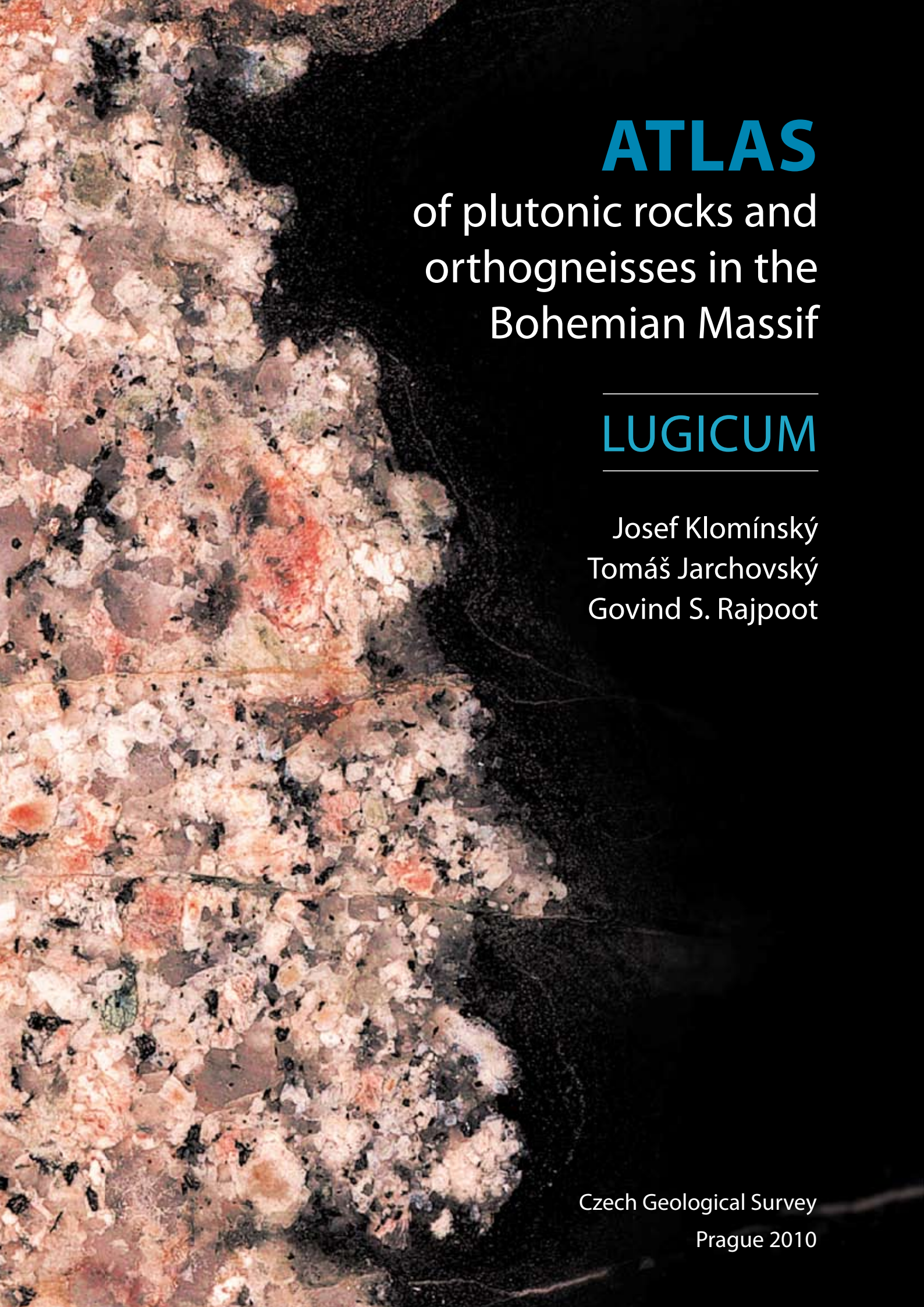

ATLAS

of plutonic rocks and orthogneisses in the Bohemian Massif

LUGICUM

Josef Klomínský
Tomáš Jarchovský
Govind S. Rajpoot

Czech Geological Survey
Prague 2010

CZECH GEOLOGICAL SURVEY

ATLAS
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4. LUGICUM

Compiled by

Josef Klomínský
Tomáš Jarchovský
Govind S. Rajpoot

The **Lugicum** volume 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. SAXOTHURINGICUM
4. LUGICUM
5. BRUNOVISTULICUM AND MORAVOSILESICUM

In the Introduction volume are summarized general characteristics of the plutonic rocks and orthogneisses from a 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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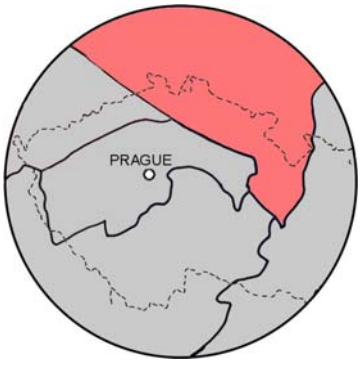
THE ATLAS OF PLUTONIC ROCKS AND ORTHOGNEISSES IN THE BOHEMIAN MASSIF



4. LUGICUM

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

FOREWORD

The Lugicum (Lusatian Zone) comprises several plutonic series and suites grouped into the Neoproterozoic, Cadomian (Early Palaeozoic) and Variscan intrusions (e.g. Lusatian Composite Batholith, Jizera-Krkonoše Orthogneisses, Strzegom Massif). They are briefly summarized by Kryza (1995) and Wiszniewska et al. (2007). Intrusions are located within several independent regions (e.g. the Elbe Zone, the Lusatian Region, the Krkonoše-Jizera Region, Kaczawa Region, Fore-Sudetic Jizera Composite Massif, Olešnice-Kudowa Massif, Orlice-Sněžník Orthogneiss, Krkonoše-Kowary Block, and the Góry Sowie/Owl Mts. Block).

References

BIELICKI, K. H. – HAASE, G. – EIDAM, J. et al. (1989): Pb-Pb and Rb-Sr dating of granitoids from the Lusatian Block. In: Wand, U. – Strauch, G. Eds: Proceedings of the Fifth Working Meeting "Isotopes in Nature", 23–45. – Inst. Isotope and Radiation Res., Leipzig.

KRÖNER, A. – JAECKEL, P. – HEGNER, E. – OPLETAL, M. (2001): Single zircon ages and whole rock Nd isotopic systematics of early Palaeozoic granitoid gneisses from the Czech and Polish Sudetes (Jizerské hory, Krkonoše Mountains and Orlice-Sněžník Complex). – Int. J. Earth Sci. (Geol. Rdsch.) 90, 304–324.

KRYZA, R. (1995): Igneous activity in the Lugicum. In: Dallmeyer, R. D. et al. Eds: Pre-Permian Geology of Central and Eastern Europe, 341–349. – Springer-Verlag, Berlin, Heidelberg.

LINNEMANN, U. – McNAUGHTON, N. J. – ROMER, R. L. – GEHMLICH, M. – DROST, K. – TONK, CH. (2004): West African provenance for Saxo-Thuringia (Bohemian Massif): Did Armorica ever leave pre-Pangean Gondwana ? – U/Pb-SHRIMP zircon evidence and the Nd-isotopic record. – Int. J. Earth Sci. (Geol. Rdsch.) 93, 683–705.

MAZUR, S. – ALEKSANDROWSKI, P. – TURNIAK, K. – AWDANKIEWICZ, M. (2007): Geology, tectonic evolution and Late Palaeozoic magmatism of Sudetes – an overview. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. Mineral. Monogr. 1, 59–87.

SEDLÁK, J. – GNOJEK, I. – ZABADAL, S. – FARBISZ, J. – CWOJDZINSKI, S. – SCHEIBE, R. (2007): Geological interpretation of a gravity low in the central of the Lugican unit (Czech Republic, Germany and Poland). – J. Geosci. 52, 181–198.

WISZNIEWSKA, J. – KRZEMIŃSKA, E. – MAZUR, S. – GAWĘDA, A. – KOZŁOWSKI, A. (2007): Foreword – brief outline of geology of Poland. In: Kozlowski A., Wiszniewska J. Eds: Granitoids in Poland. – Arch. Mineral. Monogr. 1, 5–7.

A. LUSATIA

The Lusatian region is an equivalent of the Lusatian Anticlinorium, comprising the Lusatian Greywackes and the Lusatian Composite Batholith.

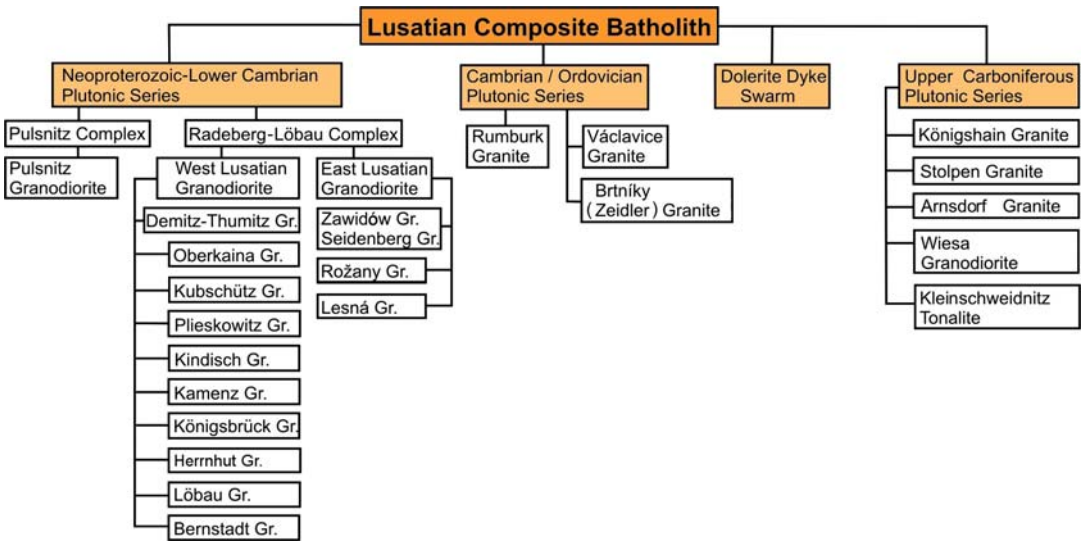

Fig. 4.1. *Lusatian Composite Batholith hierarchical scheme according to rock series and rock types (G - granodiorite).*

4.1. LUSATIAN COMPOSITE BATHOLITH (LCB)

Regional position: The Batholith is located in the SE part of the Lusatian Anticlinorium. About 30 rock types have been recognised. The Batholith consists of three plutonic series belonging to the Cadomian and Variscan orogens.

Rock types:

A. Neoproterozoic-Lower Cambrian plutonic series

Pulsnitz Complex

1. *Pulsnitz Granodiorite* – muscovite-biotite hybrid granodiorite (anatexite) with several episodes of granodiorite emplacement (Neoproterozoic).

Radeberg-Löbau Complex

1. *West Lusatian Granodiorite* (local facies: Demitz-Thumitz, Oberkaina, Kubschütz, Plieskowitz, Kindisch, Kamenz, Königsbrück, Herrnhut, Löbau, Bernstadt) – biotite ± hornblende granodiorite to tonalite (Late Cadomian and pre-Late Ordovician). The East-Lusatian Granodiorite intruded this granodiorite.
2. *East Lusatian Granodiorite* (local facies: Zawidów/Seidenberg, Rožany, Lesná) ± porphyritic medium-grained biotite granodiorite.

B. Cambrian/Ordovician plutonic series

1. *Rumburk Granite* and *Izera Orthogneiss* (see the Chapter 4.11. the Jizera-Krkonoše Orthogneisses) – porphyritic muscovite-biotite granite.
2. *Václavice Granite* – biotite monzogranite to granodiorite.
3. *Brtníky (Zeidler) Granite* – biotite monzogranite.

C. Dolerite dyke swarm

Up to 2000 mafic dykes of older dolerites and younger alkali-dolerites (lamprophyres) up to 100 m thick. They postdate the Lusatian granodiorites, but are older than late Variscan stock granites.

D. Upper Carboniferous plutonic series

1. *Königshain Granite* – porphyritic biotite granite.
2. *Stolpen Granite* – porphyritic biotite granite.
3. *Arnsdorf Granite.*
4. *Wiesa Granodiorite* – hornblende granodiorite.
5. *Kleinschweidnitz Tonalite* – hornblende-bearing biotite quartz diorite to monzogranite.

Size and shape (on erosion level): 3600 km^2 (70 × 35 km), oval in shape. The Variscan stocks (Stolpen, Arnsdorf and Königshain) occupy only small area between 6 to 30 km^2. A flat sheet-like shape of the Rumburk Granite (thickness of 5 to 10 km).

Age and isotopic data: (Compilation of age data up to 1992 is given by Kröner et al. 1994). Neoproterozoic – Cadomian (Cambrian-Ordovician) to Variscan (Upper Carboniferous) plutonic complex. Two generations of pre-Variscan granitic rocks can be distinguished – the Lusatian granodiorites, displaying ages around 540–580 Ma and the West Sudetes orthogneisses with ages around 450–500 Ma (Jizera Orthogneiss, Rumburk Granite, Kowary Orthogneiss, Snieznik and Gieraltow Orthogneiss).

Neoproterozoic-Lower Cambrian plutonic series

Pulsnitz Granodiorite 542 ± 9 Ma (Pb-Pb zircon), 585 ± 11 Ma (Pb-Pb zircon), 584 ± 16 Ma (Pb-Pb zircon), 563 ± 18 Ma (Pb-Pb zircon), *Zawidów Granodiorite* 540 ± 7 Ma (U-Pb), 323 ± 6 Ma (Ar-Ar micas), *Pleterówka (Zawidow Granodiorite or Leśna Gneiss) Granodiorite* 533 ± 9 Ma (U-Pb zircon), *Demitz Granodiorite* 552–556 ± 18 Ma (Pb-Pb zircon), *Kamentz Granodiorite* 576 ± 16 Ma (Pb-Pb zircon), *Kindisch Granodiorite* 564 ± 15, 536 Ma, (Pb-Pb zircon), 540 Ma (SHRIMP U-Pb-Th zircon), *Radeberg Granodiorite* 540 Ma (SHRIMP U-Pb zircon), *Bernstadt Granodiorite* 587 ± 17 Ma (Pb-Pb zircon), various Lusatian granitoids between 589 and 563 (Pb-Pb K-feldspar).

Cambrian/Ordovician plutonic series

Rumburk Granite 501 ± 32 Ma (Rb-Sr whole rock), 410 Ma (K-Ar biotite), 571 ± 16 Ma (Pb-Pb zircon), 494 ± 12 Ma and 480 ± 12 Ma (Pb-Pb zircon), 505 ± 1.2 Ma (Pb-Pb zircon), 490 ± 3 Ma (Pb-Pb zircon), 494 ± 12 Ma (Pb-Pb zircon) 493 ± 4 Ma (U-Pb zircon), 480 Ma (SHRIMP U-Pb zircon). *Jizera Orthogneiss* (derivate of the Rumburk Granite) 504.6 ± 1.2 Ma (Pb-Pb zircon), *Krkonoše Orthogneiss* 501.5 ± 1.1 Ma (Pb-Pb zircon).

Dolerite Dyke Swarm

Dolerite (older sequence) 400 Ma (K-Ar whole rock), *Alkali-dolerite* (younger sequence) 260 ± 25 Ma (K-Ar whole rock).

Upper Carboniferous plutonic series

Wiesa Granite 304± 14 Ma (Pb-Pb zircon), *Kleinschweidnitz Tonalite* 304 ± 10 Ma (Pb-Pb zircon), 312 ± 10 Ma (Pb-Pb zircon), *Königshain Granite* 315 ± 6 Ma (Pb-Pb zircon), *Lamprophyre* 130 Ma (K-Ar phlogopite).

Temporal relations: Lusatian (Pulsnitz) Hybrid Granodiorite → Demitz Granodiorite → Zawidów Granodiorite → Rumburk Granite → Jizera Orthogneiss → dolerite Dykes → Upper Carboniferous stocks.

Geological environment: Neoproterozoic greywackes.

Zoning: subhorizontal layering (stratification) – Lusatian Hybrid Granodiorite (the Pulsnitz Complex) in the roof of the West Lusatian Granodiorite.

Compositional zoning – from NW to SE, increasing of the acidity in sequence West Lusatian Granodiorite → Zawidow Granodiorite → Rumburk Granite.

Vertical zoning within the Lusatian Granodiorite (Radeberg-Löbau Complex) – increase of K-feldspar and decrease of biotite contents with depth. West-Lusatian and East-Lusatian granodiorites are part of the same plutonic body however, at different level of erosion.

The central LCB is mainly made up of biotite- and K-feldspar-rich two mica granodiorites and muscovite-bearing biotite quartz diorites (the Pulsnitz Complex), whereas the biotite granodiorites (the West and East Granodiorites) in the marginal domains contain less biotite and K-feldspar.

Mineralization: Cu-Ni-Co sulphide mineralization.

Heat production (μWm^{-3}): *Zawidów Granodiorite* 1.8, *Rumburk Granite* 3.46–2.19, *West Lusatian Granodiorite* 2.32, 5.36, 2.24, 2.23, 4.56, 3.70, *Pulsnitz Granodiorite* 1.86.

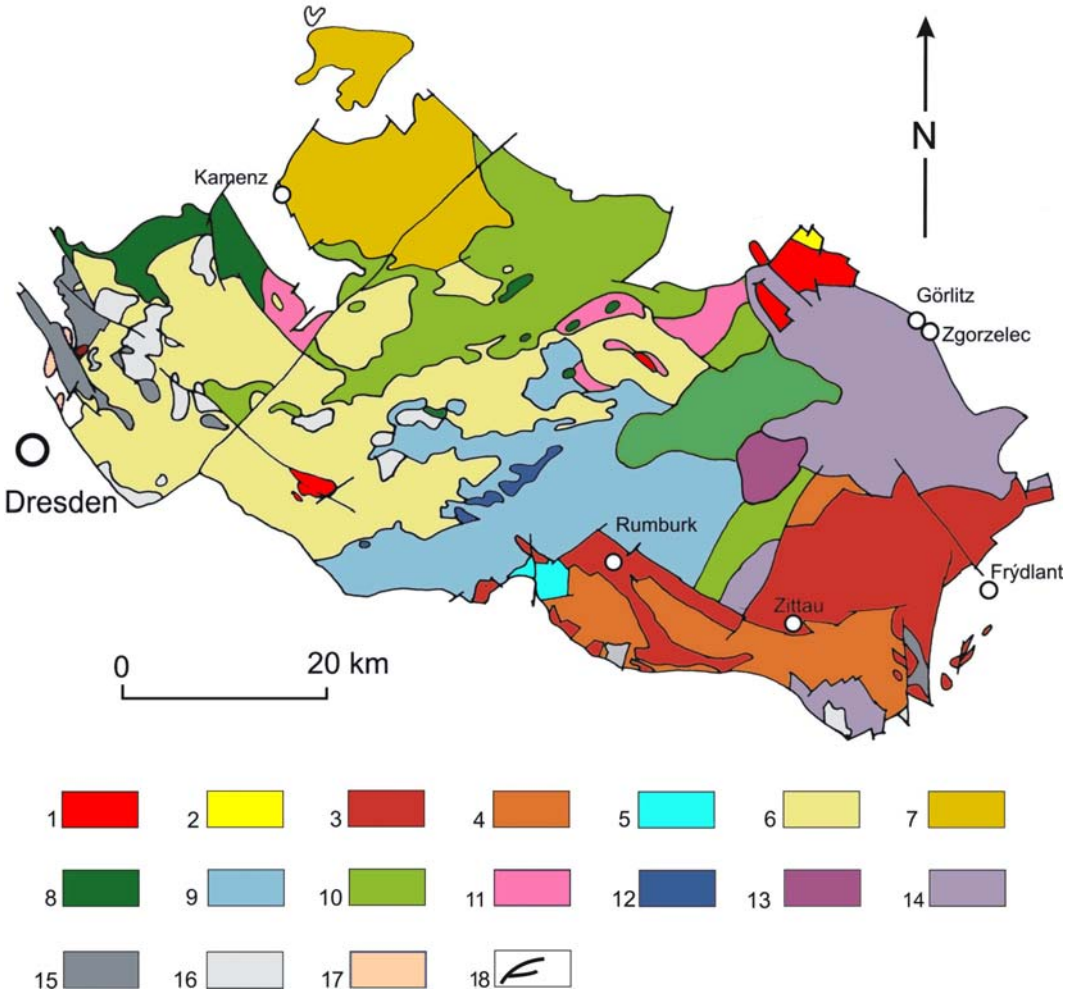

Fig. 4.2. *Lusatian Composite Batholith geological sketch-map (after Kozdrój et al. 2001).* ***Upper Carboniferous stocks:*** *1 – biotite monzogranite (Stolpen, Kőnigshain and Arnsdorf Stocks), 2 – biotite monzogranite to quartz diorite (Wiesa and Kleinschweidnitz).* ***Upper Cambrian-Lower Ordovician Granites:*** *3 – biotite monzogranite (Rumburk), 4 – biotite monzogranite (Václavice), 5 – biotite monzogranite to granodiorite (Brtníky).* ***Neoproterozoic-Lower Cambrian Granitoids:*** *Pulsnitz Complex: 6 – two-mica granodiorite (anatexite); Radeberg-Lőbau Complex: 7 – porphyritic biotite granodiorite (Kamenz), 8 – biotite granodiorite (Königsbrück), 9 – biotite (± muscovite) granodiorite (Herrnhut), 10 – biotite (± muscovite) granodiorite (Löbau) 11 – biotite granodiorite (Demitz-Thumitz, Oberkaina, Plieskowitz, Kindisch), 12 – biotite granodiorite (Bernstadt), East Lusatian Granodiorite: 13 – biotite granodiorite (Zawidów), 14 – biotite-muscovite granodiorite (Rožany), 15 – granodiorite undivided, 16 – "Islands" of Proterozoic country rocks, 17 – Dohna Composite Stock, 18 – faults.*

References

ADAMOVÁ, M. – OPLETAL, M. (2001): New geological mapping in the Czech part of the Lusatian Massif and its tectonic and geochemical implications. – Z. geol. Wiss. Berlin 29, 445–453.

BIAŁEK, D. (1998): Aspects of geochemistry of the Zawidow granodiorite and the Jizera granite-arc to rift transition. – Geolines 6, 11.

BIAŁEK, D. (1999): Chemical changes associated with deformation of granites under greenschist facies conditions: example of the Zawidów granodiorite (SE Lusatian granodiorite complex, Poland). – Tectonophysics 303, 251–261.

BIAŁEK, D. (2007): Zawidów granodiorite from the Lusatian massif in SW Poland. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 89–99.

BIELICKI, K. H. – HAASE, G. – EIDAM, J. et al. (1989): Pb-Pb and Rb-Sr dating of granitoids from the Lusatian Block. In: Wand, U. – Strauch, G. Eds: Proceedings of the Fifth Working Meeting "Isotopes in Nature", 23–45. – Inst. Isotope and Radiation Res., Leipzig.

BORKOWSKA, M. – HAMEURT, J. – VIDAL, P. (1980): Origin and age of Izera gneisses and Rumburk granites in the Western Sudetes. – Acta Geol. Pol. 30, 121–145.

BRAUSE, H. – SCHUBERT, G. – HORTENBACH, R. (1981): Beitrag zur präkambrischen und pleistozenen Tektonik im Gebiet von Kamenz. – Veröff. Mus. Westlausitz 9, 9–27.

BRAUSE, H. – STEDING, D. – SCHUBERT, G. (1964): Tektonische Beziehungen zwischen Prätertiär, Tertiär und Quartär in der nördlichen Oberlausitz. – Geologie 13, 731–744.

DOMEČKA, K. (1970): Předvariské granitoidy Západních Sudet. – Sbor. geol. Věd, Geol. 18, 161–191.

DUTHOU, J. L. – COUTERIE, J. P. – MIERZEJEWSKI, M. P. – PIN, C. (1991): Next dating of granite samples from the Karkonosze Mountains using Rb-Sr total rock isochrone method. – Przegl. Geol. 39, 75–79.

EIDAM, J. (1988): Zur anatektischen und magmatischen Entwicklung der granitoiden Gesteine der Lausitz Anticlinalzone. – Z. geol. Wiss. 16, 5, 393–406.

EIDAM, J. – HAMMER, J. – KORICH, D. – BIELICKI, K. H. (1995): Amphibole-bearing granites in the Lusatian Anticlinal Zone: Variscan I-type magmatism at the northern margin of the Bohemian Massif. – Neu. Jb. Mineral., Abh. 168, 3, 259–281.

EIDAM, J. – HAMMER, J. – KORICH, D. – KRAUSS, M. (1992): Zur Abgrenzung altersverschiedener Granitoide innerhalb des Lausitzer Granodiorite-Massivs. – Z. geol. Wiss. 20, 3, 289–294.

HAAKE, R. – HERRMANN, G. – PÄLCHEN, W. – PILOT, J. (1973): Zur Altersstellung der Granodiorite der westlichen Lausitz und angrenzender Gebiete. – Z. geol. Wiss. 12, 1669–1671.

HAMMER, J. (1996): Geochemie und Petrogenese der cadomischen und spätvariszischen Granitoide der Lausitz. – Freiberg. Forsch.-H., R. C 463, 107 pp.

HAMMER, J. – BRÖCKER, M. – KRAUSS, M. (1997): Alter und geologische Signifikanz von Deformationszonen im östlichen Teil des Lausitzer Granitoidkomplexes. – Terra Nostra 97, 62–63.

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Böhmischen Massivs. Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.

HECHT, L. – THURO, K. – PLINNINGER, R. – CUNEY, M. (1999): Mineralogical and geochemical characteristics of hydrothermal alteration and episyenitization in the Könighain granites, northern Bohemian Massif, Germany. – Int. J. Earth Sci. 88, 236–252.

HIRSCHMANN, G. (1962): Zur Frage des Seidenberger Granodiorits. – Geologie 11, 620–621.

HIRSCHMANN, G. (1966): Zum Alter des Lausitzer Granodiorit-Massivs. – Geologie 15, 2, 141–148.

JELIŃSKI, A. (1965): Geochemistry of the uranium in the Karkonosze Granite Massif and other granitoids massifs of Lower Silesia. – Biul. Inst. Geol. 193, 5, 5–110. (In Polish)

KORYTOWSKI, A. – DÖRR, W. – ŻELAŻNIEWICZ, A. (1993): U-Pb dating of (meta) granitoids in the NW Sudetes (Poland) and their bearing on the tectonostratigraphic correlation. – Terra Nova 5, 331–332.

KOZDRÓJ, W. – KRENTZ, O. – OPLETAL, M. Eds (2001): Comments on the Geological Map Lausitz-Jizera-Karkonosze 1 : 100,000. – Sächs. Landesamt für Umwelt und Geol. Freiberg – Czech Geol. Survey, Prague – Pan. Inst. Geol. Warszawa.

KOZŁOWSKA-KOCH, M. (1974): The granite-gneisses in Izera Highlands. – Arch. mineral. 25, 123–260. (English summary)

KOZŁOWSKI, K. (1974): Crystalline schists and leucogranites of the Stara Kamenieca-Świeradów Zdrój belt. – Geol. sudet. 9, 7–100. (English summary)

KRAMER, W. (1976): Zur Petrologie und metallogenetischen Bedeutung der Dolerite (Lamprophyre) des Lausitzer Massifs. – Z. geol. Wiss. 4, 975–994.
KRAUSS, M. – EIDAM, J. – HANNER, J. et al. (1992): Die cadomisch-variszische Entwicklung des Lausitzer Granodiorit-Komplexes. – Zbl. Geol. Paläont., Tl I, 71–85.
KRÖNER, A. – HEGNER, E. – HAMMER, J. – HAASE, G. – BIELICKI, K. H. – KRAUSS, M. – EIDAM, J. (1994): Geochronology and Nd-Sr systematics of Lusatian granitoids: significance for the evolution of the Variscan orogen in east-central Europe. – Geol. Rdsch. 83, 357–376.
KRÖNER, A. – JAECKEL, P. – HEGNER, E. – OPLETAL, M. (2001): Single zircon ages and whole rock Nd isotopic systematics of early Palaeozoic granitoid gneisses from the Czech and Polish Sudetes (Jizerské hory, Krkonoše Mountains and Orlice-Sněžník Complex). – Int. J. Earth Sci. (Geol. Rdsch.) 90, 304–324.
KRÖNER, A. – JAECKEL, P. – OPLETAL, M. (1994): Pb-Pb and U-Pb zircon ages for orthogneisses from Eastern Bohemia: further evidence for a major Cambro-Ordovician magmatic event. – J. Czech Geol. Soc. 39, 61.
LINNEMANN, U. – Mc NAUGHTON, N. J. – ROMER, R. L. – GEHMLICH, M. – DROST, K. – TONK, C. (2004): West African provenance for Saxo-Thuringia (Bohemian Massif): Did Armorica ever leave pre-Pangean Gondwana? – U/Pb-SHRIMP zircon evidence and the Nd-isotopic record. – Int. J. Earth Sci. (Geol. Rdsch.) 93, 683–705.
MARHEINE, D. – KACHLÍK, V. – MALUSKI, H. et al. (2002): The 40Ar/39Ar ages from the West Sudetes (NE Bohemian Massif): constraints on the Variscan polyphase tectonothermal development. In: Winchester, J. A. – Pharaoh, T. C. – Verniers, J. Eds: Palaeozoic Amalgamation of Central Europe. – Geol. Soc. London Spec. Publ. 201, 133–155.
MAZUR, S. – ALEKSANDROWSKI, P. (2001): The Teplá(?)/Saxothuringian suture in Karkonosze-Izera massif, Western Sudetes, Central European Variscides. – Int. J. Earth Sci. (Geol. Rdsch.) 90, 341–360.
MÖBUS, G. (1962): Der Hornblendegranodiorit von Wiesa bei Görlitz, eine randliche Ausbildung des Lausitzer Granodioritmassivs. – Geologie 11, 509–528.
MÖBUS, G. (1964): Beobachtungen im Grenzbereich Rumburger Granit – Lausitzer Granodiorit. – Mber. Dtsch. Akad. Wiss. Berlin 6, 10, 759–764.
MÖBUS, G. (1967): Der Lausitzer Granodiorit von Demitz-Thumitz bei Bischofswerda (Oberlausitz). – Geol. Jb. 13, 793–865.
OBERC-DZIEDZIC, T. (2007): Early Palaezoic Izera (Rumburk) granites from West Sudetes, Poland. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. 1, 101–110.
OBERC-DZIEDZIC, T. – PIN, C. – KRYZA, R. (2005): Early Palaeozoic crustal melting in an extensional setting: petrological and Sm-Nd evidence from the Izera granite-gneisses, Polish Sudetes. – Int. J. Earth Sci. (Geol. Rdsch.) 94, 354–368.
OLIVER, G. J. H. – CORFU, F. – KROGH, T. E. (1993): U-Pb ages from SW-Poland: Evidence for Caledonian suture zone between Baltica and Gondwana. – Jb. Geol. Soc. London 150, 355–369.
OPLETAL, M. – DOMEČKA, K. – VAVŘÍN, I. (1983): Granitoidy lužického masivu v jižní časti Šluknovského výběžku a jejich nové petrologické zařazení. – Sbor. geol. Věd., Geol. 38, 141–175.
PIN, C. – KRYZA, R. – OBERC-DZIEDZIC, T. – MAZUR, S. – TURNIAK, K. – WALDHAUSROVÁ, J. (2007): The diversity and geodynamic significance of Late Cambrian (ca. 500 Ma) felsic anorogenic magmatism in the northern part of the Bohemian massif: a review based on Sm-Nd isotope and geochemical data. In: Linnemann, U. – Nance, R. D. – Kraft, P. – Zulauf, G. Eds: The Geology of Peri-Gondwana: Avalonian-Cadomian terranes, adjoining cratons, and the Rheic Ocean. – Geol. Soc. Amer. Spec. Publ. 423, 209–229.
RÖBER, B. – HAMMER, J. – EIDAM, J. EHLING, B. C. (1996): Petrographie und Geochemie von Gesteinen des Pretzsch-Prettiner Intrusivkomplexes (östlichen Teil der Mitteldeutschen Schwelle). – Terra Nostra 97, 140–142.
RÖBER, B. – HAMMER, J. – EIDAM, J. – EHLING, B. C. (1998): Mineralogisch-geochemische Untersuchungen von cadomischen und spätvariszischen Plutonkomplexen im Ostteil der Mitteldeutschen Schwelle. – Terra Nostra 98, 126–129.
SCHUST, F. (2000): Zum magmengeologischen Bau und zur Alterdatierung Lausitzer prävariszischen Granitoidkomplexen. – Z. geol. Wiss. 28, 111–132.

SCHUST, F. – WASTERNACK, J. (2002): Granitoid-Typen in postkinematischen Granitoidplutonen: Abbilder von autonomen Intrusionsschüben – Beispiele vom Nordrand des Böhmischen Massivs (Erzgebirge – Harz – Flechtinger Scholle – Lausitz). – Z. geol. Wiss. 30, 77–117.

SEDLÁK, J. – GNOJEK, I. – ZABADAL, S. – FARBISZ, J. – CWOJDZINSKI, S. – SCHEIBE, R. (2007): Geological interpretation of gravity low in the central of the Lugian unit (Czech Republic, Germany and Poland). – J. Geosci. 52, 181–198.

STANEK, K. – RENNO, A. D. – LOBST, R. – PUSHKAREV, Y. (2001): The Lusatian basic dyke swarms. In: Tectonic and Magma 2001 IGCP Project 373, Abstract, 23–26, 92–93. – Berlin.

TICHOMIROWA, M. (2002): Zircon inheritance in diatexite granodiorites and its consequence on geochronology – a case study in Lusatia and Erzgebirge (Saxo-Thuringia, eastern Germany). – Chem. Geol. 191, 209–224.

TICHOMIROWA, M. – LINNEMANN, U. – GEHMLICH, M. (1997): Zircon ages as magmatic time marks. Comparison of the crustal evolution in different units of the Saxothuringian zone. – Terra Nostra 97, 137–141.

ŻELAŻNIEWICZ, A. – DÖRR, W. – BYLINA, P. – FRANKE, W. – HAAK, U. – HEINISCH, H. – SCHASTOK, J. – GRANDMOUNTAGNE, K. – KULICKI, C. (2004) The eastern continuation of the Cadomian orogen: U-Pb zircon evidence from Saxo-Thuringian granitoids in south-western Poland and northern Czech Republic. – Int. J. Earth Sci. (Geol. Rdsch.) 93, 773–781.

A. Neoproterozoic-Lower Cambrian plutonic series

Pulsnitz Granodiorite

Quartz-normal, sodic, peraluminous, (strongly), mesocratic, S-type, I- & M-series, granodiorite

n = 14	Median	Min	Max	QU1	QU3
SiO_2	66.20	64.80	68.50	65.60	66.70
TiO_2	0.72	0.57	0.77	0.68	0.74
Al_2O_3	15.70	15.20	16.70	15.60	15.80
Fe_2O_{3tot}	5.23	4.69	6.06	5.09	5.43
FeO	0.00	0.00	0.00	0.00	0.00
MnO	0.06	0.05	0.08	0.06	0.07
MgO	2.07	1.54	2.22	1.74	2.16
CaO	1.49	1.20	2.50	1.32	2.01
Na_2O	3.13	2.92	3.52	2.99	3.29
K_2O	3.30	3.06	3.88	3.20	3.49
P_2O_5	0.16	0.11	0.22	0.14	0.18
Mg/(Mg+Fe)	0.42	0.38	0.45	0.41	0.44
K/(K+Na)	0.41	0.37	0.46	0.39	0.42
Nor.Or	20.94	18.90	24.16	19.95	21.90
Nor.Ab	29.75	28.01	33.26	28.83	31.57
Nor.An	6.80	5.22	11.85	6.01	9.29
Nor.Q	28.60	24.64	30.94	26.67	29.33
Na+K	173.26	167.46	185.42	168.34	177.58
*Si	174.41	152.72	187.38	163.76	179.00
K-(Na+Ca)	-62.54	-90.62	-35.25	-76.70	-51.57
Fe+Mg+Ti	125.41	108.00	138.30	118.48	130.27
Al-(Na+K+2Ca)	80.30	35.52	103.45	61.77	86.84
(Na+K)/Ca	5.98	3.95	8.15	4.60	6.96
A/CNK	1.38	1.14	1.50	1.26	1.42

Trace elements (mean values in ppm): *Pulsnitz Granodiorite* – **B** 31, **Ba** 868, **Be** 2, **Co** 13.3, **Cr** 81, **Cs** 7.5, **Cu** 23, **Ga** 20, **Hf** 6.1, **Li** 50, **Ni** 36, **Nb** 12, **Pb** 23, **Rb** 125, **Sc** 12.4, **Sn** -, **Sr** 202, **Ta** 1.02, **Th** 11.3,

U 3.0, **V** 93, **Y** 30, **Zn** 81, **Zr** 214, **La** 38, **Ce** 77, **Nd** 39, **Sm** 5.9, **Eu** 1.38, **Tb** 0.91, **Yb** 2.9, **Lu** 0.46 (Hammer et al. 1999).

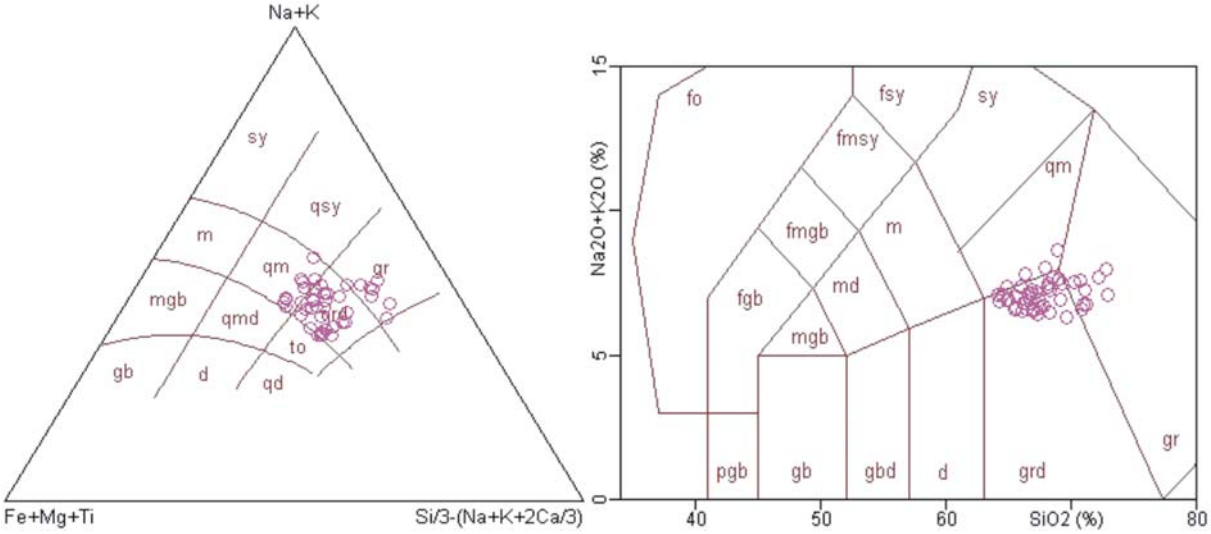

Fig. 4.3. *Lusatian Composite Batholith – Pulsnitz Granodiorite ABQ and TAS diagrams.*

West Lusatian Granodiorite

Quartz-poor, sodic, peraluminous, melanocratic, S-type, I- & M-series, granodiorite

n = 26	Median	Min	Max	QU1	QU3
SiO_2	66.60	64.80	69.70	66.00	68.30
TiO_2	0.72	0.51	0.88	0.67	0.76
Al_2O_3	15.60	14.60	16.70	15.30	15.70
Fe_2O_3	5.06	3.36	6.06	4.68	5.39
FeO	0.00	0.00	0.00	0.00	0.00
MnO	0.06	0.05	0.08	0.06	0.07
MgO	1.72	1.03	2.22	1.54	2.07
CaO	1.88	1.20	3.30	1.41	2.45
Na_2O	3.38	2.92	3.88	3.13	3.49
K_2O	3.30	3.04	4.12	3.20	3.50
P_2O_5	0.18	0.11	0.26	0.15	0.20
Mg/(Mg+Fe)	0.41	0.37	0.45	0.39	0.43
K/(K+Na)	0.40	0.35	0.46	0.38	0.43
Nor.Or	20.94	18.65	25.24	19.95	22.20
Nor.Ab	31.57	28.01	36.00	29.75	32.76
Nor.An	8.55	5.22	15.23	6.25	11.45
Na+K	177.90	167.46	200.10	173.26	186.24
Nor.Q	27.19	24.18	30.94	25.94	29.05
*Si	165.22	148.36	187.38	159.08	177.81
K-(Na+Ca)	-71.75	-103.37	-35.25	-90.23	-53.50
Fe+Mg+Ti	117.46	74.05	138.30	105.64	126.89
Al-(Na+K+2Ca)	45.14	11.35	103.45	29.73	80.30
(Na+K)/Ca	5.17	2.95	8.65	4.24	6.96
A/CNK	1.19	1.05	1.50	1.13	1.38

Trace elements (mean values in ppm): *West Lusatian Granodiorite* – **B** 20, **Ba** 754, **Be** 2, **Co** 7.1, **Cr** 27, **Cs** 7.1, **Cu** 9, **Ga** 20, **Hf** 5.7, **Li** 45, **Ni** 12, **Nb** 9, **Pb** 23, **Rb** 145, **Sc** 9.3, **Sr** 123, **Ta** 0.97, **Th** 10.4, **U** 4.8, **V** 40, **Y** 32, **Zn** 51, **Zr** 207, **La** 30, **Ce** 63, **Nd** 36, **Sm** 5.6, **Eu** 1.01, **Tb** 0.69, **Yb** 3.1, **Lu** 0.49 (Hammer et al. 1999).

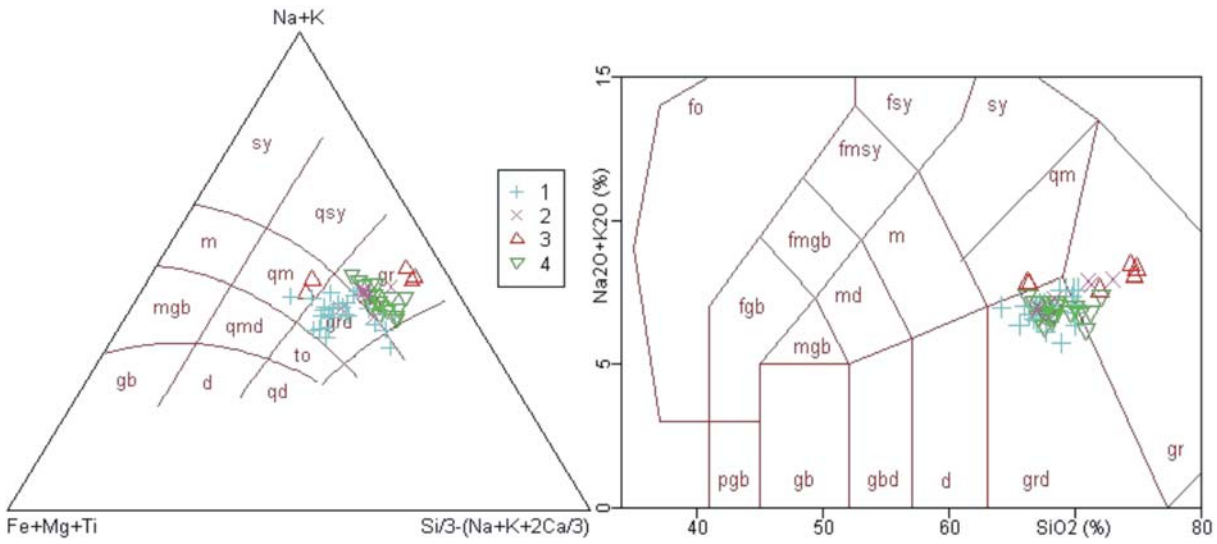

Fig. 4.4. *Lusatian Composite Batholith – West Lusatian Granodiorite ABQ and TAS diagrams. 1 – amphibole-biotite granodiorite, 2 – biotite granodiorite, 3 – biotite monzogranite, 4 – Herrnhut Granodiorite.*

Zawidów Granodiorite

Quartz-poor, sodic, peraluminous, mesocratic, S-type, I- & M-series, granodiorite

n = 16	**Median**	**Min**	**Max**	**QU1**	**QU3**
SiO_2	65.98	63.40	70.53	64.25	67.60
TiO_2	0.63	0.00	0.91	0.00	0.75
Al_2O_3	15.78	13.33	18.38	15.14	16.46
Fe_2O_3	1.22	0.58	3.04	0.72	1.78
FeO	2.96	1.70	5.27	2.27	3.66
MnO	0.02	0.00	0.09	0.00	0.05
MgO	1.46	0.85	2.33	1.27	1.86
CaO	1.77	0.77	3.42	1.29	2.09
Na_2O	3.26	2.19	4.02	3.02	3.49
K_2O	3.74	3.33	4.56	3.59	4.03
P_2O_5	0.17	0.00	0.32	0.07	0.21
Mg/(Mg+Fe)	0.37	0.22	0.50	0.34	0.45
K/(K+Na)	0.43	0.37	0.58	0.41	0.44
Nor.Or	24.02	21.02	28.32	22.84	25.07
Nor.Ab	31.41	20.67	37.89	28.83	33.53
Nor.An	8.50	3.06	16.94	5.50	11.02
Nor.Q	24.95	14.33	32.30	21.96	27.03
Na+K	188.85	167.49	213.38	173.68	193.59
*Si	156.33	104.78	199.80	139.71	167.52
K-(Na+Ca)	-61.83	-109.68	-8.27	-73.22	-47.71
Fe+Mg+Ti	103.63	64.33	134.31	95.77	123.81
Al-(Na+K+2Ca)	45.46	-0.95	94.49	23.89	82.88
(Na+K)/Ca	6.07	2.99	12.54	3.94	7.41
A/CNK	1.21	1.01	1.50	1.12	1.35

Th – 15, **U –** 11 (ppm).

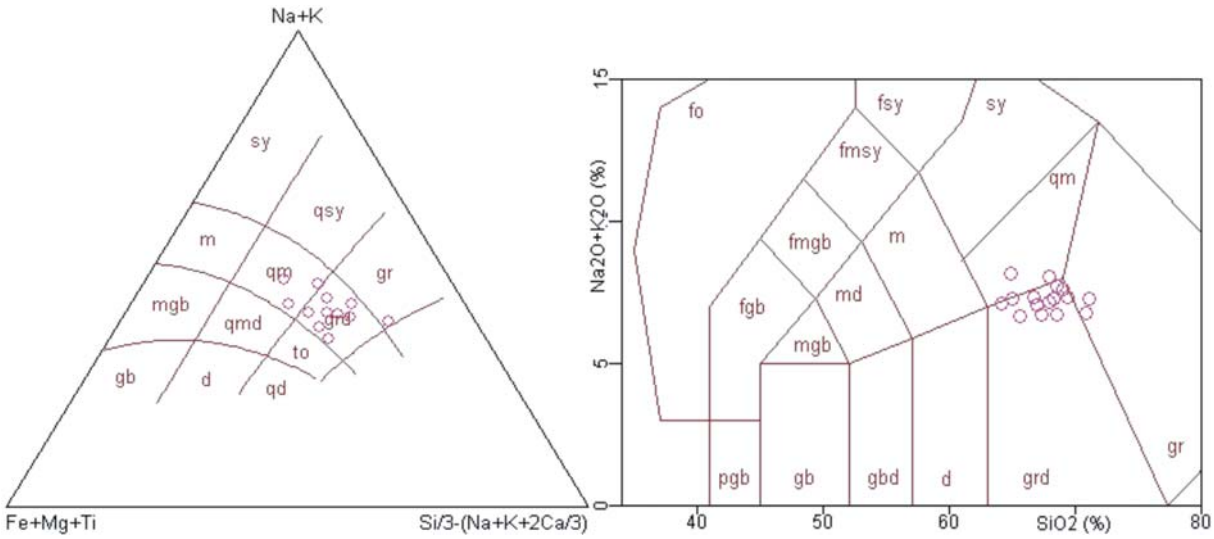

Fig. 4.5. *Lusatian Composite Batholith – East Lusatian Granodiorite ABQ and TAS diagrams. Zawidow Granodiorite.*

B. Cambrian/Ordovician plutonic series

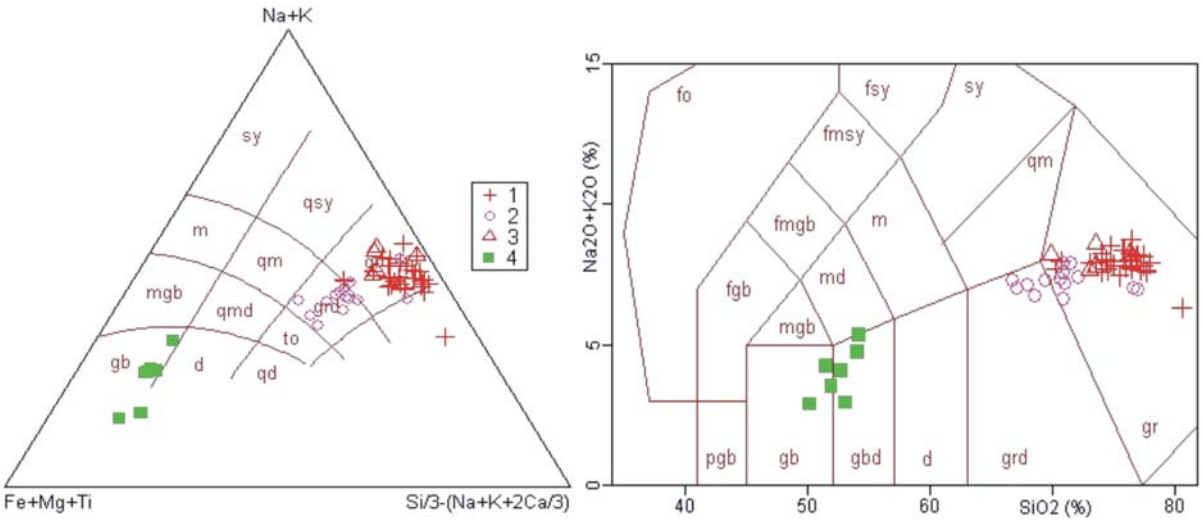

Fig. 4.6. *Lusatian Composite Batholith – Cambrian/Ordovician plutonic series ABQ and TAS diagrams. 1 – Rumburk Granite, 2 – Václavice Granite, 3 – Brtníky Granite, 4 – Dolerite Dyke Swarm.*

Rumburk Granite

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

n = 12	Median	Min	Max	QU1	QU3
SiO_2	75.27	72.52	76.82	74.34	75.65
TiO_2	0.11	n.d.	0.23	0.08	0.15
Al_2O_3	13.02	12.43	14.00	12.46	13.17
Fe_2O_3	0.51	0.28	0.86	0.40	0.60
FeO	0.95	0.33	1.78	0.58	1.40
MnO	0.00	0.00	0.04	0.00	0.02
MgO	0.25	0.13	0.60	0.18	0.40
CaO	0.45	0.29	1.17	0.30	0.54
Na_2O	3.01	2.54	4.37	2.73	3.25
K_2O	4.52	3.88	5.37	4.32	4.96
P_2O_5	0.20	n.d.	0.53	0.17	0.32

Mg/(Mg+Fe)	0.23	0.15	0.34	0.19	0.32
K/(K+Na)	0.49	0.37	0.56	0.45	0.54
Nor.Or	27.72	23.43	32.73	26.46	30.50
Nor.Ab	28.01	23.75	40.33	25.49	30.30
Nor.An	0.83	0.13	4.26	0.18	1.59
Na+K	200.85	187.28	225.10	191.38	206.23
Nor.Q	36.24	31.12	40.55	33.40	37.05
*Si	210.99	182.46	231.52	198.91	215.69
K-(Na+Ca)	-15.84	-64.96	20.75	-43.37	7.67
Fe+Mg+Ti	29.54	18.85	49.82	21.07	35.84
Al-(Na+K+2Ca)	31.64	8.65	55.51	22.26	44.03
(Na+K)/Ca	22.26	9.87	39.08	13.68	29.17
A/CNK	1.17	1.07	1.27	1.14	1.23

Trace elements (mean values in ppm):
Rumburk Granite – **Ba** 180, **Co** 2.0, **Cr** 15, **Cs** 8.6,**Cu** 5, **Ga** 20, **Hf** 3.1, **Ni** 9, **Nb** 8, **Pb** 18, **Rb** 288, **Sc** 16.0, **Sr** 40, **Ta** 1.40, **Th** 11.0, **U** 4.0, **V** 13, **Y** 29, **Zn** 23, **Zr** 94, **La** 14, **Ce** 29, **Nd** 16, **Sm** 3.5, **Euro** 0.32, **Tb** 0.69, **By** 2.7, **Lu** 0.42 (Hammer et al. 1999).
Rumburk Granite – **As** 5, **Ba** 143, **Cr** 295, **F** 853, **Cu** 10, **Ni** 11, **Nb** 5, **Pb** 11, **Rb** 296, **Sn** 11, **Sr** 22, **V** 7, **Y** 35, **Zn** 20, **Th** 28, **U** 6 (Opletal et al. 1983).

Václavice Granodiorite

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

n = 7	Median	Min	Max	QU1	QU3
SiO_2	69.11	68.93	69.89	69.00	69.34
TiO_2	0.51	0.45	0.63	0.45	0.58
Al_2O_3	14.72	14.20	14.76	14.21	14.72
Fe_2O_3	0.91	0.40	1.86	0.65	1.77
FeO	2.33	1.66	2.95	1.66	2.76
MnO	0.05	0.02	0.20	0.05	0.05
MgO	1.35	1.01	1.53	1.25	1.44
CaO	0.76	0.48	1.69	0.55	1.30
Na_2O	3.26	3.20	3.77	3.25	3.45
K_2O	4.20	2.91	4.45	3.41	4.30
P_2O_5	0.20	0.16	0.24	0.19	0.20
Li_2O	0.003	0.000	0.005	0.000	0.004
Mg/(Mg+Fe)	0.43	0.35	0.43	0.40	0.43
K/(K+Na)	0.45	0.35	0.47	0.37	0.46
Nor.Or	26.47	18.41	27.87	21.60	26.99
Nor.Ab	31.22	30.65	36.30	30.94	32.92
Nor.An	2.61	0.85	7.67	1.50	5.29
Nor.Q	30.15	27.62	31.37	28.94	30.15
Na+K	194.06	177.31	202.63	186.52	199.36
*Si	177.51	173.28	187.28	176.07	183.95
K-(Na+Ca)	-33.58	-83.87	-20.20	-72.44	-22.65
Fe+Mg+Ti	84.26	75.30	95.22	83.08	88.03
Al-(Na+K+2Ca)	55.19	38.63	80.10	44.81	70.09
(Na+K)/Ca	14.95	5.88	22.48	7.75	20.33
A/CNK	1.25	1.19	1.42	1.21	1.35

Trace elements (mean values in ppm): *Václavice Granite* – **As** 18, **Ba** 784, **Cr** 133, **F** 674, **Cu** 17, **Ni** 23, **Nb** 5, **Pb** 16, **Rb** 119, **Sn** 9, **Sr** 213, **V** 59, **Y** 35, **Zn** 77 (Opletal et al. 1983).

Brtníky Granite

Quartz-rich, sodic, peraluminous, mostly leucocratic, S-type, granite

	9brtgr	10brtgr	11brtgr	12brtgr	13brtgr
SiO_2	75.01	71.92	71.83	72.17	71.72
TiO_2	0.19	0.26	0.27	0.21	0.30
Al_2O_3	14.22	19.59	14.36	14.52	14.19
Fe_2O_3	0.21	1.14	1.00	0.78	0.70
FeO	0.07	0.82	1.31	0.94	1.56
MnO	0.01	0.04	0.06	0.04	0.05
MgO	0.08	0.39	0.53	0.37	0.67
CaO	0.30	0.25	0.59	0.59	1.43
Na_2O	3.71	4.03	4.09	4.11	3.73
K_2O	4.38	4.44	3.53	4.32	3.78
P_2O_5	0.05	0.06	0.09	0.07	0.12
Mg/(Mg+Fe)	0.34	0.27	0.29	0.28	0.35
K/(K+Na)	0.44	0.42	0.36	0.41	0.40
Nor.Or	26.55	25.67	21.76	26.32	23.32
Nor.Ab	34.18	35.41	38.32	38.06	34.97
Nor.An	1.20	0.81	2.44	2.52	6.61
Nor.Q	34.25	27.68	31.09	28.43	29.95
Na+K	212.72	224.32	206.93	224.35	200.62
*Si	199.86	171.71	184.55	169.02	180.26
K-(Na+Ca)	-32.07	-40.23	-67.55	-51.42	-65.61
Fe+Mg+Ti	8.00	38.65	47.31	34.74	50.93
Al-(Na+K+2Ca)	55.83	151.47	54.03	39.75	27.04
(Na+K)/Ca	39.76	50.32	19.67	21.32	7.87
A/CNK	1.26	1.66	1.25	1.17	1.12

Trace elements (mean values in ppm): *Brtníky Granite* – **As** 5, **Ba** 300, **Cr** 310, **F** 540, **Cu** 20, **Ni** 14, **Nb** 5, **Pb** 10, **Rb** 223, **Sn** 8, **Sr** 43, **V** 12, **Y** 36, **Zn** 20 (Opletal et al. 1983).

C. <u>Dolerite Dyke Swarm</u>

Dolerite

Quartz-poor, sodic, metaluminous, gabbro

n = 7	Median	Min	Max	QU1	QU3
SiO_2	51.19	48.67	52.25	49.92	51.81
TiO_2	1.37	0.98	2.79	1.06	1.72
Al_2O_3	14.97	12.51	18.49	13.43	16.17
Fe_2O_3	2.37	1.34	2.98	1.75	2.86
FeO	7.81	5.22	10.50	6.09	8.74
MnO	0.15	0.11	0.18	0.12	0.16
MgO	5.55	2.78	9.22	3.80	7.74
CaO	8.58	6.70	10.60	8.15	9.51
Li_2O	0.00	0.00	0.01	0.00	0.00
Na_2O	2.81	2.14	3.37	2.44	2.93
K_2O	1.03	0.44	2.45	0.62	1.17
P_2O_5	0.19	0.12	0.28	0.12	0.22
Mg/(Mg+Fe)	0.54	0.33	0.68	0.35	0.56
K/(K+Na)	0.19	0.11	0.38	0.13	0.19
Nor.Or	7.09	2.84	17.18	4.11	8.17

Nor.Ab	28.35	22.81	34.65	23.90	30.67
Nor.An	47.84	37.23	58.21	44.29	48.13
Nor.Q	0.61	0.00	2.94	0.00	1.75
Na+K	116.42	82.86	137.86	88.08	119.71
*Si	65.57	52.53	88.07	58.55	69.93
K-(Na+Ca)	-227.69	-266.53	-153.29	-238.98	-225.68
Fe+Mg+Ti	301.14	228.01	403.48	256.72	329.77
Al-(Na+K+2Ca)	-118.78	-181.57	-94.80	%-163.99	-104.87
(Na+K)/Ca	0.76	0.48	1.15	0.52	0.81
A/CNK	0.76	0.58	0.78	0.62	0.76

D. Upper Carboniferous plutonic series

4.1.01. STOLPEN STOCK

Regional position: a member of the Lusatian Composite Batholith.

Rock types: *Stolpen Granite* – porphyritic biotite granite.

Size and shape (on erosion level): 6 × 2 km, E-W elongated body.

Contact aureole: indistinct.

Geological environment: Pulsnitz Complex.

Age and isotopic data: Variscan – the Stolpen Stock intruded into the two-mica granodiorite (anatexite) of the *Radeberg-Löbau Complex.*

Zoning: not described.

Mineralization: not known.

References

EIDAM, J. – HAMMER, J. – KORICH, D. – BIELICKI, K. H. (1995): Amphibole-bearing granites in the Lusatian Anticlinal Zone: Variscan I-type magmatism at the northern margin of the Bohemian Massif. – Neu. Jb. Mineral., Abh. 168, 3, 259–281.

HAAKE, R. – HERRMANN, G. – PÄLCHEN, W. – PILOT, J. (1973): Zur Altersstellung der Granodiorite der westlichen Lausitz und angrenzender Gebiete. – Z. geol. Wiss. 12, 1669–1671.

HAMMER, J. (1996): Geochemie und Petrogenese der cadomischen und spätvariszischen Granitoide der Lausitz. – Freiberg. Forsch.-H., R. C 463, 107 pp.

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Böhmischen Massivs. Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.

KOZDRÓJ, W. – KRENTZ, O. – OPLETAL, M. Eds (2001): Comments on the Geological Map Lausitz-Jizera-Karkonosze 1 : 100,000. – Sächs. Landesamt für Umwelt und Geol. Freiberg – Czech Geol. Survey, Prague – Pan. Inst. Geol. Warszawa.

KRÖNER, A. – HEGNER, E. – HAMMER, J. – HAASE, G. – BIELICKI, K. H. – KRAUSS, M. – EIDAM, J. (1994): Geochronology and Nd-Sr systematics of Lusatian granitoids: significance for the evolution of the Variscan orogen in east-central Europe. – Geol. Rdsch. 83, 357–376.

4.1.02. KÖNIGSHAIN STOCK

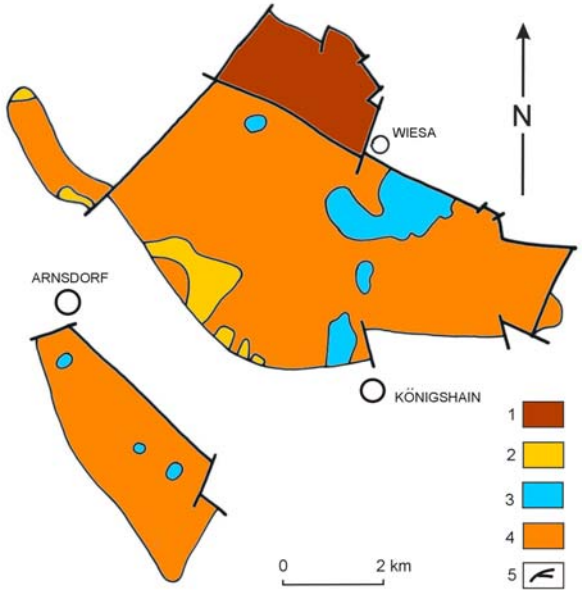

Fig. 4.7. *Königshain Stock geological sketch-map (after Kozdrój et al. 2001). 1 – Wiesa Granodiorite, Königshain Granite: 2 – fine-grained granite, 3 – porphyritic granite, 4 – equigranular granite, 5 – faults.*

Regional position: a member of the Lusatian Composite Batholith. The Königshain Stock was emplaced at the northeastern margin of the Lusatian Composite Batholith.

Rock types: *Königshain Granite* – porphyritic medium-to fine-grained or equigranular biotite monzogranite.

Three rock facies:
Equigranular biotite granite (main type),
Porphyritic biotite granite (roof facies?),
Fine-grained biotite granite (marginal facies).

1. *Wiesa Granodiorite* – ± hornblende biotite granodiorite.
2. *Schlieren Granite.*
3. *Aplite Granite.*

Size and shape (on erosion level): outcrop divided in to two separated parts of 30 and 7.5 km^2 respectively. The depth of magma solidification is about 5–7 km (Dudek et al. 1991).

Contact aureole: up to 3 km zones in Görlitz greywackes, recrystallized mylonites at the contact with Lusatian granodiorite.

Geological environment: southern contact – Zawidów Granodiorite, on NW and SE Precambrian greywacke-pelite sequence, on NE Palaeozoic schists. Northern margin is of tectonic nature.

Age and isotopic data: Late Variscan, postkinematic, intruded into the Lower Carboniferous sediments.

Zoning: reverse concentric zonation (according to modal composition).

Mineralization: accessory minerals of Y-Nb, Y-Si-U and Nb-Si-Th-U.

References

DUDEK, A. – FROLÍKOVÁ, I. – NEKOVAŘÍK, Č. (1991): The depth of intrusion of Hercynian granitoid plutons in the Bohemian Massif. – Acta Univ. Carol., Geol., Kettner Vol. 3–4, 249–256. (In Czech)

EIDAM, J. – GÖTZE, J. (1991): The granitic massif of Königshain-Arnsdorf (Lusatian Anticlinal Zone): an example of a reversely zoned pluton. – Chem. Erde 51, 55–71.

EIDAM, J. – HAMMER, J. – KORICH, D. – BIELICKI, K. H. (1995): Amphibole-bearing granites in the Lusatian Anticlinal Zone: Variscan I-type magmatism at the northern margin of the Bohemian Massif. – Neu. Jb. Mineral., Abh. 168, 3, 259–281.

HAMMER, J. (1996): Geochemie und Petrogenese der cadomischen und spätvariszischen Granitoide der Lausitz. – Freiberg. Forsch.-H., R. C 463, 107 pp.

HECHT, L. – THURO, K. – PLINNINGER, R. – CUNEY, M. (1999): Mineralogical and geochemical characteristics of hydrothermal alteration and episyenitization in the Könighain granites, northern Bohemian Massif, Germany. – Int. J. Earth Sci. 88, 236–252.

MÖBUS, G. (1970): Anteile aus zwei Orogenen im homogenen Lausitzer Granodiorit. – Ber. Dtsch. Gesell. geol. Wiss., R. A15, 289–304.

MÖBUS, G. – LINDERT, W. (1967): Das Granitmassiv von Königshain bei Görlitz (Oberlausitz). – Abh. Dtsch. Akad. Wiss. Berl., Kl. Bergb. Hüttenwes. Montageol. 1, 81–160.

PÄLCHEN, W. – THIERGÄRTNER, H. (1970): Anwendung der Trendanalyse zum Studium des Aufbaus von Granitkörpern am Beispiel des Granitmassivs von Königshain, Oberlausitz. – Geologie 19, 55–71.

Stolpen & Königshain Granites

Quartz-rich, sodic-potassic, weakly peraluminous, leucocratic, S-type, M-series, granite

	1319Stolp	**1320König**
SiO_2	75.70	76.98
TiO_2	0.09	0.07
Al_2O_3	13.17	12.20
Fe_2O_3	0.43	0.38
FeO	0.74	0.70
MgO	0.15	0.11
CaO	0.92	0.64
Na_2O	3.59	3.46
K_2O	4.77	4.78
P_2O_5	n.d.	n.d.
Mg/(Mg+Fe)	0.19	0.16
K/(K+Na)	0.47	0.48
Nor.Or	28.73	28.93
Nor.Ab	32.87	31.82
Nor.An	4.65	3.25
Nor.Q	32.09	34.76
Na+K	217.13	213.14
*Si	191.90	206.32
K-(Na+Ca)	-30.97	-21.57
Fe+Mg+Ti	20.54	18.12
Al-(Na+K+2Ca)	8.69	3.61
(Na+K)/Ca	13.23	18.68
A/CNK	1.03	1.01

Trace elements (mean values in ppm):

*Königshain Granite – equigranular gra*nite – **Ga** 21, **Nb** 29, **Pb** 57, **Rb** 347, **Th** 33, **U** 12, **Y** 58, **Zn** 21, **Zr** 145, **La** 8, **Ce** 21, **Pr** 3.5, **Nd** 15, **Eu** 0.56, **Gd** 4.74, **Tb** 0.75, **Dy** 4.97, **Ho** 0.9, **Er** 2.48, **Tm** 0.44, **Yb** 2.93, **Lu** 0.44 (Hecht et al. 1999).

Königshain Granite – porphyritic granite – **Ba** 481,**Cr** 10, **Ga** 20, **Nb** 23, **Pb** 37, **Rb** 237, **Sr** 98, **Th** 28, **U** 13, **V** 6, **Y** 28, **Zn** 28, **Zr** 77, **La** 38, **Ce** 74, **Pr** 8, **Nd** 27, **Sm** 6.5, **Eu** 0.05, **Gd** 7.20, **Tb** 1.41, **Dy** 9.67, **Ho** 2.11, **Er** 5.80, **Tm** 1.10, **Yb** 7.03, **Lu** 1.05 (Hecht et al. 1999).

Kleinschweidnitz Granodiorite – **B** 12, **Ba** 817, **Be** 2.0, **Co** 10, **Cr** 28, **Cs** 3.4, **Cu** 10, **Ga** 19, **Hf** 5.53, **Li** 13, **Ni** 12, **Nb** 9, **Pb** 16, **Rb** 100, **Sc** 11.4, **Sr** 448, **Ta** 1.04, **Th** 13.8, **U** 3.8, **V** 65, **Y** 23, **Zn** 58, **Zr** 206, **La** 37, **Ce** 68, **Nd** 23, **Sm** 5.3, **Eu** 1.18, **Tb** 0.72, **Yb** 2.1, **Lu** 0.38 (Eidam et al. 1995).

Wiesa Granodiorite – **B** 15, **Ba** 1240, **Be** 1.5, **Co** 10, **Cr** 60, **Cs** 4.9,**Cu** 12, **Ga** 22, **Hf** 6.8, **Li** 29, **Ni** 22, **Nb** 12, **Pb** 23, **Rb** 176, **Sc** 9.0, **Sr** 457, **Ta** 1.50, **Th** 31.4, **U** 10.5, **V** 83, **Y** 26, **Zn** 46, **Zr** 350, **La** 61, **Ce** 108, **Nd** 35, **Sm** 7.2, **Eu** 1.38, **Tb** 0.87, **Yb** 2.1, **Lu** 0.47 (Eidam et al. 1995).

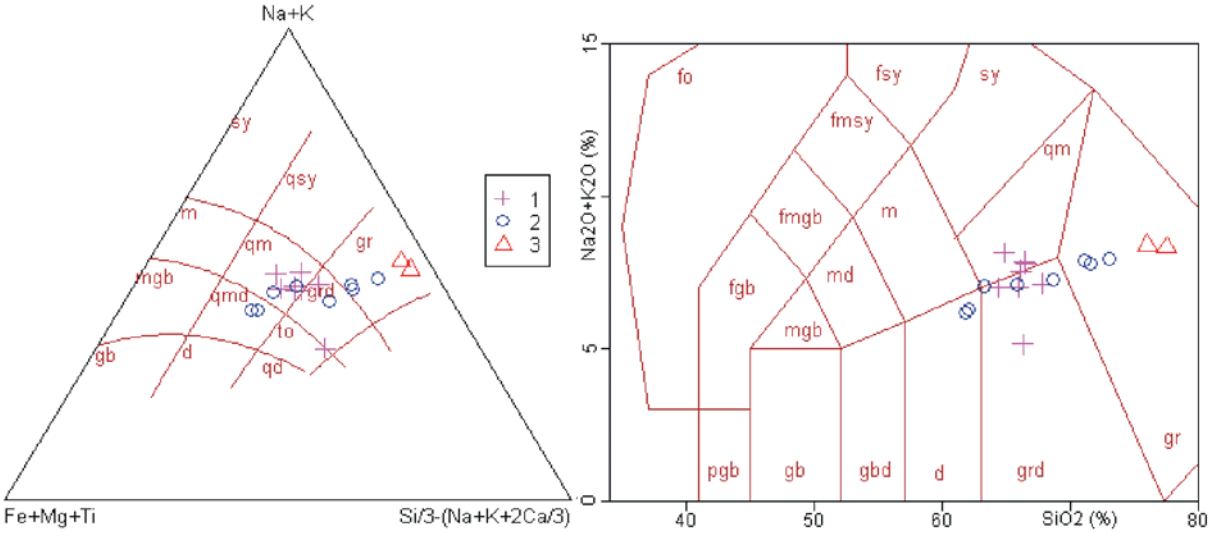

Fig. 4.8. *Lusatian Composite Batholith – Upper Carboniferous plutonic series ABQ and TAS diagrams. 1 – amphibole granodiorite to monzogranite (Wiesa Granodiorite), 2 – biotite granodiorite to biotite granite, 3 – Königshain and Stolpen Granites.*

4.1.03. DOHNA COMPOSITE STOCK

Regional position: in the Elbe zone, a part of the Lusatian Composite Batholith (Fig. 4.12.).

Rock types:

1. *Pulsnitz Granodiorite* – muscovite-biotite granodiorite (anatexite and restite rich) – main type (equivalent of the Pulsnitz Granodiorite of the Lusatian Composite Batholith).
2. *Dohna Granodiorite* (Type DO1) – biotite granodiorite (in contact with DO2).
3. *Dohna Granodiorite* (Type DO2) – biotite granodiorite to tonalite (in contact with graywackes).
4. *Dohna Granodiorite* (Type DO3) – porphyritic biotite granodiorite to tonalite (muscovite- bearing).
5. *Sürssen Granodiorite* (SÜ) – biotite granodiorite to monzogranite.
6. *Rumburk Granite* (RU) – muscovite-bearing biotite monzogranite (equivalent of the Rumburk Granite of the Lusatian Composite Batholith).

Size and shape (on erosion level): outcrop 3 × 1 km in the Labe (Elbe) valley, large part of the body under the younger sedimentary cover.

Age and isotopic data: *Dohna Granodiorites (DO 1–3)* 300–370 Ma (K-Ar), 538 to 600 Ma (Pb-Pb zircon). Granitoid polyphase body consists of several types of Neoproterozoic granodiorites (D01-DO3, PU, SÜ), *Rumburk Granite,* subvolcanic tourmaline granite (486 ± 4 Ma, 486 ± 6 Ma, (Pb-Pb zircon).

Geological environment: Neoproterozoic graywackes and hornfelses with knotted schist interlayers.

Contact aureole: narrow aureole in Neoproterozoic rocks, prevailing contacts are faults and mylonitic zones. Granitoids are in the contact aureole of the Meissen Composite Massif.

Zoning: not observed.

Mineralization: not observed.

Heat production (μWm^{-3}): *Dohna Granodiorite* 1.38.

Trace elements (mean values in ppm): *Dohna Granodiorite* – **Ba** 784**, Co** 10.3**, Cr** 43, **Cs** 6.4**, Cu** 9**, Ga** 18, **Hf** 6.3**, Ni** 17**, Nb** 10**, Pb** 22, **Rb** 138, **Sc** 11.5, **Sr** 196**, Ta** 0.83, **Th** 10.8, **U** 2.4, **V** 52, **Y** 35, **Zn** 64, **Zr** 204, **La** 32, **Ce** 68, **Nd** 45**, Sm** 4.8, **Eu** 1.28, **Tb** 0.96**, Yb** 3.2, **Lu** 0.47 (Hammer et al. 1999).

References

GEHMLICH, M. – LINNEMANN, U. – TICHOMIROVA, M. – TODT, W. (2000): U-Pb und Pb-Pb-Zirkondatierungen an Orthosteinen der Elbezone: Konsequenzen für variszische Deckenüberschiebungen im Saxothuringikum. – Z. Dtsch. geol. Gesell. 151/3, 209–230.

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Bömischen Massivs. Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.
SCHUST, F. (2000): Das Dohnaer Massif in der südöstlichen Elbezone. – Geoprofil 10, 39–54, Freiberg.
SCHMIDT, K. (1955): Die Granodiorite des Elbtales. – Abh. Dtsch. Akad. Wiss. Berlin, Kl. Chem., Geol., Biol. 4, 8, 45 pp.
WENZEL, T. – SCHMIDT, W. – HENGST, M. – WOLF, D. – PILOT, J. (1989): Geochronological study of some types of granitoids from the Elbe Valley zone. In: Wand, U. – Strauch, G. Eds: Proceedings of the Fifth Working Meeting "Isotopes in Nature", 203–216. – Inst. Isotope and Radiation Res., Leipzig.

4.1.04. BROSSNITZ STOCK

***Regional position**:* separate subsurface satellite stock of the Lusatian Composite Batholith. A member of the Radeberg-Löbau Complex (Fig. 4.12.).

Rock types: *Brossnitz Monzogranite* – biotite granite.

Size and shape (on erosion level): three small stocks (max. size 2 × 2 km).

Age and isotopic data: Neoproterozoic. No isotopic data.

Mineralization: not known.

References

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Böhmischen Massivs. Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.
RÖLLIG, G. – BRÄUER, H. – VIEHWEG, M. et al. (1990): Altersstellung und petrographische Charakteristik der Plutonite im Gebiet des Zentralteils der Mitteldeutschen Schwelle. – Z. angew. Geol. 36, 208–212.

4.1.05. SCHWARZKOLLM STOCK

Regional position: separate subsurface satellite stock of the Lusatian Composite Batholith. A member of the Radeberg-Löbau Complex (Fig. 4.12.).

Rock types: *Schwarzkollm Granodiorite* – biotite granodiorite.

Size and shape (on erosion level): tectonically segmented oval stock (7 × 4 km).

Age and isotopic data: 530 ± 6 Ma (Pb-Pb zircon).

Mineralization: not known.

References

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Böhmischen Massivs. Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.
RÖLLIG, G. – BRÄUER, H. – VIEHWEG, M. et al. (1990): Altersstellung und petrographische Charakteristik der Plutonite im Gebiet des Zentralteils der Mitteldeutschen Schwelle. – Z. angew. Geol. 36, 208–212.

B. ELBE ZONE

The elbe zone within the elbe lineament represents a nw-se elongated segment, which separates the Saxothuringian Zone from the Lugicum s.s. in the NE. The Elbe Zone reaches a width of about 25–30 km and can be traced over a distance of 300 km. In the Elbe zone, several differently metamorphosed sedimentary units of Early Palaeozoic and Proterozoic are present. all these units are very often thermally influenced by Cadomian intrusions of the Dohna Composite Stock, the Lass Granodiorite, Variscan intrusions of the Meissen Composite Massif and Markersbach Massif (see the Saxothuringicum volume). The last one belongs to the Smrčiny-Krušné hory (Fichtelgebirge-Erzgebirge) Batholith.

4.2. MEISSEN COMPOSITE MASSIF

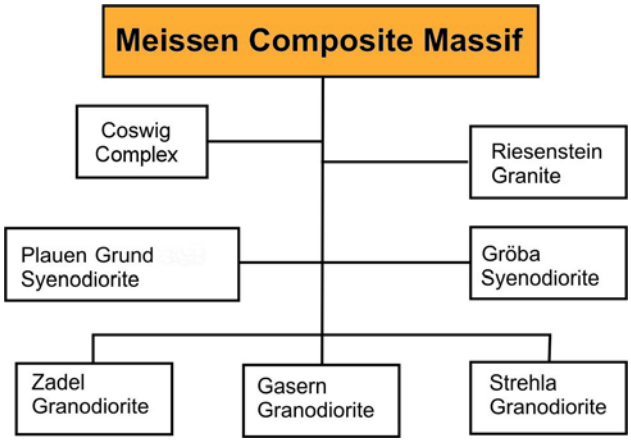

Fig. 4.9. *Meissen Composite Massif hierarchical scheme according to rock types.*

Regional position: Isolated Variscan intrusion within the Elbe zone.

Rock types:

1. *Plauenscher Grund Syenodiorite* (265 km^2) – porphyritic hornblende syenodiorite (monzonite).
2. *Zadel Granodiorite* (Hauptgranit) (220 km^2) – biotite granodiorite.
3. *Gasern Granodiorite* (50 km^2) – biotite-hornblende granodiorite.
4. *Riesenstein (Meissen) Granite* – biotite granite.
5. *Gröba Syenodiorite* – augite syenodiorite.
6. *Strehla Granodiorite* – hornblende granodiorite.
7. *Coswig Complex* consists of a group of the Coswig Gneiss and strongly deformed Coswig biotite Granite.

Size and shape (on erosion level): 600 km^2 (max length of 70 km and max. width of 20 km).

Age and isotopic data: Younger than Lower Carboniferous sediments. The monzonites were intruded by several granodiorites and monzogranites termed the Zadel Granite and the Riesenstein Granite in the centre of the Meissen Composite Massif. The Coswig Granite (480 Ma), partly deformed to orthogneiss, forms small isolated lenses in the centre of the Meissen Composite Massif (not shown in the map).

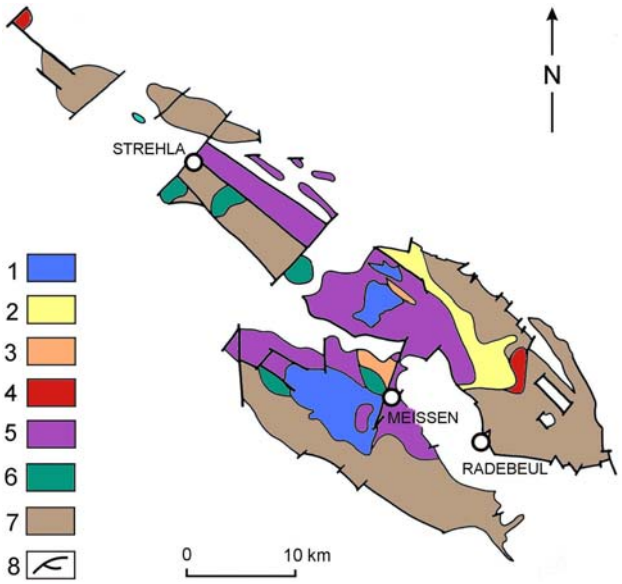

Fig. 4.10. *Meissen Composite Massif geological sketch-map (after Kozdrój et al. 2001). 1 – Upper Carboniferous cover (volcanics), 2 – Gasern Granodiorite, 3 – Riesenstein (Meissen) Granite, 4 – Strehla Granodiorite, 5 – Zadel Granodiorite (Hauptgranit), 6 – Gröba Syenodiorite, 7 – Plauenscher Grund Syenodiorite, 8 – faults.*

Zadel Granodiorite 323 Ma, 300 ± 50 Ma (K-Ar), 355 ± 12 Ma (Pb/Pb zircon), 326.8 ± 3.6 Ma (Ar-Ar biotite), *Gröba Syenodiorite* 326 ± 6 Ma (K-Ar biotite) 323.5± 1 Ma (Ar-Ar white mica), *Plauenscher Grund Syenodiorite* 325 ± 6 Ma (U-Pb zircon), 32.1 ± 2,8 Ma to 330.4 ± 2.8 Ma (Ar-Ar amphibole), *Coswig Granite* 480 Ma.

Geological environment: Early Palaeozoic (Ordovician, Upper Devonian and Lower Carboniferous) slates, phyllites, mafic rocks, carbonates, graphite schists, quartzite and

Neoproterozoic assimilates – gneisses, amphibolites and the cover of basic and acid volcanics of the Stephanian age.

Contact aureole: 2–4 km wide zone of pyroxene hornfelses.

Zoning: Strong compositional zoning from SE to NW (syenodiorite – granodiorite – granite). The rim of the Meissen Massif consists of K-rich gabbros and diorites that grade within some tens of meters into monzodiorites and monzonites.

Mineralization: Fluorite.

Heat production (μWm^{-3}): 6.67.

References

BOMBACH, K. – HENGST, M. – PILOT, J. (1989): Pb-Pb age determinations on single zircons from the GDR by thermal ion mass spectrometry. In: Wand, U. – Strauch, G. Eds: Proceedings of the Fifth Working Meeting "Isotopes in Nature", 53–67. – Inst. Isotope and Radiation Res., Leipzig.

MOHNICKE, M. – KURZE, M. – TICHOMIROVA, M. (2001): Petrogenese und Alterstellung der Gesteine des Coswiger Komplexes. In: Tectonics and Magma 2001 Meeting, Bautzen, 75–77. – Berlin.

NASDALA, L. – WENZEL, T. – PIDGEON, R. T. – KRONZ, A. (1999): Internal structures and dating of complex zircons from Meissen Massif monzonites, Saxony. – Chem. Geol. 156, 331–341.

PFEIFFER, L. (1964): Beiträge zur Petrologie des Meissener Massivs. – Freiberg. Forsch.-H., R. C 179, 1–22.

SHARP, W. P. – WENZEL, T. – NASDALA, L. – MERTZ, D. F. – BECKTER, T. (1997): Geochronology of Hercynian Meissen Massif magmatic rocks based on $^{40}Ar/^{39}Ar$ (amphibole, mica) $^{206}Pb/^{238}U$ SHRIMP (zircon) data (P). 149. – Hauptversamml. dtsch. geol. Gesell.

WENZEL, T. – HENGST, M. – PILOT, J. (1993): The plutonic rocks of the Elbe valley zone (Germany): evidence for the magmatic development from single-zircon evaporation and K-Ar age determinations. – Chem. Geol. 104, 75–92.

WENZEL, T. – MERTZ, D. F. – OBERHÄNSLI, R. – BECKER, T. – RENNE, P. R. (1997): Age, geodynamic setting, and mantle enrichment processes of a K-rich intrusion from the Meissen massif (northern Bohemian Massif) and implications for related occurrences from the mid-European Hercynian. – Geol. Rdsch. 86, 556–570.

WENZEL, T. – OBERHÄNSLI, R. – MEZGER, K. (1994a): Basische und intermediäre Gesteine des Meissener Massifs (Elbe Zone): Magmenquellen und geotektonische Stellung. – Ber. Dtsch. mineral. Gesell. 1, 307.

WENZEL, T. – OBERHÄNSLI, R. – MEZGER, K. (1994b): K-rich plutonic rocks and lamprophyres from the Meissen Massif (northern Bohemian Massif): Geochemical evidence for variably enriched lithospheric mantle sources. – Neu. Jb. Mineral., Abh. 175, 249–293.

WENZEL, T. – SCHMIDT, W. – HENGST, M. – WOLF, D. – PILOT, J. (1989): Geochronological study of some types of granitoids from the Elbe Valley zone. In: Wand, U. – Strauch, G. Eds: Proceedings of the Fifth Working Meeting "Isotopes in Nature", 203–216. – Inst. Isotope and Radiation Res., Leipzig.

Plauenscher Grund (Spitzgrund) Syenodiorite

Quartz-poor, sodic, metaluminous, mesocratic, monzonite – quartz syenite

	Spgr1	**Spgr3**	**Spgr4**	**Hei1**	**Leuben4**	**Leuben1**
SiO_2	61.70	63.50	59.90	60.00	52.30	53.40
TiO_2	0.09	0.13	0.13	0.20	0.34	0.35
Al_2O_3	14.85	16.12	15.92	16.37	17.27	17.01
Fe_2O_3	2.02	1.13	2.08	2.38	3.07	2.81
FeO	2.37	2.46	2.51	1.71	4.71	4.57
MnO	0.10	0.09	0.12	0.10	0.14	0.14
MgO	2.43	2.14	2.90	2.30	3.99	3.76
CaO	4.99	4.58	4.84	4.85	6.95	7.06
Na_2O	4.79	4.80	4.65	4.69	4.02	4.05
K_2O	4.31	4.46	5.54	5.05	5.01	5.13
P_2O_5	0.56	0.49	0.58	0.49	0.82	0.83
Mg/(Mg+Fe)	0.50	0.52	0.53	0.51	0.48	0.48
K/(K+Na)	0.37	0.38	0.44	0.41	0.45	0.45

Nor.Or	26.76	25.87	34.07	29.97	27.47	28.66
Nor.Ab	45.20	42.31	43.46	42.31	33.50	34.39
Nor.An	13.32	18.29	13.02	17.58	26.61	24.85
Nor.Q	6.39	6.81	0.28	3.33	0.00	0.00
Na+K	246.08	249.59	267.68	258.57	236.10	239.61
*Si	36.90	48.25	7.09	16.64	-28.57	-27.29
K-(Na+Ca)	-152.04	-141.87	-118.73	-130.61	-147.28	-147.66
Fe+Mg+Ti	119.73	103.14	134.60	113.21	207.32	196.53
Al-(Na+K+2Ca)	-132.42	-96.37	-127.66	-110.07	-144.82	-157.36
(Na+K)/Ca	2.77	3.06	3.10	2.99	1.91	1.90
A/CNK	0.71	0.79	0.73	0.76	0.73	0.71

Trace elements (mean values in ppm): *Plauenscher Grund Syenodiorite* – **Ba** 1848, **Cr** 52, **Cu** 53, **Ga** 19.7, **Ni** 19, **Nb** 24, **Pb** 34, **Rb** 158, **Sr** 1431, **Th** 45, **U** 12, **V** 132, **Y** 26, **Zn** 78, **Zr** 297, **La** 106, **Ce** 179, **Nd** 68, **Sm** 10.8, **Eu** 12.51, **Tb** 0.99, **Yb** 2.21, **Lu** 0.25 (Wenzel et al. 1989).

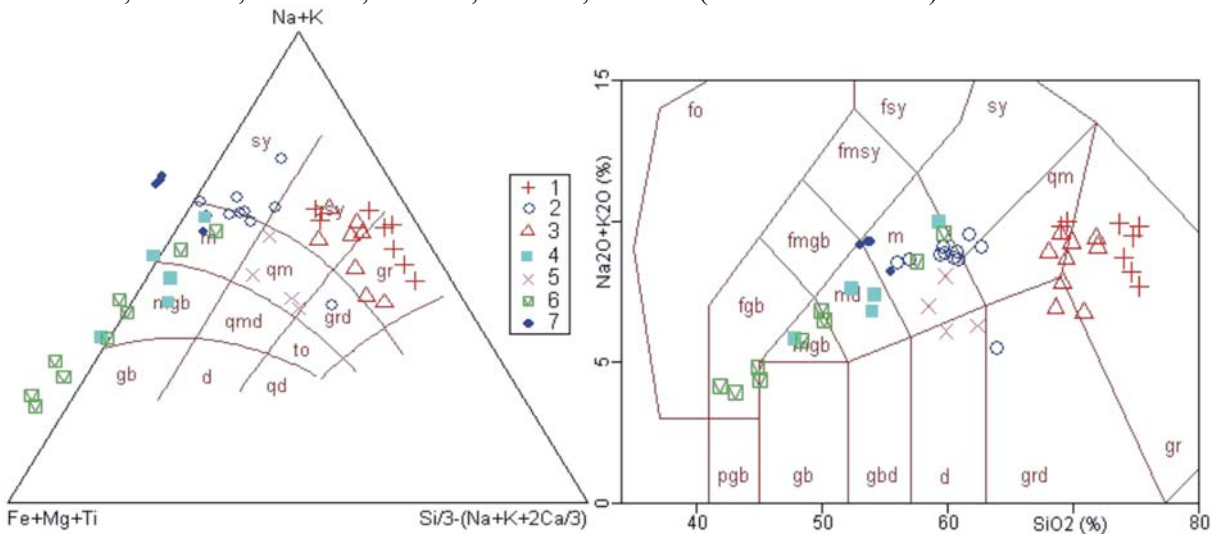

Fig. 4.11. *Meissen Composite Massif ABQ and TAS diagrams. 1 – Reissenstein (Meissen) Granite, 2 – Plauenscher Grund Syenodiorite, 3 – Zadel Granodiorite, 4 – Gröba Syenodiorite, 5 – Strehla Granodiorite, 6 – Freital Granitoids, 7 – Leuben Granitoids.*

Zadel Granodiorite (Hauptgranit)

Quartz-normal, sodic, metaluminous, mesocratic, granite-granodiorite

	Klein-Zadel 1	**Klein-Zadel 3**	**Klein-Zadel 4**	**Klein-Zadel 6**	**BöseBrüder 6**
SiO_2	69.50	71.69	72.20	69.45	71.74
TiO_2	n.d.	0.22	0.21	0.29	0.22
Al_2O_3	15.85	14.80	14.95	15.94	14.88
Fe_2O_3	0.25	1.67	1.60	2.40	1.72
FeO	1.34	n.d.	n.d.	n.d.	n.d.
MnO	0.05	0.04	0.05	0.05	0.07
MgO	1.03	0.82	0.83	0.90	0.61
CaO	2.03	1.30	1.19	1.88	1.79
Na_2O	4.52	4.70	4.99	5.17	4.91
K_2O	4.67	4.34	4.43	4.45	4.38
P_2O_5	0.27	0.11	0.11	0.16	0.12
Mg/(Mg+Fe)	0.53	0.49	0.50	0.42	0.40
K/(K+Na)	0.40	0.38	0.37	0.36	0.37
Nor.Or	28.21	25.97	26.21	26.28	25.91
Nor.Ab	41.49	42.74	44.86	46.41	44.14

Nor.An	8.48	5.80	5.19	8.27	8.10
Nor.Q	18.13	22.56	21.10	16.14	20.41
Na+K	245.01	243.82	255.08	261.32	251.44
*Si	116.43	138.45	131.32	101.63	125.28
K-(Na+Ca)	-82.90	-82.70	-88.19	-105.87	-97.36
Fe+Mg+Ti	47.35	44.03	43.27	56.03	39.44
Al-(Na+K+2Ca)	-6.15	0.46	-3.94	-15.34	-23.07
(Na+K)/Ca	6.77	10.52	12.02	7.79	7.88
A/CNK	1.00	1.01	0.99	0.96	0.93

Riesenstein (Meissen) Granite

Quartz-normal, sodic, metaluminous, leuco/mesocratic, I-type granite

	Meissen	**Meissen**	**Meissen**	**GP1**	**GP2**
SiO_2	74.92	74.34	75.81	70.03	69.40
TiO_2	0.19	0.21	0.15	0.44	0.42
Al_2O_3	13.21	13.55	13.18	14.79	15.39
Fe_2O_{3tot}	1.35	1.49	1.12	2.94	2.68
MnO	0.03	0.03	0.02	0.04	0.04
MgO	0.24	0.33	0.13	1.25	1.25
CaO	0.79	0.87	0.46	1.03	1.40
Na_2O	4.59	5.04	4.24	5.04	5.81
K_2O	4.88	4.94	5.62	5.01	4.03
P_2O_5	0.05	0.07	0.03	0.13	0.14
Mg/(Mg+Fe)	0.26	0.30	0.18	0.45	0.48
K/(K+Na)	0.41	0.39	0.47	0.40	0.31
Nor.Or	28.87	29.41	33.20	29.82	23.87
Nor.Ab	41.27	45.20	38.06	45.60	52.31
Nor.An	2.14	0.00	0.75	4.29	6.04
Nor.Q	26.13	23.38	26.78	16.65	14.60
Na+K	251.73	267.53	256.15	269.01	273.05
*Si	154.52	134.55	158.96	107.25	95.32
K-(Na+Ca)	-58.59	-73.26	-25.70	-74.63	-126.88
Fe+Mg+Ti	25.25	29.49	19.14	73.36	69.86
Al-(Na+K+2Ca)	-20.49	-32.46	-13.73	-15.30	-20.75
(Na+K)/Ca	17.87	17.24	31.23	14.65	10.94
A/CNK	0.93	0.90	0.95	0.96	0.94

Strehla Granodiorite

Quartz-poor, sodic-potassic, metaluminous, melanocratic,
I-type monzonite

	Strehla1	**Strehla2**	**Strehla3**
SiO_2	61.86	59.59	58.81
TiO_2	0.83	0.81	0.82
Al_2O_3	15.35	16.67	16.65
Fe_2O_3	1.63	3.28	1.71
FeO	4.31	4.03	4.48
MnO	n.d.	n.d.	0.12
MgO	3.50	2.31	2.63
CaO	4.88	5.83	4.86
Li_2O	n.d.	n.d.	n.d.
Na_2O	3.06	2.88	3.53

K_2O	3.18	3.20	4.38
P_2O_5	0.63	0.92	0.31
Mg/(Mg+Fe)	0.52	0.37	0.43
K/(K+Na)	0.41	0.42	0.45
Nor.Or	20.53	20.23	28.07
Nor.Ab	30.02	27.68	34.39
Nor.An	21.92	24.47	23.94
Nor.Q	15.83	15.61	5.50
Na+K	166.26	160.88	206.91
*Si	118.91	100.41	61.58
K-(Na+Ca)	-118.25	-128.95	-107.58
Fe+Mg+Ti	177.69	164.68	159.34
Al-(Na+K+2Ca)	-38.86	-41.44	-53.27
(Na+K)/Ca	1.91	1.55	2.39
A/CNK	0.93	0.94	0.88

Freital Monzodiorite

quartz-poor, sodic, metaluminous, melanocratic, I-type monzodiorite

	Frei14	**Frei15**	**Frei9**
SiO_2	41.93	44.19	46.75
TiO_2	1.52	1.26	1.18
Al_2O_3	11.86	15.83	16.87
Fe_2O_3tot	14.27	12.48	10.45
FeO	n. d.	n. d.	n. d.
MnO	0.24	0.19	0.17
MgO	8.92	6.82	5.76
CaO	13.31	12.00	8.95
Na_2O	1.81	2.46	3.25
K_2O	2.01	1.85	2.33
P_2O_5	1.49	1.12	0.88
Mg/(Mg+Fe)	0.55	0.52	0.52
K/(K+Na)	0.42	0.33	0.32
Nor.Q	0.00	0.00	0.00
Nor.Or	13.11	11.41	14.75
Nor.Ab	17.94	23.06	31.27
Nor.An	40.49	54.45	41.37
Na+K	101.08	118.66	154.35
*Si	-26.70	-16.16	-1.39
K-(Na+Ca)	-253.07	-254.09	-215.00
Fe+Mg+Ti	419.16	341.37	288.63
Al-(Na+K+2Ca)	-342.87	-235.76	-142.25
(Na+K)/Ca	0.43	0.55	0.97
A/CNK	0.43	0.60	0.73

C. THE MIDDLE-GERMAN CRYSTALLINE ZONE

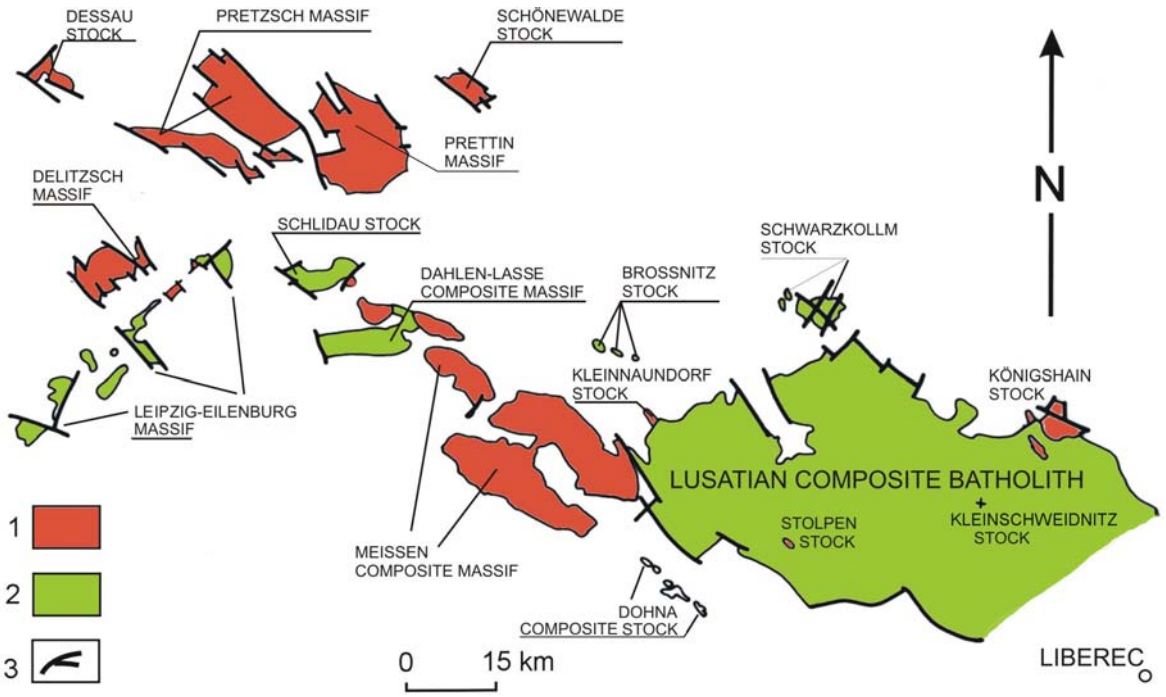

Fig. 4.12. *Granitoid plutonites in the NE margin of the Bohemian Massif – geological sketch-map (after Kozdrój et al. 2001). 1 – Variscan (Carboniferous) Plutons, 2 – Pre-Cadomian and Cadomian (Upper Proterozoic-Cambrian-Ordovician) Plutons, 3 – faults.*

4.3. DELITZSCH MASSIF

Regional position: Mid-German Crystalline Rise. A member of the hidden Delitzsch Complex (under a sedimentary cover).

Rock types:

1. *Delitzsch Diorite.*
2. *Delitzsch Granodiorite.*
3. *Delitzsch Monzogranite.*

Size and shape: tectonically segmented hidden massif, oval in shape 100 km^2.

Age and isotopic data: *Delitzsch Diorite* 311 ± 11 Ma 300.3 ± 1.1 Ma (Pb-Pb zircon), 292 ± 10 Ma (Rb-Sr whole rock), *Delitzsch Granodiorite* 237 ± 10 Ma (Rb-Sr whole rock), *Delitzsch Monzogranite* 218 ± 5 Ma (Rb-Sr whole rock).

Mineralization: not known.

References

ANTHES, G. – REISCHMANN, T. (2001): Timing of granitoid magmatism in the eastern mid-German crystalline rise. – J. Geodynamics 31, 119–143.

HAASE, G. – BIELICKI, K.-H. – RÖLLIG, G. – GERSTENBERGER, H. – HABEDANK, M, – HILLER, H. (1989): Rb-Sr and Pb-Pb geochronology of plutonic rocks from the central German crystalline zone and adjacent regions. In: Wand, U. – Strauch, G. Eds: Proceedings of the Fifth Working Meeting "Isotopes in Nature", 131–142. – Inst. Isotope and Radiation Res., Leipzig.

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Böhmischen Massivs. Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.

KOPP, J. – NAUMANN, R. – NIETZSCHE, H. (2001): Die Mitteldeutsche Kristallinzone (MKZ) zwischen Saale und Neisse: Petrologische Aspecte zur Plutonitgenese. In: Tectonic and Magma 2001 IGCP Project 373, Abstract Vol., 23–26. – Berlin.

4.4. PRETZSCH MASSIF

Regional position: Mid-German Crystalline Rise. A member of the hidden Delitzsch Complex (under a sedimentary cover).

Rock types:

1. *Pretzsch Granite – biotite* granite to granodiorite.
2. *Pretzsch Tonalite* – tonalite to quartz diorite.
3. *Pretzsch Quartz monzonite* – quartz monzonite to quartz monzodiorite.
4. *Pretzsch Diorite.*

Size and shape: two separate tectonically segmented subsurface intrusions (more than 400 km^2).

Age and isotopic data: *Pretzsch Monzogranite* 344 ± 16 Ma (Pb-Pb zircon), *Pretzsch Quartz monzonite* 327 ± 5 Ma (Pb-Pb zircon), *Pretzsch Granodiorite* 333 ± 4 Ma (Pb-Pb zircon), *Pretzsch Tonalite* 331 ± 4, 330 ± 5 Ma (Pb-Pb zircon).

Zoning: Lower Carboniferous Pretzsch-Schönewalde plutonic complex is characterized by normal concentric zoning. The trend in increasing SiO_2 content towards the centre of the complex is displayed by the following petrological sequence: quartz monzodiorite-quartz monzonite → amphibole-bearing granodiorite-monzogranite → amphibole-free biotite monzogranite.

The biotite monzogranite of the inner zone is the most abundant rock in the granitoid complex. The quartzmonzodiorite and quartz monzonite are exposed only in the SW- and SE part of the outer zone. These K-rich rocks show chemical characteristics of shoshonitic series (SiO_2 = 49.5 – 63.3 %, K_2O = 2.0 – 7.2 %).Similar to the Meissen Composite Massif.

Mineralization: not known.

References

ANTHES, G. – REISCHMANN, T. (2001): Timing of granitoid magmatism in the eastern mid-German crystalline rise. – J. Geodynamics 31, 119–143.

EIDAM, J. – EHLING, B. C. – HAMMER, J. – KORICH, D. – RAPPSIBER, I. (2009): The plutonite complex of Pretzsch-Schönewalde – compositional normal zoned complex with high-K to shoshonitic granitoid rocks. – GeoDresden 2009, p. 271.

GOTTESMANN, B. – KNOTH, W. (1966): Petrographie und regionalgeologische Stellung des Granodiorites von Pretzsch (Elbe). – Geologie 15, 1023–1032.

HAASE, G. – BIELICKI, K.-H. – RÖLLIG, G. – GERSTENBERGER, H. – HABEDANK, M, – HILLER, H. (1989): Rb-Sr and Pb-Pb geochronology of plutonic rocks from the central German crystalline zone and adjacent regions. In: Wand, U. – Strauch, G. Eds: Proceedings of the Fifth Working Meeting "Isotopes in Nature", 131–142. – Inst. Isotope and Radiation Res., Leipzig.

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Böhmischen Massivs. Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.

KRAMER, W. (1981): Geochemisch-petrologische Untersuchungen an variszischen Magmatiten tief- bis subkrustalen Ursprungs und deren geotektonische Bedeutung im Vorfeld der Osteuropäischen Tafel. – Z. geol. Wiss. 9, 1325–1332.

KOPP, J. – NAUMANN, R. – NIETZSCHE, H. (2001): Die Mitteldeutsche Kristallinzone (MKZ) zwischen Saale und Neisse: Petrologische Aspecte zur Plutonitgenese. In: Tectonic and Magma 2001 IGCP Project 373, Abstract Vol., 23–26. – Berlin.

KOPP, J. – RÖLLIG, G. (1996): Probleme des basischen und intermediären Magmatismus im Plutonit-massiv von Pretzsch-Prettin-Schönewalde (Zentralteil der Mitteldeutschen Kristallinzone). – Z. geol. Wiss. 24, 551–568.

RÖLLIG, G. – BRÄUER, H. – VIEHWEG, M. et al. (1990): Altersstellung und petrographische Charakteristik der Plutonite im Gebiet des Zentralteils der Mitteldeutschen Schwelle. – Z. angew. Geol. 36, 208–212.

Pretzsch Massif

Pretzsch Granite – quartz-normal, sodic, peraluminous, mesocratic granite
Pretzsch Granodiorite – quartz-normal, sodic, peraluminous, mesocratic granodiorite
Pretzsch Quartz Monzonite – quartz-normal, sodic, peraluminous, melanocratic quartz monzonite
Pretzsch Tonalite – quartz-normal, sodic, peraluminous, melanocratic tonalite
Pretzsch Diorite – quartz-poor, sodic, metaluminous, melanocratic diorite

	Monzogranite	**Granodiorite**	**Quartz monzonite**	**Tonalite**	**Diorite**
SiO_2	68.20	64.60	56.30	56.70	53.90
TiO_2	0.36	0.49	1.07	0.90	1.18
Al_2O_3	14.90	14.90	15.90	17.80	17.90
Fe_2O_3	3.23	1.42	1.64	1.62	1.56
FeO	n.d.	2.29	5.80	5.50	6.50
MnO	0.06	0.07	0.16	0.16	0.36
MgO	1.10	1.66	4.00	3.70	3.70
CaO	1.28	2.84	1.82	5.95	4.98
Na_2O	3.90	3.00	3.20	2.50	3.20
K_2O	4.60	4.02	3.37	2.16	3.72
P_2O_5	0.11	0.25	0.28	0.24	0.30
Mg/(Mg+Fe)	0.40	0.45	0.49	0.48	0.44
K/(K+Na)	0.44	0.47	0.41	0.36	0.43
Nor.Q	23.10	23.11	13.33	13.53	1.52
Nor.Or	28.43	25.94	23.56	14.49	24.95
Nor.Ab	36.63	29.42	34.01	25.49	32.62
Nor.An	5.89	13.59	8.50	31.73	25.81
Na+K	223.52	182.16	174.82	126.54	182.25
*Si	139.62	142.46	115.89	117.29	57.58
K-(Na+Ca)	-51.01	-62.10	-64.16	-140.91	-113.08
Fe+Mg+Ti	72.27	97.01	213.97	199.97	216.66
Al-(Na+K+2Ca)	23.43	9.16	72.52	10.82	-8.34
(Na+K)/Ca	9.79	3.60	5.39	1.19	2.05
A/CNK	1.10	1.05	1.34	1.05	1.00

Trace elements (mean values in ppm): *Pretzsch-Prettin-Schönewalde plutonites:*

Biotite monzogranite-granodiorite – **Ba** 340, **Co** 6, **Cr** 12 ,**Cu** 3, **Ga** 21, **Hf** 10.8, **Ni** 9, **Nb** 22, **Pb** 7, **Rb** 133, **Sr** 786, **Ta** 0.9, **Th** 10.1, **U** 3.6, **V** 26, **Y** 24, **Zn** 44, **Zr** 124, **W** 4.2, **La** 76, **Ce** 157, **Nd** 76, **Sm** 14.7, **Eu** 1.72, **Tb** 1.89, **Yb** 4.0, **Lu** 0.96 (Kopp et al. 2001).
Amphibole monzogranite-granodiorite – **Ba** 1199, **Co** 3, **Cr** 5,**Cu** 25, **Ga** 16, **Hf** 7.1, **Ni** 49, **Nb** 13, **Pb** 13, **Rb** 97, **Sr** 320, **Ta** 0.9, **Th** 10.4, **U** 4.6, **V** 173, **Y** 16, **Zn** 49, **Zr** 190, **W** 17.6, **La** 26.9, **Ce** 60, **Nd** 29, **Sm** 5.9, **Eu** 0.91, **Tb** 0.88, **Yb** 2.7, **Lu** 0.62 (Kopp et al. 2001).
Tonalite-quartz diorite – **Ba** 789, **Co** 16, **Cr** 9, **Cu** 16, **Ga** 20, **Hf** 13.5, **Ni** 12, **Nb** 16,**Pb** 7, **Rb** 84, **Sr** 449, **Ta** 1.1, **Th** 4.1, **U** 2.3, **V** 92, **Y** 16, **Zn** 124, **Zr** 190, **W** 3.4, **La** 30, **Ce** 75, **Nd** 46, **Sm** 10.1, **Eu** 1.38, **Tb** 1.57, **Yb** 3.9, **Lu** 0.95 (Kopp et al. 2001.)
Quartz monzonite-quartz monzodiorite – **Ba** 997, **Co** 3, **Cr** 8, **Cu** 34, **Ga** 14, **Hf** 3.9, **Ni** 22, **Nb** 11, **Pb** 53, **Rb** 128, **Sr** 317, **Ta** 1.6, **Th** 10.7, **U** 3.6, **V** 74, **Y** 30, **Zn** 31, **Zr** 187, **W** 5.1, **La** 26, **Ce** 72, **Nd** 22, **Sm** 3.6, **Eu** 0.83, **Tb** 0.40, **Yb** 0.97, **Lu** 0.16 (Kopp et al. 2001).
Quartz syenite – **Ba** 460, **Co** 8, **Cr** 20, **Cu** 8, **Ga** 17, **Hf** 4.6, **Ni** 9, **Nb** 15, **Pb** 10, **Rb** 162, **Sr** 83, **Ta** 0.8, **Th** 9.9, **U** 3.2, **V** 73, **Y** 27, **Zn** 43, **Zr** 150, **W** 15, **La** 33, **Ce** 66, **Nd** 27, **Sm** 4.1, **Eu** 1.01, **Tb** 0.35, **Yb** 1.10, **Lu** 0.20 (Kopp et al. 2001.)
Amphibole quartz syenite – **Ba** 420, **Co** 5, **Cu** 3, **Pb** 6, **Sr** 78, **Th** 9.8, **U** 11.5, **V** 69, **Zn** 42, **Zr** 133, **W** 12, (Kopp et al. 2001).
Diorite – **Ba** 449, **Co** 52, **Cr** 9, **Cu** 18, **Ga** 17.5, **Hf** 4.5, **Ni** 31, **Nb** 12, **Pb** 18, **Rb** 110, **Sr** 575, **Ta** 0.6, **Th** 4.1, **U** 2.3, **V** 185, **Y** 43.6, **Zn** 142, **Zr** 212, **W** 10.5, **La** 29, **Ce** 65, **Nd** 37, **Sm** 6.9, **Eu** 17, **Tb** 0.4, **Yb** 2.9, **Lu** 0.4 (Kopp et al. 2001).

Gabbro – **Ba** 273, **Co** 37, **Cr** 29, **Cu** 32, **Ga** 22, **Hf** 5.4, **Ni** 12, **Nb** 0.5, **Pb** 4, **Rb** 8, **Sr** 558, **Ta** 0.1, **Th** 0.6, **U** 0.2, **V** 436, **Y** 37, **Zn** 101, **Zr** 61, **W** 1.2, **La** 8, **Ce** 20, **Nd** 14, **Sm** 2.8, **Eu** 1.09, **Tb** 0.5, **Yb** 2.7, **Lu** 0.4 (Kopp et al. 2001).

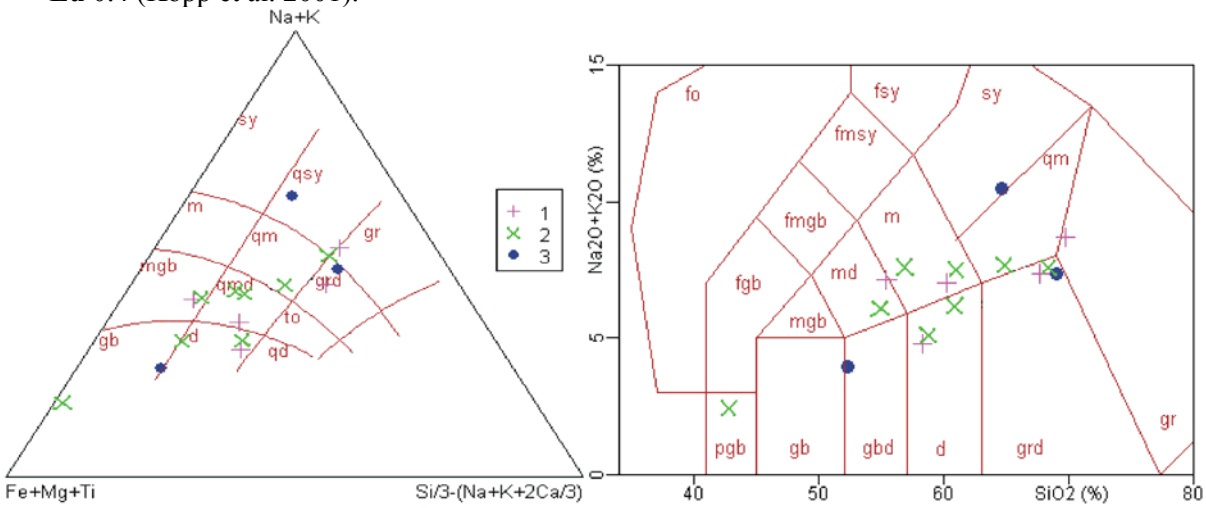

Fig. 4. 13. *Pretzsch-Prettin-Schőnewalde intrusions ABQ and TAS diagrams. 1 – Pretzsch Massif, 2 – Prettin Massif, 3 – Schönewalde Stock.*

4.5. DESSAU STOCK

Regional position: Mid-German Crystalline Rise. A member of the hidden Delitzsch Complex (under a sedimentary cover – see Fig. 4.12.).

Rock types:

Dessau Gabbro

Dessau Granite – medium-grained porphyritic granite (I type).

Size and shape (on erosion level): 13 km^2 tectonically segmented irregular subsurface stock under a sedimentary cover.

Age and isotopic data:

Dessau Granite 328 ± 1 Ma (Pb-Pb zircon).

Mineralization: not known.

References

ANTHES, G. – REISCHMANN, T. (2001): Timing of granitoid magmatism in the eastern mid-German crystalline rise. – J. Geodynamics 31, 119–143.

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Böhmischen Massivs. Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.

RÖLLIG, G. – BRÄUER, H. – VIEHWEG, M. ET AL. (1990): Altersstellung und petrographische Charakteristik der Plutonite im Gebiet des Zentralteils der mitteldeutschen Schwelle. – Z. angew. Geol. 36, 208–212.

4.6. PRETTIN MASSIF

Regional position: Mid-German Crystalline Rise. A member of the hidden Delitzsch Complex (under a sedimentary cover – see Fig. 4.12.).

Rock types:

1. *Prettin Granite* – granite to granodiorite.
2. *Prettin Quartz monzonite* – quartz monzonite to quartz monzodiorite.
3. *Prettin Tonalite* – tonalite to quartz diorite.
4. *Prettin Diorite* – diorite to gabbro.

Size and shape: 20 km^2, tectonically segmented circular massif under a sedimentary cover.

Age and isotopic data: *Prettin Granite* 330 ± 3 Ma (Pb-Pb zircon), *Prettin Granodiorite* 536 ± 19 Ma (Rb-Sr whole rock), *Prettin Diorite* 495 ± 3 Ma (Rb-Sr whole rock).

Mineralization: not known.

References

HAASE, G. – BIELICKI, K.-H. – RÖLLIG, G. – GERSTENBERGER, H. – HABEDANK, M, – HILLER, H. (1989): Rb-Sr and Pb-Pb geochronology of plutonic rocks from the central German crystalline zone and adjacent regions. In: Wand, U. – Strauch, G. Eds: Proceedings of the Fifth Working Meeting "Isotopes in Nature", 131–142. – Inst. Isotope and Radiation Res., Leipzig.

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Böhmischen Massivs. Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.

KOPP, J. – NAUMANN, R. – NIETZSCHE, H. (2001): Die Mitteldeutsche Kristallinzone (MKZ) zwischen Saale und Neisse: Petrologische Aspecte zur Plutonitgenese. In: Tectonic and Magma 2001 IGCP Project 373, Abstract Vol., 23–26. – Berlin.

KOPP, J. – RÖLLIG, G. (1996): Probleme des basischen und intermediären Magmatismus im Plutonit-massif von Pretzsch-Prettin-Schönewalde (Zentralteil der Mitteldeutschen Kristallinzone). – Z. geol. Wiss. 24, 551–568.

RÖLLIG, G. – BRÄUER, H. – VIEHWEG, M. et al. (1990): Altersstellung und petrographische Charakteristik der Plutonite im Gebiet des Zentralteils der Mitteldeutschen Schwelle. – Z. angew. Geol. 36, 208–212.

Prettin Massif

Prettin Granodiorite – quartz-normal, sodic, metaluminous, mesocratic granodiorite
Prettin Quartz Monzonite – quartz-normal, potassic, metaluminous, mesocratic quartz monzonite
Prettin Quartz Monzonite – quartz-normal, sodic/potassic, metaluminous, melanocratic quartz monzonite
Prettin Tonalite – quartz-normal, sodic, peraluminous, melanocratic tonalite
Prettin Quartz Diorite – quartz-normal, sodic, peraluminous, melanocratic diorite
Prettin Diorite – quartz-normal, potassic, peraluminous, melanocratic diorite

	Grano-diorite	**Quartz monzonite**	**Quartz monzonite**	**Tonalite**	**Quartz diorite**	**Diorite**
SiO_2	66.50	62.20	58.60	57.40	55.30	52.90
TiO_2	0.44	0.61	0.70	0.83	1.10	1.07
Al_2O_3	15.20	14.60	14.80	17.20	16.60	16.30
Fe_2O_3	0.97	1.11	5.81	7.75	8.60	0.93
FeO	2.12	3.50	n.d.	n.d.	n.d.	7.10
MnO	0.07	0.11	0.09	0.13	0.25	0.21
MgO	1.32	2.40	3.84	3.70	4.32	5.60
CaO	3.06	3.78	4.60	5.34	3.34	5.96
Na_2O	4.40	2.60	3.00	2.90	3.80	2.10
K_2O	2.97	4.74	4.20	2.10	3.60	3.74
P_2O_5	0.16	0.31	0.38	0.32	0.30	0.37
Mg/(Mg+Fe)	0.43	0.48	0.56	0.48	0.49	0.55
K/(K+Na)	0.31	0.55	0.48	0.32	0.38	0.54
Nor.Q	19.95	16.49	10.90	16.78	6.84	1.49
Nor.Or	18.59	31.17	27.61	13.66	23.53	26.41
Nor.Ab	41.85	25.98	29.98	28.67	37.75	22.54
Nor.An	14.97	18.60	22.61	26.85	16.15	32.43
Na+K	205.05	184.54	185.98	138.17	199.06	147.17
*Si	127.50	115.59	84.43	116.79	68.03	75.45
K-(Na+Ca)	-133.49	-50.66	-89.66	-144.22	-105.75	-94.64
Fe+Mg+Ti	79.94	129.84	176.84	199.31	228.72	262.88
Al-(Na+K+2Ca)	-15.68	-32.64	-59.40	9.16	7.81	-39.63

(Na+K)/Ca	3.76	2.74	2.27	1.45	3.34	1.38
A/CNK	0.96	0.92	0.85	1.05	1.05	0.91

Trace elements (mean values in ppm): *Prettin Monzogranite* – **Ba** 610, **Co** 6.0, **Cs** 4.8, **Ga** 18, **Hf** 7.3, **Nb** 11, **Pb** 23, **Rb** 180, **Sc** 7.1, **Sr** 246, **Ta** 1.4, **Th** 29.0, **U** 10.6, **V** 36, **Y** 17, **Zn** 55, **Zr** 249, **La** 58, **Ce** 105, **Nd** 40, **Sm** 7.0, **Eu** 1.41, **Tb** 0.8, **Yb** 1.9, **Lu** 0.28 (Hammer et al. 1999.)
Prettin Quartz monzonite – **Ba** 1263, **Co** 18.0, **Cs** 5.6, **Ga** 17, **Hf** 5.4, **Nb** 13, **Pb** 20, **Rb** 178, **Sc** 20.0, **Sr** 338, **Th** 18.3, **U** 5.2, **V** 120, **Y** 23, **Zn** 67, **Zr** 179, **La** 36, **Ce** 67, **Nd** 33, **Sm** 7.3, **Eu** 1.48, **Tb** 0.83, **Yb** 2.4, **Lu** 0.36 (Hammer et al. 1999).
Prettin Tonalite – **Ba** 630, **Co** 21.0, **Cs** 4.8, **Ga** 20, **Hf** 3.2, **Nb** 8, **Pb** 18, **Rb** 97, **Sc** 22.0, **Sr** 503, **Th** 8.0, **U** 2.5, **V** 161, **Y** 16, **Zn** 98, **Zr** 177, **La** 16, **Ce** 36, **Nd** 20, **Sm** 5.3, **Eu** 1.38, **Tb** 1, **Yb** 2.9, **Lu** 0.41 (Hammer et al. 1999).
Prettin Quartz diorite – **Ba** 1428, **Co** 21.0, **Ga** 20, **Hf** 4.0, **Nb** 14, **Pb** 15, **Rb** 133, **Sc** 22.0, **Sr** 282, **Th** 61.0, **U** 2.0, **V** 152, **Y** 31, **Zn** 127, **Zr** 261, **La** 29, **Ce** 58, **Nd** 29, **Sm** 5.8, **Eu** 1.34, **Tb** 0.75, **Yb** 2.2, **Lu** 0.3 (Hammer et al. 1999).

4.7. SCHÖNEWALDE STOCK

Regional position: Mid-German Crystalline Rise. A member of the hidden Delitzsch Complex (under a sedimentary cover – see Fig. 4.12.).

Rock types:

1. *Schönewalde Granite* – granite to granodiorite.
2. *Schönewalde Quartz monzonite* – quartz monzonite to quartz monzodiorite.
3. *Schönewalde Diorite* – diorite.

Size and shape: 13 km^2, tectonically outlined rectangular subsurface stock.

Age and isotopic data: *Schönewalde Granite* 336 ± 4 Ma (Pb-Pb zircon).

Mineralization: not known.

References

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Böhmischen Massivs. Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.

KOPP, J. – NAUMANN, R. – NIETZSCHE, H. (2001): Die Mitteldeutsche Kristallinzone (MKZ) zwischen Saale und Neisse: Petrologische Aspecte zur Plutonitgenese. In: Tectonic and Magma 2001 IGCP Project 373, Abstract Vol., 23–26. – Berlin.

KOPP, J. – RÖLLIG, G. (1996): Probleme des basischen und intermediären Magmatismus im Plutonitmassiv von Pretzsch-Prettin-Schönewalde (Zentralteil der Mitteldeutschen Kristallinzone). – Z. geol. Wiss., 24, 551–568.

RÖLLIG, G. – BRÄUER, H. – VIEHWEG, M. et al. (1990): Altersstellung und petrographische Charakteristik der Plutonite im Gebiet des Zentralteils der Mitteldeutschen Schwelle. – Z. angew. Geol. 36, 208–212.

Schönewalde Stock

Schönewalde Granodiorite – quartz-normal, sodic, metaluminous, mesocratic granodiorite
Schönewalde Quartz Monzonite – quartz-normal, potassic, peraluminous, mesocratic quartz monzonite
Schönewalde Diorite – quartz-normal, sodic, metaluminous, melanocratic diorite

	Granodiorite	**Quartz monzonite**	**Diorite**
SiO_2	66.40	62.00	50.70
TiO_2	0.40	0.53	1.21
Al_2O_3	14.40	17.00	17.60
Fe_2O_3	1.86	2.28	1.31
FeO	1.50	1.70	7.30
MnO	0.07	0.08	0.14

MgO	1.20	0.70	5.80
CaO	3.15	1.51	8.69
Na_2O	3.70	3.70	2.60
K_2O	3.37	6.33	1.24
P_2O_5	0.13	0.14	0.34
Mg/(Mg+Fe)	0.40	0.25	0.55
K/(K+Na)	0.37	0.53	0.24
Nor.Q	23.61	12.12	0.00
Nor.Or	21.31	39.54	8.66
Nor.Ab	35.56	35.13	27.60
Nor.An	15.81	6.95	48.33
Na+K	190.95	253.80	110.23
*Si	139.98	72.21	67.74
K-(Na+Ca)	-104.02	-11.92	-212.53
Fe+Mg+Ti	78.98	76.25	277.14
Al-(Na+K+2Ca)	-20.51	26.19	-74.52
(Na+K)/Ca	3.40	9.43	0.71
A/CNK	0.94	1.10	0.84

Trace elements (mean values in ppm): *Schönewalde Granite* – **B** 36, **Ba** 619, **Be** 3, **Co** 7.2, **Cr** 18, **Cu** 20, **Ga** 14, **Li** 47, **Ni** 3.2, **Nb** 9.8, **Pb** 11, **Rb** 136, **Sc** 8, **Sn** 4.2, **Sr** 247, **V** 42, **W** 4.4, **Y** 22, **Zn** 69, **Zr** 170 (Kopp and Röllig 1996).
Schönewalde Quartz monzonite – **B** 30, **Ba** 1217, **Be** 5.6, **Co** 9, **Cr** 17, **Cu** 31, **Ga** 15, **Li** 50, **Ni** 5.3, **Nb** 19, **Pb** 16, **Rb** 199, **Sn** 5, **Sr** 235, **V** 37, **W** 3.9, **Y** 44, **Zn** 59, **Zr** 577 (Kopp and Röllig 1996).
Schönewalde Diorite – **B** 12, **Ba** 449, **Be** 2.9, **Co** 26, **Cr** 141, **Cu** 30, **Ga** 17, **Li** 36, **Ni** 32, **Nb** 5, **Pb** 7.4, **Rb** 45, **Sn** 6.8, **Sr** 547, **V** 198, **W** 1.5, **Y** 35, **Zn** 90, **Zr** 168 (Kopp and Röllig 1996).

4.8. DAHLEN-LASSE MASSIF

Regional position: Mid-German Crystalline Rise. A member of the hidden Delitzsch Complex (under a sedimentary cover – see Fig. 4.12.).

Rock types:
Dahlen-Lasse Granodiorite – granodiorite.

Size and shape: 80 km^2, tectonically outlined rectangular subsurface stock.

Age and isotopic data: *Dahlen-Lasse Granodiorite* 530 ± 4 Ma (Pb-Pb zircon).

Mineralization: not known.

References

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Böhmischen Massivs – Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.

RÖLLIG, G. – BRÄUER, H. – VIEHWEG, M. et al. (1990): Altersstellung und petrographische Charakteristik der Plutonite im Gebiet des Zentralteils der Mitteldeutschen Schwelle. – Z. angew. Geol. 36, 208–212.

4.9. SCHLIDAU STOCK

Regional position: North-Saxonian Anticlinorium (under a sedimentary cover – see Fig. 4.12.).

Rock types: *Schlidau Granodiorite* – granodiorite.

Size and shape (on erosion level): tectonically outlined subsurface oval stock, 21 km^2.

Age and isotopic data: *Schlidau Granodiorite* 550 ± 4 Ma (Pb-Pb zircon).

Mineralization: not known.

References

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Böhmischen Massivs. Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.

4.10. LEIPZIG-EILENBURG MASSIF

Regional position: North-Saxonian Anticlinorium (under a sedimentaray cover – see Fig. 4.12.).

Rock types: *Leipzig-Eilenburg Granodiorite.*

Size and shape: seven separate, tectonically segmented subsurface stocks, 55 km^2.

Age and isotopic data: *Leipzig-Eilenburg Granodiorite* 555 ± 4 Ma (Pb-Pb zircon).

Mineralization: not known.

References

HAMMER, J. – EIDAM, J. – RÖBER, B. – EHLING, B. D. (1999): Prävariszischer und variszischer granitoider Magmatismus am NE-Rand des Böhmischen Massivs. Geochemie und Petrogenese. – Z. geol. Wiss. 27, 401–415.

RÖLLIG, G. – BRÄUER, H. – VIEHWEG, M. et al. (1990): Altersstellung und petrographische Charakteristik der Plutonite im Gebiet des Zentralteils der Mitteldeutschen Schwelle. – Z. angew. Geol., 36, 208–212.

Trace elements (mean values in ppm): *Leipzig-Eilenburg Granodiorite* – **Ba** 730, **Co** 9, **Cr** 28, **Cs** 5.8, **Cu** 25, **Ga** 19, **Hf** 5.4, **Ni** 57, **Nb** 13, **Pb** 25, **Rb** 135, **Sc** 9.9, **Sr** 131, **Th** 9.3, **U** 26, **V** 52, **Y** 42, **Zn** 78, **Zr** 211, **La** 34, **Ce** 67, **Nd** 30, **Sm** 6.2, **Eu** 1.07, **Tb** 0.7, **Yb** 2.1, **Lu** 0.31 (Hammer et al. 1999).

D. KRKONOŠE-JIZERA REGION

Also termed, as the Krkonoše-Jizera Block comprises several plutonic series and suites grouped into several Cadomian metamorphosed intrusions and a large Variscan granite massif (e.g. Krkonoše-Kowary Orthogneiss, the Bítouchov Metagranite, Paczyn Gneisses, and Krkonoše-Jizera Composite Massif).

4.11. JIZERA-KRKONOŠE–KOWARY ORTHOGNEISSES

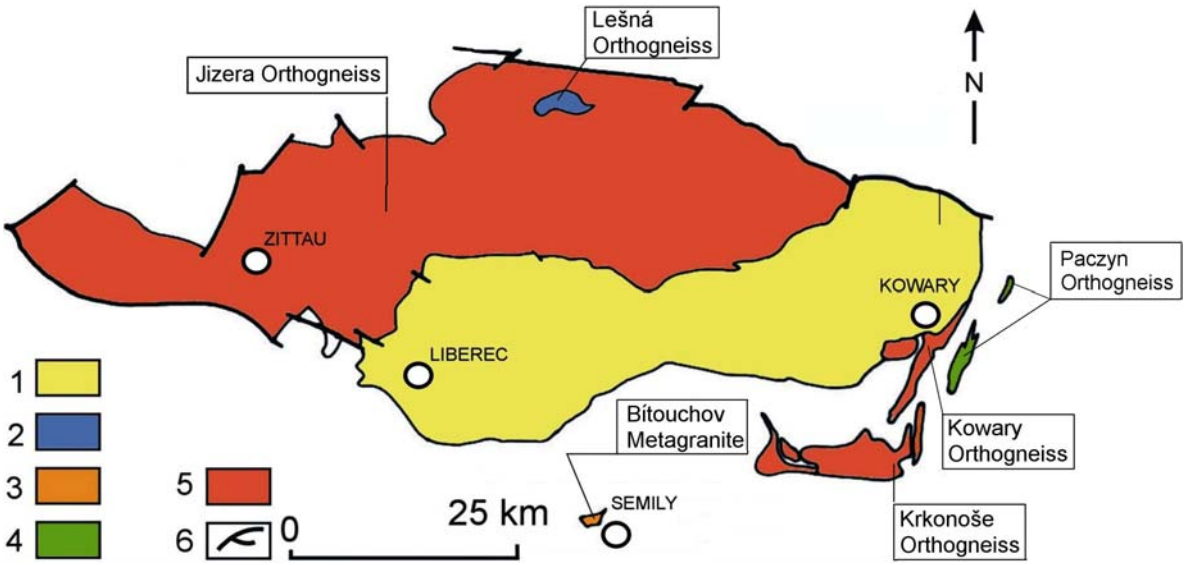

Fig. 4.14. *Jizera-Krkonoše-Kowary Orthogneiss, Paczyn Gneiss and the Krkonoše-Jizera Composite Massif geological sketch-map (after Kozdrój et al. 2001). 1 – Krkonoše-Jizera Composite Massif, 2 – Lešná Orthogneiss, 3 – Bítouchov Metagranite, 4 – Paczyn Orthogneiss, 5 – Jizera-Krkonoše-Kowary Orthogneiss, 6 – faults.*

Regional position: Jizera-Krkonoše region of the Lugicum. A large metamorphosed intrusion (segment of the Lusatian Composite Batholith) separated by the Upper Carboniferous Krkonoše-Jizera Composite Massif into the Jizera Orthogneiss and Krkonoše Orthogneiss. These rocks are interpreted in terms of magmatic origin. The Jizera Orthogneiss derives from the Rumburk Granite and the Zawidów Granodiorite.

Rock types:

1. *Jizera-Krkonoše Orthogneiss* – augen to laminated granitic orthogneiss.
2. *Lešná Gneiss* – granodiorite orthogneiss (Cadomian member of the Radeberg-Löbau Complex of the Lusatian Composite Batholith).
3. *Kowary Orthogneiss.*
4. *Leucocratic Orthogneisses.*

Size and shape (on erosion level): 1500 km^2, numerous elongated bodies of various size from tens metres to few kilometres thick (reaching the depth of 6 km). The Jizera Orthogneiss passes to the west into the Zawidow Granodiorite and the Rumburk Granite.

Age and isotopic data: *Jizera Orthogneiss* (derivate of the Rumburk Granite) 335–328 Ma and 334 ± 2 Ma (Ar-Ar micas), 504.6 ± 1.2 Ma (Pb-Pb zircon), 462 ± 15 Ma (Rb-Sr whole rock), *Jizera-Krkonoše Orthogneisses* 481 Ma (U-Pb, Pb-Pb zircon), 509–490 Ma (Pb-Pb single zircon), 501.5 ± 1.1 Ma (Pb-Pb zircon), 503.2 ± 1.0 Ma (Pb-Pb zircon), 320-310 Ma ages (Rb-Sr micas) are probably products of isotopic resetting, *Lešná Orthogneiss* 540 ± 19–21 Ma (Pb-Pb zircon), *Kowary Orthogneiss* 492–481 Ma (U-Pb zircon), 487 ± 8 Ma (U-Pb SHRIMP zircon) – the best approximation of the protolith intrusive age, *Leucogneiss* 473 ± 16 Ma (Rb-Sr whole rock), *Pleterówka (Zawidów Granodiorite or Lešná Orthogneiss) Granodiorite* 533 ± 9 Ma (U-Pb zircon).

Contact aureole: contacts of orthogneisses with the surrounding metapelitic lithologies are mostly tectonic in nature; however, primary intrusive contact cannot be excluded.

Geological environment: both Proterozoic–Cambrian to Lower Ordovician metasedimentary sequences. The Jizera Gneiss is bordered by the late-Variscan Krkonoše-Jizera Composite Massif to the south.

Mineralization: Sn greisens?

Jizera –Krkonoše and Kowary Orthogneisses

Quartz-rich, sodic-potassic, weakly peraluminous, leucocratic, S–type, M-series, granite

n = 8	Median	Min	Max	QU1	QU3
SiO_2	75.06	70.22	77.95	73.15	76.99
TiO_2	0.10	0.07	0.47	0.08	0.13
Al_2O_3	13.24	12.31	14.94	12.68	13.57
Fe_2O_3	0.84	0.35	2.32	0.47	0.92
FeO	0.70	0.60	1.12	0.62	0.79
MnO	0.03	n.d.	0.11	0.01	0.06
MgO	0.21	0.14	1.00	0.16	0.44
CaO	0.38	0.25	0.90	0.33	0.40
Na_2O	2.94	1.34	4.39	2.59	3.17
K_2O	4.65	2.54	5.11	3.62	4.98
P_2O_5	0.19	0.13	0.25	0.17	0.20
Mg/(Mg+Fe)	0.21	0.16	0.40	0.17	0.28
K/(K+Na)	0.49	0.35	0.71	0.35	0.53
Nor.Or	28.23	15.59	31.37	22.05	30.92
Nor.Ab	27.32	12.83	40.64	24.05	29.58
Nor.An	0.53	-0.08	3.60	0.19	0.71
Nor.Q	38.28	26.64	47.55	31.79	40.43
Na+K	191.01	148.98	218.52	156.22	203.37
*Si	220.65	160.34	272.30	187.63	234.18
K-(Na+Ca)	-7.38	-80.85	55.36	-54.25	7.74
Fe+Mg+Ti	27.67	17.96	70.77	21.80	32.80
Al-(Na+K+2Ca)	44.87	38.04	98.53	39.71	61.21
(Na+K)/Ca	26.55	13.24	44.95	13.62	28.06
A/CNK	1.23	1.19	1.65	1.21	1.34

Kowary Orthogneiss K1	
SiO_2	76.27
TiO_2	0.13
Al_2O_3	12.75
Fe_2O_3t	1.26
MnO	0.02
MgO	0.20
CaO	0.84
Na_2O	3.33
K_2O	4.20
P_2O_5	0.26
Mg/(Mg+Fe)	0.24
K/(K+Na)	0.45
Nor.Q	37.51
Nor.Or	25.46
Nor.Ab	30.68
Nor.An	2.52
Na+K	196.63
*Si	216.51
K-(Na+Ca)	-33.26
Fe+Mg+Ti	22.38
Al-(Na+K+2Ca)	23.79
(Na+K)/Ca	13.13
A/CNK	1.13

Trace elements (mean values in ppm): *Jizera Orthogneiss* – **Co** 37, **Sc** 7,**V** 35,**Cu** 21, **Pb** 17, **Zn** 63, **Sn** 4, **Ge** 1.9, **W** 259, **Rb** 218, **Cs** 6.3, **Ba** 355, **Sr** 72, **Be** 3.9, **Ga** 20, **Ta** 1.5, **Nb** 12, **Zr** 109, **Th** 18.2, **U** 6.6 (Oberc-Dziedzic et al. 2005).

Kowary Orthogneiss – **Ni** 3, **Co** 15, **Cu** 9, **Pb** 11, **Zn** 53, **Rb** 310, **Ba** 78, **Sr** 40, **Ga** 19, **Ta** 7.5, **Nb** 16.4, **Hf** 3.6, **Zr** 83, **Y** 32, **Th** 13.5, **U** 2.97.

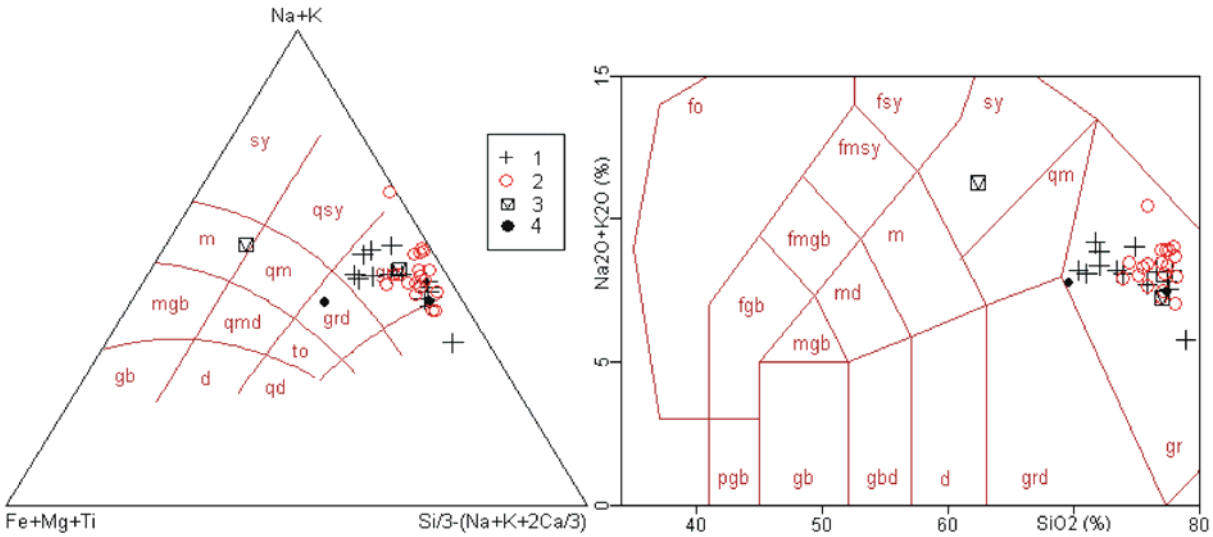

Fig. 4.15. *Jizera-Krkonoše Orthogneisses and Bítouchov Metagranite ABQ and TAS diagrams. 1 – Jizera-Krkonoše Orthogneisess, 2 – aplitic gneiss, 3 – Bítouchov Metagranite, 4 – Lešná Orthogneiss.*

References

BIAŁEK, D. (1998): Aspects of geochemistry of the Zawidow granodiorite and the Jizera granite-arc to rift transition. – Geolines 6, 11.

BORKOWSKA, M. – HAMEURT, J. – VIDAL, P. (1980): Origin and age of Izera gneisses and Rumburk granites in the Western Sudetes. – Acta Geol. Pol. 30, 121–145.

GRYGAR, R. – VAVRO, M. – KREML, P. (1993): Kinematika krkonošské střižné zóny ve vztahu k regionální deformaci krkonošského krystalinika. – Sbor. věd. Prací Vys. Šk. Báňské v Ostravě 39, 85–96. (In Czech)

JECZMYK, M. – SUSKOWIAKOWA, M. (1989): Budowa geologiczna i charakterystyka geochemiczna skal krystalicznych okolia Bogatyni (Sudety zachodnyje). – Biul. Inst. Geol. 360, 5–38.

KOZLOWSKA-KOCH, M. (1961): The granite gneisses of Izera Highland. – Arch. mineral. 25, 123–260. (In Polish)

KRÖNER, A. – JAECKEL, P. – HEGNER, E. – OPLETAL, M. (2001): Single zircon ages and whole rock Nd isotopic systematics of early Palaeozoic granitoid gneisses from the Czech and Polish Sudetes (Jizerské hory, Krkonoše Mountains and Orlice-Sněžník Complex). – Int. J. Earth Sci. (Geol. Rdsch.) 90, 304–324.

KRÖNER, A. – JAECKEL, P. – OPLETAL, M. (1994): Pb-Pb and U-Pb zircon ages for orthogneisses from Eastern Bohemia: further evidence for a major Cambro-Ordovician magmatic event. – J. Czech Geol. Soc. 39, 61.

MARHEINE, D. – KACHLÍK, V. – MALUSKI, H. et al. (2002): The 40Ar/39Ar ages from the West Sudetes (NE Bohemian Massif): constraints on the Variscan polyphase tectonothermal development. In: Winchester, J. A. – Pharaoh, T. C. – Verniers, J. Eds: Palaeozoic Amalgamation of Central Europe. – Geol. Soc. London Spec. Publ. 201, 133–155.

OBERC-DZIEDZIC, T. (1988): The development of gneisses and granites in the eastern part of the Izera crystalline unit in the light of the textural investigation. – Acta Univ. wratislav. 997, Prace geol.-mineral. 13, 1–184.

OBERC-DZIEDZIC, T. (2003): The Izera granites: an attempt of the reconstruction of predeformational history. In: Ciężkowski, W. – Wojewoda, J.– Żelaźniewicz, A. Eds: Sudety Zachodnie: od wendu do czwartorzędu, 41–52. – WIND, Wroclaw. (In Polish).

OBERC-DZIEDZIC, T. – KRYZA, R. – MOCHNACKA, K. – LARIONOV, A. (2010): Ordovician passive continental margin magmatism in the Central-European Variscides: U-Pb zircon data from the SE part of the Karkonosze-Izera Massif, Sudetes, SW Poland. – Int. J. Earth Sci. (Geol. Rdsch.) 99, 27–46..

OBERC-DZIEDZIC, T. – PIN, C. – KRYZA, R. (2005): Early Palaeozoic crustal melting in an extensional setting: petrological and Sm-Nd evidence from the Izera granite-gneisses, Polish Sudetes. – Int. J. Earth Sci. (Geol. Rdsch.) 94, 354–368.

OLIVER, G. J. H. – KELLEY, S. (1993): ^{40}Ar- ^{39}Ar fusion age and isotopic data from the Polish Sudetes: Variscan tectonothermal reworking of Caledonian protoliths. – Neu. Jb. Geol. Paläont., Mh. 321–344.

PRZEWLOCKI, M. – THOMAS, H.-H. – FAUL, H. (1962): Age of some granitic rocks in Poland. – Geochim. cosmochim. Acta 26, 1069–1075.

SEDLÁK, J. – GNOJEK, I. – ZABADAL, S. – FARBISZ, J. – CWOJDZINSKI, S. – SCHEIBE, R. (2007): Geological interpretation of gravity low in the central of the Lugian unit (Czech Republic, Germany and Poland). – J. Geosci. 52, 181–198.

SMULIKOWSKI, K. (1958): Lupky mikowe i granitognejsy na polnocznych zboczach Pasma Kamenickiego w Sudetach zachodnich. – Biul. Paň. Inst. Geol. 127, 5–31.

ŽABA, J. (1982): Klasyfikacja i nomenklatura gneisów i granitów bloku Izerskiego (Sudety Zachodnie) – propozicja. – Geologica sudet. 17, 141–154.

ŽABA, J. (1982): Modes of plagioclase twinning in the polygenetic metamorphic complex of Izerski Stóg massif, Izera Block (Western Sudetes). – Acta Univ. Carol., Geol. 4, 273–287.

ŻELAŻNIEWICZ, A. – DÖRR, W. – BYLINA, P. – FRANKE, W. – HAAK, U. – HEINISCH, H. – SCHASTOK, J. – GRANDMOUNTAGNE, K. – KULICKI, C. (2004) The eastern continuation of the Cadomian orogen: U-Pb zircon evidence from Saxo-Thuringian granitoids in south-western Poland and northern Czech Republic. – Int. J. Earth Sci. 93, 773–781.

4.12. BÍTOUCHOV METAGRANITE

Regional position: Jizera-Krkonoše region of the Lugicum. The intrusion in the Železný Brod Metavolcanic Complex.

Rock types:

1. *Bítouchov Metagranite* – medium-grained (albite)-biotite granite (epizonally metamorphosed).
2. *Bítouchov Metagranite* – fine-grained hornblende (riebeckite?) albite granite.
3. *Diorite* – hornblende diorite – large lenticular enclave within the albite biotite granite.

Size and shape (on erosion level): 2 × 1 km, strong dynamic deformation along the contact (a broad zone up to 200 m wide of the foliated metagranite).

Age and isotopic data: synkinematic intrusion, similar to albite granites found as pebbles in the Upper-Ordovician metaconglo-merates 540 Ma (U-Pb zircon), mylonitized metagranite 352 ± 6 Ma (Ar-Ar muscovite).

Geological environment: the Bítouchov Granite is intruding the Cambrian Železný Brod Volcanic Complex.

Mineralization: not known.

References

FEDIUK, F. (1953): Geologicko-petrografické poměry v údolí Jizery mezi Spálovem a Bítouchovem (Železnobrodsko). – Sbor. Ústř. Úst. geol. 20, 505–576.

KETTNER, R. (1921): Geologie starého pohoří Železnobrodského v Podkrkonoší. – Sbor. St. geol. Úst. Čs. Republ. 1, 123–144.

MARHEINE, D. – KACHLÍK, V. – MALUSKI, H. et al. (2002): The 40Ar/39Ar ages from the West Sudetes (NE Bohemian Massif): constraints on the Variscan polyphase tectonothermal development. In: Winchester, J. A. – Pharaoh, T. C. – Verniers, J. Eds: Palaeozoic Amalgamation of Central Europe. – Geol. Soc. London Spec. Publ. 201, 133–155.

ŻELAŻNIEWICZ, A. – DÖRR, W. – BYLINA, P. – FRANKE, W. – HAACK, U. – HEINISCH, H. – SCHASTOK, J. – GRANDMONTAGE, K. – KULICKI, C. (2004): The eastern continuation of the Cadomian orogen: U-Pb zircon evidence from Saxo-Thuringian granitoids in south-western Poland and the northern Czech Republic. – Int. J. Sci. (Geol. Rdsch.) 93, 773–781.

4.13. PACZYN ORTHOGNEISS

Regional position: Jizera-Krkonoše Region of the Lugicum. Equivalent of the Krkonoše Orthogneiss.

Rock types:

1. *Paczyn Orthogneiss* (felsic Orthogneisses) – Na-rich albite granodiorite and metagranite.
2. *Paczyn Quartz-amphibolites* (hornblende orthogneiss) – quartz-bearing gabbro, quartz-diorite and tonalite.

Size and shape (on erosion level): 20 km^2, sill-like intrusion.

Age and isotopic data: *Paczyn Orthogneiss* 505 ± 5 Ma and 494 ± 2 (U-Pb zircon).

Geological environment: in the East Krkonoše Metabasite Complex. Chemically close to both the oceanic plagiogranites and the anatectic magmatites related to a volcanic arc environment.

Mineralization: not known.

References

KRYZA, R. – PIN, C. (1997): Cambrian/Ordovician magmatism in the Polish Sudetes: no evidence for subduction-related setting. – Terra Nova 9, Abstract Supl. 1, pp. 144.

NAREBSKI, W. (1968): Geochemistry and the problem of origin of metabasic rocks of the Rudawy Janowickie Mts. (E. Karkonosze). – Bull. Acad. Pol. Sci., Sér. Sci. Géol. Géogr. 16, 1–7.

NAREBSKI, W. – DOSTAL, J. – DUPUY, C. (1986): Geochemical characteristics of Lower Palaeozoic spilite-keratophyre series in West Sudetes (Poland): petrogenetic and tectonic implications. – Neu. Jb. Mineral., Abh. 155, 243–258.

NAREBSKI, W. – TEISSEYRE, J. H. (1971): On petrogenesis of the Paczyn gneisses in the West Sudetes. – Bull. Acad. Pol. Sci., Sér. Sci. Géol. Géogr. 19, 193–203.

OLIVER, G. J. H. – CORFU, F. – KROGH, T. E. (1993): U-Pb Ages from SW Poland: evidence for a Caledonian suture zone between Baltica and Gondwana. – Jb. Geol. Soc. London 150, 355–369.

PATOČKA, F. – SMULIKOWSKI, W. (1998): The geochemical correlation of the East Krkonoše Complex metabasites (West Sudetes, Czech Republic and Poland) – relation to the Cambrian-Ordovician northern Gondwana break-up: A review. – Acta Univ. Carol., Geol. 42, 485–488.
SMULIKOWSKI, W. – ULICYN, L. – BACHLIŃSKI, R. (2002): Paczyn Gneisses (East Karkonosze Complex. West Sudetes). Two metamorphosed series: 1. Quartz-bearing gabbro to tonalite, 2. Leucotonalite; Petrography and major element chemistry. – Mineral. Soc. Pol. Spec. Pap. 20, 205–207.
SZALAMACHA, M. – SZALAMACHA, M. (1991): Ofiolit Leszczyńca w Rudawach Janowickich. – Biul. Inst. Geol. 367, 61–84.

4.14. KRKONOŠE-JIZERA COMPOSITE MASSIF (KJCM)

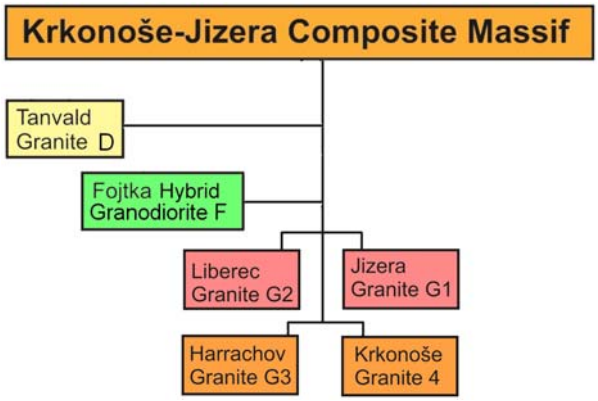

Fig. 4.16. *Krkonoše-Jizera Composite Massif hierarchical scheme according to rock types.*

Regional position: Krkonoše-Jizera Crystalline Complex – Proterozoic-Lower Palaeozoic metasediments, metavolcanics and orthogneisses.

Rock types:

Composite Massif of three plutonic suites:

<u>Suite A:</u>

1. *Jizera Granite* – porphyritic medium-grained biotite granite to granodiorite (G1).
2. *Liberec Granite* – porphyritic coarse-grained biotite granite (G2).
3. *Harrachov Granite* – medium-grained biotite granite (G3).
4. *Krkonoše Granite* – fine-grained biotite granite (G4).

<u>Suite B:</u>

1. *Fojtka Hybrid Granodiorite* – porphyritic medium to fine-grained hornblende-biotite granodiorites to quartz diorite (F).

<u>Suite C:</u>

1. *Tanvald Granite* – medium-grained two-mica alkali-feldspar granite (D).

In Polish part of the KJCM four main granite facies predominate (Borkowska 1966):

1. Porphyritic coarse-grained granite,
2. Medium-grained granite,
3. Fine-to medium, equigranular granite
4. Granophyric granite.

Size and shape (on erosion level): over 1000 km^2 (70 × 10–20 km), long elliptical shape. An inclined (from N to S) wedge-like (assymetric) ethmolith (in thickness of 4 to 10 km) has been interpreted from the gravity data for the Krkonoše-Jizera Composite Massif. The depth of magma solidification is about 5–7 km (Dudek et al. 1991).The shape of the Tanvald Granite can be modelled as steeply inclined slab in length of ca 25 km with approximate thickness of some 2–3 km (based on gravity data).

Age and isotopic data: *Jizera and Liberec Granite* 304–293 Ma (K-Ar biotite), 328, 312 ± 6 Ma and 330–325 Ma (Rb-Sr whole rock), 304 ± 14 Ma (Pb-Pb zircon), 320 ± 2 Ma (Ar-Ar biotite), *Krkonoše Granite* 310 ± 5 Ma (Rb-Sr whole rock), *Fojtka Hybrid Granodiorite* 310 Ma (K-Ar biotite), *Tanvald Granite* is intruded by the Liberec Granite 312 ± 2 Ma (Ar-Ar muscovite), 321± 14 Ma (U-Th-Pb monazite). Micromonzodiorite dyke within the Krkonoše Granite in Polish part of the massif 318 (SHRIMP U-Pb zircon). Porphyritic (Radomierza) granite 318.5 ± 3.7 Ma (SHRIMP U-Pb zircon). Even-grained (Meidzianka) granite 314.9 ± 4.5 Ma (SHRIMP U-Pb zircon). Medium-grained (Fajka Hill) granite 314.1 ± 3.3 Ma (SHRIMP U-Pb zircon), 304 ± 2 Ma (SHRIMP U-Pb reequilibrated zircon from a microgranular enclave).

Kusiak et al. (2008): medium-grained porphyritic granite – 313.0 ± 6.0 Ma (U-Pb zircon, SHRIMP). Coarse-grained porphyritic granite – 308.7 ± 4.7 Ma (U-Pb zircon, SHRIMP). Fine-grained granite 303.7 ± 6.6 Ma (U-Pb zircon, SHRIMP).

Zoning: well defined subhorizontal compositional and structural reverse zoning (layering) – Jizera Granodiorite (upper layer) and the Liberec granite (lower layer). Younger (G3 and G4) phases are asymmetrically located along southern and eastern margins. N-S stratification and distinct asymmetric zoning of the Tanvald Granite. Transition of the porphyritic muscovite - biotite granite at the northern endocontact with the

Liberec Granite into highly evolved (high Rb and F content) biotite-muscovite granite in the southern part of the Tanvald intrusion.

Contact aureole: pronounced up to 1.5 km wide zone, – biotite (hornblende) hornfelses, spotted schists with cordierite and andalusite in contact with the Tanvald Granite and Proterozoic-Lower Palaeozoic metasediments. Almost sharp (intrusive) sub-vertical southern contact plane of the Liberec Granite with the Tanvald Granite.

Geological environment: Neoproterozoic two-mica schists and amphibolites, Cambrian-Ordovician Jizera Orthogneiss and Ordovician-Silurian to Lower Devonian phyllites.

Mineralization: W-Sn, Ba-F, U, Co, Cu, Ag.

Heat production (μWm^{-3}): *Tanvald Granite* 5.53, 2.81, *Liberec Granite* 3.95.

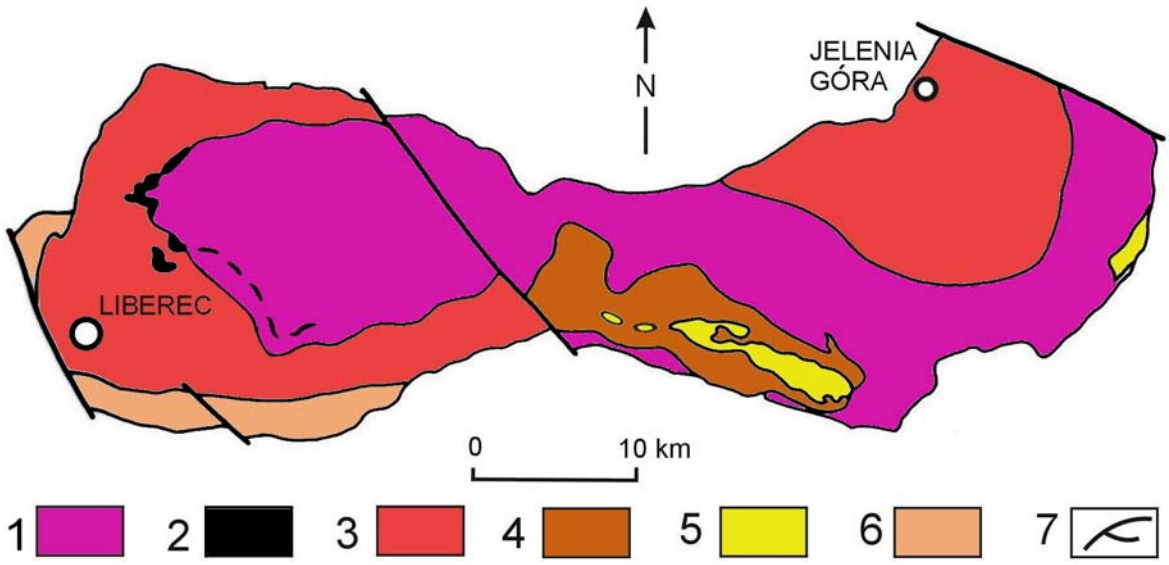

Fig. 4.17. *Krkonoše-Jizera Composite Massif geological sketch-map (adapted after Kozdrój et al. 2001). 1 – Jizera Granite, 2 – Fojtka Granodiorite, 3 – Liberec Granite, 4 – Harrachov Granite, 5 – Krkonoše Granite, 6 – Tanvald Granite, 7 – faults.*

References

AWDANKIEWICZ, M. – AWDANKIEWICZ, H. – KRYZA, R. (2005): Petrology of mafic and felsic dykes from the eastern part of the Karkonosze massif. – Pol. Tow. Mineralog. Prace Spec. 26, 111–114.

BORKOWSKA, M. (1966): Petrografia granitów Karkonoszy. – Geologica sudet. 2, 7–108.

CLOOS, H. (1925): Einführung in die tectonische Behandlung magmatisher Erscheinungen (Granittektonik). –194 pp. Berlin.

CHALOUPSKÝ, J. (1963): Konglomeráty z krkonošského krystalinika. – Sbor. Ústř. Úst. geol., Odd. geol. 28, 143–190.

CHALOUPSKÝ, J. et al. (1989): Geology of the Krkonoše and Jizerské hory Mts. – 288 pp. Czech Geol. Survey, Prague.

DEPCIUCH, T. – LIS, J. (1971): Wiek bezwzgledny K-Ar granitoidów masywu Karkonoszy. – Kwart. Geol. 15, 856–861.

DIOT, H. – MAZUR, S. – COUTERIE, J. P. (1994): Magmatic structures in the Karkonosze granite. In Kryza, F. Ed.: Magmatisme et evolution métamorphique des Sudetes, 36–39. – Uniw. Wrocł., Inst. Nauk Geol. Wrocław.

DIOT, H. – MAZUR, S. – PIN, CH. (1995): Karkonosze Batholith (NE Bohemian Massif): the evidence for pluton emplacement during transtensional-extensional collapse. – J. Czech. Geol. Soc. 40, p. 62.

DIOT, H. – MIERZEJEWSKI, M. (1994): The magnetic fabric in the Karkonosze granite. In: Kryza F. Ed.: Magmatisme et evolution metamorhique des Sudetes, 34–35. – Uniw. Wrocł., Inst. Nauk Geol. Wrocław.

DOWGIALLO, J. (2000): Thermal water prospecting results at Jelenia Góra-Cieplice (Sudetes, Poland) versus geothermometric forecasts. – Environ. Geol. 39, 433–435.

DUDEK, A. – FROLÍKOVÁ, I. – NEKOVAŘÍK, Č. (1991): The depth of intrusion of Hercynian granitoid plutons in the Bohemian Massif. – Acta Univ. Carol., Geol., Kettner Vol. 3–4, 249–256. (In Czech)

DUTHOU, J. L. – COUTERIE, J. P. – MIERZEJEWSKI, M. P. – PIN, C. (1991): Next dating of granite samples from the Karkonosze Mountains using Rb-Sr total rock isochrone method. – Przegl. Geol. 39, 75–79.

EIDAM, J. (1994): Geochronology and Nd-Sr systematics of Lusatian granitoids: significance for evolution of the Variscan orogen in east-central Europe. – Geol. Rdsch. 83, 357–376.

FEDIUKOVÁ, E. (1963): Těžké minerály v liberecké a železnobrodské žule. – Čas. Mineral. Geol. 8, 1, 12–20. (In Czech)

FEDIUKOVÁ, E. – KLOMÍNSKÝ, J. – SCHOVÁNEK, P. (2008): Almandine-Spesartine garnets from the alkali-feldspar Tanvald granite in northern Bohemia. – Zpr. geol. Výzk. v Roce 2007, 156–159. (In Czech)

FISTEK, J. – DOWGIALLO, J. (2003): Thermal waters at Cieplice Slaskie Spa in the light of geological investigations carried out in the years 1969–1973 and 1997–1998. In: Ciezkowski, A. et al. Eds: Sudety Zachodnie: od wendu do czwartorzedu, 207–224. – WIND, Wroclav.

GUNIA, P. – ZIOLKOWSKA-KOZDRÓJ, M. – KOZDRÓJ, W. (1998): New geochemistry data of ultrabasic rocks from eastern surroundings of the Karkonosze granite intrusion. – Bull. Pol. Acad. Sci., Earth Sci. 46, 93–108.

JARMOLOWICZ-SZULC, K. (1984): Geochronologiczne studium czesci pólnocnej oslony granitu Karkonoszy za pomoca metod trakowych. – Arch. mineral. 39, 2, 140–183.

JELIŃSKI, A. (1965): Geochemistry of the uranium in the Karkonosze Granite Massif and other granitoids massifs of Lower Silesia. – Biul. Inst. Geol. 193, 5, 5–110. (In Polish)

KENNAN, P. S. – DZIEDZIC, H. – LORENC, M. W. – MIERZEJEWSKI, P. (1999): A review of Rb-Sr isotope patterns in the Carboniferous granitoids of the Sudetes in SW Poland. – Geologica sudet. 32, 49–53.

KLAR, A. (1986): Stochastic model of Karkonosze granitoid crystallization in area near Szklarska Poreba, Sudetes Mts., Southwestern Poland. – Prace Mineral. 76, 1–69. (In Polish)

KLOMÍNSKÝ, J. (1969): Krkonošsko-jizerský granitoidní masiv. – Sbor. geol. Věd, Geol. 15, 7–133.

KLOMÍNSKÝ, J. (2006): Geothermal field in the western part of the Krkonoše-Jizera granite massif – fiction or reality? – Zpr. geol. Výzk. v Roce 2005, 179–181. (In Czech)

KLOMÍNSKÝ, J. – BĚLOHRADSKÝ, V. – FEDIUK, F. – SCHOVÁNEK, P. (2005): Vratislavický zlom – nový odkryv u Liberce v severních Čechách. – Zpr. geol. Výzk. v Roce 2004, 35–38. (In Czech)

KLOMÍNSKÝ, J. – FEDIUK, F. – SCHOVÁNEK, P. – JARCHOVSKÝ. T. (2009): Tanvald Massif – relict of the magmatic body in the Krkonoše-Jizera Composite Massif. – Zpr. geol. Výzk. v Roce 2008.

KLOMÍNSKÝ, J. – SCHOVÁNEK, P. – JARCHOVSKÝ, T. – SULOVSKÝ, P. – TOUŽIMSKÝ, M. (2007): Contact of the Tanvald and Liberec Granites near Jablonec nad Nisou. – Zpr. geol. Výzk. v Roce 2006, 24–29. (In Czech)

KRÖNER, A. – HEGNER, E. – HAMMER, J. – HAASE, G. – BIELICKI, K. H. – KRAUSS, M. – EIDAM, J. (1994): Geochronology and Nd-Sr systematics of Lusatian granitoids – significance for the evolution of the Variscan orogen in East- and Central-Europe. – Geol. Rdsch. 83, 357–376.

KUSIAK, M. A. – DUNKLEY, D. J. – SŁABY, E. – BUDZYŃ, B. – MARTIN, H. (2008a): Metasomatized zircon from the equigranular granite of the Karkonosze Pluton, NE Bohemian Massif. In: Proceedings MMET 2008 Conference: Mineral Equilibria, Metasomatism, and Mass Transport: Evolution and Stabilization of Rock on a Fluid-Rock World: Smolenice, Slovakia. 87–90. Geol. Inst. Slovak Acad. Sci. P. 87–90.

KUSIAK, M. A. – DUNKLEY, D. J. – SŁABY, E. – BUDZYŃ, B. – MARTIN, H. (2008b): U-Pb chronology of zircon from granites of the Karkonosze Pluton, NE Bohemian Massif. – 4th SHRIMP Workshop June 29. July. Abstract Volume, 78–80: Sankt Peterburg, Russia, VSEGEI (Russian Geol. Res. Inst.).

KUSIAK, M. A. – DUNKLEY, D. J. – SŁABY, E. – MARTIN, H. – BUDZYŃ, B. (2009): Sensitive high-resolution ion microprobe analysis of zircon reequilibrated by late magmatic fluids in a hybridised pluton. – Geology, 37, 12, 1063–1066.

KVIČÍNSKÝ, Z. (1986): Position of the Tanvald granite in relationship to the Krkonoše-Jizerské hory and Lužické hory Plutons. – Věst. Ústř. Úst. geol. 61, 361–365.

LORENC, M. W. (1994): Role of basic magmas in the granitoid evolution (a comparative study of some Hercynian massifs). – Geologica sudet. 28, 3–121.

LORENC, M. – OLSZYNSKI, W. – WISZNIEWSKA, J. (1998): Distribution of phosphorus in granites and pegmatites of the Sudetes Mts. and rapakivi granites from Mazury Complex (NE Poland). – Acta Univ. Carol., Geol. 42, 69–72.

MACHOWIAK, K. – AMSTRONG, R. (2007): SHRIMP U-Pb zircon age of the Karkonosze granite. – Mineral. Polonica, Spec. Pap., 31, 193-196.

MACHOWIAK, K. – AMSTRONG, R. – KRYZA R. – MUSZYŃSKI, A. – (2008): Late-orogenic magmatism in the Central Europea Variscides: SHRIMP U-Pb zircon age constraints from the Żeleżniak Intrusion, Kaczawa Mountains, West Sudetes. – Geologica sudet., 40, 1–18.

MALUSKI, H. – PATOČKA, F. (1997): Geochemistry and $^{40}Ar/^{39}Ar$ geochronology of the mafic metavolcanic rocks from the Rýchory Mountains complex (west Sudetes, Bohemian Massif): paleotectonic significance. – Geol. Mag. 134, 703–716.

MARHEINE, D. – KACHLÍK, V. – MALUSKI, H. et al. (2002): The 40Ar/39Ar ages from the West Sudetes (NE Bohemian Massif): constraints on the Variscan polyphase tectonothermal development. In: Winchester, J. A. – Pharaoh, T. C. – Verniers, J. Eds: Palaeozoic Amalgamation of Central Europe. – Geol. Soc. London Spec. Publ. 201, 133–155.

MÁŠKA, M. (1954): K tektonické analýze krystalinika (Drobná tektonika Krkonoš). – Knih. Ústř. Úst. geol. 27, 259 pp.

MAZUR, S. (1998): Variscan Thrusting and Extensional Collapse in the Krkonosze-Izera Massif, West Sudetes: Tectonic, Sedimentary and Magmatic Record. – Geolines 6, 43–44.

MAZUR, S. – ALEKSANDROWSKI, P. – TURNIAK, K. – AWDANKIEWICZ, M. (2007): Geology, tectonic evolution and Late Palaeozoic magmatism of Sudetes – an overview. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 59–87.

MICHNIEWITZ, M. – BOBIŃSKI, W. – SIEMĄRKOWSKI, J. (2006): Mineralizacja cynowa w środkowej części pasma łupkowego Starej Kamienicy (Sudety zachodnie). – Prace Pań. Inst. Geol. 185, 136 pp. (In Polish)

MIERZEJEWSKI, M. P. (1973): Rozwój i nastepstwo niektórych struktur w plutonie Karkonoszy. In: Oberc, J. Ed.: Przewodnik do konferencji terenowej Institutu Geologicznego Uniwersytetu Wroslawskiego, 7–20. – Wroclaw.

MIERZEJEWSKI, M. P. (2001): Understanding the Karkonosze Mts. Granite. In: Tectonic and Magma 2001 IGCP Project 373, Abstract Vol. 23–26, 70–74. – Berlin.

MIERZEJEWSKI, M. P. (2003): The structures of the late stages of the granite magma emplacement in the Karkonosze Mts. pluton. In: Ciezkowski, A. et al. : Sudety Zachodnie: od wendu do czwartorzedu, 81–94. – WIND, Wroclaw. (In Polish)

MIERZEJEWSKI, M. P. – OBERC-DZIEDZIC, T. (1990): The Izera-Karkonosze block and its tectonic development (Sudetes, Poland). – Neu. Jb. Geol. Paläont. 179, 197–222.

MIERZEJEWSKI, M. P. – PIN, C. – DUTHOU, J. L. – COUTURIE, J. P. (1994): Sr-Nd isotopic study of the Karkonosze granite (Western Sudetes). In: Kryza, R. Ed.: Igneous activity and metamorphic evolution of the Sudetes area. Abstracts, 82 pp. – Wroclaw,

MIERZEJEWSKI, M. P. – WOJNAR, B. (1985): Sekwencja dwóch cial granitowych i temperatury ich krystalizacji w endokontaktach. – Geologica sudet. 21, 321–352.

MIKULSKI, S. Z. (2007): Metal ore potential of the parent magma of granite – the Karkonosze massif example. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 111–122.

MIKULSKI, S. Z. – STEIN, H. J. (2007): Re-Os age for molybdenite from the West Sudetes, SW Poland. – In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. Mineral. Monogr. 1, 203–216.

OBERC-DZIEDZIC, T. (1985): Wplyw granitu karkonoskiego na gneisy izerskie. – Kwart. Geol. 29, 571–588.

PIN, CH. – MIERZEJEWSKI, M. P. – DUTHOU, J. L. (1987): Isochronous age Rb-Sr of Karkonosze granite from quarry Sklarska Poreba Huta and significance of initial 87Sr/86Sr in this granite. – Przegl. Geol. 10, 512–517. (In Polish)

PIN, CH. – MIERZEJEWSKI, M. P. – DUTHOU, J. L. - COUTURIE, J. (1987): Étude isotopique Rb-Sr du granite du Karkonosze. In: Lorenc, Majerovicz (ed.): Pétrologie et géologie du socle Varisque des Sudetes polonaises: resultats de la co-operation entre les Universités de Wrocław et Clermont-Ferrand, 43–47. – Uniw. Wrocł., Inst. Nauk Geol., Wrocław.

PRZEWŁOCKI, K. – MAGDA, W. – THOMAS, H. H. (1962): Age of some granitic rocks in Poland. – Geochim. cosmochim. Acta 26, 1069.
SEDLÁK, J. – GNOJEK, I. – ZABADAL, S. – FARBISZ, J. – CWOJDZINSKI, S. – SCHEIBE, R. (2007): Geological interpretation of gravity low in the central of the Lugian unit (Czech Republic, Germany and Poland). – J. Geosci. 52, 181–198.
SLABY, E. (2002): Porphyritic granite facies – Szklarska Poreba Huta. – Mineral. Soc. Pol. Spec. Pap. 20, 245–247.
SLABY, E. – GALBARCZYK-GASIOROWSKA, L. – BASZKIEWICZ, A. (2002): Mantled alkali-feldspar megacrysts from the marginal part of the Karkonosze granitoid massif (SW Poland). – Acta Geol. pol. 52, 501–519.
SLABY, E. – GALBARCZYK-GASIOROWSKA, L. – SELTMANN, R. – MÜLLER, A. (2007): Alkali feldspar megacryst growth: geochemical modelling. – Mineral. Petrology 89, 1–29.
SLABY, E. – GÖTZE, J. (2004) Feldspar crystallization under magma-mixing conditions shown by cathodoluminescence and geochemical modelling–a case study from the Karkonosze pluton (SW Poland). – Mineral. Mag. 68, 561–577.
SLABY, E. – MARTIN, H. (2008): Mafic and felsic magma interaction in granites: the Hercynian Karkonosze Pluton (Sudetes, Bohemian Massif). – J. Petrology, 49, 1–39.
SLABY, E. – SELTMANN, R. – KOBER, B. – MÜLLER, A. – GALBARCZYK-GASIOROWSKA, L. – JEFFRIES, T. (2007): LREE distribution patterns in zoned alkali feldspar megacrysts from the Karkonosze pluton - implications for the parental magma composition. – Mineral. Mag. 71, 193–217.
ŠRÁMEK, J. – TOMEK, Č. – RYCHTÁR, J. (1989): Detailní tíhový průzkum jižního okraje krkonošsko-jizerského plutonu a okolního krystalinika. – Čas. Mineral. Geol. 34, 181–194.
WATZNAUER A. (1930): Der südliche Kontakt des Riesengebirgsgranits und das angenzende Schiefergebiet. – Lotos 78, 112–164, Praha.
WATZNAUER, A. (1935): Die Geologie des Bezirkes Gablonz. – Heimatkd. Bezirk. Gablonz 4, 1–119.
WILAMOWSKI, A. (1998): Geotectonic environment of the Karkonosze and Tatra granite intrusions based on geochemical data. – Arch. mineral. 51, 261–271. (In Polish)
WINCHESTER, J. A. – FLOYD, P. A. – CROWLEY, Q. G. et al. (2002): Palaeozoic amalgamation of Central Europe: New results from recent geological and geophysical investigations. – Tectonophysics 360.
WISZNIEWSKA, J. – KRZEMIŃSKA, E. – MAZUR, S. – GAWĘDA, A. – KOZŁOWSKI, A. (2007): Foreword – brief outline of geology of Poland. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 5–7.
ŽÁK, J. – KLOMÍNSKÝ, J. (2007): Magmatic structures in the Krkonoše-Jizera Plutonic Complex: evidence for localized multiphase flow and small-scale thermal-mechanical instabilities in a granitic magma chamber. – J. volcanol. geotherm. Res. 164, 254–267.
ŽÁK, J. – VERNER, K. – KLOMÍNSKY, J. – CHLUPÁČOVÁ, M. (2007): „Granite tectonics“ revised: insights from comparison of K-feldspar shape-fabric, anisotropy of magmatic susceptibility (AMS), brittle fractures in the Jizera granite, Bohemian Massif. – Int. J. Earth Sci. (Geol. Rundsch).
ŽÁK, J. – VERNER, K. – TÝCOVÁ, P. (2008a): Grain-scale processes in actively deforming magma mushes: New insights from electron backscatter diffraction (EBSD) analysis of biotite schlieren in the Jizera granite, Bohemian Massif. – Lithos 106, 309–322.
ŽÁK, J. – VERNER, K. – TÝCOVÁ, P. (2008b): Multiple magmatic fabrics in plutons: an overlooked tool for interactions between magmatic processes and regional deformation? – Geol. Mag. 145, 4, 537–551.
ŽÁK, J. – VYHNÁLEK, B. – KABERLE, P. (2006): Is there a relationship between magmatic fabric and brittle fractures in plutons? A view based on structural analysis, anisotropy of magnetic susceptibility and thermo-mechanical modelling of the Tanvald pluton (Bohemian Massif). – Phys. Earth Planet. Int. 157, 286–310.

Krkonoše-Jizera Granites (G1–G4)

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

n = 42	Median	Min	Max	QU1	QU3
SiO_2	71.61	68.91	77.11	70.21	72.86
TiO_2	0.39	0.05	0.62	0.24	0.50
Al_2O_3	13.77	12.03	15.20	13.23	14.28
Fe_2O_3	0.59	0.00	1.39	0.49	0.95
FeO	1.72	0.32	2.55	1.18	1.87
MnO	0.06	0.01	0.08	0.04	0.06
MgO	0.69	0.00	1.20	0.47	0.85
CaO	.75	0.59	2.58	1.29	1.98
Na_2O	3.34	2.95	3.82	3.23	3.47
K_2O	4.54	3.26	5.22	4.29	4.75
P_2O_5	0.11	0.00	0.66	0.08	0.14
Mg/(Mg+Fe)	0.35	0.00	0.48	0.28	0.38
K/(K+Na)	0.47	0.37	0.53	0.45	0.49
Nor.Or	28.05	20.18	31.88	26.22	29.07
Nor.Ab	31.03	27.37	35.35	30.34	32.37
Nor.An	8.13	-0.19	12.45	5.92	9.48
Nor.Q	29.05	22.30	37.06	26.00	31.44
Na+K	204.82	184.82	218.77	200.76	207.01
*Si	176.58	140.71	215.74	158.68	187.75
K-(Na+Ca)	-41.32	-78.98	-4.23	-54.62	-27.91
Fe+Mg+Ti	53.12	12.60	79.51	40.14	62.65
Al-(Na+K+2Ca)	6.39	-11.94	33.75	-1.04	13.83
(Na+K)/Ca	6.49	4.66	20.12	5.86	8.92
A/CNK	1.03	0.97	1.24	1.00	1.06

Trace elements (mean values in ppm): *Krkonoše-Jizera Granite* – **Ba** 11, **Ce** 30, **Cr** 44, **Cu** 45, **La** 14, **Nb** 20, **Ni** 5, **Pb** 58, **Rb** 336, **Sr** 9, **Ta** 8, **Th** 38, **U** 7, **Y** 23, **Zn** 15, **Zr** 59 (Lorenc et al. 1998).
Jizera Granite (G_1) – **Pb** 50**, Ga** 18, **Ni** <10, **V** 33, **Co** <10, **W** 51, **Sn** 12, **Zr** 146, **Rb** 219, **Sr** 170, **Nb** 12, **U** 4.0 (Klomínský 1969).
Liberec Granite (G_2) – **Pb** 26, **Ga** 14, **Ni** <10, **V** 16, **Co** <10, **W** 22, **Sn** 15, **Zr** 125, **Rb** 239, **Sr** 112, **Nb** 11, **U** 5.1 (Klomínský 1969).
Harrachov Granite (G_3) – **Pb** 12**, Ga** 14, **Ni** <10, **Co** <10, **W** 15, **Sn** 14, **Zr** 100, **Rb** 246, **Sr** 186, **Nb** 12, **U** 3.8 (Klomínský 1969).
Krkonoše Granite (G_4) – **Pb** 23, **Ga** 15, **Ni** <10, **Co** <10, **W** 17, **Sn** 35, **Zr** 25, **Rb** 277, **Sr** 50 (Klomínský 1969).

Tanvald Granite

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

n = 10	Median	Min	Max	QU1	QU3
SiO_2	74.43	73.77	75.15	74.18	74.65
TiO_2	0.05	0.01	0.15	0.04	0.07
Al_2O_3	14.28	13.61	14.63	14.26	14.41
Fe_2O_3	0.31	0.01	0.49	0.21	0.32
FeO	0.68	0.43	0.97	0.60	0.73
MnO	0.07	0.04	0.09	0.05	0.08
MgO	0.07	0.02	0.20	0.05	0.07
CaO	0.27	0.19	0.88	0.21	0.46

Na_2O	4.00	3.53	4.41	3.89	4.12
K_2O	4.19	4.07	4.86	4.17	4.29
P_2O_5	0.12	0.07	0.15	0.10	0.13
Mg/(Mg+Fe)	0.11	0.04	0.23	0.09	0.12
K/(K+Na)	0.41	0.38	0.46	0.40	0.42
Nor.Or	25.33	24.56	29.14	25.14	25.94
Nor.Ab	36.81	32.42	40.45	35.75	37.78
Nor.An	0.51	0.09	3.97	0.31	1.52
Nor.Q	31.15	29.58	33.70	30.35	32.65
Na+K	217.62	211.38	237.43	213.34	224.95
*Si	183.94	174.12	199.81	178.69	193.16
K-(Na+Ca)	-43.86	-59.99	-30.66	-49.77	-43.16
Fe+Mg+Ti	15.65	10.01	23.26	13.77	18.22
Al-(Na+K+2Ca)	46.22	23.03	59.21	41.22	50.38
(Na+K)/Ca	32.51	13.56	70.08	24.73	55.77
A/CNK	1.21	1.10	1.28	1.18	1.23

Trace elements (mean values in ppm): *Tanvald Granite* – **B** 18, **Ba** 9**, Be** 4.5, **Co** 13**, Cr** 15, **Cs** 14.5**,Cu** 7, **Ga** 22, **Hf** 6.1**, Ni** 7, **Nb** 22, **Pb** 16, **Rb** 474**, Sc** 7, **Sn** 15, **Sr** 7, **Y** 16, **Zn** 43, **Zr** 18, **Pb** <10, **Ga** 22, **Ni** <10, **Co** <10, **W** 5, **V** 15, **Sn** 28, **Zr** 8, **Rb** 362, **Sr** 90**, Nb** 25, **U** 4.2 (Klomínský 1969).

Fojtka Hybrid Granodiorite

Quartz-poor, sodic, metaluminous, melano-mesocratic, I-type, I-series, granodiorite

	471FOJ	**472FOJ**	**473FOJ**	**474FOJ**
SiO_2	67.63	60.36	69.02	62.26
TiO_2	0.72	1.30	0.57	0.98
Al_2O_3	13.88	14.97	14.22	15.78
Fe_2O_3	0.77	1.09	0.54	1.13
FeO	3.00	5.30	2.69	4.31
MnO	0.07	0.11	0.07	0.12
MgO	1.60	3.14	1.00	1.76
CaO	2.63	5.39	2.51	4.02
Li_2O	n.d.	n.d.	n.d.	n.d.
Na_2O	3.38	3.41	3.29	3.67
K_2O	4.29	3.03	4.40	3.51
P_2O_5	0.18	0.30	0.15	0.41
Mg/(Mg+Fe)	0.43	0.47	0.35	0.37
K/(K+Na)	0.46	0.37	0.47	0.39
Nor.Or	27.10	19.78	27.50	22.42
Nor.Ab	32.46	33.83	31.25	35.62
Nor.An	12.69	27.36	12.13	18.64
Nor.Q	22.09	10.66	24.42	14.88
Na+K	200.16	174.37	199.59	192.95
*Si	143.77	96.42	153.48	104.66
K-(Na+Ca)	-64.88	-141.82	-57.50	-115.59
Fe+Mg+Ti	100.15	181.66	76.18	130.13
Al-(Na+K+2Ca)	-21.38	-72.62	-9.85	-26.44
(Na+K)/Ca	4.27	1.81	4.46	2.69
A/CNK	0.94	0.82	0.98	0.95

Trace elements (mean values in ppm): *Fojtka Hybrid Granodiorite* – **Pb** <10, **Ga** 11, **Ni** 17, **Co** 14, **W** <10, **V** 59, **Sn** 17, **Zr** 90, **Rb** 180, **Sr** 210, **Nb** 6 (Klomínský 1969).

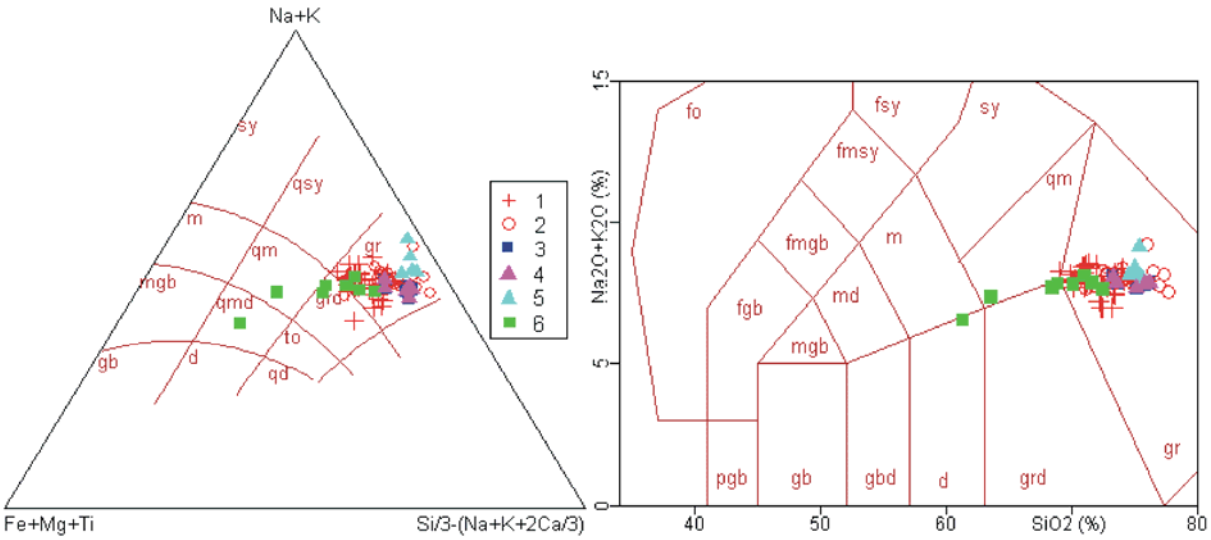

Fig. 4.18. *Krkonoše-Jizera Composite Massif ABQ and TAS diagrams. 1 – Jizera Granite, 2 – Liberec Granite, 3 – Harrachov Granite, 4 – Krkonoše Granite, 5 – Tanvald Granite, 6 – Fojtka Hybrid Granodiorite.*

Polish part of the Krkonoše-Jizera Composite Massif

Krkonoše Central Granite

Quartz-rich, sodic/potassic, low peraluminous, mesocratic, S-type granite

n = 9	Median	Min	Max	QU1	QU3
SiO_2	72.22	69.57	75.93	70.22	72.31
TiO_2	0.31	0.14	0.39	0.23	0.37
Al_2O_3	13.25	12.16	14.49	13.03	14.06
Fe_2O_{3tot}	2.22	1.43	2.69	1.68	2.47
MnO	0.05	0.02	0.06	0.04	0.05
MgO	0.77	0.29	0.93	0.65	0.85
CaO	1.24	0.33	1.69	0.68	1.41
Na_2O	3.38	2.92	3.87	3.01	3.43
K_2O	4.45	3.26	5.49	4.08	4.91
P_2O_5	0.10	0.04	0.15	0.06	0.12
Mg/(Mg+Fe)	0.40	0.28	0.49	0.38	0.41
K/(K+Na)	0.48	0.36	0.55	0.44	0.52
Nor.Or	27.03	20.22	33.87	25.50	30.34
Nor.Ab	31.67	27.43	36.49	28.64	32.50
Nor.An	5.63	1.34	8.38	3.06	6.37
Nor.Q	31.12	27.78	36.49	30.07	32.18
Na+K	198.48	188.01	213.37	194.96	208.07
*Si	183.86	162.99	212.73	174.24	187.20
K-(Na+Ca)	-28.42	-85.80	13.87	-48.97	-12.44
Fe+Mg+Ti	52.46	26.87	59.31	41.03	55.90
Al-(Na+K+2Ca)	19.87	4.36	51.95	14.63	28.49
(Na+K)/Ca	9.58	6.44	36.26	7.75	15.50
A/CNK	1.09	1.03	1.24	1.07	1.13

Trace elements (mean values in ppm): *Krkonoše Central Granite* – **Cu** 11, **Pb** 26, **Zn** 37, **As** 6, **W** 11, **Ni** 4, **Cr** 15, **V** 19, **Nb** 14, **Ba** 351, **Rb** 262, **Sr** 16, **Zr** 140, **Hf** 4.5, **Th** 26, **U** 4.

Krkonoše Range Granite (equivalent to the Jizera Granite)

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

n = 7	Median	Min	Max	QU1	QU3
SiO_2	74.20	69.22	78.85	70.10	74.76
TiO_2	0.34	0.02	0.46	0.27	0.36
Al_2O_3	13.52	11.94	14.72	12.79	14.00
Fe_2O_{3tot}	2.17	0.21	3.04	1.86	2.20
MnO	0.05	0.01	0.07	0.04	0.05
MgO	0.80	0.12	1.14	0.67	0.85
CaO	1.29	0.40	1.83	0.90	1.44
Na_2O	3.34	2.10	3.59	3.06	3.40
K_2O	4.04	3.80	6.53	3.93	4.68
P_2O_5	0.12	0.03	0.18	0.11	0.15
Mg/(Mg+Fe)	0.41	0.40	0.52	0.41	0.43
K/(K+Na)	0.45	0.42	0.67	0.42	0.48
Nor.Or	25.26	23.06	39.31	23.91	28.24
Nor.Ab	30.64	19.21	33.51	28.25	32.00
Nor.An	5.53	1.83	8.53	3.79	6.32
Nor.Q	32.95	28.19	38.40	29.43	33.36
Na+K	199.17	184.66	207.15	192.66	199.29
*Si	196.91	168.81	226.27	173.19	199.16
K-(Na+Ca)	-43.03	-63.92	63.75	-63.61	-24.46
Fe+Mg+Ti	51.67	5.86	70.28	43.31	52.79
Al-(Na+K+2Ca)	24.82	13.80	47.37	15.15	26.26
(Na+K)/Ca	8.50	5.90	28.94	6.39	9.97
A/CNK	1.11	1.06	1.22	1.08	1.12

Trace elements (mean values in ppm): *Krkonoše Range Granite* – **Cu** 8, **Pb** 20, **Zn** 40,**As** 4, **W** 8, **Ni** 6.4, **Cr** 23, **Nb** 14, **Ba** 340, **Rb** 221, **Sr** 135, **Zr** 141, **Hf** 4.4, **Th** 2.3, **U** 4.3.

Krkonoše Granophyric Granite (equivalent to the Harrachov Granite)

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

n = 9	Median	Min	Max	QU1	QU3
SiO_2	76.37	73.32	76.68	75.22	76.45
TiO_2	0.07	0.06	0.29	0.07	0.08
Al_2O_3	12.79	12.11	13.06	12.57	12.99
Fe_2O_{3tot}	0.78	0.68	1.94	0.74	0.81
MnO	0.03	0.02	0.17	0.02	0.05
MgO	0.02	0.00	0.72	0.00	0.06
CaO	0.64	0.62	1.34	0.63	0.67
Na_2O	3.83	3.28	4.23	3.62	4.05
K_2O	4.52	4.22	5.29	4.40	4.94
P_2O_5	0.01	0.01	0.09	0.01	0.02
Mg/(Mg+Fe)	0.05	0.01	0.42	0.01	0.13
K/(K+Na)	0.44	0.40	0.50	0.42	0.46
Nor.Or	27.12	25.70	31.73	26.45	29.53
Nor.Ab	34.76	30.89	38.61	33.91	36.82
Nor.An	3.19	3.04	6.36	3.08	3.28
Nor.Q	32.35	28.83	34.50	31.76	32.39
Na+K	226.54	195.44	228.69	224.62	227.37
*Si	190.96	165.48	199.46	188.07	191.37

K-(Na+Ca)	-40.14	-67.74	-11.75	-45.78	-29.55
Fe+Mg+Ti	10.74	9.87	45.82	10.25	13.87
Al-(Na+K+2Ca)	3.80	-25.73	6.08	3.41	4.75
(Na+K)/Ca	19.09	8.18	20.69	18.42	20.17
A/CNK	1.02	0.91	1.02	1.01	1.02

Trace elements (mean values in ppm): *Krkonoše Granophyric Granite* – **Cu** 10, **Pb** 49, **Zn** 11, **As** 5, **Sn** 39, **Cr** 20, **Nb** 19, **Ba** 16, **Rb** 304, **Sr** 10, **Zr** 65, **Hf** 4.3, **Th** 30, **U** 20.

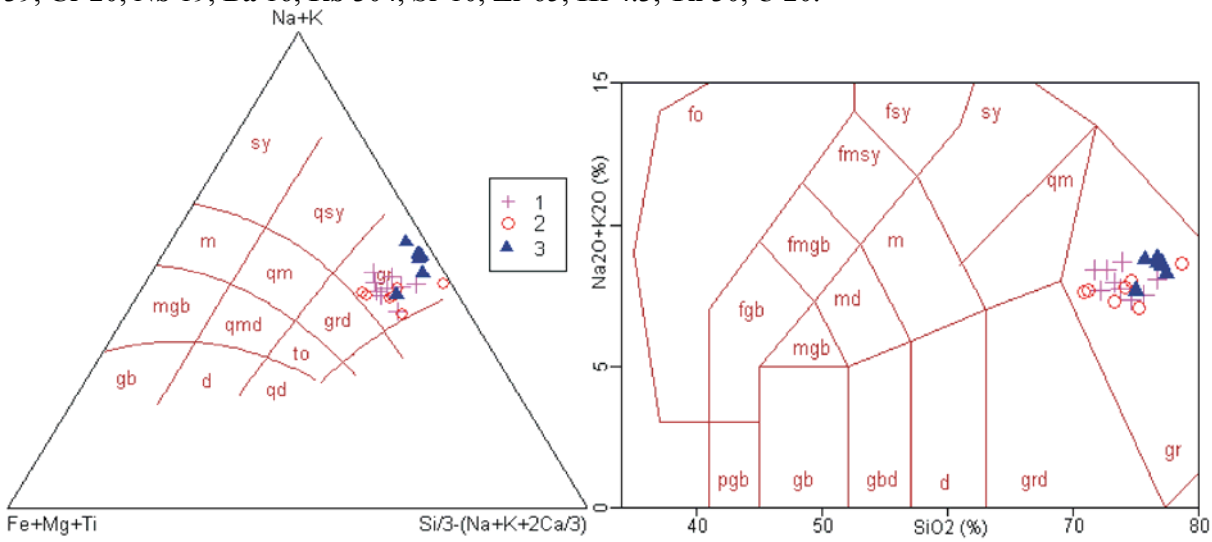

Fig. 4.19. *Krkonoše-Jizera Composite Massif (Polish part) ABQ and TAS diagrams. 1 – Krkonoše Central Granite, 2 – Krkonoše Range Granite, 3 – Granophyric Granite.*

E. KACZAWA REGION (INCLUDING THE FORE-SUDETIC BLOCK)

The Kaczawa metamorphic complex and Fore-Sudetic Block comprise pre-Variscan gneisses of probable magmatic origin (Strzelin Porphyritic Gneiss, the Gościecice Augen Gneiss and Doboszowice Gneiss). The Wadroze Wielkie Gneiss (intrude a low-grade Palaeozoic complex) and intrusions of post-kinematic Variscan granitoids: the Żeleźniak (Bukowinka) Stock, the Strzegom-Sobótka Massif, and the Lipowe Hills Stock.

References

MAZUR, S. – ALEKSANDROWSKI, P. – TURNIAK, K. – AWDANKIEWICZ, M. (2007): Geology, tectonic evolution and Late Palaeozoic magmatism of Sudetes – an overview. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 59–87.

4.15. ŻELEŻNIAK (BUKOWINKA) STOCK

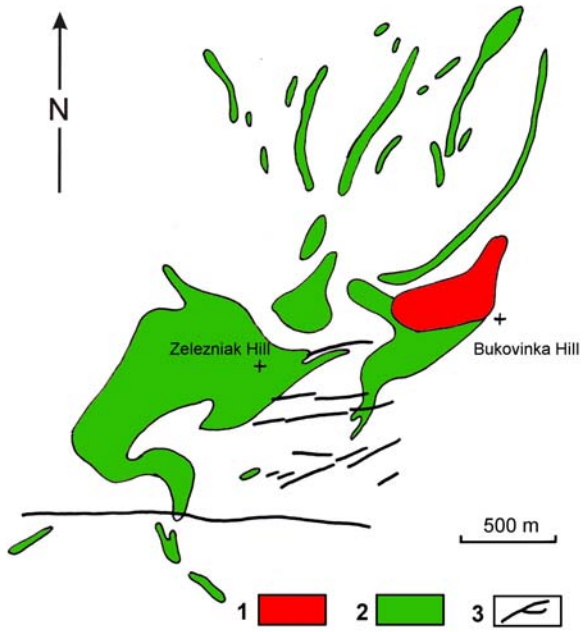

Fig. 4.20. *Żeleźniak (Bukowinka) Stock geological sketch-map (adapted according to Mikulski 2005). 1 – Bukowinka Granite, 2 – Dacite porphyry, 3 – Quartz-sulphide veins.*

Regional position: Late-Carboniferous hypabyssal (high-level) volcano-plutonic intrusion in Lower Palaeozoic schists along a fault system bounding the Swierzawa and Bolkow tectonic units.

Rock types:

Group 1 – fine-grained subvolcanic facies (rhyolites, rhyodacites, dacites and trachyandesites).

Group 2 – medium-grained hybabyssal facies (porphyritic microgranitoids).

1. *Żeleźniak Microgranite* – fine-grained porphyritic monzogranite.
2. *Żeleźniak Granodiorite* – equigranular, coarse-grained biotite-hornblende granodiorite.
3. *Bukowinka Granite* – ± porphyritic biotite-hornblende fine-to medium-grained monzogranite.
4. *Kersantite.*
5. *Rhyolite, rhyodacite, dacite, trachyandesite.*

Size and shape (on erosion level): a fairly irregular star-like shape composed of its core, ca. 3 km^2 large, and a number roughly radially arranged dykes, several hundreds of meters thick and up to 7 km long. The core 500 m in diameter. The presence of the diathermal breccias suggests they are remnants of a chimney pipe. The intrusion may represent a multi-pulse injection lava dome, from which short-lived volcanic venting of material to the surface.

Age and isotopic data: *Żeleźniak Microgranite* 315 ± 1.8 Ma, 316 ± 1.2 Ma (U-Pb SHRIMP zircon), 2598.2 ± 4.6 Ma, 2063 ± 13 Ma (inherited zircon), *Bukowinka Granite* 307.2 ± 4.4 Ma (Pb-evaporation zircon). Molybdenite 304 ± 1 Ma and 309 ± 1 Ma (Re-Os). Au-As-Cu mineralization at Stara Góra 317 ± 17 Ma, 316.6 ± 0.4 Ma (arsenopyrite).

Geological environment: Lower Palaeozoic greenschist-facies metavolcanic rocks.

Contact aureole: a broad thermal aureole NE of the stock indicates subsurface extension of the intrusion.

Zoning: numerous radiating kersantite dykes cut the intrusion and extends outwards to a radius of 7 km.

Mineralization: Au-As-Cu Stara Góra (Altenberg) deposit agenetically linked to the intrusion.

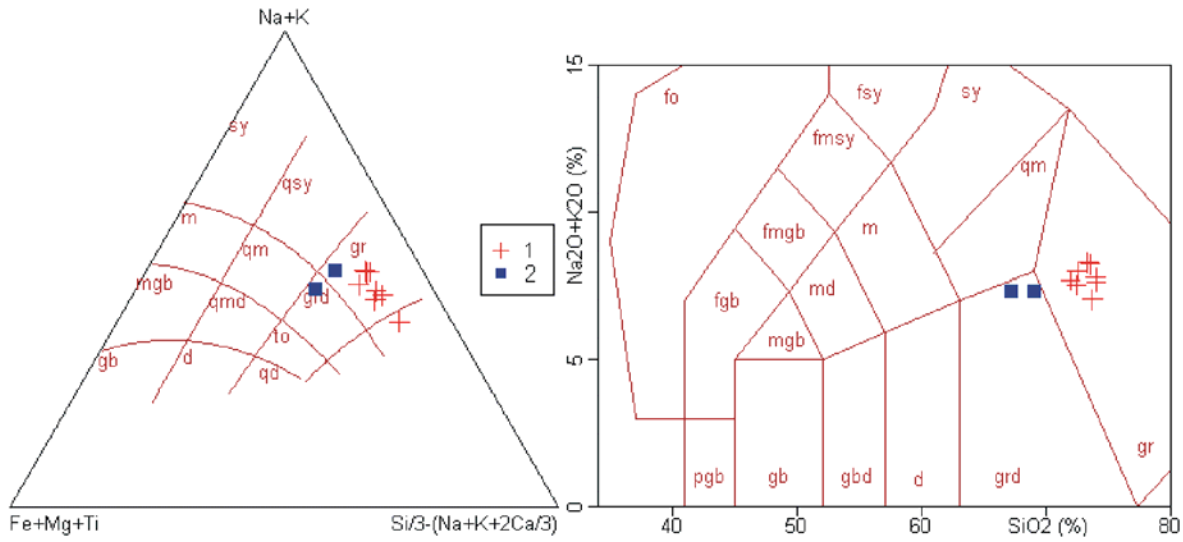

Fig. 4.21. *Żelezniak Hill Massif ABQ and TAS diagrams. 1 – Żeleźniak Granite, 2 – Żeleźniak Granodiorite.*

References

MACHOWIAK, K. – AMSTRONG, R. – KRYZA R. – MUSZYŃSKI, A. – (2008): Late-orogenic magmatism in the Central Europea Variscides: SHRIMP U-Pb zircon age constraints from the Żeleźniak Intrusion, Kaczawa Mountains, West Sudetes. – Geologica sudet., 40, 1–18.

MACHOWIAK, K. – MUSZYŃSKI, A. – AMSTRONG, R. (2004): High-level volcanic-granodioritic intrusions from Żeleźniak Hill (Kaczawa Mountains, Sudetes, SW Poland). In: Breitkreuz, C. – Petford, N. Eds: Physical geology of high-level magmatic systems. – Geol. Soc. London Spec. Publ. 234, 67–74.

MACHOWIAK, K. – NIEMCZYK, W. (2005): Subvolcanic rocks of the Żeleźniak intrusion (Kaczawa Mountains) compared with the Karkonosze granite. – Przegl. Geol. 53, 51–52.

MAJEROWICZ, A. – SKURZEWSKI, A. (1987): Granity z okolic Wojcieszowa w Górach Kaczawskich. – Acta Univ. Wratislav, Prace geol.-mineral. 10, 265–274.

MIKULSKI, S. Z. (2005): Geological, mineralogical and geochemical characteristics of the Radzimowice Au-As-Cu deposit from the Kaczawa Mountains (Western Sudetes, Poland): an example of the transition of porphyry and epithermal style. – Mineralium Deposit., 39, 904–920.

MUSZYŃSKI, A. – MACHOWIAK, K. (2000): Geochemistry of igneous rocks in the area of Żeleźniak Hill (The Kaczawa Mountains). – Pol. Tow. Mineral. Prace Spec. 17, 212–214.

MUSZYŃSKI, A. – MACHOWIAK, K. – KRYZA, R. – AMSTRONG, R. (2002): SHRIMP U-Pb zircon geochronology of the Late-Variscan żelezniak rhyolite intrusion, Polish Sudetes. – Mineral. Soc. Pol. Spec. Pap. 20, 156–158.

WISZNIEWSKA, J. – KRZEMIŃSKA, E. – MAZUR, S. – GAWĘDA, A. – KOZŁOWSKI, A. (2007): Foreword – brief outline of geology of Poland. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 5–7.

Żelezniak Granite

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

n=8	Median	Min	Max	QU1	QU3
SiO_2	72.32	70.81	72.65	71.20	72.49
TiO_2	0.26	0.20	0.32	0.24	0.28
Al_2O_3	14.54	13.09	15.71	13.48	14.85
Fe_2O_3tot	2.38	2.17	2.67	2.18	2.46
MnO	0.04	0.03	0.09	0.04	0.05
MgO	0.45	0.34	0.85	0.43	0.58
CaO	1.01	0.13	1.61	0.20	1.41
Na_2O	3.48	2.34	4.14	3.02	3.52
K_2O	4.04	3.65	4.67	3.91	4.58

P_2O_5	0.11	0.08	0.13	0.09	0.11
Mg/(Mg+Fe)	0.28	0.22	0.40	0.25	0.34
K/(K+Na)	0.44	0.37	0.56	0.41	0.47
Nor.Q	29.89	28.91	39.35	29.14	33.97
Nor.Or	24.81	22.40	28.47	23.82	28.20
Nor.Ab	32.42	21.99	38.62	28.45	32.62
Nor.An	4.45	-0.02	7.35	0.14	6.61
Na+K	197.44	172.33	212.10	193.88	211.09
*Si	175.00	169.74	227.34	173.30	198.74
K-(Na+Ca)	-38.93	-74.11	18.99	-65.09	-27.49
Fe+Mg+Ti	44.71	41.39	56.42	42.36	45.09
Al-(Na+K+2Ca)	29.82	2.33	130.56	5.39	77.75
(Na+K)/Ca	8.65	7.05	74.34	7.14	38.18
A/CNK	1.13	1.02	1.76	1.03	1.39

Trace elements (in ppm): *Żelezniak Granite* – **Sr** 252, **Y** 15.5, **Sc** 5.05, **Be** 2, **V** 21, **Co** 89, **Cu** 23, **Zn** 118, **Ga** 21, **Ge** 1.6, **As** 17, **Rb** 136, **Zr** 162, **Nb** 12, **Sn** 2.
Żelezniak Granodiorite – **Sr** 483, **Y** 17, **Sc** 6, **Be** 1.5, **V** 53, **Co** 55, **Ga** 22, **Ge** 2, **As** 10, **Rb** 91, **Zr** 166, **Nb** 11, **Sn** 3.

4.16. STRZEGOM-SOBÓTKA COMPOSITE MASSIF

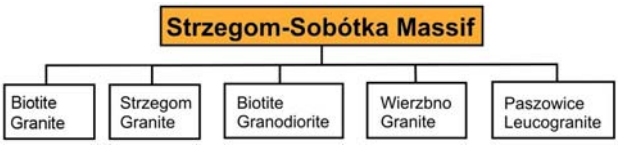

Fig. 4.22. *Strzegom-Sobótka Massif hierarchical scheme.*

Regional position: Isolated intrusion in the Kaczawa region of the Lugicum.

Rock types:

1. *Paszowice Leucogranite* – aplitic albite-muscovite leucogranite.
2. *Strzegom Granite* – biotite-hornblende granite – granodiorite (predominant type). The fine-grained variety is so-called Zimnik Granite.

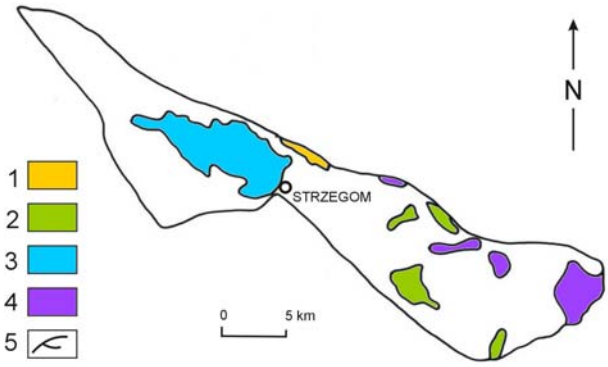

Fig. 4.23. *Strzegom-SobótkaComposite Massif geological sketch-map (adapted after Puziewitz 1990). 1 – biotite granite, 2 – Wierzbno Granite, 3 – Strzegom Granite, 4 – Chvałkow Granodiorite, 5 – outline of the Strzegom-Sobótka Massif under the sedimentary cover.*

3. *Wierzbno Granite* – two-mica granite (foliated texture).
4. *Strzeblów (Chvałkow) Granodiorite* – medium-grained biotite granodiorite. *Łazany Tonalite* is of the biotite granodiorite varieties.
5. *Biotite granite.*

Petrographic and geochemical differences among granitoids suggest that they represent separate magma batches of different origin and crystallization history.

Size and shape: 280 km^2 (45 × 8 km), elliptical, in SW outlined by NW-SE trending fault. The semi-hidden massif under younger sedimentary cover consists of several outcrops showing a different petrographic composition.

Age and isotopic data: Upper Carboniferous to Lower Permian age. *Strzegom Granite-Granodiorite* 271–280 Ma (Rb-Sr whole rock), 278 ± 7 Ma and 281 ± 12 Ma (Rb-Sr whole rock) *Paszowice Granite* 326 Ma (Rb-Sr whole rock) and *two-mica granite* are older and have a weak foliation. The other facies show younger ages ~ 280 Ma (Rb-Sr whole rock). 324 ± 7 Ma (Rb-Sr biotite), 309.1 ± 0.8 Ma and 306.4 ± 0.8 Ma (U-Pb monazite and xenotime), *Strzegom Granite* 302.9 ± 2.2 Ma (Pb-evaporation zircon), K-Ar cooling ages: biotite granodiorite 308.8 ± 4.6 Ma and 305.5 ± 4.3 Ma, hornblende-biotite monzogranite 291.0 ± 4.4 Ma and 298.7 ± 5.2 Ma, biotite monzogranite 294.2 ± 4.3 Ma.

Geological environment: Ślęża Cambrian ultramafics and mafics, Ordovician schists metamorphosed up to amphibolite facies

(Devonian -Lower Carboniferous) phyllites, metaarkoses and quartzites.

Contact aureole: strong thermal transformation of country rocks into amphibolite facies.

Zoning: distinct compositional zonation. Marginal zone in eastern part consists of leucogranite and gradually changes into biotite granodiorites to the west.

Mineralization: Sn.

References

BORKOWSKA, M. (1969): Skalenie jako wskažniki warunków krystalizacji niektórych granitoidow sudeckich. – Przegl. geol. 11, 558–560.

DOMANSKA, J. – SŁABY, E. (2003): Enclaves from the Variscan Strzegom-Sóbotka hornblende-biotite granite. – Mineral. Soc. Pol. Spec. Pap. 23, 57–59.

DOMANSKA-SIUDA, J. (2007): The granitoid Variscan Strzegom-Sobotka massif. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. Mineral. Monogr. 1, 179–191.

JANECZEK, J. (2007): Intragranitic pegmatites of the Strzegom-Sobótka massif – an overview. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 193–201.

JELIŃSKI, A. (1965): Geochemistry of the uranium in the Karkonosze Granite Massif and other granitoids massifs of Lower Silesia. – Biul. Inst. Geol. 193, 5, 5–110. (In Polish)

MACHOWIAK, K. – AMSTRONG, R. – KRYZA R. – MUSZYŃSKI, A. – (2008):Late-orogenic magmatism in the Central Europea Variscides: SHRIMP U-Pb zircon age constraints from the Żeleżniak Intrusion, Kaczawa Mountains, West Sudetes. – Geologica Sudetica, 2008, 40, 1-18.

MAJEROWICZ, A. (1972): Masyw granitowy Strzegom-Sobótka. Studium petrologiczne. – Geologica sudet. 6, 7–26.

MAJEROWICZ, A. (1986): Some selected problems concerning the tectonics of granitoids of the Strzegom-Sobótka massif (SW Poland. – Geol. Rdsch. 75, 3, 625–634.

MIKULSKI, S. Z. – STEIN, H. J. (2007): Re-Os age for molybdenite from the West Sudetes, SW Poland. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 111– 122.

OBERC-DZIEDZIC, T. (2007): Internal structure of the granite and tonalite intrusions in the Strzelin massif, Fore-Sudetic block, SW Poland. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 217– 229.

PIN, C. – PUZIEWICZ, J. – DUTHOU, J. L. (1989): Age and origin of a composite granitic massif in the Variscan belt: a Rb-Sr study of the Strzegom-Sobotka Massif, W. Sudetes (Poland). – Neu. Jb. Mineral., Abh. 160, 71–82.

PUZIEWICZ, J. (1990): Massyw granitowy Strzegom-Sobótka. Aktualny stav badań. – Arch. mineral. 45, 135–154.

PUZIEWICZ, J. – OBERC-DZIEDZIC, T. (1995): Wiek i geneza granitoidów bloku przedsudeckiego. – Rocznik Pol. Tow. Geol., Przewodnik 66 Zjazdu PTG, 273–284. Wroclaw.

TURNIAK, K. – BRÖCKNER, M. (2002): Age of the two-mica granite from the Strzegom-Sobótka massif. – New data from U/Pb monazite and xenotime study. – Pol. Tow. Mineral. Prace Spec. 20, 211–214.

TURNIAK, K. – TICHOMIROWA, M. – BOMBACH, K. (2005): Zircon Pb-evaporation ages of granitoids from the Strezegom-Sobótka massif (SW Poland). – Pol. Tow. Mineral. Prace Spec. 25, 241–245.

WISZNIEWSKA, J. – KRZEMIŃSKA, E. – MAZUR, S. – GAWĘDA, A. – KOZŁOWSKI, A. (2007): Foreword – brief outline of geology of Poland. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 5–7.

Strzegom Granite

Quartz-normal, sodic, metaluminous, mesocratic, I-type, I-series, granite

n = 9	Median	Min	Max	QU1	QU3
SiO_2	72.21	69.34	74.82	70.85	74.00
TiO_2	0.26	0.15	0.47	0.21	0.34
Al_2O_3	13.60	13.05	15.09	13.16	14.86
Fe_2O_3	0.31	0.15	1.12	0.21	0.33
FeO	1.70	1.31	3.22	1.54	2.42
MnO	0.05	0.01	0.14	0.03	0.07
MgO	0.41	0.28	1.00	0.35	0.49

CaO	1.55	1.40	3.16	1.53	1.70
Na_2O	4.01	3.37	4.44	3.83	4.32
K_2O	5.08	3.54	5.29	4.72	5.14
P_2O_5	0.03	0.00	0.12	0.03	0.07
Mg/(Mg+Fe)	0.27	0.15	0.39	0.20	0.30
K/(K+Na)	0.44	0.37	0.50	0.44	0.45
Nor.Or	30.17	21.51	31.89	28.41	31.17
Nor.Ab	37.03	31.10	41.05	35.04	39.12
Nor.An	7.53	6.26	15.38	7.16	8.26
Nor.Q	23.14	18.09	28.23	20.67	27.45
Na+K	226.93	204.56	252.69	223.81	240.49
*Si	144.55	123.40	172.85	129.74	169.23
K-(Na+Ca)	-53.02	-111.16	-29.22	-55.82	-51.02
Fe+Mg+Ti	47.86	32.94	68.37	37.25	63.39
Al-(Na+K+2Ca)	-25.44	-34.04	-10.80	-32.60	-21.44
(Na+K)/Ca	8.10	3.63	10.12	7.36	8.59
A/CNK	0.92	0.89	0.96	0.90	0.93

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Wierzbno Granite

Quartz-normal**,** sodic-potassic, moderately peraluminous, leucocratic, granite

n = 8	**Median**	**Min**	**Max**	**QU1**	**QU3**
SiO_2	73.86	72.48	74.40	73.30	74.20
TiO_2	0.17	0.00	0.30	0.05	0.20
Al_2O_3	13.70	13.39	15.77	13.67	14.00
Fe_2O_3	0.47	0.14	1.45	0.40	0.82
FeO	0.92	0.00	1.15	0.71	1.01
MnO	0.02	0.00	0.05	0.00	0.03
MgO	0.29	0.21	0.53	0.27	0.37
CaO	0.86	0.44	2.23	0.70	1.10
Na_2O	3.58	3.07	4.43	3.49	3.63
K_2O	4.80	3.75	5.30	4.22	5.13
P_2O_5	0.07	0.02	0.41	0.03	0.11
Mg/(Mg+Fe)	0.24	0.21	0.80	0.22	0.33
K/(K+Na)	0.45	0.44	0.50	0.44	0.47
Nor.Or	28.91	22.92	31.80	25.49	31.09
Nor.Ab	32.85	28.52	40.49	32.04	33.32
Nor.An	3.86	2.05	10.84	3.07	5.40
Nor.Q	29.12	22.48	39.20	27.08	31.31
Na+K	217.44	178.69	254.85	202.22	227.09
*Si	174.33	138.93	228.84	162.70	186.62
K-(Na+Ca)	-34.81	-53.38	-17.36	-51.73	-27.35
Fe+Mg+Ti	30.79	11.08	41.21	26.97	34.80
Al-(Na+K+2Ca)	8.81	-34.02	115.31	-1.74	17.17
(Na+K)/Ca	14.01	5.47	22.77	7.04	14.81
A/CNK	1.05	0.89	1.60	1.00	1.07

Strzeblow Granodiorite

Quartz-normal, sodic, metaluminous,mesocratic, I-type, I-series, granodiorite

	grd1214	grd210S	grd216S	grd225S
SiO_2	69.75	68.80	66.75	63.96
TiO_2	n.d.	0.45	0.23	0.76
Al_2O_3	14.94	15.80	13.44	15.88
Fe_2O_3	1.42	0.62	2.96	1.93
FeO	2.03	2.70	4.98	3.68
MnO	n.d.	0.06	n.d.	0.02
MgO	0.63	0.40	1.10	1.42
CaO	1.55	2.81	1.77	4.80
Na_2O	3.89	3.75	3.45	4.39
K_2O	4.78	4.44	4.30	2.18
P_2O_5	n.d.	n.d.	0.35	0.20
Mg/(Mg+Fe)	0.25	0.18	0.20	0.32
K/(K+Na)	0.45	0.44	0.45	0.25
Nor.Or	29.24	27.03	27.25	13.55
Nor.Ab	36.16	34.70	33.22	41.47
Nor.An	7.96	14.37	6.94	23.67
Nor.Q	22.44	20.65	22.76	16.03
Na+K	227.02	215.28	202.63	187.95
*Si	141.51	133.00	146.64	109.82
K-(Na+Ca)	-51.68	-76.85	-51.59	-180.97
Fe+Mg+Ti	61.69	60.93	136.62	120.19
Al-(Na+K+2Ca)	11.09	-5.22	-1.82	-47.29
(Na+K)/Ca	8.21	4.30	6.42	2.20
A/CNK	1.04	0.98	1.02	0.88

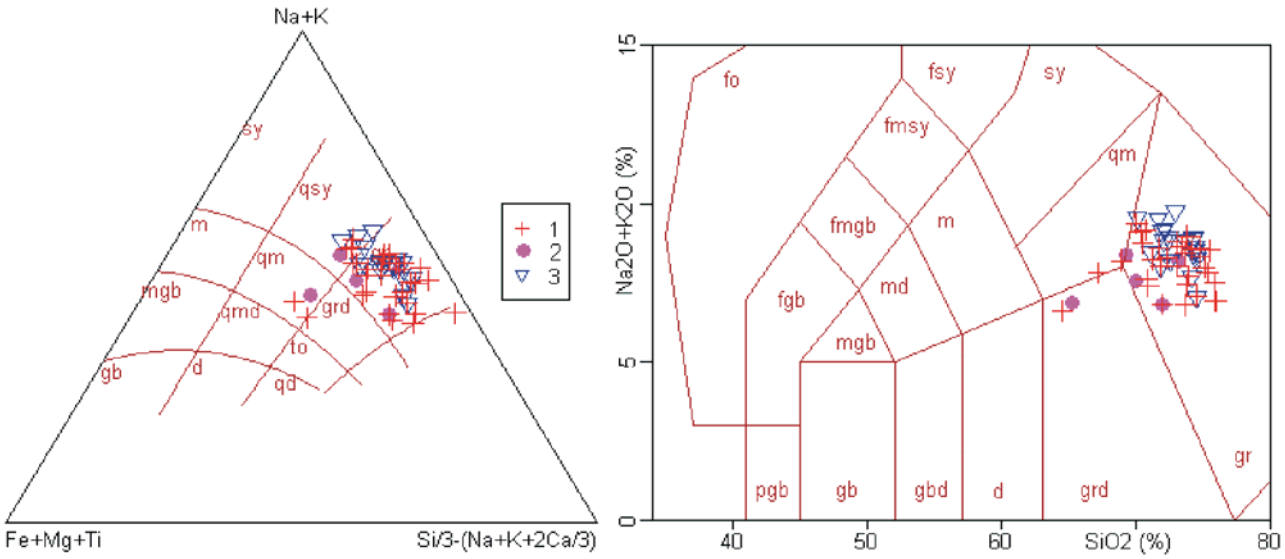

Fig. 4.24. *Strzegom-Sobótka Massif ABQ and TAS diagrams. 1 – Strzegom Granite, 2 – Strzeblow (Łazany) granodiorite to tonalite, 3 – Wierzbno Granite.*

4.17. LIPOWE HILLS STOCK

Regional position: within the Fore-Sudetic Block, a part of the Niemcza crystalline complex, close spatial relationship to the Strzelin Massif.

Rock types:

Górka Sobotecka Granite – muscovite-biotite granite.

Lipowe Hills Granodiorite – fine-grained granodiorite and medium-grained biotite tonalite (sills and dykes?).

Age and isotopic data: 329 ± 11 Ma (Rb-Sr whole rock).

Size and shape (on erosion level): small bodies of unknown shape (the largest outcrop 1 × 0.5 km).

Geological environment: augen orthogneiss, sillimanite gneiss, migmatitic gneiss and mylonitic gneiss.

Contact aureole: sharp and discordant contacts although transition zones can also be present.

Mineralization: no indications.

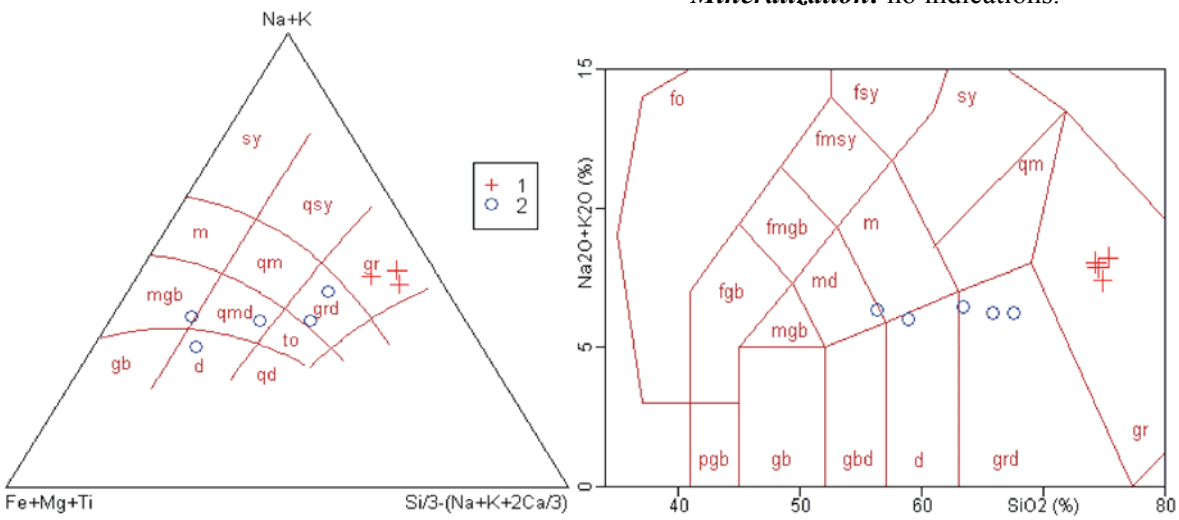

Fig. 4.25. *Lipowe Hills Stock ABQ and TAS diagrams. 1 – Górka Sobotecka Granite, 2 – Lipowe Hills Granodiorite.*

References

OBERC-DZIEDZIC, T. (2007): Internal structure of the granite and tonalite intrusions in the Strzelin massif, Fore-Sudetic block, SW Poland. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 217–229.

OBERC-DZIEDZIC, T. – PIN, CH. (2000): The granitoids of the Lipowe Hills (Fore-Sudetic Block) and their relationship to the Strzelin granites. – Geologica sudet. 33, 17–22.

4.18. OLEŠNICE-KUDOWA MASSIF

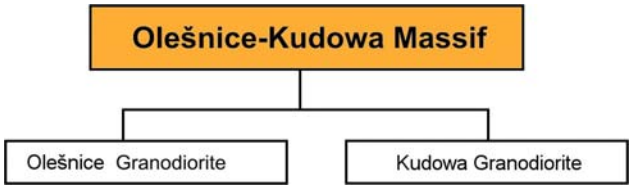

Fig. 4.26. *Hierarchic scheme of the Olešnice-Kudowa Massif according to rock types.*

Regional position: composite intrusion between Nové Město and Stronie units (Lugicum Zone).

Rock types:

1. *Olešnice (Older) Granodiorite* – porphyritic biotite granodiorite (older facies).
2. *Kudowa (Younger) Granodiorite* – leucocratic granodiorite to granite (younger facies).

Size and shape (on erosion level): 120 km^2, tectonic contact in the west, sheet-like body dipping to the east.

Age and isotopic data: *Olešnice Granodiorite* 360 ± 18 Ma (K-Ar biotite). *Kudowa Granodiorite* 344 ± 17 Ma (K-Ar biotite). Olešnice-Kudowa Massif 331 ± 11 Ma (Rb-Sr whole rock).

The granodiorite pebbles in Upper Carboniferous conglomerate.

Geological environment: Stronie Unit of albite mica schists, partly feldspathized, greenschists, phyllites and the Nové Město Unit on the W (amphibolites).

Zoning: Distinct concentric compositional zoning, in central parts more mafic Olešnice

Granodiorite and Kudowa Granodiorite at the periphery.

Mineralization: no indications.

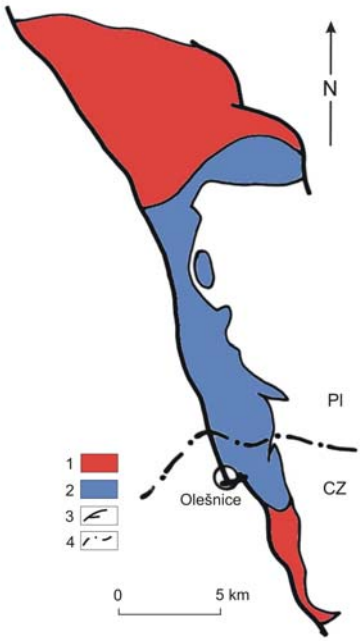

Fig. 4.27. *Olešnice-Kudowa Massif geological sketch-map (adapted after Opletal et al. 1980). 1 – Kudowa Granodiorite, 2 – Olešnice Granodiorite, 3 – faults, 4 – state border.*

References

BACHLINSKI, R. (2007): Kudowa-Olešnice granitoid massif. – Arch. mineral. Monogr. 1, 275–286. BORKOWSKA, M. (1969): Feldspars of the Kudowa granitoids as indicator of their crystallization temperatures. – Bull. Acad. Polon. Sci., Sér. geol. 17, 103–109.

DOMEČKA, K. – OPLETAL, M. (1974): Granitoidy západní časti orlicko-kladské klenby. – Acta. Univ. Carol., Geol., 75–109.

GIERWIELANIC, J. (1957): Geologia a petrografia granitu Kudowy i jego oslony. In: Przew. 30 zjazdu Pol. Tow. Geol. w Ziemi Klodzkiej, 100–119. – Wroclaw.

JELIŃSKI, A. (1965): Geochemistry of the uranium in the Karkonosze Granite Massif and other granitoids massifs of Lower Silesia. – Biul. Inst. Geol. 193, 5, 5–110. (In Polish)

OPLETAL, M. et al. (1980): Geologie Orlických hor. Oblastní regionální geologie ČSR. – 202 pp. Ústř. úst. geol. Praha.

WISZNIEWSKA, J. – KRZEMIŃSKA, E. – MAZUR, S. – GAWĘDA, A. – KOZŁOWSKI, A. (2007): Foreword – brief outline of geology of Poland. In: Kozłowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 5–7.

Olešnice Granodiorite

Large variation of chemical composition. Quartz-poor, sodic, weakly peraluminous, mesocratic, S-type, M-series, granodiorite

n = 12	Median	Min	Max	QU1	QU3
SiO_2	66.60	61.96	68.82	66.19	67.00
TiO_2	0.43	n.d.	0.73	0.00	0.47
Al_2O_3	15.68	15.04	18.34	15.19	17.07
Fe_2O_3	0.81	0.40	2.48	0.62	1.80
FeO	2.00	1.62	4.09	1.79	2.18
MnO	0.00	0.00	0.05	0.00	0.04
MgO	1.89	1.08	4.43	1.58	2.56
CaO	2.24	0.97	3.24	1.40	2.60
Na_2O	4.39	3.86	5.37	4.15	5.01
K_2O	3.33	1.85	5.20	2.53	3.49

P_2O_5	0.13	0.00	0.27	0.06	0.15
Mg/(Mg+Fe)	0.55	0.35	0.63	0.46	0.59
K/(K+Na)	0.31	0.23	0.46	0.25	0.34
Nor.Or	20.45	11.46	31.51	15.55	21.76
Nor.Ab	40.98	36.73	50.49	39.05	47.68
Nor.An	10.72	4.67	16.65	5.50	12.14
Nor.Q	16.90	8.59	28.73	12.43	19.58
Na+K	213.41	173.20	246.29	209.26	223.50
*Si	119.50	90.86	174.24	96.05	134.48
K-(Na+Ca)	-139.16	-162.99	-44.93	-159.60	-91.11
Fe+Mg+Ti	98.29	78.05	207.09	81.93	108.27
Al-(Na+K+2Ca)	16.82	-39.03	94.33	7.64	24.35
(Na+K)/Ca	5.22	3.36	12.21	4.52	6.78
A/CNK	1.08	0.89	1.39	1.03	1.10

Th – 22, **U** – 8 (ppm).

Kudowa Granodiorite to Granite

Quartz-normal, sodic, metaluminous, leucocratic, S-type, M-series, granite

n = 14	**Median**	**Min**	**Max**	**QU1**	**QU3**
SiO_2	72.06	70.01	75.13	70.79	73.56
TiO_2	n.d.	0.00	0.19	0.00	0.00
Al_2O_3	14.16	13.51	16.97	13.71	14.61
Fe_2O_3	1.13	0.10	1.58	0.82	1.34
FeO	0.30	0.13	1.52	0.17	1.03
MnO	0.00	0.00	0.05	0.00	0.00
MgO	0.44	0.03	1.51	0.22	0.78
CaO	1.53	1.02	3.16	1.30	1.92
Na_2O	4.45	3.56	5.55	4.04	4.93
K_2O	3.90	1.11	5.11	3.71	4.12
P_2O_5	0.05	0.00	0.16	0.00	0.06
Mg/(Mg+Fe)	0.36	0.04	0.58	0.29	0.48
K/(K+Na)	0.35	0.12	0.47	0.33	0.40
Nor.Or	23.50	6.64	30.53	22.06	23.89
Nor.Ab	40.75	32.56	50.03	37.77	44.15
Nor.An	6.78	2.89	15.11	5.49	7.94
Nor.Q	24.05	20.56	31.43	22.81	25.76
Na+K	226.89	193.95	257.87	215.79	233.83
*Si	145.98	130.00	187.70	137.88	157.74
K-(Na+Ca)	-97.14	-191.57	-37.24	-111.06	-77.01
Fe+Mg+Ti	27.72	16.57	73.47	21.77	53.93
Al-(Na+K+2Ca)	-15.21	-58.24	56.55	-26.82	10.85
(Na+K)/Ca	8.30	3.83	14.18	4.90	9.13
A/CNK	0.95	0.82	1.20	0.91	1.04

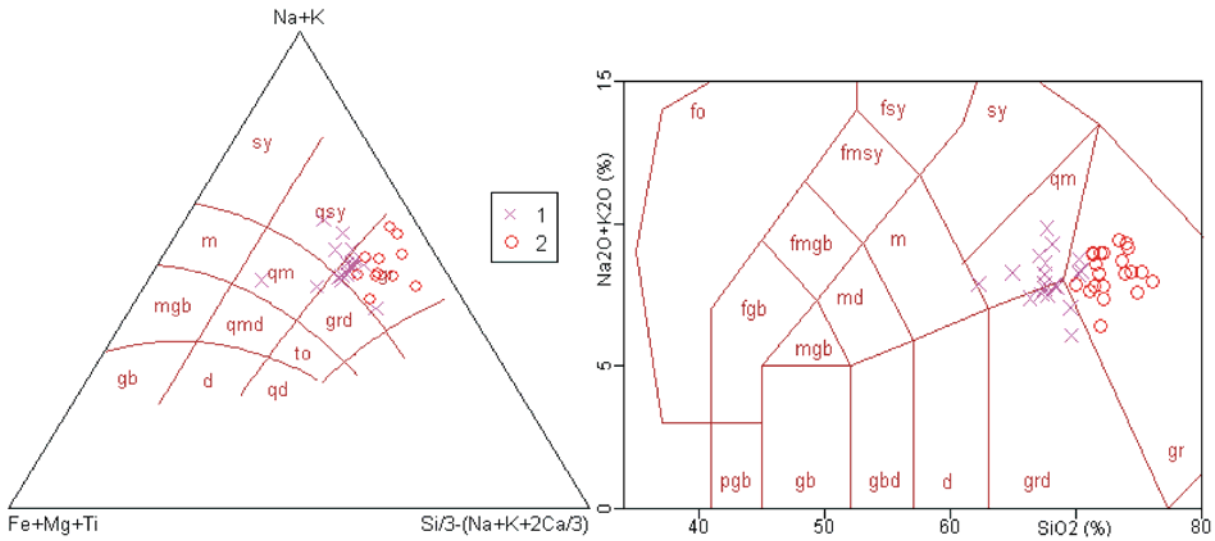

Fig. 4.28. *Olešnice-Kudowa Massif ABQ and TAS diagrams. 1 – Olešnice Granodiorite, 2 – Kudowa Granodiorite to Granite.*

4.19. NOVÝ HRÁDEK STOCK

Regional position: Isolated body in the Orlické Hory-Kłodzko Dome area, northeast Bohemia (Lugicum).

Rock types:

Nový Hrádek Granite (Čermná Granite) leucocratic alkali-feldspar granite – three textural varieties with gradational relation. Narrow rim of the leucocratic Q-diorite in the endocontact.

Age and isotopic data: *Nový Hrádek Granite* 360 ± 18 Ma (K-Ar biotite), Upper Carboniferous cover.

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

Geological environment: Nové Město unit of the Neoproterozoic age. It is represented by phyllites and metabasites affected by contact metamorphism.

Contact aureole: 100–150 m wide, parallel with margin of the intrusion.

Zoning: distinct textural and compositional concentric zoning (marginal massive variety and central foliated variety) with gradational relation. Increase of acidity towards the margin in SE direction.

Mineralization: no indications.

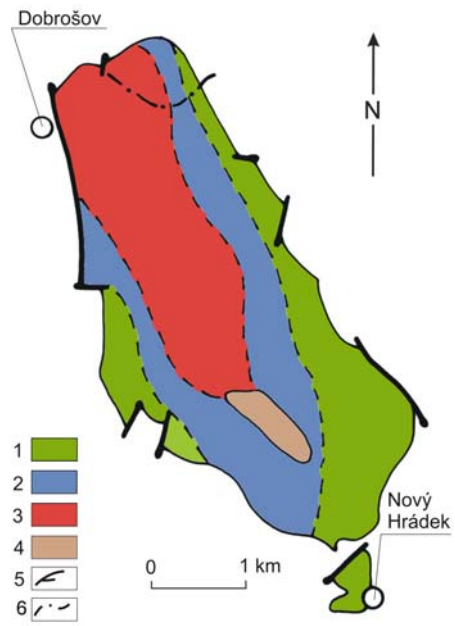

Fig. 4.29. *Nový Hrádek Stock geological sketch-map (adapted after Opletal et al. 1980). Nový Hrádek Granite: 1 – strongly foliated granite, 2 – moderately foliated granite, 3 – unfoliated granite, 4 – metamorphic country rocks, 5 – faults, 6 – state border.*

References

DOMEČKA, K. – OPLETAL, M. (1974): Granitoidy západní časti orlicko-kladské klenby. – Acta. Univ. Carol., Geol., 75–109.

OPLETAL, M. et al. (1980): Geologie Orlických hor. Oblastní regionální geologie ČSR. – 202 pp. Ústř. úst. geol. Praha.

Nový Hrádek Granite

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

	544Novh	545Novh	549Novh	546Novh	547Novh	548Novh
SiO_2	75.10	76.41	72.40	75.28	75.55	75.15
TiO_2	0.14	0.08	0.35	0.11	n.d.	n.d.
Al_2O_3	13.51	12.79	14.35	13.03	13.13	14.32
Fe_2O_3	0.75	0.94	1.81	0.80	1.31	2.18
FeO	0.70	0.46	1.32	0.44	0.17	0.30
MnO	0.11	0.10	0.02	0.10	n.d.	n.d.
MgO	0.07	0.02	0.62	0.05	0.04	0.81
CaO	0.07	0.05	0.37	0.10	0.41	0.70
Na_2O	4.50	4.67	4.62	4.48	3.89	3.57
K_2O	4.30	4.20	3.10	n.d.	5.12	3.46
P_2O_5	0.02	0.02	0.07	0.01	0.14	n.d.
Mg/(Mg+Fe)	0.08	0.02	0.27	0.07	0.05	0.39
K/(K+Na)	0.39	0.37	0.31	0.00	0.46	0.39
Nor.Or	25.78	25.03	18.83	0.00	30.60	20.84
Nor.Ab	41.00	42.30	42.65	43.25	35.33	32.68
Nor.An	0.22	0.12	1.41	0.46	1.12	3.54
Nor.Q	30.06	30.92	30.61	48.76	30.72	36.29
Na+K	236.51	239.87	214.91	144.57	234.24	188.67
*Si	179.29	183.44	182.36	271.88	180.02	219.93
K-(Na+Ca)	-55.16	-62.41	-89.86	-146.35	-24.13	-54.22
Fe+Mg+Ti	22.64	19.68	60.83	18.77	19.77	51.59
Al-(Na+K+2Ca)	26.30	9.51	53.70	107.75	8.99	67.58
(Na+K)/Ca	189.48	269.04	32.57	81.07	32.04	15.11
A/CNK	1.11	1.04	1.24	1.73	1.05	1.32

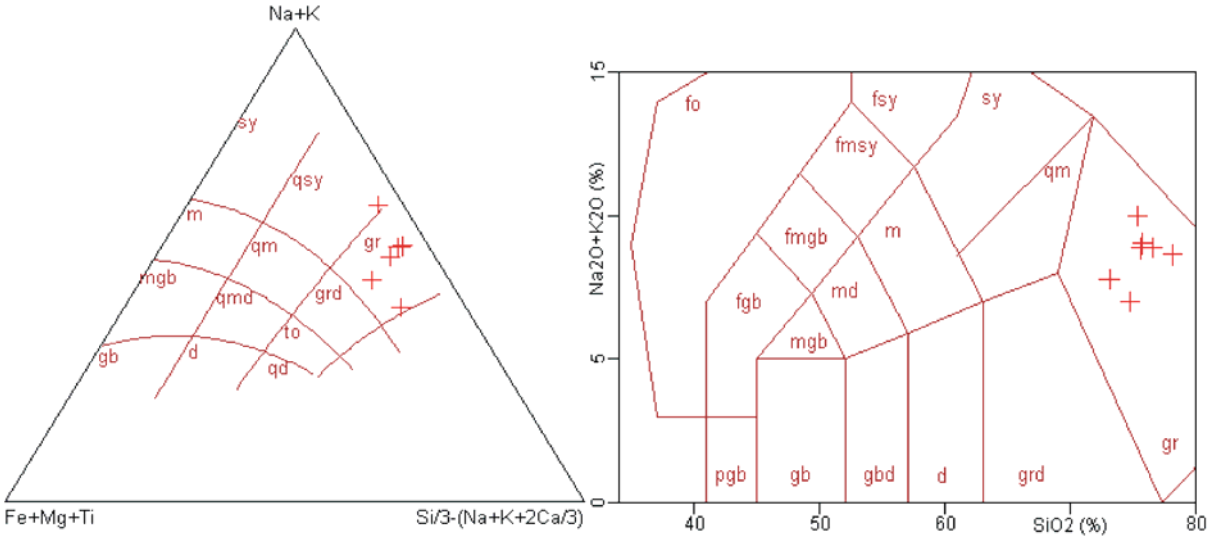

Fig. 4.30. *Nový Hrádek Stock ABQ and TAS diagrams. Nový Hrádek Granite.*

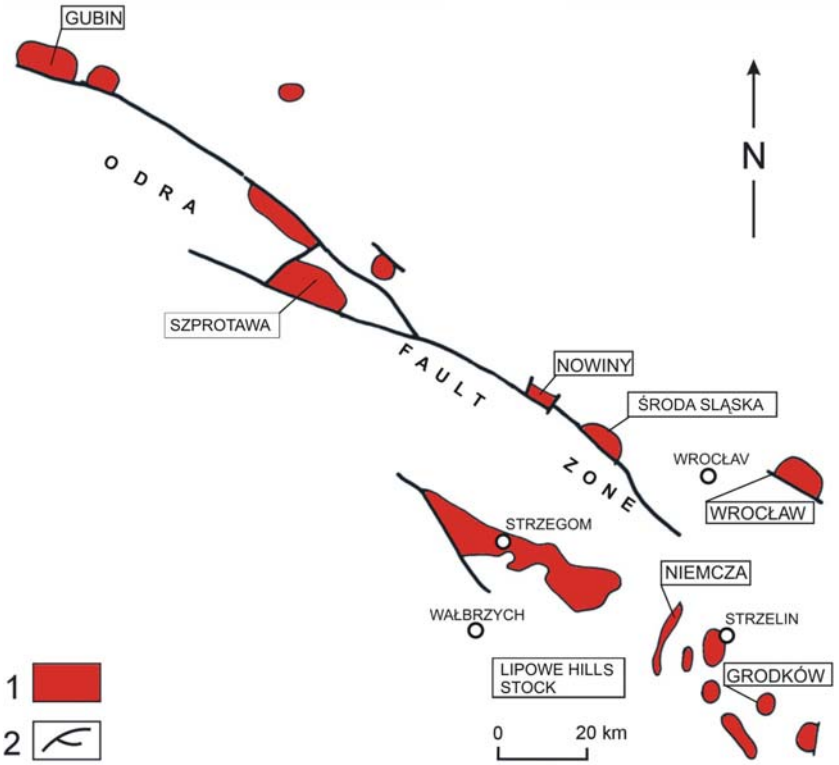

Fig. 4.31. *Odra Fault Granitoids geological sketch-map in the basement of the sedimentary cover (after Oberc-Dziedzic et al. (1999). 1 – Odra Fault Granitoids, 2 – faults.*

4.20. ODRA FAULT INTRUSIONS

Regional position: Several subsurface granitoid massifs and stocks (under a sedimentary cover) along the Odra Fault Zone (ca. 200 km long and up to 20 km wide), a Permian-Mesozoic horst outlining the northeastern edge of the Bohemian Massif.

Rock types:
Gubin Granodiorite – biotite granodiorite to granite.
Szprotawa Granodiorite – medium-grained hornblende-biotite granodiorite to granite.
Şroda Sląska Monzonite – hornblende-biotite quartz monzonite to quartz monzodiorite.
Wrocław Monzonite – quartz monzonite to granite.
Grodków Granite – biotite granite (resembles the Strzelin granites) to tonalite.

Size and shape: several oval massifs and stocks on the area of 600 km^2 (mostly under the sedimentary cover).

Age and isotopic data: *Szprotawa Granitoids* (Leszno Dolne Granite) 344 ± 1 Ma (U-Pb zircon), Permian sedimentary deposits in the cover, *Grodków Granitoids* 332–338 Ma (Rb-Sr whole rock), *Środa Sląska (Przedmoscie) Monzonite* 344 ± 1 Ma (Pb-U zircon).

Contact aureole: schistose hornfelses.

Mineralization: traces of molybdenite.

References

DÖRR, W. – ŻELAŻNIEWICZ, A. – BYLINA, P. – SCHASTAK, J. – FRANKE, W. – HAAK, U. – KILICKU, C. (2006): Tournaisian age of granitoids from the Odra Fault Zone (southwestern Poland): equivalent of the Mid-German Crystalline High? – Int. J. Earth Sci. (Geol. Rdsch.) 95, 341–349.

OBERC-DZIEDZIC, T. – ŹELAŹNIEWICZ, A. – CWOJDZIŃSKI, S. (1999): Granitoids of the Odra Fault Zone: late- to post-orogenic Variscan intrusions in the Saxothuringian Zone, SW Poland. – Geologica sudet. 32, 55–71.

SACHANBIŃSKI, M. (1980): Granitoidy obszaru przedsudeckiego w swietle badaň geochemicznych. – Arch. mineral. 36, 135–242.

WISZNIEWSKA, J. – KRZEMIŃSKA, E. – MAZUR, S. – GAWĘDA, A. – KOZŁOWSKI, A. (2007): Foreword – brief outline of geology of Poland. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 5–7.

Odra Fault Granitoids

Gubin Granite – quartz-normal, sodic, metaluminous, mesocratic, I-type granite
Szprotawa Granodiorite – quartz-normal, potassic, meta/per-aluminous, I-type granodiorite
Wrocław Monzonite – quartz-normal, sodic/potassic, meta/peraluminous, I-type quartz monzonite

	Gubin Granite		**Szprotawa Granodiorite**		**Wrocław Monzonite**	
Sample	Przyb1/1477	Zarkow2/993	Leszno268	Niegosl399	Chrzast	Katna12667
SiO_2	70.76	67.71	52.05	62.59	55.59	65.74
TiO_2	0.22	0.48	0.10	0.10	0.80	0.58
Al_2O_3	13.80	14.37	14.52	16.44	14.49	14.22
Fe_2O_3	1.54	2.23	4.06	2.04	2.01	5.08
FeO	0.68	1.22	7.23	3.57	5.42	1.44
MnO	0.09	0.06	0.06	0.05	0.08	0.02
MgO	0.80	1.26	7.66	1.06	4.43	1.61
CaO	1.28	1.69	5.04	2.80	6.44	0.71
Na_2O	4.34	4.00	1.55	2.30	2.75	2.80
K_2O	5.03	4.60	3.40	4.51	2.75	5.40
P_2O_5	0.08	0.05	0.05	0.05	0.29	0.24
Mg/(Mg+Fe)	0.40	0.41	0.55	0.26	0.52	0.32
K/(K+Na)	0.43	0.43	0.59	0.56	0.40	0.56
Nor.Q	21.47	20.88	3.97	22.85	6.78	25.32
Nor.Or	30.54	28.51	25.00	29.44	19.04	34.14
Nor.Ab	40.05	37.69	17.32	22.82	28.93	26.90
Nor.An	5.99	8.45	30.71	14.99	35.20	2.08
Na+K	246.85	226.75	122.21	169.98	147.13	205.01
*Si	130.50	128.80	106.64	143.97	84.71	151.26
K-(Na+Ca)	-56.08	-61.55	-67.70	-28.39	145.19	11.64
Fe+Mg+Ti	51.37	82.21	342.87	102.83	220.60	130.92
Al-(Na+K+2Ca)	-21.50	-4.82	-16.81	53.01	-92.25	48.92
(Na+K)/Ca	10.81	7.52	1.36	3.40	1.28	16.19
A/CNK	0.93	0.99	0.95	1.20	0.77	1.24

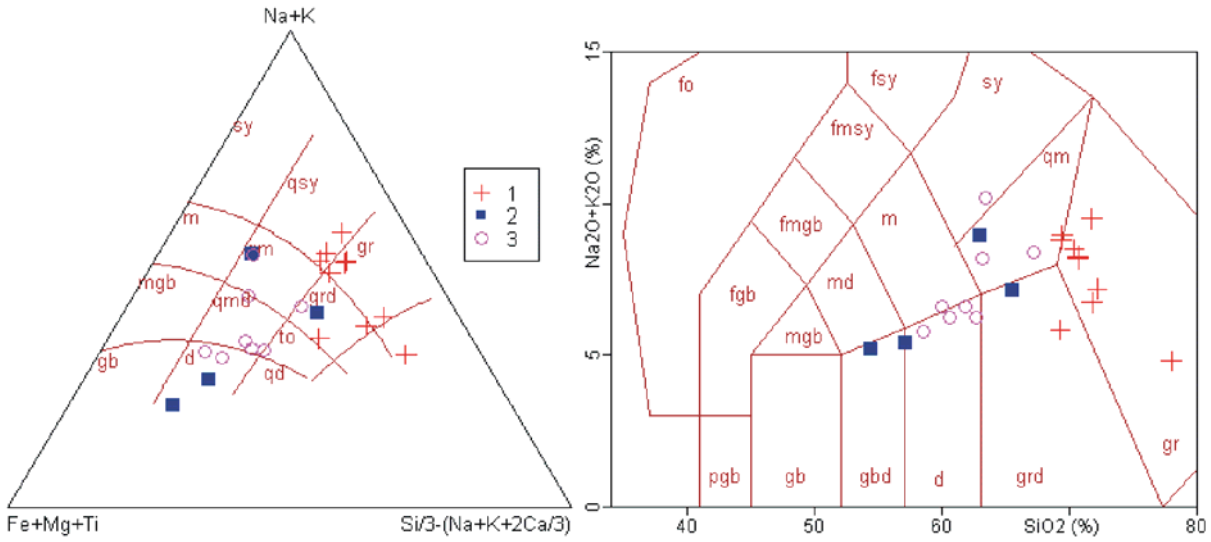

Fig. 4. 32. *Odra-Fault Granitoids ABQ and TAS diagrams. 1 – Gubin Granodiorite, 2 – Szprotawa Granodiorite, 3 – Wrocław Monzonite.*

4.21. ORLICA-SNĚŽNÍK ORTHOGNEISS

Regional position: the Orlica-Sněžník Orthogneiss represents a large metamorphosed intrusion in the easternmost termination of Lugicum. The granitic and migmatitic rocks forming a core of the Orlice-Sněžník Dome were affected by strong ductile deformation during the Variscan orogeny. The Sněžník Orthogneiss and the Gieraltów Orthogneiss represent granitic associations typically confined to late- to post-collision or within plate settings.

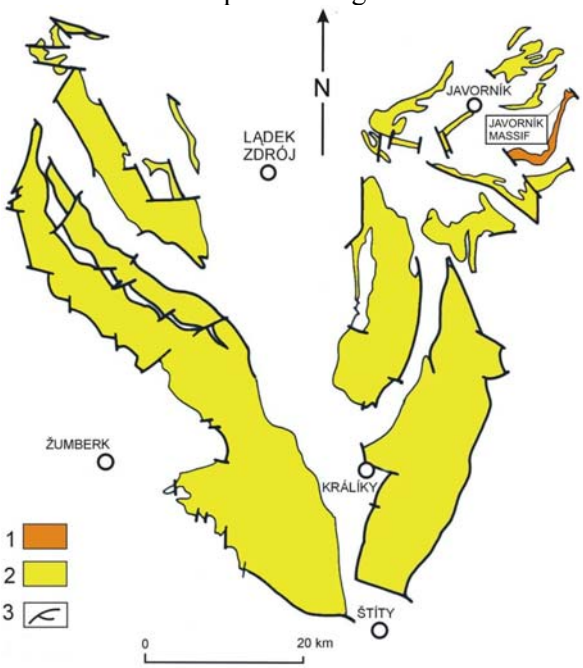

Fig. 4.33. *Orlica-Sněžník Orthogneiss and Javorník Massif geological sketch-map (adapted after Opletal and Domečka 1983). 1 – Javorník Massif, 2 – Orlica-Sněžník Dome, 3 – faults.*

Size and shape (on erosion level): total map area of 1,500 km^2, a series of sills within mica-schists of the Stroňa series arranged into three domal structures:

Říčky Anticlinorium,
Orel Anticlinorium,
Spalona-Mládkov Anticlinorium.

The Orlice-Sněžník Dome is the tectonically dismembered original batholith emplaced during thrust tectonics. The original thicknes should be at least several kilometres.

Rock types:

Sněžník Orthogneiss – augen coarse-grained orthogneiss ("Augengneiss") derived from Caledonian porphyritic granite.

Gieraltów Orthogneiss – layered to massive fine-grained migmatitic gneiss (different products of migmatitic mobilization postdating the presumably Ordovician Sněžník Orthogneiss).

Age and isotopic data: *Gieraltów Orthogneiss*: 464 ± 18 Ma (Rb-Sr whole rock) and 333 ± 7 Ma (Ar-Ar micas). *Sněžník Orthogneiss:* 395 ± 35 Ma, 320-340 Ma (Ar-Ar mica), 487 ± 11 Ma (Rb-Sr whole rock), 511 ± 1.1 Ma (Pb-Pb zircon), 507.1 ± 1.3 Ma (Pb-Pb zircon), 503.5 ± 1.1 Ma (Pb-Pb zircon), 540-530 Ma (U-Pb and Pb-Pb zircon cores), 488–504 Ma (U-Pb zircon), 490 Ma Sm-Nd). 329 Ma and 334 ± 3 Ma (Ar-Ar muscovite) – cooling age dating medium grade metamorphism and deformation during the Variscan orogeny.

Geological environment: mica-schists of the Stronie series.

Contact aureole: intrusion into the Stronie series of the Neoproterozoic age.

Mineralization: no indications.

References

BORKOWSKA, M. – CHOUKROUNE, P. – HAMEURT, J. – MARTINEAU, F. (1990): A geochemical investigation of the age significance and structural evolution of the Caledonian-Variscan granite-gneisses of the Snieznik metamorphic area (Central Sudetes, Poland). – Geologica sudet. 25, 1–27.

BORKOWSKA, M. – DÖRR, W. (1998): Some remarks on the age and mineral chemistry of orthogneisses from the Ladek-Snieznik Metamorhic Massif, Sudetes, Poland. – Terra Nostra 98, 2, 27–30.

BORKOWSKA, M. – ORLOWSKI, R. (2001): Orthogneisses of the Ladek-Snieznik metamorphic complex: their petrological diversity and genetic relations. In: Tectonic and Magma 2001 IGCP Project 373, Abstract Vol. 23–26. – Berlin.

ČECH, S. – GAWLIKOWSKA, E. (1999): Góry Stolowe Mts. Geological map for tourists 1 : 50,000. – Panst. Inst. Geol., Warzsawa – Czech Geol. Survey, Prague.

DON, J. – DUMICZ, M. – WOJCIECHOWSKA, I. – ZELAZNIEWICZ, A. (1990): Lithology and tectonics of the Orlica-Snieznik Dome, Sudetes. Recent state of knowledge. – Neu. Jb. Geol. Paläont., Abh. 179, 159–188.

GAWLIKOWSKA, E. – OPLETAL, M. (1997): Snieznik area. Geological map for tourists 1 : 50,000. – Panst. Inst. Geol., Warzsawa – Czech Geol. Survey, Prague.

GLASCOCK, J. M. – SCHNEIDER, D. A. – MANECKI, M. (2003): Exhumation history of the Orlica-Snieznik Dome (Bohemian Massif) revealed through Ar-Ar thermochronometry. – Geol. Soc. Amer. Abstracts with Programs 35, 6, 638.
GROCHOLSKI, A. (1986): Proterozoic and Palaeozoic of southwestern Poland in a light of new data. – Biul. Inst. geol. 355, 8–29.
GRZESKOWIAK, A. – ZELAZNIEWICZ, A. (2002): On the significance of gneissic enclaves in the 500 Ma metagranite the Ladek-Snieznik metamorphic unit, the West Sudetes. – Geolines 14, 28–29.
KRÖNER, A. – HEGNER, E. – JAECKEL, P. (1997): Cambrian to Ordovician granitoid orthogneisses in the Polish and Czech West Sudetes Mts and their geodynamic significance. – Terra Nostra 97, 67–68.
KRÖNER, A. – JAECKEL, P. – HEGNER, E. – OPLETAL, M. (2001): Single zircon ages and whole rock Nd isotopic systematics of early Palaeozoic granitoid gneisses from the Czech and Polish Sudetes (Jizerské hory, Krkonoše Mountains and Orlice-Sněžník Complex). – Int. J. Earth Sci. (Geol. Rdsch.) 90, 304–324.
LIEW, T. C. – HOFMANN, A. W. (1988): Precambrian crustal components, plutonic associations, plate environment of the Hercynian Fold Belt of central Europe: Indications from a Nd and Sr isotopic study. – Contr. Mineral. Petrology 98, 129–138.
MALUSKI, H. – RAJLICH, P. – SOUČEK, J. (1995): Pre-Variscan, Variscan and Early Alpine thermo-tectonic history of the northeastern Bohemian Massif: An Ar-Ar study. – Geol. Rdsch. 84, 345–358.
MARHEINE, D. – KACHLÍK, V. – MALUSKI, H. et al. (2002): The 40Ar/39Ar ages from the West Sudetes (NE Bohemian Massif): constraints on the Variscan polyphase tectonothermal development. In: Winchester, J. A. – Pharaoh, T. C. – Verniers, J. Eds: Palaeozoic Amalgamation of Central Europe. – Geol. Soc. London Spec. Publ. 201, 133–155.
OLIVER, G. J. H. – CORFU, F. – KROGH, T. E. (1993): U-Pb Ages from SW Poland: evidence for Caledonian suture zone between Baltica and Gondwana. – J. Geol. Soc. London 150, 355–369.
OPLETAL, M. et al. (1980): Geologie Orlických hor. Oblastní regionální geologie ČSR. – 202 pp. Ústř. úst. geol. Praha.
OPLETAL, M. – DOMEČKA, K. (1974): Granitoidy západní části orlicko-kladské klenby. – Acta Univ. Carol., Geol. 1, 75–109.
OPLETAL, M. – DOMEČKA, K. (1983): Synoptic geological map of the Orlické hory Mts. 1 : 100,000. – Czech Geol. Survey, Prague.
PŘIKRYL, R. – SCHULMANN, K. – MELKA, R. (1996): Perpendicular fabrics in the Orlické hory orthogneisses (western part of the Orlice-Sněžník Dome, Bohemian Massif) due to high temperature E-W deformational event and late lower temperature N-S overprint. – J. Czech Geol. Soc. 41, 156–166.
TURNIAK, K. – MAZUR, S. – WYSOCZANSKI, R. (2000): SHRIMP zircon geochronology and geochemistry of the Orlica-Snieznik gneisses (Variscan belt of Central Europe) and their tectonic implications. – Geodyn. Acta 13, 293–312.
ŻELAŻNIEWICZ, A. (1988): Orthogneisses due to irrotational extension, a case from the Sudetes, Bohemian massif. – Geol. Rdsch. 77, 3, 671–682.

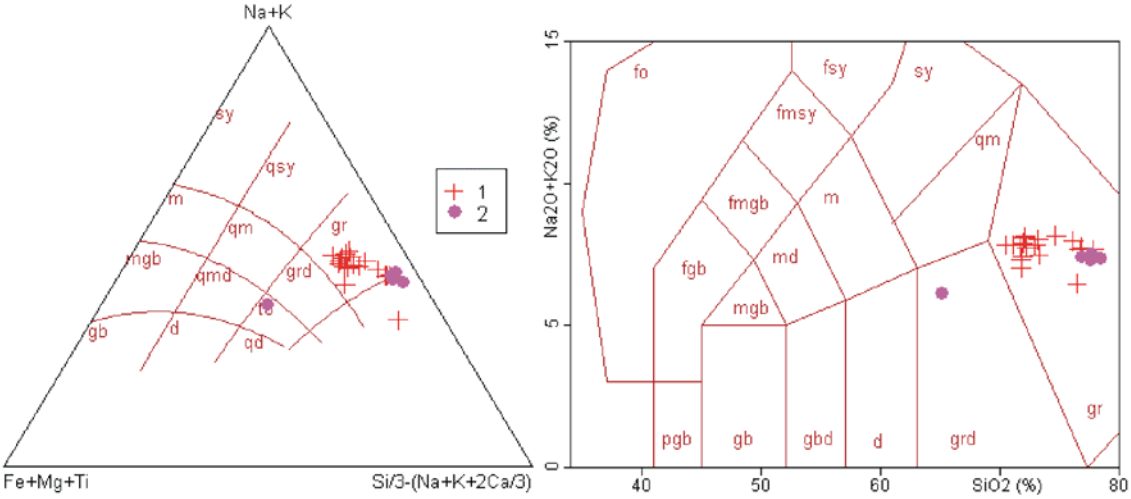

Fig. 4.34. *Orlica-Sněžník Orthogneiss ABQ and TAS diagrams. 1 – Sněžník Orthogneiss, 2 – Gieraltów Orthogneiss.*

Sněžník Orthogneiss

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

n = 18	Median	Min	Max	QU1	QU3
SiO_2	71.50	70.42	77.44	70.55	73.92
TiO_2	0.25	0.07	0.36	0.17	0.31
Al_2O_3	14.35	12.32	15.66	13.33	14.87
Fe_2O_3	1.16	0.56	1.96	0.97	1.30
FeO	0.99	0.58	2.04	0.71	1.13
MnO	0.03	0.00	0.11	0.03	0.04
MgO	0.55	0.20	0.93	0.37	0.62
CaO	1.36	0.25	2.13	0.60	1.55
Na_2O	3.10	1.34	3.31	3.02	3.28
K_2O	4.58	3.85	5.05	4.40	4.75
P_2O_5	0.14	0.02	0.21	0.07	0.17
Mg/(Mg+Fe)	0.29	0.19	0.38	0.26	0.31
K/(K+Na)	0.48	0.44	0.71	0.47	0.51
Nor.Or	27.88	24.04	31.36	27.07	28.89
Nor.Ab	29.19	12.83	30.96	27.97	30.60
Nor.An	6.13	0.12	10.19	1.70	7.29
Nor.Q	30.95	28.47	45.76	29.63	34.14
Na+K	195.78	148.98	207.67	190.52	200.42
*Si	180.67	170.34	260.74	174.95	198.28
K-(Na+Ca)	-32.29	-60.81	55.36	-39.28	-6.17
Fe+Mg+Ti	45.51	24.13	64.64	36.51	52.31
Al-(Na+K+2Ca)	37.86	25.07	98.53	34.48	43.75
(Na+K)/Ca	8.13	4.97	43.92	6.79	17.52
A/CNK	1.17	1.11	1.65	1.15	1.20

Trace elements (mean values in ppm): *Sněžník Orthogneiss* – **Co** 5, **Cr** 42, **Cu** 7, **Ni** 7, **Nb** 10, **Pb** 7, **Rb** 220, **Sn** 7, **U** 11.3.

F. GÓRY SOWIE BLOCK

The Góry Sowie Block comprises pre-Variscan granitoid orthogneisses as well as their migmatitic and anatectic derivates, tectonically interlayered with paragneisses and affected by several consecutive tectono-metamorphic events. The Złoty Stok Massif and small stocks east of the Sudetic Marginal Fault represent Variscan intrusions.

References

MAZUR, S. – ALEKSANDROWSKI, P. – TURNIAK, K. – AWDANKIEWICZ, M. (2007): Geology, tectonic evolution and Late Palaeozoic magmatism of Sudetes – an overview. In: Kozłowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 59–87.

4.22. NIEMCZA STOCKS

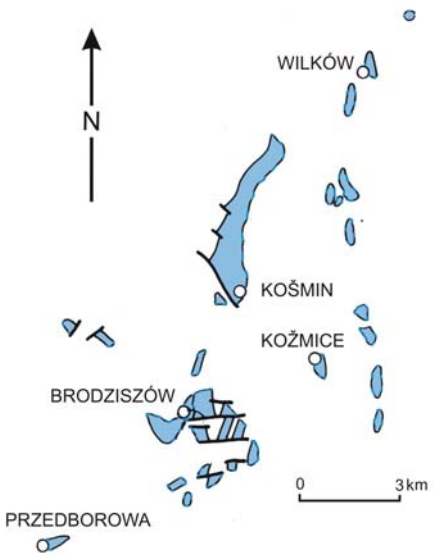

Fig. 4.35. *Niemcza Stocks geological sketch-map (adapted according to Lorenc 1998).*

Regional position: Late-tectonic intrusive rocks of Variscan age within the Niemcza zone adjacent to the Góry Sowie Block.

Rock types:

Kośmin Granodiorite – porphyritic medium-grained amphibole-biotite granodiorite (predominant type).

Przedborowa Diorite – fine-grained amphibole-biotite quartz monzodiorite, tonalite and quartz diorite.

Kożmice Monzodiorite – biotite-pyroxene fine-grained monzodiorite to syenite.

Size and shape (on erosion level): several small sheet-like bodies of late-tectonic granitoids (parallel to the structural trend of the enclosing rocks) within the N-S trending, 20 km long and 5 km wide Niemcza shear zone.

Age and isotopic data: *Kożmice Syenite* 338 ± 2.3 Ma (U-Pb zircon), *syn-kinematic granodiorite* 331.9 ± 1.7 Ma (Ar-Ar hornblende), *Kośmin Granodiorite* 338 Ma (Rb-Sr Whole rock). Cooling age: 300–277 Ma (K/Ar).

Geological environment: mica-schist of the Niemcza-Kameniec Ząbkowicki unit, metamorphic rocks of the Niemcza zone, Góry Sowie orthogneisses.

Contact aureole: not reported.

Mineralization: not known.

References

DEPCIUCH, T. (1972): Wiek bezwzględny K-Ar granitoidów Kłodzko-Złotostockich i strefy Niemczy. – Kwart. geol. 16, 103–111.

DZIEDZIC, H. (1963): „Syenity“ strefy Niemczy. – Arch. mineral. 24, 5–126.

KENNAN, P. S. – DZIEDZIC, H. – LORENC, M. W. – MIERZEJEWSKI, P. (1999): A review of Rb-Sr isotope patterns in the Carboniferous granitoids of the Sudetes in SW Poland. – Geologica sudet. 32, 49–53.

LORENC, M. W. (1998): Nadania izotopowe metodą Rb-Sr skał intruzyjnych strefy Niemczy (Dolny Śląsk). – Arch. mineral. 51, 153–164.

LORENC, M. W. – KENNAN, P. S. (2007): Intrusive rocks from the Niemcza zone (Lower Silesia, Poland) in the light of petrologic and Rb-Sr isotope studies. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 253–259.

OLIVER, G. J. H. – CORFU, F. – KROGH, T. E. (1993): U-Pb ages from SW-Poland: Evidence for Caledonian suture zone between Baltica and Gondwana. – J. Geol. Soc. London 150, 355–369.

PUZIEWITZ, J. (1992): Origin of the Kożmice granodiorite (Niemcza zone, Lower Silesia). – Arch. mineral. 47, 95–146. (In Polish)

WISZNIEWSKA, J. – KRZEMIŃSKA, E. – MAZUR, S. – GAWĘDA, A. – KOZŁOWSKI, A. (2007): Foreword – brief outline of geology of Poland. In: Kozłowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 5–7.

Kośmin Granodiorite

Quartz-normal, sodic/potassic, peraluminous, mesocratic, I-type granodiorite

n = 6	Median	Min	Max	QU1	QU3
SiO_2	58.81	56.26	65.60	58.78	62.31
TiO_2	0.53	0.30	1.46	0.53	0.60
Al_2O_3	15.09	13.58	17.14	14.46	15.36
Fe_2O_3	2.02	0.06	3.70	1.10	2.15
FeO	4.35	2.12	6.19	3.98	4.57
MnO	0.03	0.00	0.18	0.00	0.03
MgO	3.22	2.33	5.43	3.01	3.85
CaO	4.91	3.70	7.14	4.55	6.52
Na_2O	2.95	2.16	3.34	2.72	3.12
K_2O	3.50	3.20	4.54	3.50	3.85
P_2O_5	0.28	0.12	0.50	0.16	0.31
Mg/(Mg+Fe)	0.50	0.45	0.57	0.49	0.50
K/(K+Na)	0.46	0.40	0.54	0.44	0.46
Nor.Or	22.39	20.66	28.49	21.83	23.07
Nor.Ab	28.68	19.67	32.47	25.78	29.75
Nor.An	24.17	17.43	32.53	23.59	25.68
Nor.Q	9.30	2.67	25.21	4.57	10.00
Na+K	169.51	151.45	201.20	162.09	169.59
*Si	89.77	51.68	157.86	63.95	90.39
K-(Na+Ca)	-115.28	-151.57	-79.44	-120.55	-108.44
Fe+Mg+Ti	167.27	120.91	247.86	157.06	217.08
Al-(Na+K+2Ca)	-68.74	-145.64	32.34	-139.40	-61.84
(Na+K)/Ca	1.70	1.19	2.48	1.44	1.94
A/CNK	0.84	0.67	1.13	0.67	0.85

Trace elements (mean values in ppm): **Pb** 26, **Rb** 174, **Th** 16.5, **U** 6, **Nb** 10.4, **Sr** 413, **Zr** 162

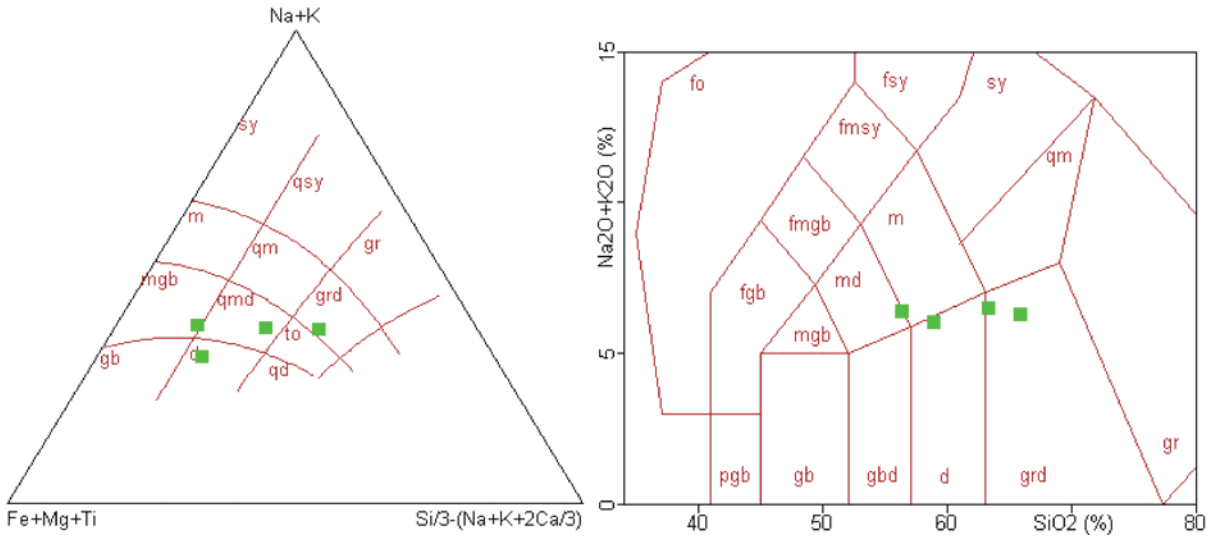

Fig.4.36. *Niemcza Stocks ABQ and TAS diagrams. Kośmin Granodiorite.*

4.23. GÓRY SOWIE (OWL MTS.) ORTHOGNEISS

Regional position: In the Góry Sowie Block, tectonically interlayered with paragneisses.

Rock types:

Góry Sowie Orthogneiss – strongly foliated biotite ± muscovite ± sillimanite gneisses of trondhjemite-granodiorite composition.

Size and shape (on erosion level): a series of strongly deformed sills within the area of 700 km^2 (mostly under the sedimentary cover).

Age and isotopic data: *Góry Sowie Orthogneiss*: 463 ± 8 Ma (U-Pb zircon), 473–488 Ma (Pb-Pb zircon), 487 ± 2 Ma and 482 ± 2 Ma (Pb-Pb single zircon).

Migmatites: 375 ± 4 Ma to 362 ± 8 Ma and 372 ± 7 to 360 ± 7 (Rb-Sr whole rock), *migmatitic gneiss* 381 ± 2 Ma and 383–379 Ma (U-Pb monazite), *augengneiss:* 384–380 Ma (U-Pb xenotime).

Anatectic granite: 378 ± 2 Ma and *pegmatite:* 383–370 Ma (U-Pb monazite and xenotime) and 359 ± 3 Ma (Ar-Ar muscovite).

Ścinawka Metagranite (the Kłodzko Metamorphic Complex) 503–513, 505.8 ± 3.1 Ma (Pb-Pb zircon).

Góry Sowie Orthogneiss is intruded by post-tectonic granitoid bodies (e.g. the Kożmice Granodiorite) providing identical age 334.0 ± 1.9, 332.1 ± 1.9 Ma, (Pb-Pb zircon).

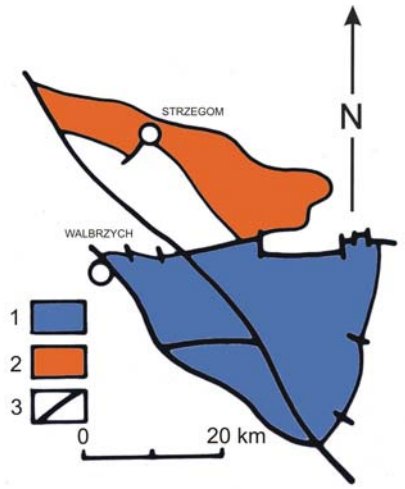

Fig. 4.37. *Góry Sowie Orthogneiss geological sketch-map. 1 – Góry Sowie Orthogneiss, 2 – Strzegom-Sobótka Massif, 3 – faults.*

Trace elements (mean values in ppm): *Góry Sowie Orthogneiss* – **Ba** 885, **Co** 58, **Cr** 50, **Cu** 13, **Ga** 18.2, **Ni** 13, **Nb** 10, **Rb** 92.5, **Sr** 224, **V** 63, **Y** 28, **Zn** 63, **Zr** 162, **La** 24.7, **Ce** 60, **Pr** 6.4, **Nd** 26.7, **Sm** 5.6, **Eu** 1.25, **Gd** 5.3, **Tb** 0.8, **Dy** 4.2, **Ho** 0.8, **Er** 2.2, **Yb** 1.9, **Lu** 0.28 (Kröner and Hegner 1998).

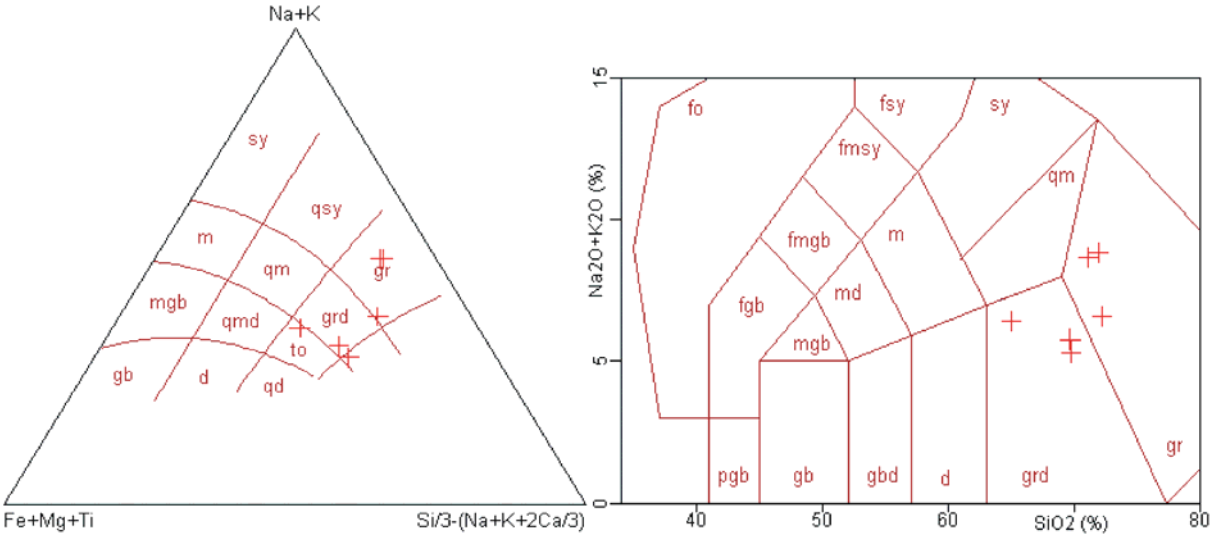

Fig. 4. 38. *Góry Sowie Orthogneiss ABQ and TAS diagrams.*

References

BREEMEN, O. VAN – BOWES, D. R. – AFTALION, M. – ŻELAŻNIEWICZ, A. (1988): Devonian tectonothermal activity in the Sowie Góry Gneissic Block, Sudetes, southwestern Poland: Evidence from Rb-Sr and U-Pb isotopic studies. – Ann. Soc. Geol. Polon. 58, 3–19.

BRÖCKER, M. – ŻELAŻNIEWICZ, A. – ENDERS, M. (1998): Rb-Sr and U-Pb geochronology of migmatitic gneisses from the Góry Sowie (West Sudetes, Poland): the importance of Mid-Late Devonian metamorphism. – J. Geol. Soc. London 155, 1025–1036.

DZIEDZIC, H. (1985): Variscan rejuvenation of the Precambrian gneisses along the eastern margin of the Góry Sovie Massif of Fore-Sudetic Block. – Krystalinikum 18, 7–27.

KRÖNER, A. – HEGNER, E. (1998): Geochemistry, single zircon ages and Sm-Nd systematics of granitoid rocks from the Góry Sowie (Owl Mts.) Polish West Sudetes: evidence for early Palaeozoic arc-related plutonism. – J. Geol. Soc. London 155, 711–724.

KRYZA, R. (1981): Migmatitization of the northern part of the Sowie Góry. – Geologica sudet. 16, 7–100.

MARHEINE, D. – KACHLÍK, V. – MALUSKI, H. et al. (2002): The 40Ar/39Ar ages from the West Sudetes (NE Bohemian Massif): constraints on the Variscan polyphase tectonothermal development. In: Winchester, J. A. – Pharaoh, T. C. – Verniers, J. Eds: Palaeozoic Amalgamation of Central Europe. – Geol. Soc. London Spec. Publ. 201, 133–155.

MAZUR, S. – ALEKSANDROWSKI, P. – TURNIAK, K. – AWDANKIEWICZ, M. (2007): Geology, tectonic evolution and Late Palaeozoic magmatism of Sudetes – an overview. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 59–87.

MAZUR, S. – TURNIAK, K. – BRÖCKER, M. (2004): Neoproterozoic and Cambro-Ordovician magmatism in the Variscan Kłodzko Metamorphic Complex (West Sudetes, Poland): new insights from U/Pb zircon dating. – Int. J. Earth Sci. (Geol. Rdsch.) 93, 758–772.

TIMMERMANN, H. – PARRISH, R. R. – NOBLE, S. R. (2000): New U-Pb monazite and zircon data from the Sudetes Mountains in SW Poland: evidence from a single-cycle Variscan orogeny. – J. Geol. Soc. London 157, 265–268.

ZAHNISER, S. J. – SCHNEIDER, D. A. – MANECKI, M. (2003): Exhumation of the Gory Sowie (Bohemian Massif) revealed through Ar-Ar thermochronometry. – Geol. Soc. Amer., 2003 Annual Meeting 35, 6, 638.

Góry Sowie Orthogneiss

Quartz-rich/normal, prevalent sodic,peraluminous, mesocratic, S-type metagranite

	PL4	PL6	PL11	PL15	PL16	PL17
SiO_2	69.02	69.18	64.28	70.20	71.63	71.41
TiO_2	0.74	0.73	0.89	0.27	0.49	0.27
Al_2O_3	14.37	14.21	16.42	16.53	14.10	15.13
Fe_2O_3tot	5.24	5.22	6.35	1.67	3.54	1.86
MnO	0.09	0.09	0.09	0.02	0.05	0.04
MgO	1.87	2.06	2.21	0.62	0.86	0.45
CaO	2.20	1.92	2.28	0.68	1.75	1.09
Na_2O	3.26	3.64	3.73	3.27	3.46	2.87
K_2O	2.01	2.10	2.63	5.27	3.10	5.88
P_2O_5	0.15	0.14	0.03	0.15	0.25	0.25
Mg/(Mg+Fe)	0.41	0.43	0.40	0.42	0.32	0.32
K/(K+Na)	0.29	0.28	0.32	0.51	0.37	0.57
Nor.Q	34.79	32.55	24.03	27.70	34.04	28.45
Nor.Or	12.64	13.14	16.50	32.04	19.06	35.66
Nor.Ab	31.15	34.62	35.58	30.22	32.32	26.45
Nor.An	10.57	9.11	11.81	2.45	7.32	3.86
Na+K	147.88	162.05	176.21	217.42	177.47	217.46
*Si	208.88	198.92	153.30	163.96	199.11	165.75
K-(Na+Ca)	-101.75	-107.11	-105.18	-5.75	-77.04	12.80
Fe+Mg+Ti	121.32	125.66	145.55	39.69	71.83	37.85
Al-(Na+K+2Ca)	55.86	48.53	64.93	82.95	37.01	40.79
(Na+K)/Ca	3.77	4.73	4.33	17.93	5.69	11.19
A/CNK	1.27	1.23	1.25	1.36	1.18	1.19

4.24. KŁODZKO-ZŁOTY STOK MASSIF

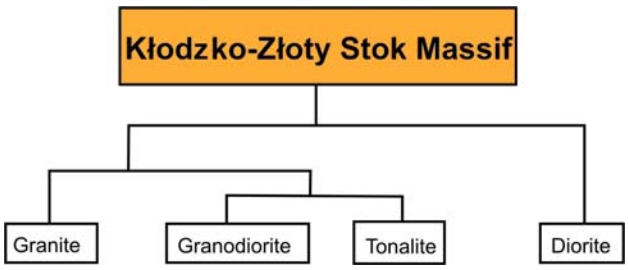

Fig. 4.39 *Kłodzko-Złoty Stok Massif hierarchical scheme according to rock types.*

Regional position: Variscan isolated intrusion in the Central Sudetes (the Góry Sowie) resembles the durbachites from the Moldanubian Zone.

Rock types:

Złoty Stok Tonalite – medium to coarse-grained biotite-hornblende and pyroxene tonalite to melagranodiorite.

Złoty Stok Diorite – hornblende pyroxene diorite – (granitized amphibolite enclaves).

Złoty Stok Granodiorite – biotite granodiorite.

Ołdrzychovice Quartz syenite.

Granite Dykes – leucocratic granite.

Size and shape (on erosion level): 87 km^2 (12 × 6.5 km), elliptical.

Age and isotopic data: Upper Carboniferous (intruding Lower Carboniferous sediments), *Złoty Stok Tonalite* 301–295 Ma (K-Ar mica), 331 ± 11 Ma (Rb-Sr whole rock).

Geological environment: unmetamorphosed Upper Carboniferous mudstones (cover?), Lower Carboniferous mudstones and graywackes and Silurian up to Dinantian sediments. Precambrian mica schists, migmatites mylonites and cataclastics on the SE exocontact. The Haniak Gneiss (similar to the Gierałtów Orthogness) at the exo-contact (dislocation zone).

Contact aureole: hornfels contacts with distinct zoning, internal contact zone up to 600 m and external zone up to 2.2 km from the intrusion, cordierite, wollastonite, andalusite and silimanite. Generally intrusive, discordant and sharp contacts.

Zoning: weak compositional zoning. Northwestern peripheries of the massif are richer in dark minerals (higher colour index).

Mineralization: hydrothermal As-Au-Sb veins.

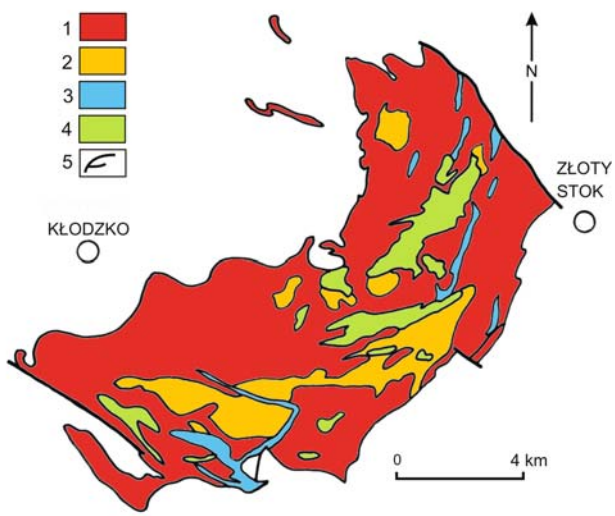

Fig. 4.40. *Kłodzko-Złoty Stok geological sketch-map (after Sawicki 1980). 1 – Złoty Stok Tonalite, 2 – Porphyritic granitoids, 3 – Złoty Stok Diorite, 4 – Ordovician and Cambrian metasediments (hornfelses), 5 – faults.*

References

BACHLINSKI, R. – BAGINSKI, B. (2007): Kłodzko-Złoty Stok granitoid massif. In: Kozlowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 261–273.

BACHLINSKI, R. – HAŁAS, S. (2002): K-Ar dating of biotite Kudowa Zdrój granitoids (Central Sudetes, SW Poland). – Bull. Pol. Acad. Sci., Earth Scie. 50, 113–116.

BEDERKE, E. (1922): Die Intrusivmasse von Glatz-Reichestein. – Abh. Preuss. Geol. Landesanst., Neue Folge 89, 39–69.

DEPCIUCH, T. (1972): Wiek bezwzględny K-Ar granitoidów Kłodzko-Złotostockich i strefy Niemczy. – Kwart. geol. 16, 103–111.

GADOMSKI, M. (1968): Trace elements in micas of the granitization zone Zlóty Stok-Skrzynka in Sudetes. – Arch. mineral. 28, 113–241. (In Polish)

JELIŃSKI, A. (1965): Geochemistry of the uranium in the Karkonosze Granite Massif and other granitoids massifs of Lower Silesia. – Biul. Inst. Geol. 193, 5, 5–110. (In Polish).

KOZŁOWSKA-KOCH, M. (1971): The „Haniak Gneisses“near Złoty Stok in the Sudetes. – Bull. Pol. Acad. Sci., Earth Sci. 19, 4, 205–214.

LEICHMANN, J. – GAWEDA, O. (2001): Kłodzko-Złóty Stok and Niemcza zone granitoids – a shallow level intrusion of durbachites in the Rhenohercynian zone? – Mitt. Österr. mineral. Gesell. 146, 169–170.

LORENC, M. W. (1991): Remarks on genesis of the Kłodzko-Złóty Stok intrusion (comparative study based on enclaves). – Arch. mineral. 47, 79–98.

LORENC, M. W. (1994): A role of mafic magmas in the evolution of granitic intrusions (a comparative study from selected Hercynian massifs). – Geologica sudet. 28, 1–130.

MAZUR, S. – ALEKSANDROWSKI, P. – TURNIAK, K. – AWDANKIEWICZ, M. (2007): Geology, tectonic evolution and Late Palaeozoic magmatism of Sudetes – an overview. In: Kozłowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 59–87.

VAN BREEMEN, O. – BOWES, D. R. – AFTALION, M. – ŻELAŻNIEWICZ, A. (1988): Devonian tectonothermal activity in the Sowie Góry Gneissic Block, Sudetes, southwestern Poland: Evidence from Rb-Sr and U-Pb isotopic studies. – Ann. Soc. Geol. Polon. 58, 3–19.

WIERZCHOLOWSKI, B. (1969): Granitoids of Bardo in Sudetes. – Arch. mineral. 28, 107–132. (In Polish)

WIERZCHOLOWSKI, B. (1976): Granitoidy Kłodzko-Złotostockie i jich kontaktowe oddziatywassie na skaly ostony. – Geologica sudet. 11, 1–147.

WISZNIEWSKA, J. – KRZEMIŃSKA, E. – MAZUR, S. – GAWĘDA, A. – KOZŁOWSKI, A. (2007): Foreword – brief outline of geology of Poland. In: Kozłowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 5–7.

WOJCIECHOWSKA, I. (2002): The geotectonic position of the Kłodzko-Złoty Stok granitoids. – Pol. Tow. Mineral. Prace Spec. 20, 231–233.

1 – Złoty Stok Tonalite

Large variation in composition. Quartz-normal, sodic, metaluminous, meso- to melanocratic, I-type, M-series tonalite

	tonal1	tonal4	tonal15	tonal16	tonal22	tonal23
SiO_2	64.37	61.90	61.61	63.66	61.92	64.18
TiO_2	0.63	0.66	0.71	0.66	0.42	0.52
Al_2O_3	16.12	15.93	14.85	15.34	15.99	15.76
Fe_2O_3	1.16	1.07	3.96	1.66	1.20	0.66
FeO	3.38	4.67	4.04	1.24	4.30	4.44
MnO	0.07	0.14	0.11	0.11	0.04	0.04
MgO	2.22	4.03	2.54	3.81	3.30	2.31
CaO	3.63	4.42	4.66	7.04	4.98	4.61
Na_2O	3.55	2.95	3.10	4.45	3.10	3.33
K_2O	3.43	1.85	2.86	0.97	3.64	2.85
P_2O_5	0.21	0.32	0.13	0.28	0.13	0.15
Mg/(Mg+Fe)	0.47	0.55	0.37	0.70	0.52	0.45
K/(K+Na)	0.39	0.29	0.38	0.13	0.44	0.36
Nor.Or	21.67	12.29	18.35	6.07	23.47	18.28
Nor.Ab	34.08	29.79	30.23	42.31	30.38	32.46
Nor.An	17.78	22.30	24.18	35.03	26.04	23.76
Nor.Q	17.95	20.80	19.34	13.82	12.00	18.00
Na+K	187.38	134.47	160.76	164.19	177.32	167.97
*Si	126.57	156.39	125.64	105.29	107.00	133.28
K-(Na+Ca)	-106.46	-134.73	-122.41	-248.54	-111.55	-129.15
Fe+Mg+Ti	124.58	186.70	177.80	140.87	162.06	133.93
Al-(Na+K+2Ca)	-0.28	20.72	-35.33	-114.02	-40.92	-22.89
(Na+K)/Ca	2.89	1.71	1.93	1.31	2.00	2.04
A/CNK	1.01	1.10	0.90	0.74	0.89	0.94

Trace elements (mean values in ppm): *Kłodzko-Złoty Stok Tonalite* – **Ba** 991, **Sr** 433**, Rb** 130, **Zr** 238, **Y** 24, **Nb** 56, **Ni** 51, **Co** 23, **Cr** 168, **Th** 26, **U** 9.

2 – Złoty Stok Diorite

Wide range in composition Quartz-normal, sodic, metaluminous, melanocratic, I-type, M-series diorite to quartz monzodiorite

n = 8	Median	Min	Max	QU1	QU3
SiO_2	56.86	55.36	62.66	56.19	59.65
TiO_2	0.70	0.42	0.96	0.62	0.84
Al_2O_3	16.03	12.57	17.84	14.95	16.73
Fe_2O_3	1.29	0.40	2.64	0.82	2.23
FeO	5.01	3.46	6.73	4.02	5.33
MnO	0.12	0.07	0.17	0.10	0.14
MgO	3.74	2.29	7.03	2.80	5.29
CaO	5.23	4.33	7.83	4.94	6.65
Na_2O	2.92	2.07	3.60	2.60	3.20
K_2O	3.30	1.05	3.90	1.60	3.67
P_2O_5	0.14	0.11	0.46	0.13	0.22
Mg/(Mg+Fe)	0.52	0.41	0.62	0.48	0.57
K/(K+Na)	0.38	0.20	0.55	0.24	0.43
Nor.Or	21.50	7.20	26.42	10.68	23.71
Nor.Ab	29.40	20.42	34.59	26.77	31.43

Nor.An	27.44	22.06	44.03	25.35	30.37
Nor.Q	7.47	5.07	16.07	5.20	10.42
Na+K	147.48	113.29	188.36	139.17	166.71
*Si	86.86	78.93	130.52	79.98	109.07
K-(Na+Ca)	-132.25	-208.33	-100.24	-203.18	-104.70
Fe+Mg+Ti	201.74	143.50	288.75	144.60	235.25
Al-(Na+K+2Ca)	-52.74	-137.80	-0.77	-71.41	-27.69
(Na+K)/Ca	1.66	0.81	2.35	1.05	1.76
A/CNK	0.88	0.65	1.02	0.83	0.93

Trace elements (mean values in ppm): *Kłodzko-Złoty Stok Diorite* – **Ba** 980, **Sr** 400, **Rb** 120, **Zr** 180, **Y** 24, **Nb** 25, **Ni** 213, **Co** 50, **Cr** 800.

3 – Złoty Stok Granodiorite

Quartz normal/rich, sodic, peraluminous, mesocratic, I/S type granodiorite

	grd9	**grd24**	**grd25**	**grd26**	**grd27**
SiO_2	61.03	65.64	67.60	65.58	71.24
TiO_2	0.69	0.37	0.43	0.51	0.38
Al_2O_3	16.27	15.43	13.12	15.43	13.34
Fe_2O_3	0.79	0.60	1.43	1.40	0.74
FeO	4.43	3.95	3.38	3.41	3.82
MnO	0.11	0.02	0.04	0.03	0.02
MgO	3.23	2.02	2.82	2.16	1.56
CaO	4.73	3.38	1.78	2.09	1.02
Na_2O	2.87	3.30	2.80	3.96	2.75
K_2O	3.60	3.37	2.24	3.76	3.17
P_2O_5	0.28	0.04	0.21	0.03	0.20
Mg/(Mg+Fe)	0.52	0.44	0.52	0.45	0.38
K/(K+Na)	0.45	0.40	0.34	0.38	0.43
Nor.Or	23.52	21.62	14.93	23.78	20.42
Nor.Ab	28.50	32.17	28.36	38.06	26.92
Nor.An	23.91	17.92	8.40	10.89	4.08
Nor.Q	13.75	20.71	34.81	18.41	36.88
Na+K	169.05	178.04	137.92	207.62	156.05
*Si	113.30	145.93	215.95	131.36	227.05
K-(Na+Ca)	-100.52	-95.21	-74.54	-85.22	-39.62
Fe+Mg+Ti	160.38	117.28	140.34	125.01	105.94
Al-(Na+K+2Ca)	-18.23	4.43	56.25	20.85	69.54
(Na+K)/Ca	2.00	2.95	4.35	5.57	8.58
A/CNK	0.96	1.02	1.31	1.08	1.39

Trace elements (mean values in ppm): *Złoty Stok Granodiorite* – **Ba** 900, **Sr** 380, **Rb** 150, **Zr** 255, **Y** 26, **Nb** 140,**Ni** 34, **Co** 19, **Cr** 90.

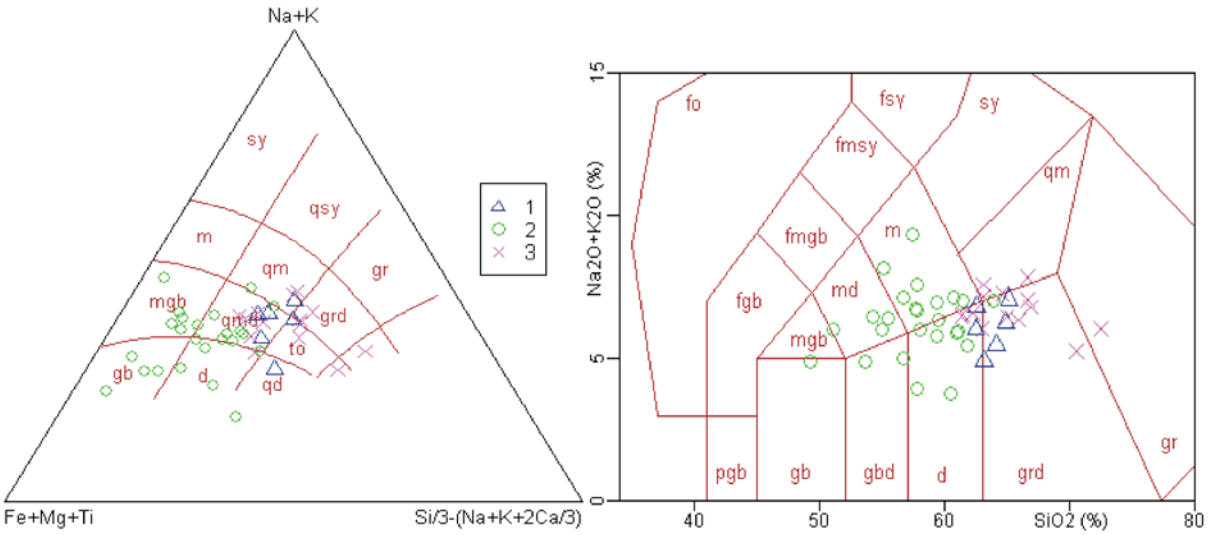

Fig. 4.41. Kłodzko-Złoty Stok Massif ABQ and TAS diagrams. 1 – Złoty Stok Tonalite, 2 – Złoty Stok Diorite, 3 – Złoty Stok Granodiorite.

G. EAST BOHEMIAN PLUTONS

East Bohemian Plutonites between the low-grade or even unmetamorphosed Proterozoic and Palaeozoic sediments of the Barrandian-Železné hory Mts. (Bohemicum) unit in the north, high-grade metamorphic rocks of the Moldanubian unit in the south and the Lugicum in the east. They comprise the Litice Massif, Polička Massif, and the Great Tonalite Dyke (Zábřeh Massif). Majority of them are intruding the Lusatian crystalline rocks.

4.25. GREAT TONALITE DYKE (ZÁBŘEH MASSIF)

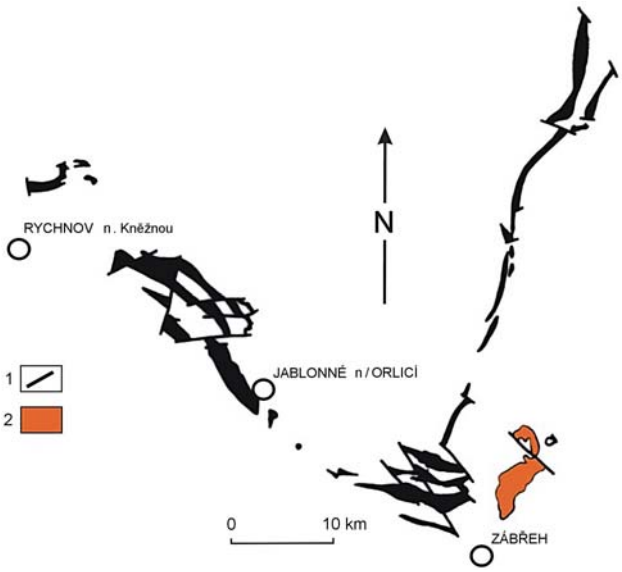

Fig. 4.42. Great Tonalite-Dyke (Zábřeh Massif) and Šumperk Massif geological sketch-map: 1 – Great Tonalite Dyke, 2 – Šumperk Massif.

Regional position: syntectonic tabular intrusion (sheet) situated between two continental plates represented by the Lugicum and Moravosilesicum (the Zábřeh and Nové Město Groups) at the northeastern margin of the Bohemian Massif.

In the hanging wall is a band of strongly sheeted gabbros and a banded amphibolite unit in the footwall.

Rock types:

Zábřeh Tonalite – composition varies between hornblende-biotite tonalite, granodiorite and granite.

Rychnov Granodiorite – hornblende-biotite ± pyroxene granodiorite to granite.

Size and shape (on erosion level): ca. 150 km^2, series of tabular sills (sheets) of several tens up to several hundreds (280 m) meters thick and about 120 km long, arch-like structure, moderately dipping to the W and NE.

Age and isotopic data: *Zábřeh Tonalite* 375 Ma (K-Ar hornblende), 335 Ma (K-Ar biotite), 339 ± 7 Ma (Pb-Pb zircon).

Contact aureole: not clearly defined, tectonic and/or intrusive discordant contact. Thickness of the thermal aureole in the hanging wall is 1–3 m (gradational contact) and tectonic footwall contact.

Geological environment: biotite paragneisses, amphibolite, and rocks in the footwall show granulite low-pressure facies metamorphism.

Mineralization: unknown.

References

BURIÁNEK, D. – NĚMEČKOVÁ, M. – HANŽL, P. (2003): Petrology and geochemistry of plutonic rocks from the Polička and Zábřeh crystalline units (NE Bohemian Massif). – Bull. Czech Geol. Surv. 78, 9–22.

GRYGAR, R. – KALENDOVÁ, J. (1987): Strukturně-geologická mapa ČSR, 1 : 200 000. List Šumperk. – Uran. Průzk. Liberec.

MARTINEC, P. (1977): Geologické poměry. In: Roček, Z. et al: Příroda Orlických hor a Podorlicka, 105–216. – Okres. mus. Orlických hor, Rychnov n. Kněžnou.

NĚMEC, D. (1975a): Petrochemie und Genese der lamprophyrischen und lamproiden Ganggesteine im Nordostteil der Böhmischen Masse (ČSSR). – Z. geol. Wiss. 3, 37–52.

NĚMEC, D. (1975b): Petrographie der lamprophyrischen und lamproiden Ganggesteine im Nordostteil der Böhmischen Masse (ČSSR). – Z. geol. Wiss. 3, 23–36.

OPLETAL, M. et al. (1980): Geologie Orlických hor. Oblastní regionální geologie ČSR. – 202 pp. Ústř. úst. geol. Praha.

OPLETAL, M. – DOMEČKA, K. (1974): Granitoidy západní části orlicko-kladské klemby. – Acta Univ. Carol., Geol. 1, 75–109.

OPLETAL, M. – DOMEČKA, K. (1983): Synoptic geological map of the Orlické hory Mts. 1 : 100,000. – Czech Geol. Survey, Prague.

PARRY, M. – ŠTÍPSKÁ, P. – SCHULMANN, K. – HROUDA, F. – JEŽEK, J. – KRÖNER, A. (1997): Tonalite sill emplacement at an oblique plate boundary: northeastern margin of the Bohemian Massif. – Tectonophysics 280, 61–81.

RENÉ, M. (1998): Evolution of a tonalite suite in the northeastern part of the Bohemian Massif. – Geolines 6, 53.

ŠTÍPSKÁ, P. – SCHULMANN, K. – KRÖNER, A. (2004): Vertical extrusion and middle crustal spreading of omphacite granulite: a model of syn-convergent exhumation (Bohemian Massif, Czech Republic). – J. metamorph. Geol. 22, 179–198.

WIERZCHOLOWSKI, B. (1996): Bielice granitoids in Sudetes and their metamorphic mantle. – Arch. mineral. 26, 589–649. (In Polish)

WISZNIEWSKA, J. – KRZEMIŃSKA, E. – MAZUR, S. – GAWĘDA, A. – KOZŁOWSKI, A. (2007): Foreword – brief outline of geology of Poland. In: Kozłowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 5–7.

Zábřeh Tonalite

Wide range in composition. Quartz-normal, sodic, metaluminous, melanocratic, I-type, I-series, granodiorite

n = 11	Median	Min	Max	QU1	QU3
SiO_2	62.14	60.34	66.30	61.29	63.20
TiO_2	0.91	0.62	1.64	0.71	1.22
Al_2O_3	15.23	12.78	15.69	14.60	15.59
Fe_2O_{3tot}	5.80	4.22	6.44	5.05	6.11
MnO	0.11	0.06	0.28	0.10	0.11
MgO	3.12	2.61	3.62	3.01	3.14
CaO	4.12	3.23	5.47	3.82	4.83
Na_2O	3.04	1.90	4.60	2.44	3.43
K_2O	3.29	2.01	4.05	2.82	3.55
P_2O_5	0.15	0.07	0.27	0.11	0.17
Mg/(Mg+Fe)	0.52	0.47	0.55	0.48	0.53
K/(K+Na)	0.40	0.33	0.47	0.37	0.43
Nor.Or	20.88	13.27	25.76	18.75	22.92
Nor.Ab	29.27	19.06	41.26	24.66	33.01
Nor.An	21.57	17.02	27.13	19.53	24.24
Nor.Q	16.53	6.31	37.21	14.11	19.22
Na+K	176.34	103.99	231.25	138.61	181.18
*Si	118.16	38.48	218.42	101.79	128.56

K-(Na+Ca)	-108.66	-163.17	-76.46	-125.79	-93.33
Fe+Mg+Ti	163.83	136.05	182.04	149.36	166.49
Al-(Na+K+2Ca)	-42.14	-118.21	50.05	-67.69	-4.89
(Na+K)/Ca	2.12	1.50	3.25	1.87	2.41
A/CNK	0.89	0.73	1.21	0.82	0.99

Trace elements (mean values in ppm): *Zábřeh Tonalite* – **Ba** 1643, **Cr** 101, **Cu** 64, **Ni** 42, **Pb** 43, **Rb** 91, **Sr** 476, **Zn** 113.

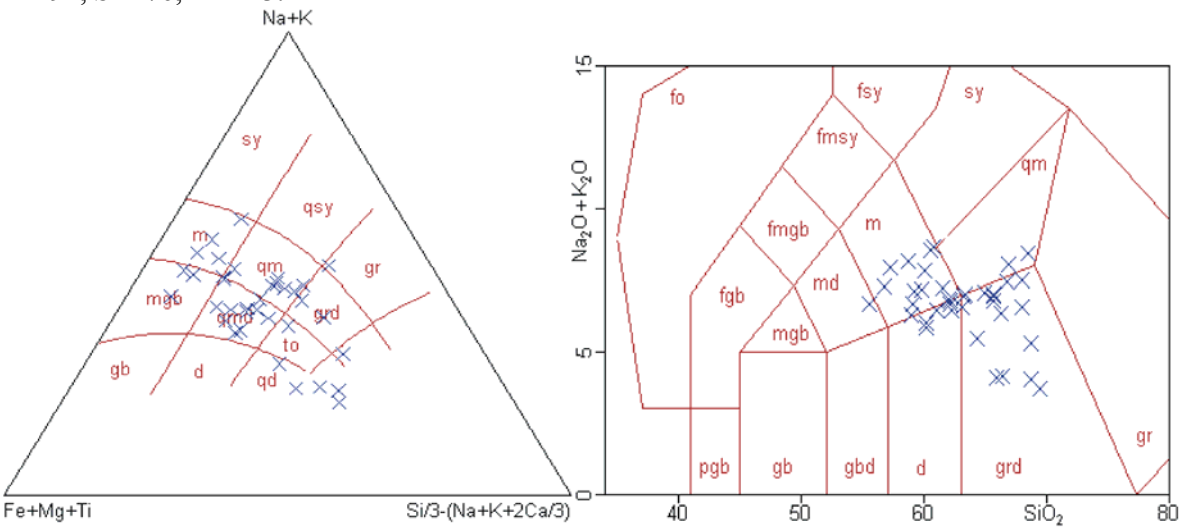

Fig. 4. 43 *Great Tonalite Dyke (Zábřeh Massif) ABQ and TAS diagrams. Zábřeh Tonalite.*

4.26. POLIČKA COMPOSITE MASSIF (PCM)

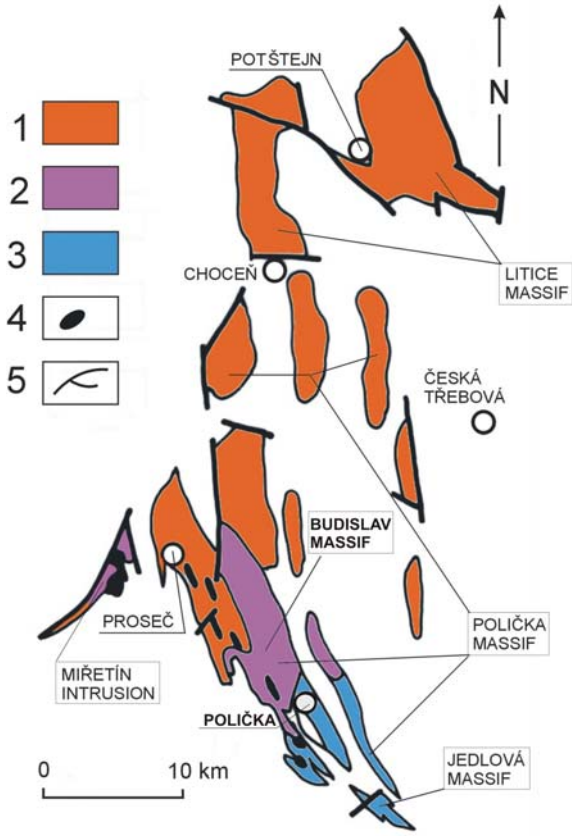

Fig. 4.44. Polička Composite Massif and and Litice Massif geological sketch-map (modified after Buriánek et al. 2003). 1 – Granite to Granodiorite, 2 – Polička Granodiorite, 3 – Polička Tonalite, 4 – Diorite to Gabbro, 5 – faults.

Regional position: Lugicum (Polička crystalline complex).

Size and shape (on erosion level): ca. 200 km^2, concordant tongue-like bodies and a series of large elongated sills (sheets) – two sills (40 × 3 km) are mostly covered by Cretaceous sediments. Major outcrops: The Budislav Massif (the largest body 26 × 6 km), Jedlová Massif (4 × 5 km) and Miřetín Intrusion (sheet) are included in the Polička Massif.

Rock types:

1. *Polička Tonalite* – ± porphyritic (meta)granodiorite to tonalite.
2. *Zderaz Granite* – muscovite-biotite granite to biotite granite/granodiorite.
3. *Jedlová Tonalite* – pyroxene-bearing amphibole-biotite tonalite.
4. *Polička Diorite to Gabbro* – amphibole gabbro to amphibole-biotite diorite.

Age and isotopic data: 332 Ma (K-Ar hornblende), 360 Ma (K-Ar biotite), *Polička Tonalite* 354 ± 4 Ma (U-Pb zircon).

Geological environment: Neoproterozoic metamorphosed volcano-sedimentary sequence.

Contact aureole: sharp intrusive contacts, no contact aureole.

Mineralization: unknown.

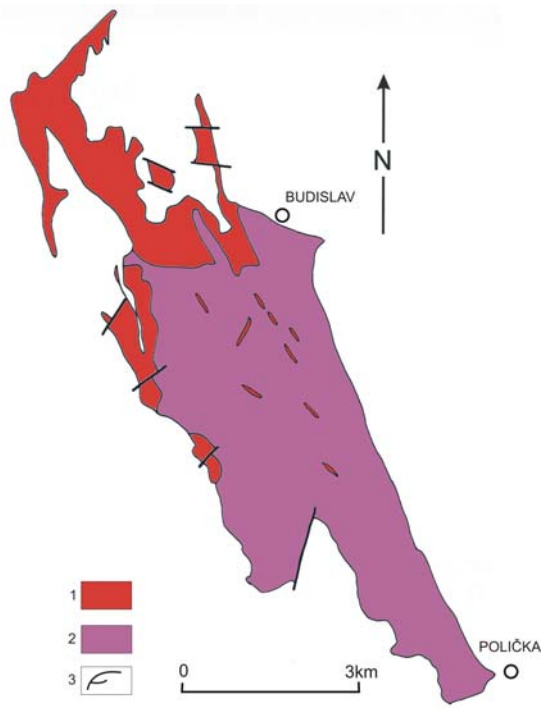

Fig. 4.45. Budislav Massif geological sketch-map (modified after Vondrovic 2006). 1 – Zderaz Granite, 2 – Polička Granodiorite to Tonalite, 3 – faults.

References

BURIÁNEK, D. – NĚMEČKOVÁ, M. – HANŽL, P. (2003): Petrology and geochemistry of plutonic rocks from the Polička and Zábřeh crystalline units (NE Bohemian Massif). – Bull. Czech Geol. Surv. 78, 9–22.

FIALA, F. (1929): Petrografické poměry křídového podloží v jihovýchodním okolí Proseče. – Věst. Král. čes. Společ. Nauk, Tř. mat-přírodověd. 1, 1–87.

GRYGAR, R. – KALENDOVÁ, J. (1987): Strukturně-geologická mapa ČSR, 1 : 200 000. List Šumperk. – Uran. Průzk. Liberec.

OPLETAL, M. et al. (1980): Geologie Orlických hor. Oblastní regionální geologie ČSR. – 202 pp. Ústř. úst. geol. Praha.

SVOBODA, J. (1956): Zpráva o mapování poličského krystalinika pro generální mapu Vysoké Mýto. – Zpr. geol. Výzk. v Roce 1955, 194–197.

VONDROVIC, L. (2006): Aplikace metody anizotropie magmatické susceptibility (AMS) při strukturní analýze granitoidů: Záznam strukturního vývoje budislavského plutonu (poličské krystalinikum). BSc dissert, 37 pp. – Přírodověd. fak. Univ. Karl. v Praze.

VONDROVIC, L. – VERNER, K. (2007): Záznam strukturního vývoje vápenato-alkalických intruzí poličského krystalinika. In: Breiter, K. Ed.: 3. sjezd České geologické společnosti, Volary 19.–22. září 2007, 85. – Czech Geol. Soc. Prague.

VONDROVIC, L. – VERNER, K. – BURIÁNEK, D. (2009): Stavby a podmínky vmístění vápenato-alkalických intruzivních hornin: Implikace pro variský geodynamický vývoj východního okraje Českého masivu. In: Kohút, M. – Šimon, L. (eds) Spoločný kongres Slovenskej a Českej geologickej spoločnosti, Zborník abstraktov a exkurzný sprievodca. Štátny geologický ústav Dionýza Štúra, Bratislava, pp 198–199 (in Czech).

Zderaz Granite

Quartz-normal, sodic, moderately peraluminous, mesocratic, S-type, M-series, granite

	1323Zder	**1324Zder**	**1325Zder**
SiO_2	71.72	70.75	70.58
TiO_2	0.16	0.38	0.81
Al_2O_3	15.07	16.00	12.41
Fe_2O_3	1.09	1.87	5.39
FeO	0.91	n.d.	n.d.
MnO	0.02	n.d.	0.21
MgO	0.54	0.46	2.54
CaO	1.82	2.14	2.57
Li_2O	n.d.	n.d.	n.d.
Na_2O	4.06	3.80	3.20
K_2O	3.83	3.30	1.80
P_2O_5	0.07	n.d.	n.d.
Mg/(Mg+Fe)	0.33	0.33	0.47
K/(K+Na)	0.38	0.36	0.27
Nor.Or	23.12	20.06	11.38
Nor.Ab	37.25	35.12	30.75
Nor.An	8.76	10.93	13.65
Nor.Q	27.39	29.31	35.47
Na+K	212.33	192.69	141.48
*Si	163.92	174.37	219.53
K-(Na+Ca)	-82.15	-90.72	-110.87
Fe+Mg+Ti	41.73	39.60	140.70
Al-(Na+K+2Ca)	18.70	45.19	10.57
(Na+K)/Ca	6.54	5.05	3.09
A/CNK	1.07	1.17	1.04

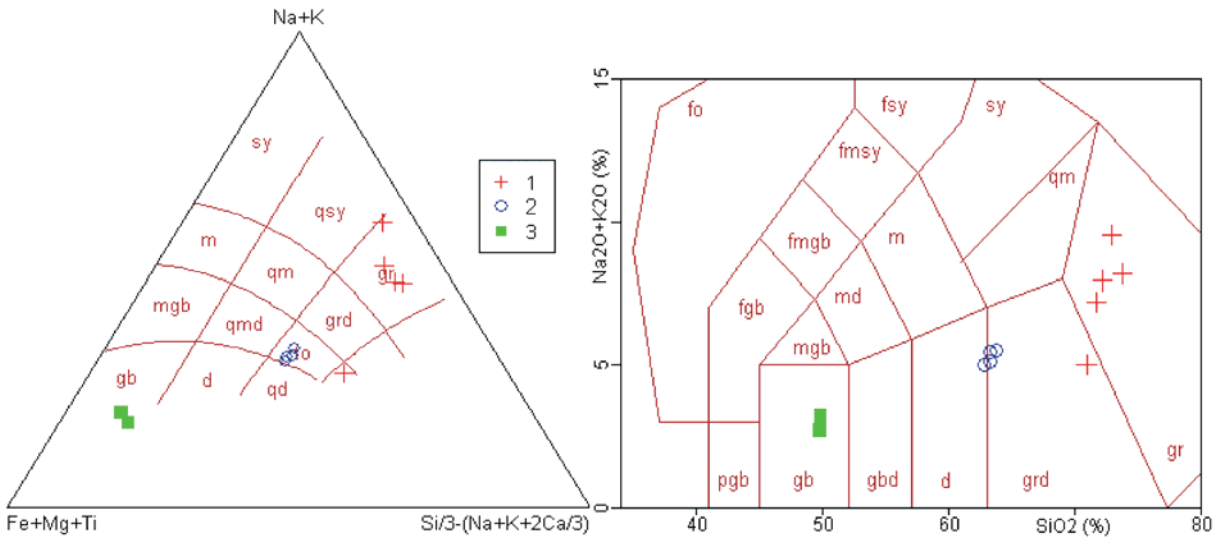

Fig. 4.46. *Polička Massif ABQ and TAS diagrams. 1 – Zderaz Granite, 2 – Polička Tonalite, 3 – Polička Gabbro.*

4.27. LITICE MASSIF (LM)

Regional position: Lugicum (Zábřeh crystalline complex).

Rock types:

Litice Granite – ± cataclastic biotite leucogranodiorite

Rychnov Granodiorite – medium-grained amphibole-biotite granodiorite

Size and shape: ca. 100 km^2, two discordant elliptical bodies (14 × 6 and 12 × 3 km respectively) mostly covered by Cretaceous sediments.

Age and isotopic data: Carboniferous. No isotopic data.

Contact aureole: not clearly defined.

Geological environment: Neoproterozoic and Palaeozoic metasediments.

Mineralization: unknown.

References

GRYGAR, R. – KALENDOVÁ, J. (1987): Strukturně-geologická mapa ČSR, 1 : 200 000. List Šumperk. – Uran. průzk. Liberec.

OPLETAL, M. et al. (1980): Geologie Orlických hor. Oblastní regionální geologie ČSR. – 202 pp. Ústř. úst. geol. Praha.

Litice Granite

Quartz-normal, sodic, peraluminous/metaluminous, mesocratic, S-type, M-series, granodiorite

	1355Lit	1356Lit	1357Lit	1358Lit
SiO_2	69.61	71.16	69.66	69.96
TiO_2	n.d.	0.29	0.56	0.20
Al_2O_3	15.78	15.19	14.93	15.65
Fe_2O_3	1.98	0.67	1.61	1.52
FeO	1.98	1.55	0.75	1.52
MnO	0.05	0.01	0.08	0.02
MgO	0.89	0.62	0.32	0.83
CaO	1.66	1.55	2.32	1.45
Na_2O	4.90	4.50	3.73	5.04
K_2O	4.16	3.74	4.54	4.50
P_2O_5	0.23	0.12	0.10	n.d.
Mg/(Mg+Fe)	0.29	0.34	0.20	0.34
K/(K+Na)	0.36	0.35	0.44	0.37
Nor.Or	24.74	22.60	27.56	26.70

Nor.Ab	44.29	41.34	34.42	45.45
Nor.An	6.77	7.06	11.15	7.23
Nor.Q	18.65	24.57	24.20	17.75
Na+K	246.45	224.62	216.76	258.18
*Si	120.00	151.73	142.12	112.70
K-(Na+Ca)	-99.40	-93.44	-65.34	-92.95
Fe+Mg+Ti	74.47	49.00	45.57	63.31
Al-(Na+K+2Ca)	4.24	18.40	-6.31	-2.56
(Na+K)/Ca	8.33	8.13	5.24	9.99
A/CNK	1.03	1.08	0.99	0.99

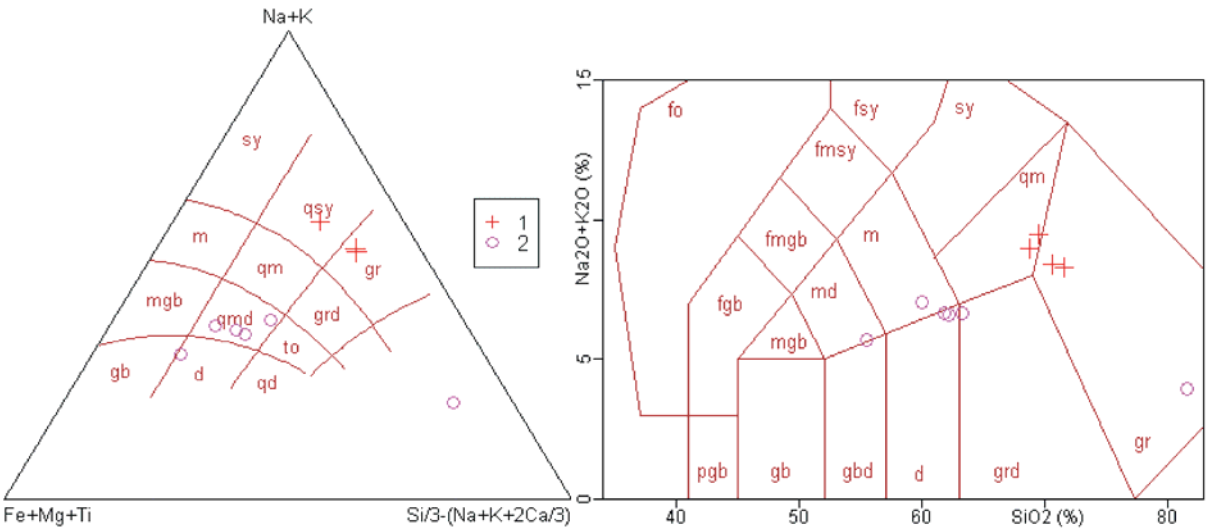

Fig. 4.47. *Litice Massif ABQ and TAS diagrams. 1 – Litice Granite, 2 – Rychnov Granodiorite.*

Rychnov Granodiorite

Quartz-normal, sodic, metaluminous, melanocratic, I- and S-type, M-series granodiorite

	576Ryc	**577Ryc**	**578Ryc**	**579Ryc**	**580Ryc**
SiO_2	60.93	61.92	61.02	58.71	52.84
TiO_2	1.00	0.92	1.02	0.90	1.48
Al_2O_3	15.09	16.86	14.87	15.21	16.15
Fe_2O_3	0.77	1.62	1.91	1.68	5.30
FeO	4.37	3.90	4.30	4.77	3.15
MnO	0.10	0.08	0.10	0.06	0.14
MgO	4.52	2.92	3.82	4.62	5.98
CaO	4.89	2.92	4.34	4.75	4.30
Na_2O	2.95	3.72	2.80	2.96	4.15
K_2O	3.62	2.81	3.68	3.95	1.25
P_2O_5	0.30	0.20	0.26	0.20	0.43
Mg/(Mg+Fe)	0.61	0.49	0.53	0.56	0.57
K/(K+Na)	0.45	0.33	0.46	0.47	0.17
Nor.Or	23.82	18.08	24.14	26.26	8.52
Nor.Ab	29.50	36.38	27.91	29.91	43.01
Nor.An	24.82	14.34	22.00	25.04	21.35
Nor.Q	11.20	17.61	14.60	7.45	7.50
Na+K	172.06	179.71	168.49	179.39	160.46
*Si	107.84	129.10	118.44	89.86	81.57

K-(Na+Ca)	-105.53	-112.45	-89.61	-96.35	-184.06
Fe+Mg+Ti	195.18	158.59	191.37	213.38	277.19
Al-(Na+K+2Ca)	-50.12	47.25	-31.26	-50.10	3.34
(Na+K)/Ca	1.97	3.45	2.18	2.12	2.09
A/CNK	0.87	1.19	0.92	0.87	1.04

4.28. JAVORNÍK MASSIF

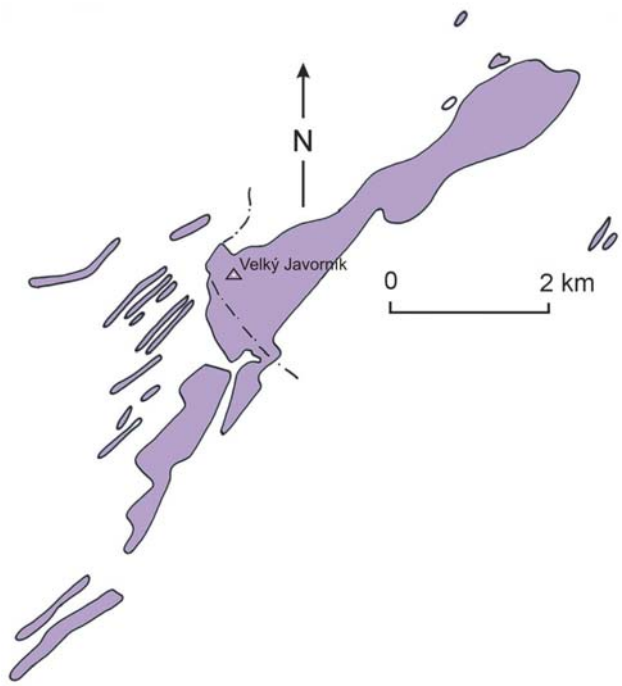

Fig. 4.48. Javorník Massif geological sketch-map (adapted after Němec 1954 – see Fig. 4.33.).

Regional position: The Javorník granitoids were emplaced into rocks of the Złoty Stok-Skrzynka shear zone (polymetamorphic metavolcanic and metapelitic rocks) in the Lugicum.

Rock types: *Javorník Granodiorite* – a cataclastic medium- to fine-grained biotite-bearing leucogranodiorite, cut by several younger dykes in two phases (granodiorite porphyry and younger amphibole syenite aplites).

Size and shape (on erosion level): 50 km^2 up to 1 km thick dyke (sheet) and several smaller sheet-like bodies.

Age and isotopic data: similar to the age of the Great Tonalite Dyke (Zábřeh Massif).

Hornblende-biotite granite 351.1 ± 3.7 and 349.6 ± 3.8 Ma (Ar-Ar hornblende and biotite), biotite-muscovite granite 344.6 ± 3.8 Ma (Ar-Ar muscovite).

Contact aureole: distinct thermal aureole with suite of dykes.

Geological environment: phyllitic schists, mica schists, and paragneisses.

Mineralization: Uranium hydrothermal veins in the country rocks.

References

BIAŁEK, D. (2003): Petrography and geochemistry of the Jawornickie granitoids. West Sudetes. – Pol. Tow. Mineralog. Prace Spec. 22, 22–24.

BIAŁEK, D. – WERNER, T. (2002): AMS and deformation patterns in the Jawornickie Granitoids, Rychlebské hory – preliminary data. – Geolines 14, 14–15.

BIAŁEK, D. – WERNER, T. (2004): Geochemistry and geochronology of the Jawornik granodiorite and its geodynamic significance in the Eastern Variscan Belt. – Geolines 17, 22–23.

BURCHART, J. (1958): O granitoidach jawornickich Sudetow Wschodnich. – Arch. mineral. 22, 237–248.

JELIŃSKI, A. (1965): Geochemistry of the uranium in the Karkonosze Granite Massif and other granitoids massifs of Lower Silesia. – Biul. Inst. Geol. 193, 5, 5–110. (In Polish)

NĚMEC, D. (1951): Petrografie javornického masivu a žilných hornin s ním sdružených I. – Přírodověd. Sbor. Ostrav. Kraje 12, 289–304.

NĚMEC, D. (1954): Petrografie javornického masivu a žilných hornin s ním sdružených II. – Sbor. Ústř. Úst. geol., Geol. 21, 2, 7–65.

WISZNIEWSKA, J. – KRZEMIŃSKA, E. – MAZUR, S. – GAWĘDA, A. – KOZŁOWSKI, A. (2007): Foreword – brief outline of geology of Poland. In: Kozłowski, A. – Wiszniewska, J. Eds: Granitoids in Poland. – Arch. mineral. Monogr. 1, 5–7.

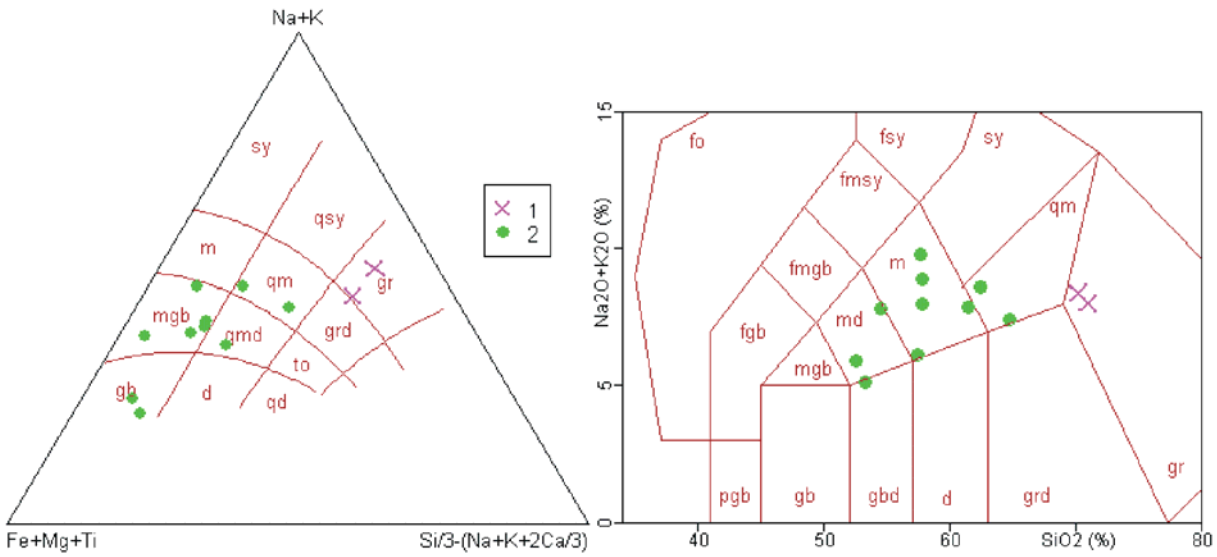

Fig. 4.49. *Javorník Granodiorite ABQ and TAS diagrams. 1 – Javorník Granodiorite, 2 – Porphyry and lamprophyre dykes.*

Javorník Granodiorite

Quartz-normal, sodic/potassic strongly peraluminous, mesocratic, S-type, monzogranite to quartz monzodiorite

	grmonz	**grdBi**
	monzogranite	biotite granodiorite
SiO_2	69.21	70.64
TiO_2	0.28	0.26
Al_2O_3	15.84	16.49
Fe_2O_3	0.86	0.05
FeO	1.18	1.04
MnO	0.03	n.d.
MgO	1.91	1.07
CaO	1.05	1.91
Na_2O	3.05	4.15
K_2O	5.18	3.83
P_2O_5	n.d.	0.08
Mg/(Mg+Fe)	0.63	0.64
K/(K+Na)	0.53	0.38
Nor.Or	32.10	23.14
Nor.Ab	28.72	38.10
Nor.An	5.46	9.15
Nor.Q	25.32	24.36
Na+K	208.41	215.24
*Si	163.07	153.95
K-(Na+Ca)	-7.16	-86.66
Fe+Mg+Ti	78.11	44.92
Al-(Na+K+2Ca)	65.21	40.47
(Na+K)/Ca	11.13	6.32
A/CNK	1.26	1.15

Atlas of plutonic rocks and orthogneisses in the Bohemian Massif

4. Lugicum

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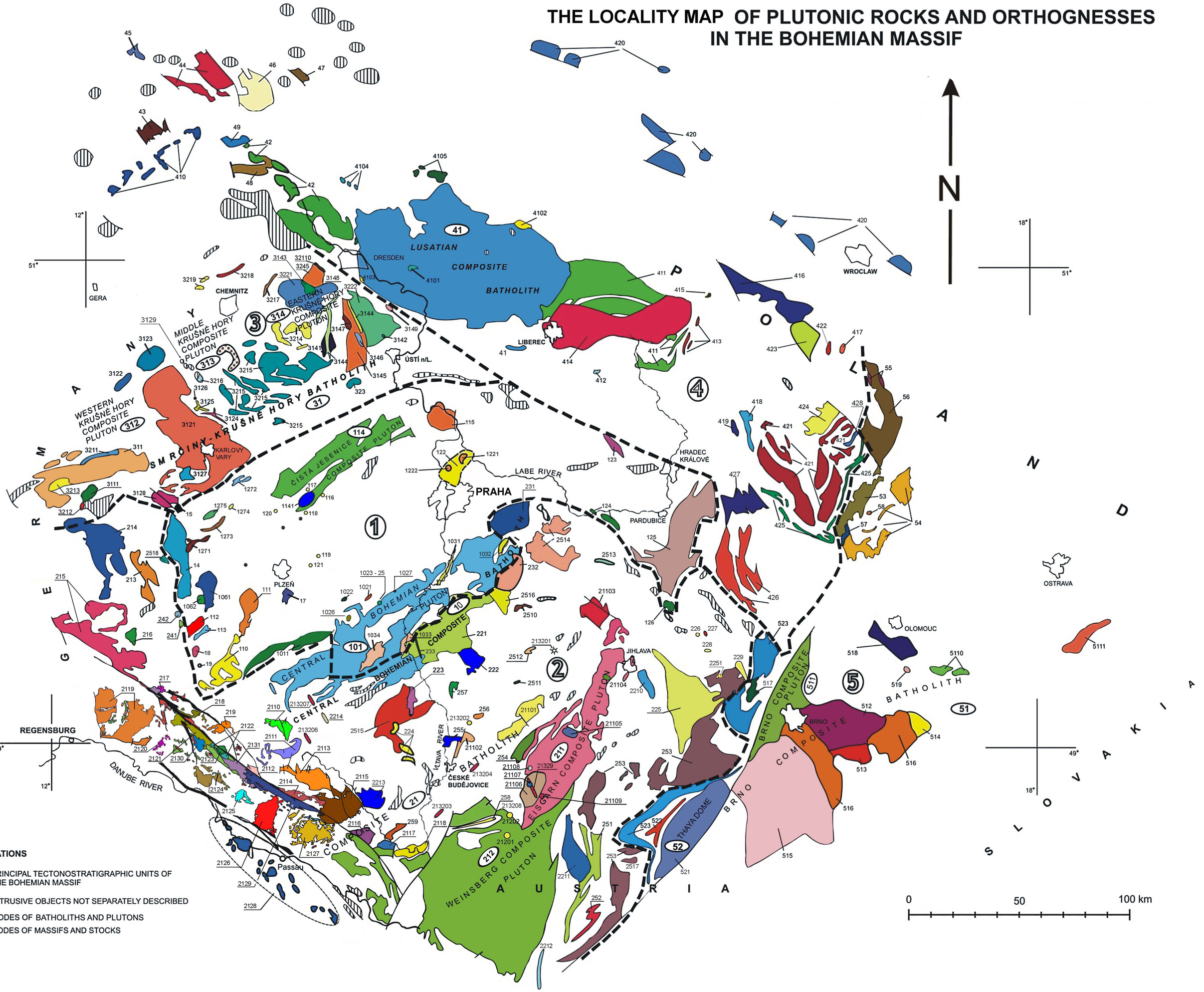
THE LOCALITY MAP OF PLUTONIC ROCKS AND ORTHOGNESSES IN THE BOHEMIAN MASSIF



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