ASSESMENT FIELD WORKSHOP ON THE LATE PALAEOZOIC VOLCANISM AT THE NORTHERN MARGIN OF THE BOHEMIAN MASSIF: SOUTHWESTERN POLAND – NORTHEN CZECH REPUBLIC – EASTERN SAXONY

Organized by

TU Bergakademie Freiberg, Germany
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Czech Geological Survey, Prague, Czech Republic
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Lectures, Abstracts and Field Stops presented by

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Bolków, Sudetes, 14th-18th June 2006

GENERAL PROGRAMME

DAY 1 (Wednesday, 14th June 2006)

13.00 – Opening and lunch

15.00 – Seminar 1

Late Palaeozoic volcanism and related plutonism in the northern Bohemian Massif: current research and open problems (I)

19.00 – Barbecue

DAY 2 (Thursday, 15th June 2006)

8.00 – Breakfast

9.00 – Seminar 2

Late Palaeozoic volcanism and related plutonism in the northern Bohemian Massif: current research and open problems (II)

11.00 – Field trip 1

Carboniferous calc-alkaline volcanism in the Intra-Sudetic Basin

19.00 – Dinner

DAY 3 (Friday, 16th June 2006)

8.00 – Breakfast

9.00 – Field trip 2

Carboniferous and Permian mildly alkaline volcanism in the Intra-Sudetic Basin

19.00 – Dinner

DAY 4 (Saturday, 17th June 2006)

8.00 – Breakfast

9.00 – Field trip 3

A. Late Paleozoic volcanic rocks in the Czech part in the Intra-Sudetic Basin
B. Carboniferous Karkonosze granite and lamprophyre dykes

17.30 – Seminar 3

Summarizing preliminary results and designing future activities

19.00 – Dinner

DAY 5 (Sunday, 18th June 2006)

8.00 – Breakfast

9.00 – Field trip 4

Permian high-K calc-alkaline volcanism in the North-Sudetic Basin

Changes in the Programme possible due to weather conditions

SEMINARS

SEMINAR 1

DAY 1 (Wednesday, 14th June 2006)
15.00-19.00

Late Palaeozoic volcanism and related plutonism in the northern Bohemian Massif: current research and open problems (I)

► **Welcome and introduction**
C. Breitkreuz and M. Awdankiewicz

► **Permocarboniferous volcanic and subvolcanic activity in Europe: What do we know and what do we want to know?**
C. Breitkreuz

► **Late Paleozoic igneous activity in the Elbe Zone**
U. Hoffman

► **Late Paleozoic dykes in eastern Saxony**
A. Renno

► **Spatial and temporal distribution of the Upper-Paleozoic volcanism in the Bohemian part of the Intra-Sudetic Basin**
V. Prouza

► **Teplice-Altenberg Caldera**
B. Mlčoch

► **Permo-Carboniferous volcanism in late Variscan continental basins of the Bohemian Massif: geochemical constraints**
J. Ulrych, F.E. Lloyd, E. Hegner, and V. von Seckendorf

SEMINAR 2

DAY 2 (Thursday, 15th June 2006)
9.00-10.30

Late Palaeozoic volcanism and related plutonism in the northern Bohemian Massif: current research and open problems (II)

► **Mechanisms of differentiation of the Karkonosze granite**
E. Słaby and H. Martin

► **Post-orogenic magmatism in the Central European Variscides: SHRIMP zircon age constraints from the Żeleźniak intrusion, Kaczawa Mountains, Polish Sudetes**
K. Machowiak, A. Muszyński, R. Armstrong and R. Kryza

► **Carboniferous and Permian magmatism in the Sudetes: volcanic centres, intrusions, magmatic evolution and open questions**
M. Awdankiewicz

SEMINAR 3

DAY 4 (Saturday, 17th June 2006)
17.30-19.00

Summarizing preliminary results and designing future activities

► **Impressions and remarks**
C. Breitkreuz

► **Discussion and brain storm**
Particticipants

FIELD TRIPS

FIELD TRIP 1

DAY 2 (Thursday, 15th June 2006)

Guide: M. Awdankiewicz

11.00-18.00

Carboniferous calc-alkaline volcanism in the Intra-Sudetic Basin

Stop 1/1 – Nagórnik
Stop 1/2 – Stare Bogaczowice
Stop 1/3 – Mniszek
Stop 1/4 – Nowy Lesieniec
Stop 1/5 – Czarny Bór

FIELD TRIP 2

DAY 3 (Friday, 16th June 2006)

Guide: M. Awdankiewicz

9.00-18.00

Carboniferous and Permian mildly alkaline volcanism in the Intra-Sudetic Basin

Stop 2/1 – Wałbrzych
Stop 2/2 – Barbarka
Stop 2/3 – Czadrówek
Stop 2/4 – Pustelnia
Stop 2/5 – Okrzeszyn

FIELD TRIP 3

DAY 4 (Saturday, 17th June 2006)

Guides: V. Prouza (3A), M. Awdankiewicz, E.Słaby (3B)

9.00-18.00

3A: Late Palaeozoic volcanic rocks in the Czech part in the Intra-Sudetic Basin

Stop 3/1 – Rožmitál at Broumov
Stop 3/2 – Hynčice, ESE of Meziměstí
Stop 3/3 – Šonov

3B: Carboniferous Karkonosze granite and lamprophyre dykes

Stop 3/4 – Sokole Góry
Stop 3/5 – Trzcińsko

FIELD TRIP 4

DAY 5 (Sunday, 18th June 2006)

Guides: M. Awdankiewicz, C. Breitkreutz, E. Słaby

9.00-15.00

Permian high-K calc-alkaline volcanism in the North-Sudetic Basin

Stop 4/1 – Bolków
Stop 4/2 – Świny
Stop 4/3 – Lubiechowa
Stop 4/4 – Dynowice
Stop 4/5 – Organy Wielisławskie

ABSTRACTS

Carboniferous and Permian magmatism in the Sudetes: volcanic centres, intrusions, magmatic evolution, open questions

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The final stages of the Variscan orogeny in Europe were associated with, and followed by, a period of extensional and wrench tectonics, intracontinental basin formation, accumulation of thick molasse successions and intense magmatism in the late Palaeozoic times (Wilson et al., 2004; Ulrych et al., 2006, and this volume). The Sudetes region, situated in the eastern part of the Variscides, at the NE margin of the Bohemian Massif, provides an excellent regional example of late- to post-orogenic, intracontinental magmatic province characterized by: 1) a broad spectrum of magma types emplaced, and 2) well exposed igneous complexes ranging from deep plutonic to volcanic levels.

The three major Permo-Carboniferous intramontane troughs of the Sudetes region are the North-Sudetic Basin, the Intra-Sudetic Basin and the Sub-Krkonoše Trough. The most complete volcano-sedimentary succession, providing a record of three distinctive stages of volcanism (Viséan, late Carboniferous, early Permian), is found in the Intra-Sudetic Basin. There, several volcanic centres erupted basic, intermediate and acidic magmas with a transition from early calc-alkaline to late mildly alkaline volcanism, culminating in the Permian (Awdankiewicz, 1999 a, b). The adjacent North-Sudetic Basin was initiated in the latest Carboniferous, volcanism occurred in the early Permian, and a bimodal, intermediate-acidic magmatic suite with high-K calc-alkaline geochemical characteristics was emplaced (Awdankiewicz, 2003; Pańczyk, 2003). Volcanic activity within the intramontane troughs was accompanied by the emplacement of granitic plutons and dykes at deeper crustal levels. One of the best examples is the ca. 320 Ma Karkonosze granite massif (e.g. Słaby et al., 2004, and this volume), cropping out within a large uplifted basement block between the intramontane troughs mentioned above; the eastern margin of the massif is intruded by a mafic to felsic, alkaline to calc-alkaline dyke swarm (various lamprophyres, monzodiorites, microgranites; Awdankiewicz et al., 2005). In addition, magmatism occurred also at several other, scattered localities, as exemplified by the ca. 315 Ma Żelaźniak intrusion (Machowiak et al., this volume). The Żelaźniak intrusion, cropping out within the crystalline basement rocks, represents an eroded, subvolcanic relict of a volcanic centre and is composed of various granitoids, rhyolites, rhyodacites and trachyandesites. Petrological and geochemical studies reported in the papers cited indicate that magmas originated from both mantle and crustal sources and underwent complex differentiation within the crust, including fractional crystallisation, mixing-mingling, recharge, contamination and other processes. However, the ongoing debate is focused on the chemical and mineralogical characteristics of magma sources involved, the role of orogeny-related subduction processes and the interplay between mantle- and crust-derived magmas.

The accumulating data show that during the Carboniferous and Permian, in a time span of ca. 40-50 My, several hundreds to a few thousand cubic kilometres of magmas were emplaced within, and erupted onto, the Sudetic crustal segment. The granitic plutonism, largely derived from melting of crustal rocks, peaked in the Carboniferous, while the volcanic activity, largely related to melting of mantle rocks, reached its climax in the early Permian. The igneous activity seems generally scattered in both space and time – in the relatively small area several independent, small- to moderate-volume magmatic systems and centres successively developed, tapping various magma sources and evolving specific magma compositions. A better understanding of this complex magmatic development requires further petrological studies and, in particular, dating and correlation of magmatic events across this igneous province.

Permocarboniferous volcanic and subvolcanic activity in Europe: What do we know and what do we want to know?

Christoph Breitkreuz, TU Bergakademie Freiberg, Germany, cbreit@geo.tu-freiberg.de

SHRIMP dating in Germany, Denmark and Poland showed that much of the Late Paleozoic SiO_2-rich volcanism in the **Central European Basin System (CEBS)** took place in a short time period at the Carboniferous-Permian boundary (293 - 303 Ma; Breitkreuz and Kennedy 1999, Breitkreuz et al. in press). Do we need more SHRIMP ages? Shall we apply TIMS dating in selected basins to unravel the basin evolution in more detail?

In contrast to previous studies, Paulick and Breitkreuz (2005) showed that the northeast-German part of the CEBS was dominated by thick SiO_2-rich lava dome complexes. How these huge volumes of volatile-poor siliceous magmas evolved remains a matter of debate. Certainly these lava dome complexes and the andesitic shield volcano complexes in the area of Berlin formed a prominent topography in the CEBS, which was completely covered only 40 Ma later, during the Zechstein. Apart from tectonic activity, the volcanic topography caused much of the prominent hiati known from the Rotliegend CEBS evolution (Geißler and Breitkreuz 2004; Roch et al. 2005).

11 SHRIMP ages define well the chronostratigraphic position of rhyolitic laccoliths and lavas of the **Halle Volcanic Complex (HVC)** in the NE Saale Basin (292 – 301 Ma; 307 Ma of the Schwerz unit remains problematic; Breitkreuz and Kennedy 1999, Ehling et al. 2005). Careful re-examination of hundreds of coal and uranium exploration drillings (Ehling and Breitkreuz in prep.) helps to clarify the stratigraphic evolution in the northeastern Saale Basin (Wettin and Halle Fm.). Preliminary observations suggest: i) HVC volcanic activity started only late in the Wettin Fm., many of the alleged precursors phases ("Porphyrite") appear to represent sills and laccoliths; ii) a prominent conglomeratic unit at the base of the Halle Fm. (Kieselschiefer-Quarzit-Konglomerat, KQK) was the preferred intrusion level for these subvolcanic units. Current diploma studies reveal that some of the Halle laccolith units pierced the roof pendant forming intrusive-extrusive complexes (compare Lorenz and Haneke 2004 for the Saar-Nahe Basin). E.g. the extrusive part of the Landsberg unit shed "Arenal-like" pyroclastic/gravity flows into adjacent basins. Also, pyroclastic dykes and vulcanian fall deposits testify to explosive activity during the late HVC evolution.

In the **eastern Erzgebirge** pyroclastic dykes are known from the Tharandter Wald Caldera and from the dyke swarm of Sayda-Berggießhübel (DSSB) related to the Altenberg-Teplice-trap door caldera systems. The DSSB pyroclastic domains have been interpreted as welded intra-vent fallback breccia by Winter et al. (2006).

In addition to the questions raised in the previous paragraphs, the Late Paleozoic magmatism in Central Europe has more puzzles to be solved:

1. In the intra-mountain basins of the decaying Variscan Orogen, rhyodacitic laccoliths and andesitic sills are important (Saar-Nahe Basin, Ilfeld Basin, Halle Volcanic Complex, Flechtingen-Roßlau Block, intra-Sudetic Basin). Re-investigation of the drill cores Parchim 1/68 and Mirow 1/74 revealed that laccolith and sill formed even in the centre of the CEBS (Geißler et al. 2006). Was their formation controlled by strike-slip systems as Breitkreuz and Mock postulated 2004? Are there other mechanisms?
2. Importance of porphyritic (high phenocryst content) laccoliths, lava and ignimbrites: Why was cool magmatism (well below liquidus) so dominant, or what cooled hot magmas down? Can petrological studies reveal the P/T-conditions at the crust/mantle boundary and at the levels of intra-crustal differentiation?
3. Termination of volcanic activity is often not well constrained and inter-basinal correlation remains problematic. Could biostratigraphic re-examination and radiometric dating of mixed volcanoclastic successions help?

Relevant references of the author can be found under: www.geo.tu-freiberg.de/dynamo/publ_breitkreuz.htm

Late Paleozoic igneous activity in the Elbe Zone

U. A. Hoffman, TU Bergakademie Freiberg (Germany), U.Hoffmann@geo.tu-freiberg.de

The NW-SE trending Elbe Zone represents a major fault system in the Variscan Orogen possibly ranging from Northern Germany to the northern margin of the Carpathians (Czech Republik). Strike-slip movements along this fault zone could be fixed by age determination of syntectonical plutonic rocks (MATTERN 1996) from the Meissen Intrusive Complex (329.1 +/- 1.4 Ma and 330.4 +/- 1.4 Ma for monzonites that occur in the outermost parts, WENZEL et al. 1997) located within the Elbe Zone. Age determinations of lamprophyre dykes in the Meissen Intrusive Complex and adjacent areas point to a similar age.

Post-collisional volcanism (Meissen Volcanic Complex, MVC) and sedimentation (Döhlen Basin, DB) in the Elbe Zone commenced directly on the exposed plutonic rocks. Pebbles of lamprophyre are described from drillcores of the lowermost conglomerates in the DB. Hence, plutonism and oldest documented volcanism are separated by a hiatus of unknown duration.

The intermontane Döhlen Basin is a key area for the investigation of volcanism in the Elbe Zone. It has a central position among several volcanic complexes, e.g. the MVC, the Tharandt Caldera, and volcanic complexes in the Eastern Erzgebirge/Krušné Hory Mts. Consequently, the basin fill of about 700 m thickness is a prominent sink for pyroclastics, redeposited pyroclastics, and volcaniclastic sediments which can be biostratigraphically controlled.

Irrespective some rhyolite dykes beyond the southern basin margin, the onset of volcanic record in the DB follows the Eastern Erzgebirge volcanism, i.e. it is post-Westfalian B/C. This can be evidenced by numerous pebbles of volcanics (welded ignimbrites) occurring in basal conglomerates in the southern part of the DB.

	thickness	Characteristics
Bannewitz Formation	> 390 m	predominant coarse-grained sediments, mainly volcaniclastic several prominent pyroclastic horizons
Niederhäslich Formation	- 300 m	predominant siltstones, locally conglomerates abundant numerous pyroclastic horizons to the top several lake horizons (limestones, laminite) and coaly strata
Döhlen Formation	- 110 m	epiclastic to pyroclastic strata higher up intercalation of max. 7 coal seams
Unkersdorf Formation up to 190 m	-110 m	intermediate to mafic volcanics
	- 50 m	Unkersdorf Tuff Member pyroclastics with sedimentary intercalations
	- 30 m	Hänichen Conglomerate, locally autochthonous breccias
basement		intermediate plutonic rocks of the Meißen Intrusive Complex low-grade metamorphic Slate Complexes high-grade metamorphic Erzgebirge gneisses

Figure 1: Generalized stratigraphic section of the Döhlen Basin.

Besides local eathering profiles and some clastic sediments, major deposition in the DB started with volcanics. This volcanism in the Unkersdorf Fm. (cp. Fig. 1) has a twofold composition. Rhyolitic low-grade ignimbrites (the so-called "Unkersdorf Tuffs") and co-genetic fall- and surge-deposits are distributed throughout the basin. The location of the source area within the basin could be deduced by lithic clast compositions. These non-welded deposits are overlain by lava flows in the northern basin part. Although collectively termed "porphyrite", the geochemistry of the intensively hydrothermal altered lava occurrences ranges from rhyodacitic to trachyandesitic compositions. Especially the silica-poor lithologies are intensively autobrecciated. Differing from the mainly calc-alkaline character of volcanic rocks in the Elbe Zone, some of these plot into the alkaline field. Relics of similar volcanics beyond the northern border link this volcanism in the DB with occurrences in the MVC, where "porphyrites" are crosscutting and overlying older felsic volcanics.

Following this volcanism, erosion of lava as well as ignimbrites in the DB reflects a stratigraphical gap. The overlying formations contain pyroclastic deposits as well, yet the source areas are always beyond the basin.

Several pyroclastic deposits disturbed and destroyed swamp forrest vegetation in the Döhlen Fm. The major pyroclastic horizon in the Niederhäslich Fm. ("Zauckerode Tuff") contains accretionary lapilli. Several metres of primary deposits can be overlain by decametres of redeposited ash reflecting the drainage of surrounding areas.

The Bannewitz Fm. is dominated by coarse volcaniclastic mass flow deposits, but pyroclastic deposits occur as well. The prominent ignimbrite horizon ("Wachtelberg Tuff") contains large lithic clasts which refer to a nearby source area.

Although some stratigraphical links with the MVC can be deduced, other relations to volcanic complexes or sedimentary basins remain problematical. For example, the evidence of equivalents to the Rochlitz Ignimbrite, which is the most important stratigraphic level in the Permo-Carboniferous of Saxony, would help to interfinger several basins.

Teplice-Altenberg Caldera

B. Mlčoch

Teplice-Altenberg caldera represents the largest centre of the Upper Palaeozoic acid volcanism in the Bohemian Masif. The southern part of this caldera is covered by Tertiary and Cretaceous sediments. The newly evaluated data from the boreholes allow to define the whole extent and the form of the structure.

The caldera is a deeply eroded volcanic centre about 18 by 35 km in size. It is filled by the Teplice rhyolite body with a sunken block of gneisses, known as „Altenberg block". The shape of the caldera is limited by large dykes of the granite porphyry. Its age can be estimated at Westphalian C/D based on radiometric dating and phytopaleontology of the associated sediments.

Post-orogenic magmatism in the Central European Variscides: SHRIMP zircon age constraints from the Żeleźniak intrusion, Kaczawa Mountains, Polish Sudetes

K. Machowiak, A. Muszyński, , R. Armstrong and R. Kryza

We present the U-Pb isotope data obtained using the SHRIMP technique on zircon crystals from the Żeleźniak subvolcanic intrusion in the Kaczawa Mountains, West Sudetes, SW Poland. The intrusion is composed of unmetamorphosed and not deformed fine-grained subvolcanic rocks (rhyolites, rhyodacites, trachyandesites) at its higher level, and medium-grained granitoids (granites, adamellites and trondhjemites) in its deeper part. The country rocks are represented by low-grade (blueschist and subsequent greenschist facies) metavolcanic and metasedimentary rocks of the Kaczawa Complex, being interpreted to comprise fragments of a Variscan accretionary prism. The Żeleźniak intrusion has been correlated with other late- to post-tectonic Variscan volcanic and plutonic bodies in the region (e.g. the Karkonosze Granite), but the scarcity and often poor quality of age constraints and of geochemical data have made such correlations speculative. The new SHRIMP zircon ages of c. 315 – 316 Ma from the Żeleźniak intrusion, which evidently post-dates the regional metamorphism and main deformation events in the country rocks, indicate the upper age limit for deeper-level tectonic and metamorphic processes in this part of the Kaczawa Complex. The ages, which are among the oldest datings received so far for the volcanic activity within the Variscan Belt in central Europe, may correspond to the final stages of the exhumation of the blueschist facies rocks in this part of the orogen.

Spatial and temporal distribution of the Upper-Paleozoic volcanism in the Bohemian part of the Intra-Sudetic Basin

V. Prouza

The volcanic products cover approx. 15 % of the area of Czech part of the Intra-Sudetic Basin. Two main groups of volcanics have been distinguished using petrochemical criteria: intermediate to basic (quartz latite-andesites to quartz latite-basalts, which are most common, quartz latites, latite-andesites, latite-basalts to basaltic andesites, generally called andesitoides) and silicic (rhyolites to rhyodacites, rhyolitic ignimbrites).

A great difference between andesitoides and rhyolites exists in the degree of explosivity. Andesitoides form prevalently small lava bodies, whereas rhyolitic rocks build up extensive bodies of pyroclastic or ignimbrite character. The complex of the Vraní hory Mts. of Žacléř area is the only one silicic of exclusively effusive style (rhyolite 350-400 m thick).

The oldest evidence of volcanic activity in the Bohemian part of the Intra-Sudetic Basin is known from the Lampertice Member of Žacléř Formation (Langsettian – small body of quartz latite-andesite at Žacléř).

Several effusive bodies of andesitoids (mostly lava flows, minor pyroclastics) occur within the Prkenný Důl – Žďárky Member (Upper Duckmantian) and the Petrovice Member (Upper Duckmantian – Bolsovian) of the Žacléř Formation. Rhyolitic tuffs and tuffites with biotite are known from the upper part of the Petrovice Member at Křenov. Sheet effusions of basaltic andesites, several km long and approx. 20 m thick occur within the Svatoňovice Member of the Odolov Formation (Westphalian D) – three lava flows, minor pyroclastics. Rhyolitic tuffs and agglomerates of Bolsovian age were penetrated by borehole Brou 1, driled E of Broumov, at the depth approx. 2070 m.

The intensity of volcanic activity increased in Permian. Sequence of rhyolitic and rhyodacitic lavas (300-400 m thick) occur in the Vraní hory Mts. within the upper part of the Nowa Ruda Member of the Broumov Formation (Lower Autunian). Quartz latite basalts to quartz latite-andesites occur at approximately same stratigraphic level at Dworki in the Javoří hory Mts. in the Broumov area, followed by the rhyolitic complex (tuffs, ignimbrites) 500-700 m thick (2nd volcanic cycle of Kozlowski 1963).

Volcanic activity continues within the Olivětín Member of the Broumov Formation (3rd volcanic cycle). Quartz latite-andesite (lava flows, pyroclastics, volcanic agglomerates) crop out within the Lower Olivětín Member at Rožmitál, Šonov and Janovičky (the Lower Šonov Group of andesitoids). Rhyolite tuffs occur at Janovičky, Mlýnský vrch and Benešov village. Effusive andesitoids of Rudný vrch, Šišák and Rožec Hills (several lava flows, pyroclastics, volcanoclastic rocks well exposed in the open quarry at Rožmitál) were laid deposed within the upper part of the Olivětín Member (the Upper Šonov Group of andesitoids). Then the volcanic activity ceased.

Thin layers of acidic “tonsteins” occur anywhere within the Permo-Carboniferous sequence, usually associated with the occurrence of coal seams.

Assumed centers of acid volcanism may be somewhere SE of Walbrzych (explosive types) and E of Vraní hory Mts. (effusive types), while tonsteins may have been derived from very distant (even hundreds km) volcanic centres. Andesitoidic rocks originated probably from several minor local sources, some probably of fissure vent character.

Mechanisms of differentiation of the Karkonosze granite

E. Słaby* and *H. Martin

Lower Carboniferous Karkonosze granite pluton is emplaced into the central part of the Karkonosze-Izera unit (Northern extremity of Bohemian Massif, SW Poland – NW Czech Republic). Structural studies by Diot et al. (1995) and Mazur (1995) revealed, that it emplaced shortly after magma generation, probably during the extensional collapse, that corresponds to the final phase of the D_2 deformation in West Sudetes. The petrogenesis and source of the granite has been subject to controversies and discussions that can be grouped into two categories: 1) Borkowska (1966) proposed that the protolith consisted of crustal rocks metamorphosed under amphibolite facies conditions; 2) based on isotope investigations, Pin *et al*. (1988) and Duthou *et al*. (1991) assumed a fairly primitive crustal source for granitic melt. Słaby et al. (2003) and Słaby & Götze, (2004) first recognized that Kakonosze granite differentiation proceeded through two distinct mechanisms: mixing and fractional crystallization. Their study was mainly based on reconstruction of feldspar crystallization paths.

Karkonosze pluton is biotite granite that forms two facies: porphyritic and equigranular. The porphyritic granite is the wider spread facies. It is also the oldest one, that has been dated by $^{40}Ar/^{39}Ar$ method at 320 ± 2 Ma (Marheine et al., 2002). The same author obtained an age of 315±2 Ma on equigranular (medium- and finegrained) granite. In many places the porphyritic granite contains abundant microgranular-mafic-enclaves and is cross cut by both syn-plutonic (composite) and late (mafic) dikes (Barbarin, 2005); all are lamprophyric to granodioritic in composition. In most of these places field relationships such as progressive contacts, ocellae, mantled feldspars, feldspars mechanically introduced into mafic enclaves or dykes, demonstrate interactions between two magmas as well as hybridization. Contrarily to porphyritic facies, medium grained granite only contains very few mafic-microgranular-enclaves whereas fine grained facies is enclave free.

In Harker's diagrams, the whole fine grained granite as well as the SiO_2-richer (>71%) porphyritic granites show a single trend of differentiation that we interpret in terms of fractional crystallization. It must be noted that if medium grained granite does not define a real trend, all samples fall on the trend of fine grained and evolved porphyritic granites.

A model of simple fractional crystallization has been tested; it is based on a double approach. First the composition of the cumulative assemblage has been calculated using a simple mass-balance algorithm (Störmer and Nicholls, 1978). In a second stage, the results of major element calculation have been reintroduced in trace element modelling using the classical Rayleigh (1896) law. Major elements indicate that it is possible to explain the whole differentiation from SiO_2 = 71% until SiO_2 = 78% by removing 25% of a cumulate made up of 63% plagioclase, 34% biotite, 2% apatite and 1% K-feldspar. Trace element modelling is consistent with this result and in addition it indicates that small amounts of accessory phases played a significant role. The calculated amount of accessory phase is about 1% zircon and 0.5% allanite.

One of the characteristics of porphyritic granite is that it is rich in mafic-microgranular-enclaves. Obviously mafic and felsic magmas interacted, as recorded by feldspar chemical composition, growth morphology and in some places by mantled textures (Słaby et al., 2003; Słaby and Götze, 2004). When enclave compositions are plotted in Harker diagrams they define a trend different of the fractional crystallization trend evidenced in the silica-rich granites; which clearly indicates that some kind of hybridization took place between a mafic magma and the granite. This is well exemplified by large hybridization zones found within porphyritic granite (Słaby and Götze, 2004); there hybrids define a trend that points towards lamprophyre composition, thus indicating that lamprophyres could be one pole of mixing with granitic magma. This is well exemplified with major elements, for instance in the Al_2O_3 vs. SiO_2 plot or better in a $(Na_2O+K_2O)/CaO$ vs. Al_2O_3. Modelling mainly based on REE corroborates this interpretation. However, it must be noted that lamprophyric magmas mixed with granitic magma not only early in its history, but that this process extended through the whole crystallization history as well. This is shown by microgranular-mafic-enclaves, syn-plutonic dikes (composite) but also by late dikes (mafic) whose chilled margins demonstrate that lamprophyric input continued even when granite was almost solid.

In addition, few enclaves and composite dikes define a different trend that does not evolve towards lamprophyric compositions. These hybrids are Al, Fe-richer and Mg and Ca-poorer than the "classical" ones, with lamprophyre affinity. This should reveal that lamprophyres were not the only mantle derived magmas implied in Karkonosze granite formation, but that another mantle source, slightly different in composition, was also active. If the effects of magma hybridization are obvious in microgranular-mafic-enclaves, they are also visible in porphyritic granite. Of course in this latter, due to huge volumetric differences (granite/enclave ratio), the effect is more discrete, but for instance diagrams such as $(Na_2O+K_2O)/CaO$ vs. Al_2O_3 clearly show that most of porphyritic granites are hybridized whereas this mechanism has almost no influence on fine grained granite composition, which is enclave free.

Isotopic data show a scattering of $^{87}Sr/^{86}Sr$ which makes them difficult to use and to interpret. $\square_{Nd}$ shows more coherent behaviour, with low values for porphyritic granite (-7 to -4); higher for granodioritic hybrids (-4 to -3) and even greater for lamprophyres (-2 to -1), thus being coherent with the assumption of mixing between granite and lamprophyre. The low ε_{Nd} in porphyritic granite are evidence of its derivation from a crustal source, however, even the poorly contaminated mafic magmas (lamprophyre dykes) possess negative ε_{Nd} which points towards an enriched mantle source; source that must be LILE-rich. On the other hand, the Karkonosze granite is not alumina oversaturated and does not contain cordierite or muscovite (with exception of the marginal two mica type), consequently, it does not belong to S-type granites: a purely sedimentary source must be precluded. The more realistic assumption should be that both mantle and crustal sources are implied in Karkonosze granite genesis: an enriched mantle and a continental crust. A point that remains unclear is the genetic link between these two magmatisms. As they both took place at the same place and at the same moment, we propose that a genetic link existed between them. This link could be that the emplacement of mantle derived magmas into or under (underplating) the lower crust could have provided additional heat such that crust melting becomes possible.

The LILE–rich character as well as the slightly negative ε_{Nd}, of the mantle derived lamprophyres indicates that the mantle source itself was enriched. Until now we have no evidences of the cause of this enrichment. Blusztajn and Shimizu (1994) envisaged the possibility of a carbonatitic metasomatism, however, due to the lack of Sr enrichment and to the high Ti/Eu ratio, this hypothesis must be discarded. On the other hand, Karkonosze granite is located in a collisional suture that before acted as a subduction such that a subduction-like metasomatism can be suspected. Indeed, in such an environment the mantle wedge is subjected to strong metasomatism either by fluids or melts coming from the subducted slab. Melts generated by basalt slab melting are Na-rich, and K-, Rb- and HREE-poor (adakites) (Martin et al., 2005). These characteristics are not consistent with lamprophyre composition. Fluids produced by dehydration of the subducted slab (sediments and/or hydrated basalts) result in an enrichment of the mantle, mainly in LILE but also give rise to a negative Nb anomaly. The calculated mantle source for lamprophyres shows these characteristics. Of course, the arguments developed in this discussion are not definitive, and for instance an alkaline melt could also have been metasomatic agent, but the origin of such an alkaline melt appears as unusual and improbable in a subduction environment.

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Permo-Carboniferous volcanism in late Variscan continental basins of the Bohemian Massif: geochemical constraints

J. Ulrych, F.E. Lloyd, E. Hegner, and V. von Seckendorf

The study was initiated by the necessity to understand the tectonic settings and development of the extensive Permo-Carboniferous volcanism in the Bohemian Massif. Variscan orogenic processes are reflected also in several gaps in deposition in the Bohemian Massif area. Geochemical (trace element and Sr-Nd isotope data) methods were preferably used in the study of volcanic rocks.

Extensive Permo-Carboniferous volcanism has been documented from the Bohemian Massif. The Late Carboniferous volcanic episode started at the Duckmantian-Bolsovian boundary and continued intermittently until Westphalian D to Stephanian B producing mainly felsic and more rarely mafic volcanics in the Central Bohemian and the Sudetic basins. During the Early Permian volcanic episode, after the intra-Stephanian hiatus, additional large volumes of felsic and mafic volcanics were extruded in the Sudetic basins. The volcanics of both episodes range from entirely subalkaline (calc-alkaline to tholeiitic) of convergent plate margin-like type to transitional and alkaline of within-plate character. A possible common magma could not be identified among the Carboniferous and Permian primitive magmas, but a common geochemical signature in the volcanic series of both episodes was recognized. On the other hand, volcanics of both episodes differ partly in geochemical and isotope characteristics. High 87Sr/86Sr (0.707-0.710) and low εNd (–6.0 to –6.1) are characteristic of the Carboniferous mafic volcanics, whereas low 87Sr/86Sr (0.705 to 0.708) and higher εNd (–2.7 to –3.4) are typical of the Permian volcanics. Felsic volcanics of both episodes vary substantially in 87Sr/86Sr (0.705 to 0.762) and εNd (–0.9 to –5.1). Different depths of magma source or heterogeneity of the Carboniferous and Permian mantle can be inferred from variation in some elements of the geochemical signature for volcanics in some basins. The Sr-Nd isotopic data with negative eNd values confirm a significant crustal component in the volcanic rocks that may have been inherited from the upper mantle source and/or from assimilation of older crust during magmatic underplating and ascending of primary basic magma. Two different types of primary magma development and formation of a bimodal volcanic series have been recognized: (i) creation of a unique magma by AFC processes within shallow level reservoir (type Intra-Sudetic Basin) and (ii) generation and mixing of independent mafic and felsic magmas, the latter by partial melting of upper crustal material in a high-level chamber (type Krkonoše Piedmont Basin). A similar origin for the Permo-Carboniferous volcanics of the Bohemian Massif is obvious, however, their geochemical peculiarities in individual basins indicate evolution in separate crustal magma chambers. Late Paleozoic volcanism was accompanied by hydrothermal processes which resulted in alteration of the rock and ore mineralization.

FIELD TRIPS

FIELD TRIP 1

DAY 2 (Thursday, 15th June 2006)

Guide: M. Awdankiewicz

11.00-18.00

Carboniferous calc-alkaline volcanism in the Intra-Sudetic Basin

Stop 1/1 – Nagórnik
Location: waterfall in the Odchodnik stream
Geology: Middle Viséan, Nagórnik Formation, conglomerates, andesite sills

The initial stages of the Intra-Sudetic Basin opening in the Middle Viséan (Turnau et al., 2002) were associated with rapid accumulation of coarse-grained siliciclastic deposits and, locally, andesitic and rhyodacitic volcanism (Nowakowski and Teisseyre, 1971; Awdankiewicz, 1999a, b; Mastalerz et al., 1993). A well exposed, ca. 20 m thick section of Middle Viséan deposits at the village of Nagórnik, close to the northern margin of the basin, comprises of conglomerates and andesites. The conglomerates form thick, probably amalgamated, northerly dipping beds and predominantly consist of moderately rounded and sorted fragments of metamorphic rocks. The conglomerates originated in an alluvial fan environment. The andesites form three conformable intercalations 0.5 to 3.5 m thick. Load casts and flame-like structures are developed along the andesite-sediment contacts. The andesites represent synsedimentary sills that intruded fresh, poorly consolidated sediments.

Stop 1/2 – Stare Bogaczowice
Location: old quarries west of Wrony village north of Stare Bogaczowice
Geology: Middle Viséan, Sady Górne Formation, rhyodacitic lavas

The Sady Górne Rhyodacites were emplaced during the earliest stages of the Intra-Sudetic Basin opening, near the northern margin of the basin (Teisseyre, 1966; Awdankiewicz 1999a, b). The Sady Górne Rhyodacites comprise two horizons of acidic lavas set within conglomerates and sandstones. The sequence dips gently to the south. The lower horizon, ca. 30 m thick, consists of phenocryst-poor lavas intercalated with ca. 1.5 m thick layer of tuffs near the base. The upper horizon, up to 18 m thick, consists of phenocryst-poor lavas overlain by, and intercalated with, phenocryst-rich lavas. The upper horizon is well exposed. At Stop 1/2A the phenocryst-poor, columnar-jointed rhyodacites can be observed. At Stop 1/2B a sharp, uneven contact of the phenocryst-rich rhyodacites overlain by phenocryst-poor rhyodacites is exposed.

The eruptive centre of the Sady Górne Rhyodacites could have been located a few km east to south-east of the visited outcrop, close to the fault zone between the Intra-Sudetic Basin and the Świebodzice Depression, where the Upper Devonian basement rocks are cut by "porphyry" dykes. The rhyodacites reflect two main eruptive events, separated by a repose and sedimentation period. The eruptions probably tapped a stratified magma chamber (Awdankiewicz, 1999a).

Stop 1/3 – Mniszek
Location: old quarry of "porphyry", southern slope of the Mniszek Hill
Geology: upper Carboniferous, Mniszek phacolith, flow-banded rhyolites

A complex of acidic intrusions and extrusions within folded Carboniferous deposits crops out along the western margin of the Wałbrzych Basin, a local depositional centre in the northern part of the Intra-Sudetic Basin (Nemec, 1979; Awdankiewicz, 1999a, b, and references therein). This complex, distinguished as the Western Wałbrzych Basin Volcanic Association (Awdankiewicz, 1999 a) comprises of the Trójgarb rhyolites (laccolith), the Chełmiec rhyodacites (laccolith, dykes, phacolith) and the Stary Lesieniec rhyodacites (lavas). The SE part of this complex represents a dome-like structure with the Chełmiec laccolith and smaller intrusions in the core, and the Stary Lesieniec lavas on the SW limb. A hiatus together with erosional and angular unconformities above the lavas show that the interrelated tectonic and igneous activity occurred between the late Westphalian and early Stephanian times (Grocholski, 1965; Nemec, 1979; Awdankiewicz, 1999a, 2004). The development of this acidic intrusive-extrusive complex was determined by NW-trending faults in the basement, providing conduits for rising magmas, and thick accumulation of young sediments within the basin, acting as a density barrier that trapped most of the magmas at a subvolcanic level (Awdankiewicz, 1999a, 2004).

The visited locality is situated within the Mniszek phacolith, ca. 1 km in diameter, saucer-shaped conformable intrusion located within the Žacleř formation deposits in the core of the Gorce syncline. The intrusion was possibly fed from a dyke oblique to the axis of the syncline. The exposed rocks are aphyric rhyolites showing well developed flow-foliation and banding. The variable, moderate to steep dips of the flow planes generally indicate the presence of wide, open folds.

Stop 1/4 – Nowy Lesieniec

Location: Nowy Lesieniec village, old quarry of "porphyry"

Geology: upper Carboniferous, Stary Lesienic Rhyodacites, aphyric rhyodacite lavas

The Stary Lesieniec Rhyodacites form a lava flow emplaced at the SW limb of the Western Wałbrzych Basin Volcanic Association (see Stop 1/3). These rhyodacitic lavas are up to 200 m thick, dip gently to the SW and wedge out rapidly (within a few km) in that direction. The section exposed at Stop 1/4 represents the inner part of the flow and consists of monotonous, massive, strongly altered lavas. Columnar, blocky and platy joints can be observed. Breccias composed of lava blocks in a red clay matrix were reported from pits on top of the section (Grocholski, 1965).

Stop 1/5 – Czarny Bór

Location: Czarny Bór village, old quarry of "porphyry"

Geology: upper Carboniferous, Stary Lesienic Rhyodacites, aphyric rhyodacite lavas

Stop 1/4 is situated in the north-westernmost part of the Stary Lesieniec rhyodacitic lava flow (see Stops 1/3, 1/4). At this locality, the phenocryst-rich rhyodacites are exposed (Awdankiewicz, 1999 a, b). This lithology is characterised by abundant phenocrysts (15 to 50 % by vol.), which are up to 10 mm in length (typically 1 to 3mm). The texture is usually glomeroporphyrytic and locally small cognate enclaves composed of tens to hundreds of phenocrysts are found. The pehenocrysts comprise albitised plagioclase, chlorite pseudomorphos after pyroxenes and amphiboles and biotite. Common acessory minerals are apatite and zircon which form microphenocrysts up to 0.7 mm and 0.3 mm long, respectively.

FIELD TRIP 2

DAY 3 (Friday, 16th June 2006)

Guide: M. Awdankiewicz

9.00-18.00

Carboniferous and Permian mildly alkaline volcanism in the Intra-Sudetic Basin

Stop 2/1 – Wałbrzych
Location: Podgórze, old quarry of "melaphyre"
Geology: Upper Carboniferous, Rusinowa-Grzmiąca maar belt, diatreme, pyroclastic flow deposits, trachyandesite cryptodome

A SSE-trending belt of rhyolitic tuffs, rhyolites and trachyandesites crops out along the eastern margin of the Wałbrzych Basin (the Eastern Wałbrzych Basin Volcanic Association). This belt represents remnants of 5 to 10, partly overlapping maar-type volcanoes that developed in late Carboniferous times (Nemec, 1979, 1981; Awdankiewicz 1999a). The activity commenced with explosive, phreatomagmatic eruptions of rhyolitic magmas and formation of diatremes filled with various volcaniclastic deposits. Subsequently, rhyolitic and trachyandesitic magmas were emplaced both into the diatremes and their country rocks as dykes, sills, plugs, laccoliths and lava domes.

In the quarry, at the margin of a diatreme, ca. 250 m wide trachyandesite cryptodome is exposed. The trachyandesites were emplaced into a sequence of mudstones, sandstones and conglomerates overlain by rhyolitic tuffs (pyroclastic flow deposits). The andesite/sediment contacts are generally conformable, but the stratification of the sedimentary and pyroclastic rocks is partly disrupted, a pipe-like apophyse projects upwards from the dome for several tens of metres, and ca. 5 m thick clastic dyke penetrates the trachyandesites. These structures document fluidisation of wet sediments in the contact zone of the trachyandesitic cryptodome. A tentative correlation of the red-coloured sedimentary rocks above the trachyandesites with the Glinik Formation suggests that the deposits within the diatreme subsided for several hundred metres (Awdankiewicz, 1999a, 2004).

Stop 2/2 – Barbarka
Location: Wałbrzych, old quarry of "poprhyry" on the Barbarka Hill
Geology: Upper Carboniferous, Rusinowa-Grzmiąca maar belt, rhyolitic lava (sill?), flow folds, sedimentary xenoliths

This locality is situated ca. 2 km west of the Rusinowa-Grzmiąca maar belt (see Stop 2/1), within the lowermost part of the Glinik Formation in the Wałbrzych Basin. According to Grocholski (1965) three rhyolite sheets, 35, 15 and 10 m thick in upward succession, crop out along the northern slope of the Barbarka Hill. The lowermost, thickest sheet is exposed at the visited quarry. The rhyolites show well-developed flow foliation/banding, folded in places. Sandy conglomerate xenoliths up to 1 m in size are found in the rhyolites. The top of this sheet observed in pits (Grocholski, 1965, Fig. 13) shows a gradation from flow-foliated rhyolite, through brecciated rhyolite to rhyolitic sandstones within a distance of 1-2 m. The sketches of Grocholski (op. cit.) suggest that the rhyolites dip more steeply than their country rocks. The rhyolites may represent a lava flow or a shallow level sill (?).

Stop 2/3 – Czadrówek
Location: Czadrówek near Kamienna Góra, old quarry of "melaphyre"
Geology: lower Rotliegendes, Słupiec Formation, Kamienna Góra Basaltic Trachyandesites, shield volcano, basic lavas, tuffs, breccias, clastic dykes

The Kamienna Góra Basaltic Trachyandesites, in the western part of the Intra-Sudetic Basin, represent a small shield volcano (10-12 km in diameter, 0.1 km high, 1-4 km^3 in volume) formed due to effusive eruptions of relatively basic lavas with SiO_2 contents of ca. 52% (Awdankiewicz, 1997, 1999a; Awdankiewicz et al., 2003). This activity represented the earliest stag of the Permian climax of volcanisms in the Intra-Sudetic Basin. The shield volcano possibly erupted over an easterly inclined palaeoslope, the oldest lavas flowed to the east, and the younger flows were successively shifted north- and westwards. Various lava types (aa, pahoehoe and block lavas) and thin tuff intercalations form the eruptive sequence. Abundant sedimentary xenoliths, volcano-sedimentary breccias and clastic dykes reflect lava-wet sediment interactions during the emplacement of the lavas.

The section at Czadrówek, ca. 1-2 km west/north-west of the inferred vent of the volcano, is 30-40 m thick and dips gently to the SE. The section consists of three successive lava horizons with sandstones and tuffs interbedded between the two lower ones. This sequence formed due to two eruptions separated by relatively long repose period. The first effusive eruption produced ca. 10 m thick aa lava flow. This flow was subjected to a prolonged weathering and it is covered by red volcanogenic sandstones composed of local lava fragments, locally overlain by green sandstones of non-volcanic provenance (sublithic arenites). The second eruption started with an explosive (phreatomagmatic ?) phase and the deposition of ca. 1 m of laminated tuffs, followed by an effusive phase and the emplacement of ca. 25 m thick aa-type lava flow. Abundant sedimentary xenoliths in the latter flow possibly reflect incorporation of poorly consolidated sediments in the vent area. The final phases of this eruption resulted in the accumulation of thin, discontinuous pahoe-hoe lava flows.

Stop 2/4 – Pustelnia
Location: Pustelnia Hill north of Lubawka, old quarry of "poprhyry"
Geology: lower Rotliegendes, Słupiec Formation, Góry Krucze Rhyolites, massive lavas

The Góry Krucze Rhyolites were emplaced during the early Permian climax of volcanism at the western limb of the Intra-Sudetic Basin (Awdankiewicz, 1999a, Awdankiewicz et al., 2003). These rhyolites represent a big (several tens of cubic km), asymmetric extrusion of acidic lavas, ca. 15 km in diameter and several hundred metres thick. In the south, near the inferred centre of eruption, the rhyolites are thickest and consist mostly of massive to flow banded lavas. Northwards the lavas become thinner and an increased amount of auto- to epiclastic breccias is observed. Following the emplacement, this rhyolitic edifice was substantially eroded and the local volcanogenic debris is abundant in the overlying Radków Formation.

At Stop 2/4, in the northern part of the Góry Krucze extrusion, massive, aphyric rhyolites are exposed. Such rhyolites represent the most common lithology of the extrusion. These rocks show blocky to platy joints and dip to the east at shallow angles. Locally indistinct flow banding and autoclastic breccias can be observed.

Stop 2/5 – Okrzeszyn
Location: old quarry of "porphyry" north of the Okrzeszyn village
Geology: lower Rotliegendes, Słupiec and Radków Formations, Góry Krucze Rhyolites, lava flow, erosional unconformity, alluvial deposits

Stop 2/5 is situated in the southernmost part of the Góry Krucze rhyolitic extrusion (see Stop 2/4). The exposed section, ca. 25 m thick, consists of lavas overlain by clastic rocks that dip gently to the NEE. The lower 20 m of this section represents a rhyolitic lava flow. This flow shows altered obsidian and spheroidal rhyolites in the lower half, and microcrystalline rhyolites above. Flow folds, autoclastic breccias and hydrothermal mineralisation can be observed. The uppermost 5 m of the section, above the rhyolites, is made up of sandy rhyolitic breccias, sandstones and mudtones.

The exposed flow is strongly eroded – the upper obsidian layer is completely lacking. A local, angular rhyolitic debris derived from the microcrystalline core of the rhyolitic lava flow represent the major component of the overlying sediments. The erosional unconformity on top of the rhyolites represents the boundary of the Słupiec Formation (below) and the Radków Formation (above). The sedimentary rocks above the rhyolites are interpreted as alluvial deposits, including channel deposits (breccias) and overbank deposits (sandstones, mudstones) with poorly developed soil horizons in places (Awdankiewicz et al., 1998).

FIELD TRIP 3A

DAY 4 (Saturday, 17th June 2006)

Guide: V. Prouza

9.00-13.30

Late Paleozoic volcanic rocks in the Czech part in the Intra-Sudetic Basin

Stop 3/1 – Rožmitál at Broumov

Location: large open quarry at the upper end of village

Geology: Olivětín Member, Broumov Formation, Aututn, lavas of basaltic andesite

Effusive basaltic andesites of the Upper Olivětín Member of the Broumov Formation (the Šonov Group of andesitoids – Permian, Autunian) – lava flows alternating with pyroclastics (unsorted, sometimes very coarse, grading to agglomerates) and volcanoclastic sediments. Petro-chemically: quartz latite-andesite, locally amygdaloidic, massive in other parts. Contraction cracks on the surface of the lava body are filled with sediments, those are silicified. Some precious minerals, as crystals of quartz, jasper, chalcedony, agate etc. are associated with amygdaloidic andesite.

Stop 3/2 – Hynčice, ESE of Meziměstí

Location: abandoned quarry at the road

Geology: Nowa Ruda Member, Broumov Formation, Autun, rhyolitic ignimbrite

Violettish-grey to pinkish, sometimes mottled rhyolitic ignimbrite of the upper part of the Nowa Ruda Member of the Broumov Formation (the rhyolite complex – Autunian). Flattened glass fragments – fiamme - are abundant. Xenoliths (andesitoids, felsites, rare sediments, tuffs, older ignimbrites, quartzites, gneisses) are common. Rocks are relativelly hard and have been used for centuries as building stone in Broumov and surroundings.

Stop 3/3 – Šonov

Location: rocky outcrops in wood at the upper end of village

Geology: Nowa Ruda Member, Broumov Formation, Autun, rhyolitic tuffs

The volcanic complex of the upper part of the Nowa Ruda Member is of rhyolitic composition. – Red (locally whitish mottling) rhyolitic tuffs and ignimbrites. Matrix is vitroclastic, phenocrysts (mostly quartz, K-feldspar, rare plagioclase) reach 15 % of the rock. Rocks are unsorted and contain fragments of volcanic glass and xenoliths, sometimes angular. Ball-type of weathering is characteristic of these volcanics. The boundary with ignimbrites (both, vertical and horizontal is transitional). Fall-out tuffs crop out at Otovice village within the rhyolite complex.

FIELD TRIP 3B

DAY 4 (Saturday, 17th June 2006)

Guides: E. Słaby, M. Awdankiewicz

13.30-18.00

Carboniferous Karkonosze granite and lamprophyre dykes

Stop 3/4 – Sokole Góry

Location: rock crags on Krzyżna Góra and Sokolik hills
Geology: Karkonosze granite, composite dike

The Lower Carboniferous Karkonosze granite (see Słaby et al., this volume) comprises poprhyrytic to medium-grained and fine-grained types. The most widespread porphyrytic granite was dated by the 40Ar/49Ar method at 320±2 Ma (Marheine et al., 2002). The porphyrytic granite is an early facies within the pluton. Its formation is influenced mostly by magama mixing-mingling. Later magma impulses don't show any sign of hybridization. Granitic magma is generated almost exclusively from crustal source. Granites crystallizing from those magmas display equigranular texture. Equigranular granite is cut by composite dikes and late mafic dikes. The very limited volume of mafic-like melt has no influence on the crust-related magma composition.

Stop 3/5 – Trzcińsko

Location: old quarry in the eastern part of the Trzcińsko village
Geology: Karkonosze granite, vogesite dyke

The eastern part of the Karkonosze granitic massif is cut by a NNE-trending dyke swarm ca. 20 km long and 10 km wide. Stop 3/5 is located in the northern part of this swarm. At a small abandoned quarry granite (weathered) cut by a vogesite dyke is exposed. The dyke dips steeply (85°) westwards and strikes to the NNE (20°), following the main trend of the swarm. The dyke is ca. 2.5 m thick, interdigitates with granite (granite 'dykes' inside the vogesite dyke) and granite/vogesite contacts are planar and sharp. These relationships suggest that the lamprophyre intruded the granite while the latter was still not fully consolidated. The vogesite is a very fine grained to apahanitic rock and consists predominantly of kaersutite and alkali feldspars (Ca-albite and K-feldspar).

FIELD TRIP 4

DAY 5 (Sunday, 18th June 2006)

Guides: M. Awdankiewicz, C. Breitkreutz, E. Słaby 9.00-15.00

Permian high-K calc-alkaline volcanism in the North-Sudetic Basin

Stop 4/1 – Bolków

Location: old railway cut NE of Bolków

Geology: Rotligendes, alluvial sandstones, rhyolitic tuffs, pyroclastic surge and flow deposits

The rhyolites and tuffs cropping out near Bolków erupted from a silicic volcanic centre located in the Wolbromek trough, in the easternmost part of the North-Sudetic Basin. The exposed section is ca. 22 m high, dips to the ESE at 15-20º and consists of sandstones (the lowermost 3 m of the section) and rhyolitic tuffs (the rest of section). The tuffs comprise: 1) ca. 1.5 m of bedded tuffs, followed by 2) ca. 17 m of massive tuffs. The bedded tuffs are rich in accretionary lapilli and consist of alternating, cm to dm thick, homogeneous and laminated layers. The massive tuffs show an indistinct planar jointing and a "nodular" texture due to abundant, oval concretions several cm in diameter. At ca. 2.5 m and 6.5 m above their base, the massive tuffs contain laterally discontinuous intercalations of laminated tuffs similar to those below. The intercalations are 10 cm and 100 cm thick, respectively, wedge out within few metres and do not contain accretionary lapilli.

The sandstones at the base of the section were deposited in an alluvial plain or distal alluvial fan envrironment (Mastalerz and Raczyński, 1993). The rhyolitic tuffs reflect an explosive, phreatomagmatic eruption of rhyolitic magma. During the initial stages of eruption pyroclastic surges (base surges) and weak pyroclastic flows were generated and the bedded tuffs accumulated. Later, a larger pyroclastic flow, or few flows in a rapid succession, were generated and the massive tuffs were deposited. The bedded intercalations in the massive tuffs may represent deposits of flow-related surges (ground surges ?). The style of eruptive and depositional processes suggest relationships to a maar or a tuff ring located within a few km of the observed section (Awdankiewicz, unpublished).

Stop 4/2 – Świny

Location: rock crags near the Świny Castle

Geology: Rotligendes, conglomerates, alluvial fan deposits, rhyolites, flow banding, lavas or ignimbrites (?)

At rock crags below the Świny Castle (stop 4/2A) coarse and medium grained conglomerates are exposed (Mastalerz and Raczyński, 1993). These deposits are thickly bedded (1m to 4m), massive to inversely graded, very poorly sorted and consist mainly of local debris derived from the Kaczawa Complex (greenstones, schists). These rocks are interpreted as debrites (deposits of dense cohesive flows) accumulated at a proximal part of an alluvial fan, close to an active fault at the margin of Wolbromek trough. Above the conglomerates, ca. 100 m south of the castle, the rhyolites are exposed at a crag ca. 15 m high (Stop 4/2B). The rhyolites show well defined flow foliation/platy joints which dip gently (10-20º) to the SE and become more densely spaced towards the top of the section. The rhyolites are highly porphyrytic, with quartz, feldspar and altered biotite phenocyrsts several mm in size. These rocks may represent a flow-foliated basal part of lava flow. However, Pańczyk (2003) argued that fiamme and eutaxitic textures can be discerned, and that these rocks represent extremely welded ignimbrites, and not lavas.

Stop 4/3 – Lubiechowa

Location: Łomy hill west of Lubiechowa village, old quarry of "melaphyre"

Geology: Rotligendes, basaltic andesite lava flows, sedimentary xenoliths, pillow-like structures, post-magmatic/diagenetic mineralisation

The exposure at Lubiechowa represents one of the most interesting sections of basaltic andesite lava flows in the North-Sudetic Basin, both for geological peculiarities and well-known post-magmatic mineralisation. The exposed section is ca. 60 m thick and dips gently to the NW. 8 major, successive lava flows, 5 to 10 m thick, can be traced along the quarry walls. The lower and middle portions of the flows are massive, and their upper parts are amygdaloidal. Throughout the section, the amygdaloidal lavas contain abundant sedimentary xenoliths (sandstones, mudstones, carbonate rocks). Locally clastic dykes and peperites are found. In some places the lavas split into oval blocks, aligned lobes and pillow-like structures, with sediments filling the inter-pillow space. A tree trunk imprint in lava (*Calamites Sp*., P. Raczyński, pers. com.) was found in the quarry. An up sequence geochemical variation is found in this lava sequence (increase of Zr and decrease of Cr contents). However, the lavas are thoroughly altered and no primary igneous phases are preserved. K-Ar dating of celadonite from amygdales suggest that the alteration processes spanned the late Permian – middle Jurassic period (252.5 – 177.5 Ma; Pękala et al., 2003).

The Lubiechowa section documents accumulation of several lava flows during, possibly, a prolonged effusive eruption. The sedimentary xenoliths together with pillow-like structures reflect an interaction of lavas with unconsolidated, fine grained (alluvial and lacustrine ?) sediments. The lavas possibly erupted through a pile of fresh sediments, or accumulated and partly sunk within such sediments as invasive flows (Awdankiewicz, unpublished).

Stop 4/4 – Dynowice

Location: Wygorzel hill south of Dynowice village, rocky crag on the NE slope

Geology: Rotligendes, rhyolites, autoclastic breccias, lavas or ignimbrites (?)

In the vicinity of Dynowice and Nowy Kościół, in the central part of the North-Sudetic Basin, an extensive outcrop (8 x 2 km) of ryolites and related volcaniclastic rocks mantles the Świerzawa horst from the NW and N. The section exposed at Stop 4/4, in the NW part of this outcrop, is over 30 m high. Two successive rhyolite units (sheets), 10 m and 20 m thick, can be distinguished. They dip to the NE at 30-55º. Their lower and central parts are massive to blocky- and platy-jointed parallel to the base and top. The platy joints are spaced at 30-50 cm and fine lamination can be seen in places. Towards the top of the sheets a gradation into brecciated zones 5-10 m thick is observed. The degree of brecciation varies from zero (platy jointed rhyolites showing no evidence of displacement or rotation) through incipient (cracked rhyolites with insignificant displacement of the component fragments) to strong (breccias with well defined angular blocks, cm to dm in size, a finer matrix, and a chaotic fabric). The most strongly brecciated rocks form irregular "pockets". The described section probably represents two successive, partly autobrecciated, rhyolitic lava flows or extremally welded rhyolitic ignimbrites (?).

Stop 4/5 – Organy Wielisławskie

Location: Wielisławka hill north of Sędziszowa, old quarry of "porphyry"

Geology: Rotligendes, rhyolitic intrusion/extrusion, flow foliation, columnar joints

Stop 4/5 is an old quarry, protected as a nature monument due to specific, perfectly developed joints resembling organ pipes. The rhyolites, a part of the silicic volcanic sequence of the Świerzawa area (see Stop 4/4), form a NE-aligned outcrop ca. 0.4 x 1.2 km in size within crystalline schists of the Kaczawa Complex. In the quarry, ca. 35 m high, the internal structure of a rhyolitic intrusion/extrusion is well exposed (Kuhn, 1923; Awdankiewicz, unpublished). Flow foliation is remarkable and defines a synclinal (concentric) pattern with the axis dipping gently (0-35º) to the NE-E. Small-scale flow folds and lineation on the flow planes show the same alignment (however, locally a strong variation is also found). The columnar joints range from oblique to almost perpendicular relative to the flow foliation planes and define a fan-like pattern converging towards the centre of the structure. Southerly dipping, moderately inclined columns (30-65º) predominate. In the upper part of the exposure rhyolites of central part of this igneous body show a less regular flow foliation and joints and, generally, a more blocky structure without strongly dominant directions. Overall, the exposed section may represent a gently inclined plug or an inner part of a lava dome.

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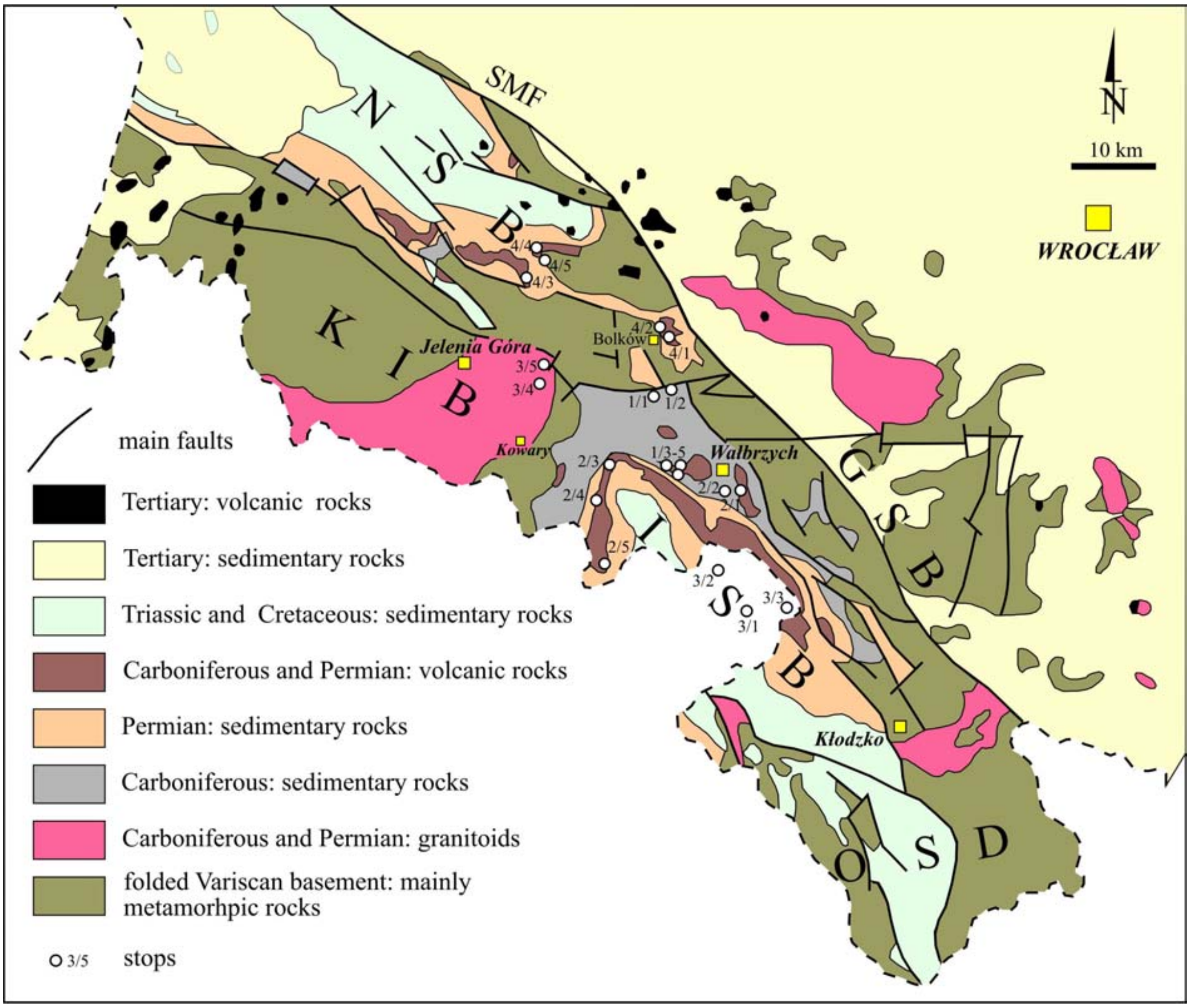
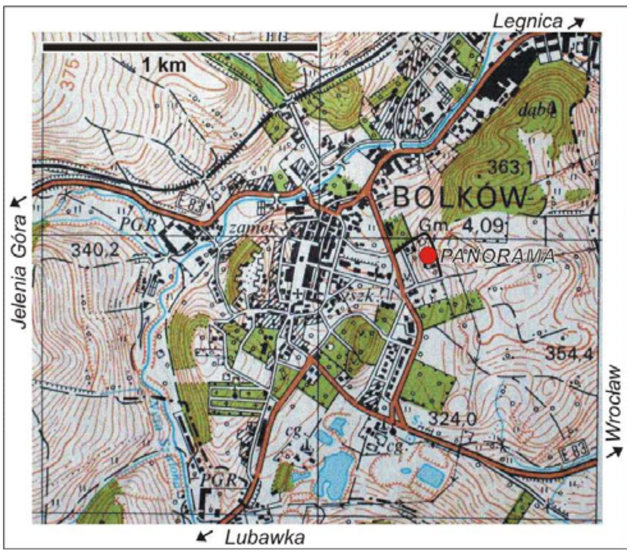


Geological sketch of the Polish Sudetes (Polish Geological Institute, 1989, modified) showing the general location of the field stops. GSB - Góry Sowie Block, ISB - Intra-Sudetic Basin, KIB - Karkonosze-Izera Block, NSB - North-Sudetic Basin, OSD - Orlica-Śnieżnik Dome.



Map of Bolków and location of the Panorama Hotel.