.56	4.82	2.95
Na+K	229.54	192.86	192.97	216.07	207.89	212.12
*Si	167.24	197.98	200.13	180.48	184.65	198.26
K-(Na+Ca)	-32.44	38.43	-27.04	-59.35	-74.55	-77.10
Fe+Mg+Ti	20.86	31.35	23.77	18.90	18.02	7.00
Al-(Na+K+2Ca)	13.82	70.32	75.92	62.10	51.01	36.77
(Na+K)/Ca	15.51	14.05	15.03	21.26	11.66	19.19
A/CNK	1.07	1.34	1.35	1.27	1.21	1.16

3.1.4.9. MARKERSBACH STOCK

Regional position: member of the YIC Plutonic Group in the Eastern Erzgebirge-Krušné hory Mts. Composite Pluton.

An independent intrusion in the SE part of the Elbtalschiefergebirge, the youngest Variscan intrusion in the Elbe zone.

Rock types: *Markersbach Granite* – occasionally porphyritic, medium-grained biotite granite. Presence of topaz greisens shows its close relation to YIC granites.

Size and shape (on erosion level): 5 km^2, an approximately oval outcrop.

Age and isotopic data: Upper Westphalian – Stephanian. No isotopic data.

Geological environment: Lower Ordovician phyllites and slates (Elbe zone) in the South, Turonian sedimentary cover in the North.

Contact aureole: Phyllitic schists are altered to andalusite-mica hornfelses and calc-silicates.

Zoning: not observed.

Mineralization: Sn-greisen.

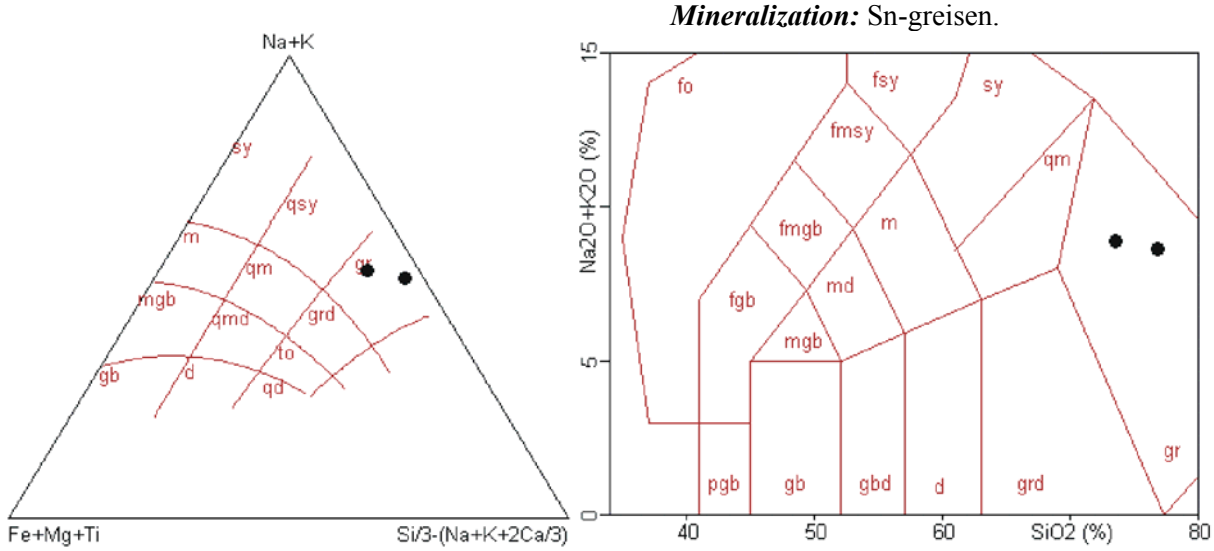

Fig. 3.47. *Markersbach Stock ABQ and TAS diagrams: Markersbach Granite.*

Markersbach Granite

Quartz-normal to -rich, sodic/potassic, peraluminous, leucocratic, I-type granite

	519	**520**
SiO_2	74.59	76.40
TiO_2	n.d.	0.04
Al_2O_3	12.98	12.90
Fe_2O_3	2.81	1.03
FeO	0.18	n.d.
MnO	n.d.	0.03
MgO	0.09	0.02
CaO	1.52	0.40

Na_2O	3.77	3.87
K_2O	5.25	4.68
P_2O_5	0.25	0.01
Mg/(Mg+Fe)	0.06	0.04
K/(K+Na)	0.48	0.44
Nor.Q	27.69	33.02
Nor.Or	31.02	28.07
Nor.Ab	33.86	35.27
Nor.An	5.89	1.95
Na+K	233.13	224.25
*Si	162.61	194.85
K-(Na+Ca)	-37.29	-32.65
Fe+Mg+Ti	39.95	13.90
Al-(Na+K+2Ca)	-32.44	14.81
(Na+K)/Ca	8.60	31.44
A/CNK	0.90	1.06

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3.2. FICHTELGEBIRGE AND KRUŠNÉ HORY MTS. (ERZGEBIRGE) ORTHOGNEISSES

In the Saxothuringicum the Cadomian basement consists of volcanosedimentary complexes with maximum ages of sedimentation around ca. 570 Ma. These complexes were intruded by post-kinemetic plutons at ca. 540–530 Ma (Linneman et al. 2008). These multiply deformed plutons of granitic composition are a characteristic feature of the crust at the northern margin of the Bohemian Massif . Relict features of contact metamorphism in their metasedimentary country rocks mostly prove their magmatic origin.

Neo-Proterozoic to Cambrian/Ordovician granitic intrusions were transformed during the Variscan orogeny into orthogneisses in form of strongly deformed sheet-like bodies, predominantly within the cores of the domal structures (the lowermost tectonic units) in the Saxo-Thuringian Zone. They consist of two orthogneiss units, the "Grey Gneiss" and "Red Gneiss". Both types are contemporaneous and of the late Cadomian age . The Grey Gneiss has been derived from almost undifferentiated granitic intrusions into a lower crustal level, whereas the weakly differentiated Red Gneiss precursors were emplaced at higher crustal levels. The Red Gneiss has been classified into the allochthonous Red Gneiss of the Early Cambrian age (524 ± 10 Ma) and the autochthonous Red Gneiss (the Catharine-Reitzenhain Gneiss) of the Early Ordovician age (480 ± 10 Ma). Depending on mineralogical composition and texture the Red Gneiss group comprises at least three types, namely granite gneiss, augengneiss and muscovite gneiss (Pietzsch 1962). According to Linnemann et al.(2008) Cadomian metagranitoids are essential part of the basal mid-pressure–mod-temperature unit. They comprise the Inner Freiberg Orthogneiss (Grey Gneiss) including the adjacent gneisses and migmatites of the eastmost Erzgebirge as well as the periclinal Wolkenstein-Bärenstein Augengneiss belt and augen gneisses in the cores of the Měděnec Structure and the Klínovec Antiform in the central Erzgebirge. U–Pb and Pb/Pb zircon ages of between ca 540 and 525 Ma (Early Cambrian) are interpreted as representing the intrusion ages of the igneous protholiths of these rocks (Košler 2004).

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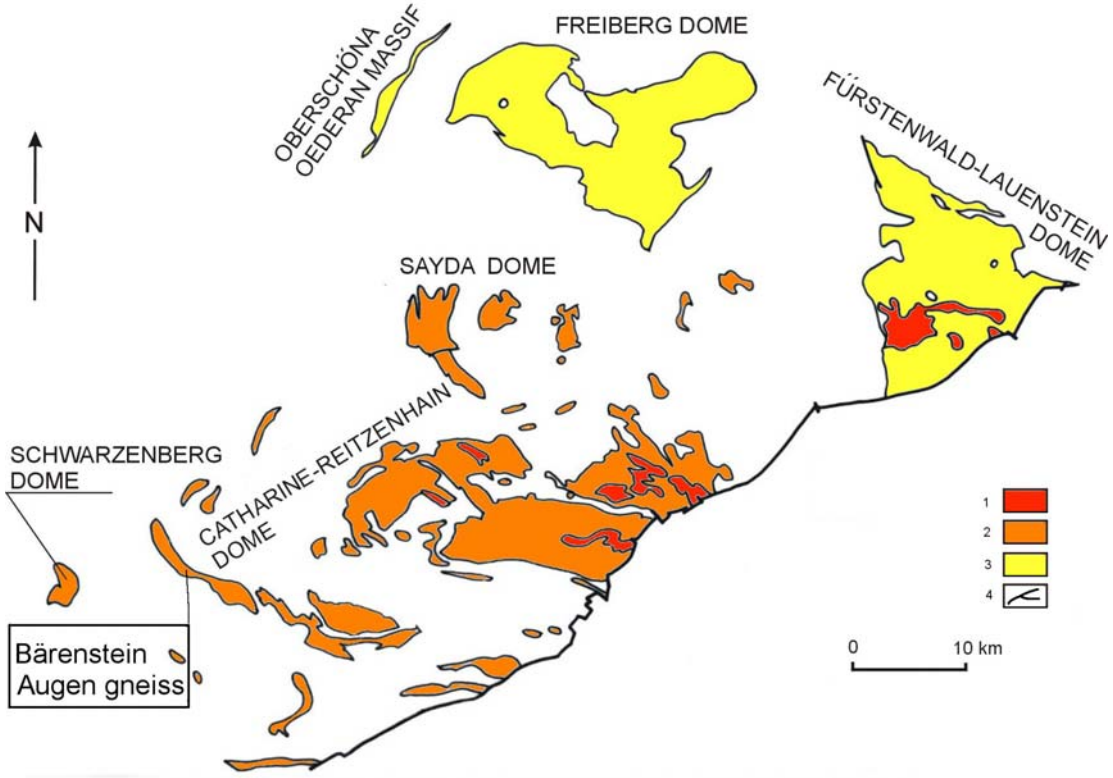

Fig. 3.48. *Krušné hory (Erzgebirge) Mts. Orthogneisses geological sketch-map (after Hoth, Tischendorf and Berger 1995). 1 – Granite Gneiss (relict granite), 2 – Red Orthogneisses, 3 – Grey (Inner) Orthogneisses, 4 – faults.*

3.2.1. RED ORTHOGNEISSES

Regional position: A number of the sheet-like bodies resulted mostly from the ductile deformation predominantly within the cores of antiforms and synforms in the Fichtelgebirge and Erzgebirge (Inner and Outher Red Orthogneisses). Allochthonous Early Cambrian Lower Crystalline intrusions (nappe units – the Oberwiesenthal Synform, Měděnec Synform, Klínovec Synform and Jöhstadt Synform) and autochthonous Early Ordovician granitic intrusions (e.g. the Catharine-Reitzenhain Dome).

Rock types:

1. *Selb Orthogneiss*
2. *Waldersdorf Orthogneiss*
3. *Wunsiedel Orthogneiss*
4. *Sayda Orthogneiss*
5. *Catharine-Reitzenhain Orthogneiss*
6. *Schwarzenberg Orthogneiss*
7. *Oberschöna-Oederan Orthogneiss*
8. *Mobendorf-Cunnersdorf Orthogneiss*
9. *Frankenberg-Sachsenburg Orthogneiss*
10. *Bieberstein-Dittmannsdorf Orthogneiss*
11. *Wolkenstein-Bärenstein Augengneiss*
12. *Sfinx Orthogneiss*
13. *Reisenstein Metagranite (relict granite).*

Depending on mineralogical composition and texture the Red (Inner) Orthogneiss group in the Erzgebirge comprises at least three types, namely granite gneiss, augengneiss and muscovite gneiss.

1. *Granite gneiss* (Reitzenhain Metagranite) – porphyritic coarse-grained, sheared granite with mylonitic textures (Riesenstein Metagranite).
2. *Augengneiss* – porphyritic biotite-muscovite gneiss (e.g. Reitzenhain Augengneiss Bärenstein Augengneiss and Sfinx Augengneiss).
3. *Muscovite Gneiss* – fine-grained biotite orthogneiss (HT mylonite to augengneiss).

Age and isotopic data:

Granite Gneiss 560–550 Ma (Pb-Pb zircon),

*Reitzenhain Augengneiss (*Metagranite) 551 ± 6, 551 ± 9, 492 ± 14, 492 ± 14 Ma (Pb-Pb zircon), *Schwarzenberg Orthogneiss* 480 ± 12 Ma (Pb-Pb zircon), *Bärenstein Augengneiss 536 ± 4 Ma (Pb/Pb evaporation zircon), Sfinx Augengneiss* 524 ± 10 Ma (U-Pb zircon).

3. *Muscovite Gneiss* 479 ± 1, 492 ± 4, 485 ± 12 Ma (Pb-Pb zircon).

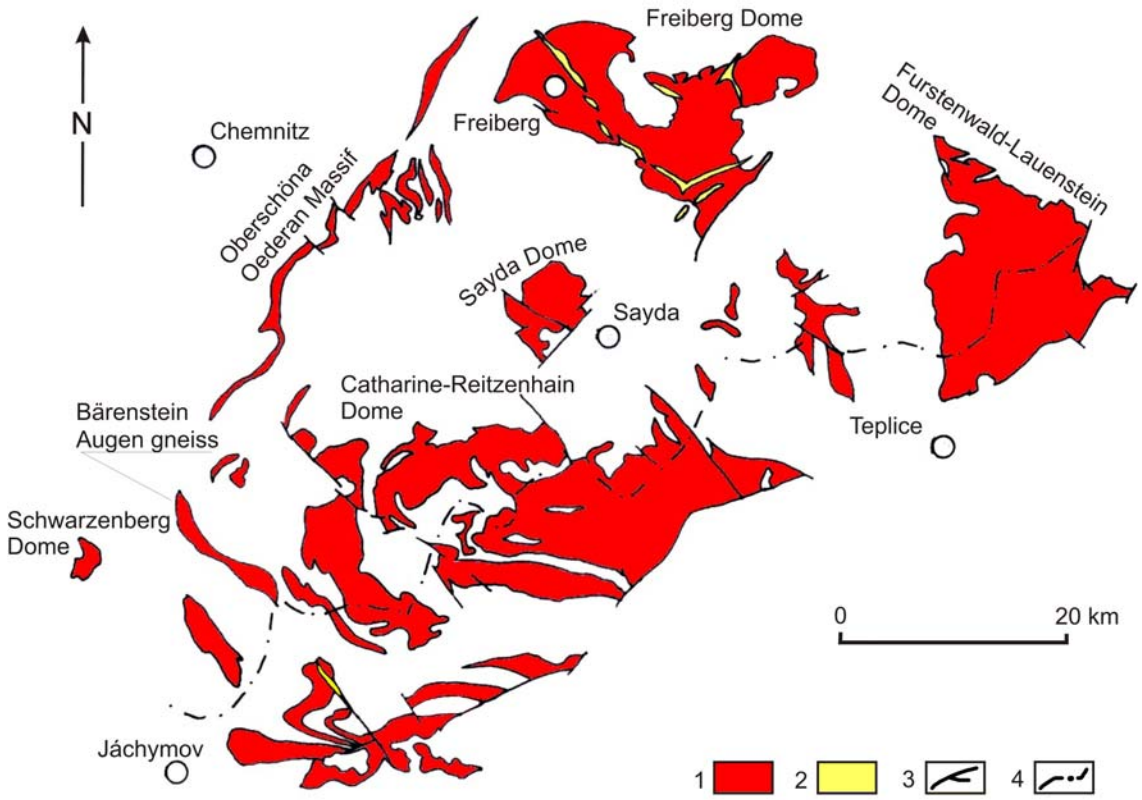

Fig. 3.49. *Krušné hory (Erzgebirge) Mts. Orthogneisses geological sketch-map (adapted after Cháb et al. 2007). 1 – Krušné hory (Erzgebirge) Mts. Orthogneisses, 2 – Late Variscan granite porphyry, 3 – faults, 4 – state border.*

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3.2.1.1. SELB ORTHOGNEISS

Regional position: The Fichtelgebirge section of the Saxothuringicum. The sheet-like intrusion within the core of the antidomal structure in the Smrčiny Mts. (Fichtelgebirge).

Rock types:

1. *Selb Orthogneiss* – medium-grained two-mica gneiss with millimetre to 2 cm long feldspar phenocrysts.
2. *Hohendorf Orthogneiss.*

Size and shape (on erosion level): 15 × 1–2 km, three sheet-like slabs at the exocontact of the Smrčiny Mts. (Fichtelgebirge) Composite Massif.

Age and isotopic data: Early Cambrian 470 ± 20 Ma (Pb-Pb zircon).

Geological environment: a body between Variscan granite and Palaeozoic mica schists.

Contact aureole: relicts of the contact metamorphism in mica schists.

Heat production (μWm^{-3}): *Selb Orthogneiss* 3.25.

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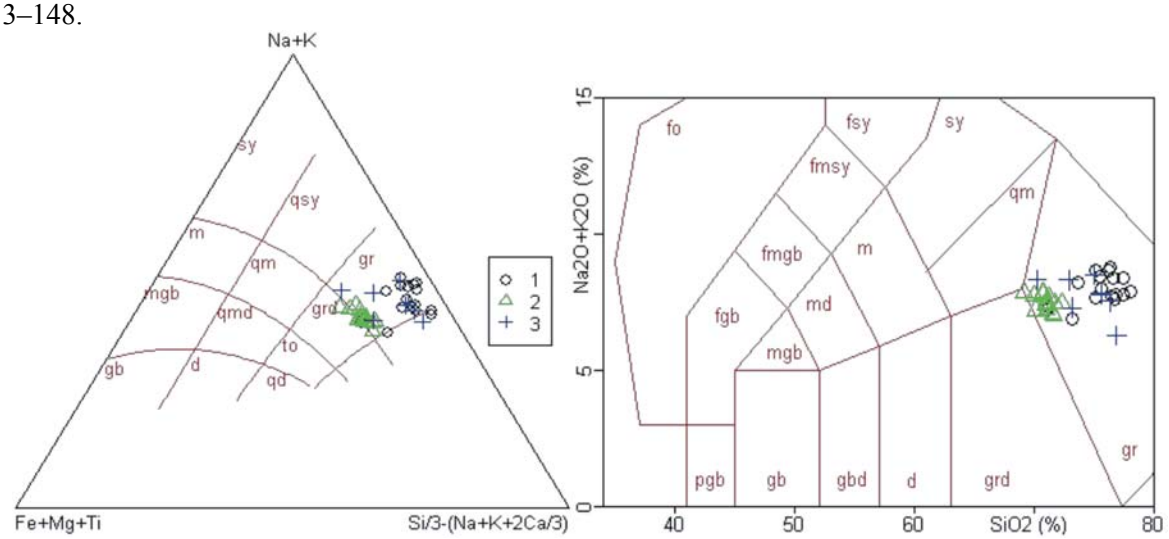

Fig. 3.50. *Fichtelgebirge Orthogneisses ABQ and TAS diagrams: 1 - Wunsiedel Orthogneiss, 2 – Selb Orthogneiss, 3 – Waldershof Orthogneiss.*

Selb Orthogneiss

Quartz-rich, sodic/potassic, peraluminous, leucocratic, S-type, granite

n = 6	Median	Min	Max	QU1	QU3
SiO_2	72.08	69.32	75.68	70.06	73.97
TiO_2	0.16	0.11	0.47	0.13	0.32
Al_2O_3	13.94	13.63	14.53	13.88	14.07
Fe_2O_{3tot}	1.73	1.40	3.83	1.42	2.59

FeO	0.03	0.03	0.04	0.03	0.03
MnO	0.25	0.17	0.92	0.20	0.62
MgO	0.58	0.44	1.24	0.47	0.84
CaO	3.27	3.11	4.46	3.13	3.35
Na_2O	4.61	1.71	5.13	4.44	4.67
K_2O	0.17	0.14	0.22	0.17	0.18
Mg/(Mg+Fe)	0.26	0.18	0.32	0.19	0.32
K/(K+Na)	0.47	0.20	0.52	0.46	0.50
Nor.Or	28.36	10.41	31.16	27.35	28.47
Nor.Ab	30.19	28.82	41.25	29.10	31.37
Nor.An	1.81	0.76	5.25	1.11	3.36
Nor.Q	30.76	26.32	40.13	29.10	32.95
Na+K	202.37	180.23	214.70	199.51	209.08
*Si	180.82	156.20	232.73	171.56	190.34
K-(Na+Ca)	-35.94	-117.96	-4.98	-39.44	-9.05
Fe+Mg+Ti	28.22	23.34	76.73	25.79	51.82
Al-(Na+K+2Ca)	37.76	29.63	72.84	37.27	41.37
(Na+K)/Ca	13.96	9.15	25.59	10.47	17.43
A/CNK	1.15	1.11	1.36	1.15	1.18

Trace elements (mean values in ppm): *Selb Orthogneiss* – **Ba** 210, **Co** 17, **Cr** 9, **Ga** 11, **Ni** 12, **Nb** 6, **Pb** 26, **Rb** 266, **Sr** 54, **Th** 11, **U** 8, **Y** 37, **Zn** 46, **Zr** 98, **La** 22, **Ce** 39, **Sc** 8 (Siebel et al. 1997).

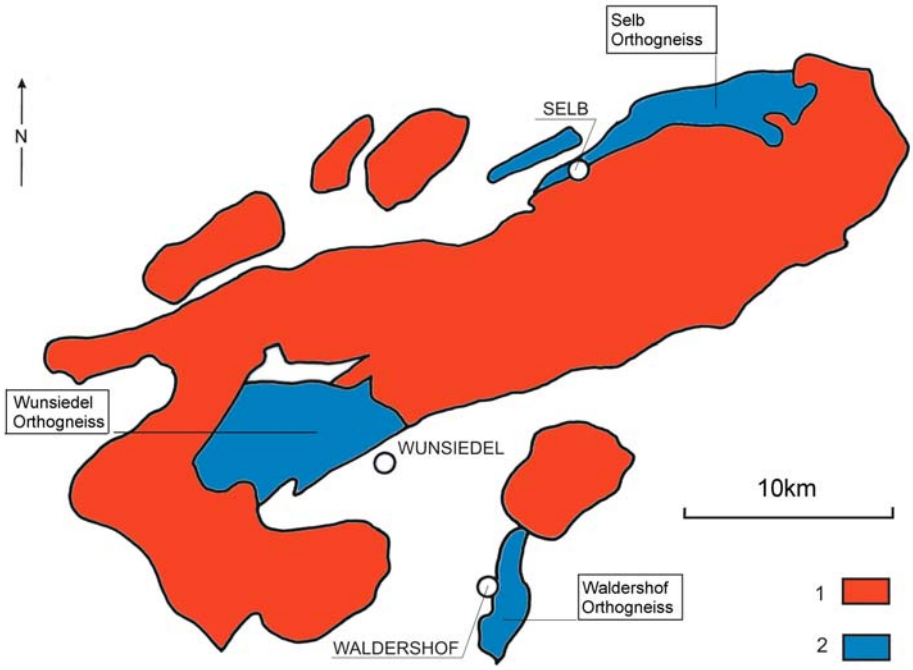

Fig. 3.51. *Fichtelgebirge Orthogneisses geological sketch-map. 1 – Fichtelgebirge-Smrčiny Composite Massif, 2 – Fichtelgebirge Orthogneisses.*

3.2.1.2. WALDERSHOF ORTHOGNEISS

Regional position: The Fichtelgebirge section of the Saxothuringicum.

Rock types:

Waldershof Orthogneiss – porphyritic (rounded phenocrysts) biotite orthogneiss (granodiorite).

Size and shape (on erosion level): an elongate north-south-trending body 10 km^2, 5 km long and 1–2 km wide. The gneiss precursor was emplaced as a clearly discordant body at a shallow crustal level.

Age and isotopic data: *Waldershof Orthogneiss* 460 Ma (U-Pb zircon).

Geological environment: the low-grade metamorphism within the surrounding rocks of the Arzberg Series.

Contact aureole: contact metamorphism caused by the Variscan Mitterteich Granite.

Heat production (μWm^{-3}): *Waldershof Orthogneiss* 3.08.

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Waldershof Orthogneiss

Quartz-rich, sodic, peraluminous, mesocratic, S-type, granodiorite

n = 13	Median	Min	Max	QU1	QU3
SiO_2	69.76	67.68	71.06	69.39	70.21
TiO_2	0.52	0.40	0.56	0.51	0.54
Al_2O_3	15.01	14.50	15.54	14.77	15.25
Fe_2O_{3tot}	3.36	3.10	3.87	3.28	3.45
FeO	0.04	0.03	0.06	0.04	0.04
MnO	0.98	0.74	1.23	0.92	1.01
MgO	1.04	0.70	1.61	0.83	1.13
CaO	2.98	2.53	3.44	2.87	3.16
Na_2O	4.44	3.54	4.77	4.18	4.60
K_2O	0.17	0.16	0.20	0.17	0.18
Mg/(Mg+Fe)	0.37	0.30	0.38	0.35	0.37
K/(K+Na)	0.49	0.40	0.55	0.47	0.51
Nor.Or	27.67	21.95	29.74	26.01	28.62
Nor.Ab	28.15	23.98	32.41	27.23	29.79
Nor.An	4.24	2.47	7.16	3.15	4.72
Nor.Q	31.55	27.51	34.78	30.73	32.56
Na+K	186.89	174.24	201.10	185.28	194.68
*Si	184.63	163.56	201.60	180.41	191.53
K-(Na+Ca)	-26.26	-54.39	6.62	-32.61	-12.79
Fe+Mg+Ti	71.80	65.45	86.05	71.45	74.99
Al-(Na+K+2Ca)	67.97	53.58	86.20	65.31	74.00
(Na+K)/Ca	10.12	6.35	15.04	9.41	13.15
A/CNK	1.30	1.23	1.41	1.28	1.33

Trace elements (mean values in ppm): *Waldersdorf Orthogneiss* – **Ba** 952, **Co** 24, **Cr** 27, **Ga** 17, **Ni** 19, **Nb** 8, **Pb** 28, **Rb** 154, **Sr** 126, **Th** 16, **U** 6, **Y** 38, **Zn** 59, **Zr** 173, **La** 57, **Ce** 77, **Sc** 10, **V** 42 (Siebel et al. 1997).

3.2.1.3. WUNSIEDEL ORTHOGNEISS

Regional position: The Fichtelgebirge section of the Saxothuringicum. Within the core of the antidomal structure in the Smrčiny Mts. (Fichtelgebirge) Massif.

Rock types:

Wunsiedel Orthogneiss – porphyritic (K-feldspars up to 10 cm in length) biotite orthogneiss (augen- and flaser-texture).

Size and shape (on erosion level): oval shape, the largest of the Fichelgebirge orthogneiss bodies (~ 30 km^2).

Age and isotopic data: *Wunsiedel Orthogneiss* 480 ± 4 Ma (Rb-Sr whole rock).

Geological environment: the Wunsiedel Orthogneiss is intruded into marbles and calc-silicate rocks of the Lower Arzberg Series.

Contact aureole: contact metamorphism associated with the Fichtelgebirge-Smrčiny Massif include the development of andalusite- and sillimanite-bearing hornfels.

Heat production (μWm^{-3}): *Wunsiedel Orthogneiss* 3.14.

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Wunsiedel Orthogneiss

Quartz-rich, potassic, peraluminous, leucocratic, S-type, granite

n = 16	Median	Min	Max	QU1	QU3
SiO_2	75.20	70.12	77.03	73.81	75.67
TiO_2	0.09	0.04	0.53	0.07	0.15
Al_2O_3	13.01	12.35	14.84	12.76	13.63
Fe_2O_{3tot}	1.55	0.78	3.64	0.98	1.76
FeO	0.02	0.01	0.03	0.02	0.03
MnO	0.15	0.03	1.00	0.08	0.21
MgO	0.40	0.30	1.32	0.33	0.57
CaO	2.98	1.95	3.32	2.62	3.09
Na_2O	4.93	4.11	6.17	4.56	5.20
K_2O	0.18	0.15	0.24	0.17	0.19
Mg/(Mg+Fe)	0.16	0.07	0.35	0.12	0.24
K/(K+Na)	0.51	0.47	0.66	0.50	0.53
Nor.Or	29.99	25.47	37.55	27.93	31.69
Nor.Ab	27.84	18.26	30.75	24.24	28.53
Nor.An	0.74	0.16	5.83	0.38	1.70
Nor.Q	35.37	31.85	40.75	32.99	37.88
Na+K	198.23	183.95	216.91	189.56	210.45
*Si	203.24	186.65	233.03	190.43	218.07
K-(Na+Ca)	-3.60	-31.30	49.90	-12.14	6.96
Fe+Mg+Ti	24.32	11.90	77.08	15.03	27.33
Al-(Na+K+2Ca)	40.53	24.89	63.84	38.33	49.39
(Na+K)/Ca	26.58	7.92	39.63	17.43	34.75
A/CNK	1.19	1.11	1.28	1.17	1.23

Trace elements (mean values in ppm): *Wunsiedel Orthogneiss* – **Ba** 199, **Co** 18, **Cr** 13, **Ga** 11, **Ni** 10, **Nb** 7, **Pb** 27, **Rb** 264, **Sr** 31, **Th** 9, **U** 8, **Y** 28, **Zn** 35, **Zr** 80, **La** 25, **Ce** 34, **Sc** 6, **V** 15 (Siebel et al. 1997).

3.2.1.4. SAYDA ORTHOGNEISS

Regional position: A sheet-like tectonically segmented bodies within the core of the Sayda Dome in the central Erzgebirge.

Rock types:

1. *Inner Red Orthogneiss* – Sayda Gneiss (Stengelgneiss) – two-mica augen gneiss.

Size and shape (on erosion level): ~ 60 km^2, a series of isolated and tectonized sills in the core of the Sayda Dome.

Age and isotopic data: *Sayda Orthogneiss* 554 Ma (U-Pb zircon).

Geological environment: Upper Proterozoic paragneisses, metatectites, two-mica schists.

Contact aureole: the Sayda Gneiss shows both features of dynamic and thermal metamorphism in the broad contact aureole (hybrid orthogneiss with andalusite/cordierite).

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3.2.1.5. CATHARINE-REITZENHAIN ORTHOGNEISS

Regional position: Sheet-like tectonically segmented bodies with a polyphase tectonometamorphic history within the core of the Catharine Dome in the central Erzgebirge

***Rock types*:**

Group I (Outer Red Orthogneiss):

1. banded partly anatectic orthogneiss (injection gneiss),
2. porphyroblastic muscovite-biotite ortho-gneiss,
3. fine-to medium-grained muscovite to biotite-muscovite partly leucocratic orthogneiss.

Group II (Inner Red Orthogneiss):

1. porphyritic deformed coarse-grained granite (metagranite), porphyroclastic orthogneiss and banded mylonitic orthogneiss,
2. ± porphyroblastic medium to coarse-grained granite,
3. fine- to medium-grained granite to granodiorite (Relict Granite).

***Size and shape (on erosion level)*:** 450 km^2, a series of the flat sheet-like sills (laccolithic intrusions) in the core of the Catharine-Reitzenhain Dome.

Age and isotopic data: *Catharine-Reitzenhain Orthogneiss* 551 Ma (U-Pb zircon), 480 ± 10 Ma, U-Pb zircon).

Geological environment: Upper Proterozoic paragneiss and mica-schist, spotted metagrey-wackes.

Heat Production (μWm^{-3}): *Inner Red Orthogneiss* 2.0, *Outer Red Orthogneiss* 3.2.

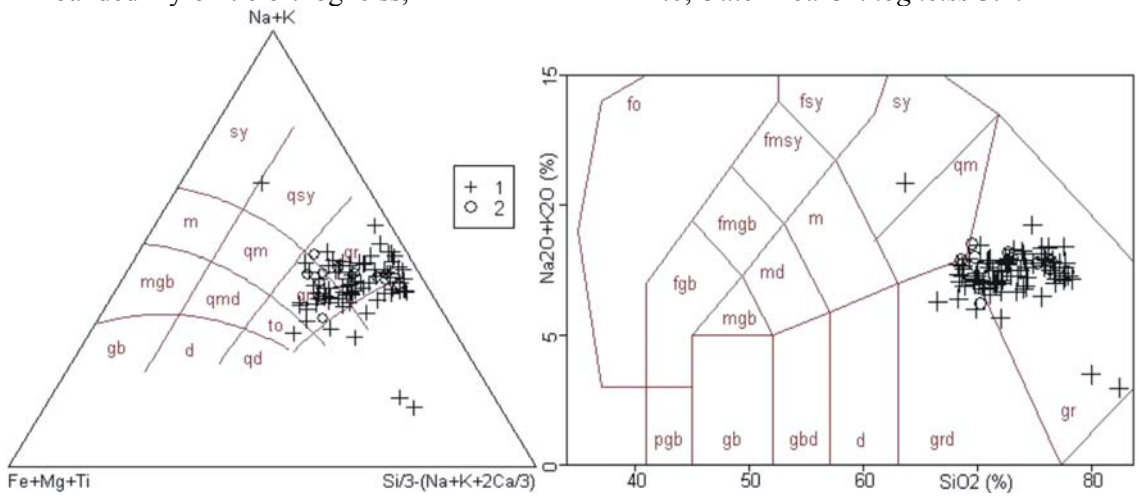

Fig. 3.52. *Catharine-Reitzenhain Orthogneiss ABQ and TAS diagrams. 1 – Catharine-Reitzenhain Orthogneiss, 2 – Erzgebirge Orthogneisses.*

Catharine-Reitzenhain Orthogneiss

Quartz-rich, sodic-potassic, strongly peraluminous, mesocratic, S-type, I-series, alkali-feldspar granite to granodiorite

n = 68	Med.	Min	Max	QU1	QU3
SiO_2	70.42	62.20	77.47	68.21	73.03
TiO_2	0.43	0.04	0.90	0.24	0.63
Al_2O_3	14.65	12.29	18.66	13.85	15.11
Fe_2O_3	0.56	0.00	2.43	0.37	0.80
FeO	1.92	0.16	4.41	1.02	2.80
MnO	0.04	0.01	3.95	0.03	0.06
MgO	0.94	0.01	2.48	0.43	1.41
CaO	1.07	0.23	2.54	0.76	1.33
Na_2O	2.91	1.49	5.29	2.71	3.19
K_2O	4.42	1.80	8.81	3.82	4.75
P_2O_5	0.17	0.05	0.36	0.15	0.21
Li_2O	0.008	0.000	0.023	0.000	0.012
Mg/(Mg+Fe)	0.38	0.01	0.56	0.32	0.43
K/(K+Na)	0.50	0.18	0.80	0.45	0.53
Nor.Or	27.14	11.02	54.20	24.46	29.61
Nor.Ab	27.91	13.93	49.24	25.95	30.24
Nor.An	4.42	-0.55	11.94	3.01	5.59
Nor.Q	31.44	8.23	42.77	28.83	34.74
Na+K	186.26	139.94	267.22	176.23	198.15
*Si	190.90	63.47	248.07	179.39	204.31
K-(Na+Ca)	-18.98	%-147.82	132.38	-38.64	-7.72
Fe+Mg+Ti	63.52	6.91	153.02	35.09	95.04
Al-(Na+K+2Ca)	55.43	13.99	134.42	43.09	70.68
(Na+K)/Ca	9.76	3.88	48.63	7.87	14.04
A/CNK	1.27	1.07	1.78	1.21	1.36

Trace elements (mean values in ppm): *Catharine-Reitzenhain Orthogneiss* – **Ba** 887, 880, 702, **Co** 78, 105, 104, **Cr** 42, 74 56, **Cu** 28, 19, 10, **Ga** 20, 18, 19, **Nb** 14, 11, 9, **Rb** 155, 167, 214, **Sr** 173, 118, 79, **V** 95, 65, 31, **Y** 30, 29, 32, **Zn** 78, 67, 44, **Zr** 232, 137 (Kröner et al. 1995).

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3.2.1.6. SCHWARZENBERG ORTHOGNEISS

Regional position: At the eastern limb of Karlovy Vary-Eibenstock Composite Massif.

Rock types:

Schwarzenberg Orthogneiss: Augengneiss, two-mica orthogneiss.

Size and shape (on erosion level): 6 km^2, 2 × 4 km, a flat sill in the core of the Schwarzenberg Dome.

Age and isotopic data: *Schwarzenberg Augengneiss* 480 ± 12 Ma (Pb-Pb zircon).

Geological environment: Cambrian two-mica schists, Schwarzenberg Granite (YIC?).

Contact aureole: not observed.

Zoning: an example of prograde zonation from mica schists to the augengneiss in the core of domal structure. Gradual increase of feldspars and decrease of muscovite content across lithostratigraphic boundaries. Magmatic origin is doubtful.

References

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3.2.1.7. OBERSCHÖNA-OEDERAN ORTHOGNEISS

Regional position: a metagranitic body along the contact between the Neoproterozoic paragneiss series and Pre-Sudetic Palaeozoic mica-schists.

Rock types: *Oberschöna-Oederan Orthogneiss* – Two phases are described:

Flaser Augengneiss – comparable with „Outer Red Orthogneiss“ of the Middle Erzgebirge Mts. In the body cores are developed as coarse-grained „basal granitoids“.

Muscovite Gneiss – closer to the contact with surrounding mica-schists. This type is similar to the Red Orthogneiss, known from Sayda and Catharina-Reitzenhain Domes.

Size and shape (on erosion level): 10 km^2, 13 × 1 km, tabular body.

Age and isotopic data: Neoproterozoic–Cadomian. No isotopic data.

Geological environment: mica-schists.

Contact aureole: injections of microgranitic character into paraseries (mm to cm layering in the former pelitic country rocks) identical with the contact phenomena observed at contacts of Sayda and Reitzenhain Orthogneisses (hybrid gneisses).

References

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3.2.1.8. MOBENDORF-CUNNERSDORF ORTHOGNEISS

Regional position: A series of NE-SW elongated bodies in the area of the Central Saxonian lineament belongs to the western most area of the Frankenberg Augengneiss complex developed in the West-Saxonian synclinorium between Granulitgebirge and Erzgebirge anticlinal zone.

Rock types:

Mobendorf-Cunnersdorf Orthogneiss:

Augengneiss – consists of muscovite, green (epizonal) biotite, garnet and albite.

Medium-grained gneiss – arises from the previous type by K-feldspar deformation (mica-schists).

Blastomylonites – result of the high-intensity cataclastic deformation of augengneisses.

Size and shape (on erosion level): intensively isoclinal folded lenses of km length.

Age and isotopic data: Neoproterozoic–Cadomian. No isotopic data.

Geological environment: An envelope of the Palaeozoic schists (Bavarian facies).

Contact aureole: missing, due to tectonic margins.

References

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3.2.1.9. FRANKENBERG-SACHSENBURG ORTHOGNEISS

Regional position: SW continuation of Mobendorf-Cunnersdorf structure.

Rock types:

Frankenberg-Sachsenburg Orthogneiss – K-feldspar two-mica augengneiss, in NE transformed into mylonitic gneiss, mica schists and gneiss mylonites. Their development is comparable with the Schwarzenberg Orthogneiss (missing contact metamorphism, link to deformation texture masked by syn- to postkinematic K-metasomatism).

Size and shape (on erosion level): a series of lenses and sills about 1 km long.

Age and isotopic data: Neoproterozoic–Cadomian. No isotopic data.

Geological environment: Neoproterozoic two-mica schists.

References

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3.2.1.10. BIEBERSTEIN-DITTMANNSDORF ORTHOGNEISS

Regional position: a heterogeneous augengneiss structure in the Upper Proterozoic Niederschlag series, elongated parallel to the Central Saxonian lineament.

Rock types:

Bieberstein-Dittmannsdorf Orthogneiss – alternating fine-grained biotite- to two-mica gneiss and red medium-grained augengneiss. K-feldspar rich parts located mainly in centres of augengneiss zones. Mineral composition and structure is similar to dyke and sill gneiss types of the Central Erzgebirge (Schwarzenberg type).

Size and shape (on erosion level): maximum 1 km thick tabular bodies.

Age and isotopic data: Neoproterozoic – Cadomian. No isotopic data.

Geological environment: Upper Proterozoic two-mica schists, Siebenlehn Metagabbro.

Contact aureole: absence of contact phenomena.

References

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3.2.2. GREY (INNER) ORTHOGNEISSES

Regional position: Eastern part of the Saxothuringian Zone.

Rock types:

1. *Freiberg Orthogneiss,*
2. *Fürstenwald-Lauenstein-Petrovice Orthogneiss*

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3.2.2.1. FREIBERG (INNER) ORTHOGNEISS

Regional position: Several sheet-like intrusions predominantly within the cores of the antidomal structure in the central Erzgebirge.

Rock types:

Freiberg Inner (Lower) Orthogneiss – strongly foliated porphyroclastic muscovite-biotite orthogneiss with accessory garnet and sillimanite (S-type, granitic protolith).

Size and shape (on erosion level): 265 km^2, flat domal sills with numerous parallel offsets.

Age and isotopic data: *Freiberg Inner Orthogneiss* 550 ± 7 Ma (U-Pb zircon), 541 ± 67 Ma (Pb-Pb zircon), 528 ± 6 Ma (U-Pb SHRIMP zircon). 534 ± 6 Ma (U-Pb SHRIMP zircon), 540 ± „ Ma (Pb/Pb evaporation zircon).

Geological environment: the Eastern Erzgebirge series and Pressnitz series of the Neoproterozoic ages.

Trace elements (mean values in ppm): *Freiberg (Inner) Orthogneiss* – **Ba** 669, **Co** 17, **Cr** 42, **Cu** 11, **Ga** 18, **Nb** 11, **Rb** 148, **Sr** 124, **V** 55, **Y** 31, **Zn** 112, **Zr** 207 (Kröner et al. 1995).

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3.2.2.2. FÜRSTENWALD-LAUENSTEIN-PETROVICE (INNER) ORTHOGNEISS

Regional position: several sheet-like bodies predominantly within the cores of the antidomal structure in the eastern Erzgebirge (Fürstenwald-Lauenstein-Petrovice Dome).

Rock types:

Fürstenwald-Lauenstein – Petrovice Inner (Lower) Orthogneiss – ± porphyritic, weakly foliated, medium-grained metagranodiorite to quartz metamonzonite.

Size and shape (on erosion level): 180 km^2, sheet-like bodies.

***Age and isotopic data*:** *Fürstenwald-Lauenstein – Petrovice Orthogneiss* 555 ± 7 Ma (U-Pb zircon).

Geological environment: the Eastern Erzgebirge series and Pressnitz (Přísečnice) series of the Neoproterozoic age.

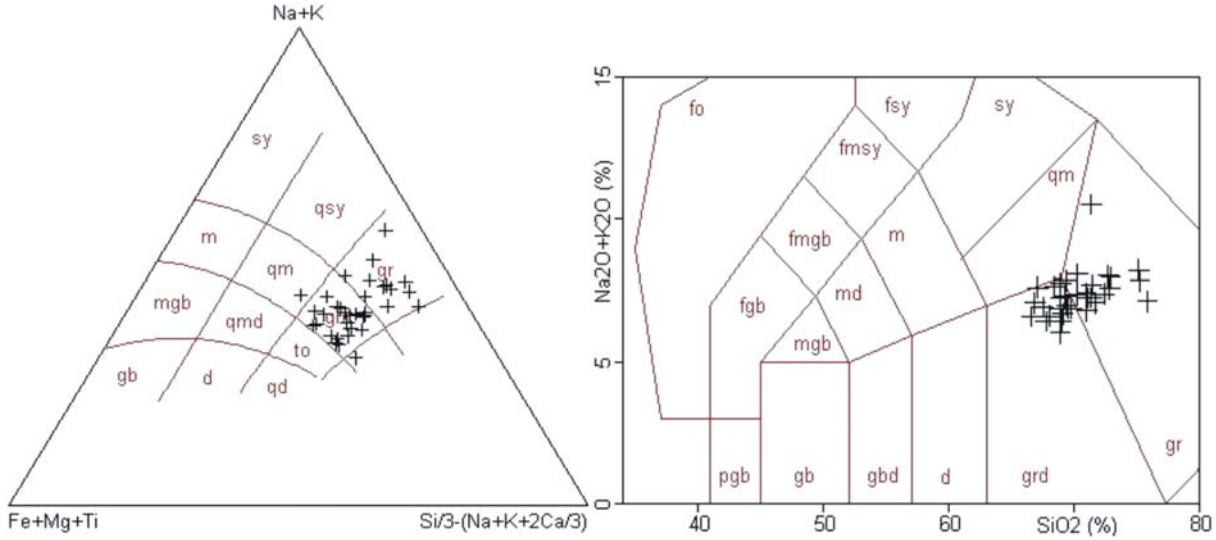

Fig. 3.53. *Fürstenwald-Lauenstein-Petrovice Orthogneiss ABQ and TAS diagrams.*

Fürstenwald-Lauenstein-Petrovice Orthogneiss

Quartz-normal, sodic-potassic to potassic, strongly peraluminous, mesocratic, S-type, I-series, granodiorite to granite

n = 14	Med.	Min	Max	QU1	QU3
SiO_2	67.92	65.53	74.57	67.70	69.34
TiO_2	0.58	0.16	0.85	0.49	0.66
Al_2O_3	14.82	13.31	15.52	14.49	15.22
Fe_2O_3	0.68	0.27	0.96	0.36	0.75
FeO	3.14	1.39	4.03	2.68	3.47
MnO	0.05	0.03	0.08	0.03	0.06
MgO	1.51	0.43	2.19	1.11	1.69
CaO	1.12	0.86	2.54	1.07	1.56
Na_2O	3.03	2.72	3.58	2.91	3.19
K_2O	3.87	3.01	5.04	3.81	4.43

P_2O_5	0.20	0.11	0.30	0.18	0.23
Li_2O	0.010	0.000	0.019	0.008	0.013
Mg/(Mg+Fe)	0.41	0.30	0.44	0.40	0.43
K/(K+Na)	0.45	0.36	0.55	0.44	0.51
Nor.Or	24.51	19.26	31.33	23.67	28.17
Nor.Ab	29.47	26.07	34.53	28.29	30.51
Nor.An	4.62	3.41	11.94	4.31	7.13
Nor.Q	28.50	22.24	37.19	26.17	30.34
Na+K	185.06	167.33	198.21	178.35	188.34
*Si	177.88	150.34	219.43	168.22	186.27
K-(Na+Ca)	-37.42	-93.36	-1.13	-55.03	-18.98
Fe+Mg+Ti	100.23	37.34	133.14	75.01	105.17
Al-(Na+K+2Ca)	49.48	31.11	83.27	45.80	61.25
(Na+K)/Ca	8.55	3.88	12.00	6.07	9.97
A/CNK	1.24	1.14	1.42	1.22	1.28

Trace elements (mean values in ppm): *Fürstenwald-Lauenstein-Petrovice Orthognei*ss – **Ba** 578, 790, **Co** 152, 143, **Cr** 19, 44, **Cu** 2, 9, **Ga** 15,18, **Nb** 7,12, **Rb** 160, 175, **Sr** 69, 112, **V** 16, 55, **Y** 24, 29, **Zn** 49, 63, **Zr** 108, 193 (Kröner et al. 1995).

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3. Saxothuringicum

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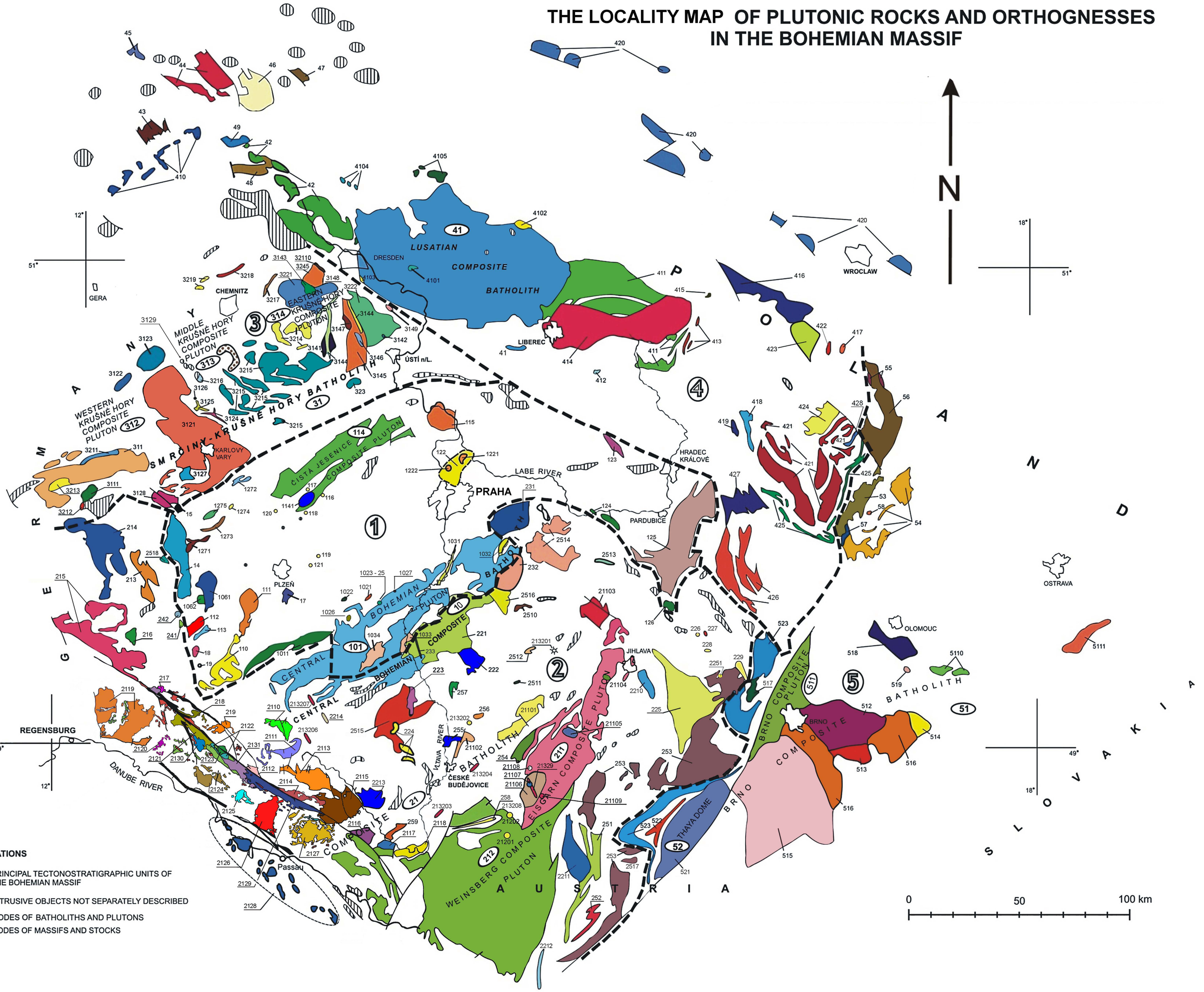
THE LOCALITY MAP OF PLUTONIC ROCKS AND ORTHOGNESSES IN THE BOHEMIAN MASSIF



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