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EXCURSION GUIDE

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Field excursion on West Sudetes

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INTRODUCTION TO THE FIELD TRIP (FIRST DAY)
Metamorphic and Structural Features of the Izera-Karkonosze Massif and the Kaczawa Mountains, West Sudetes

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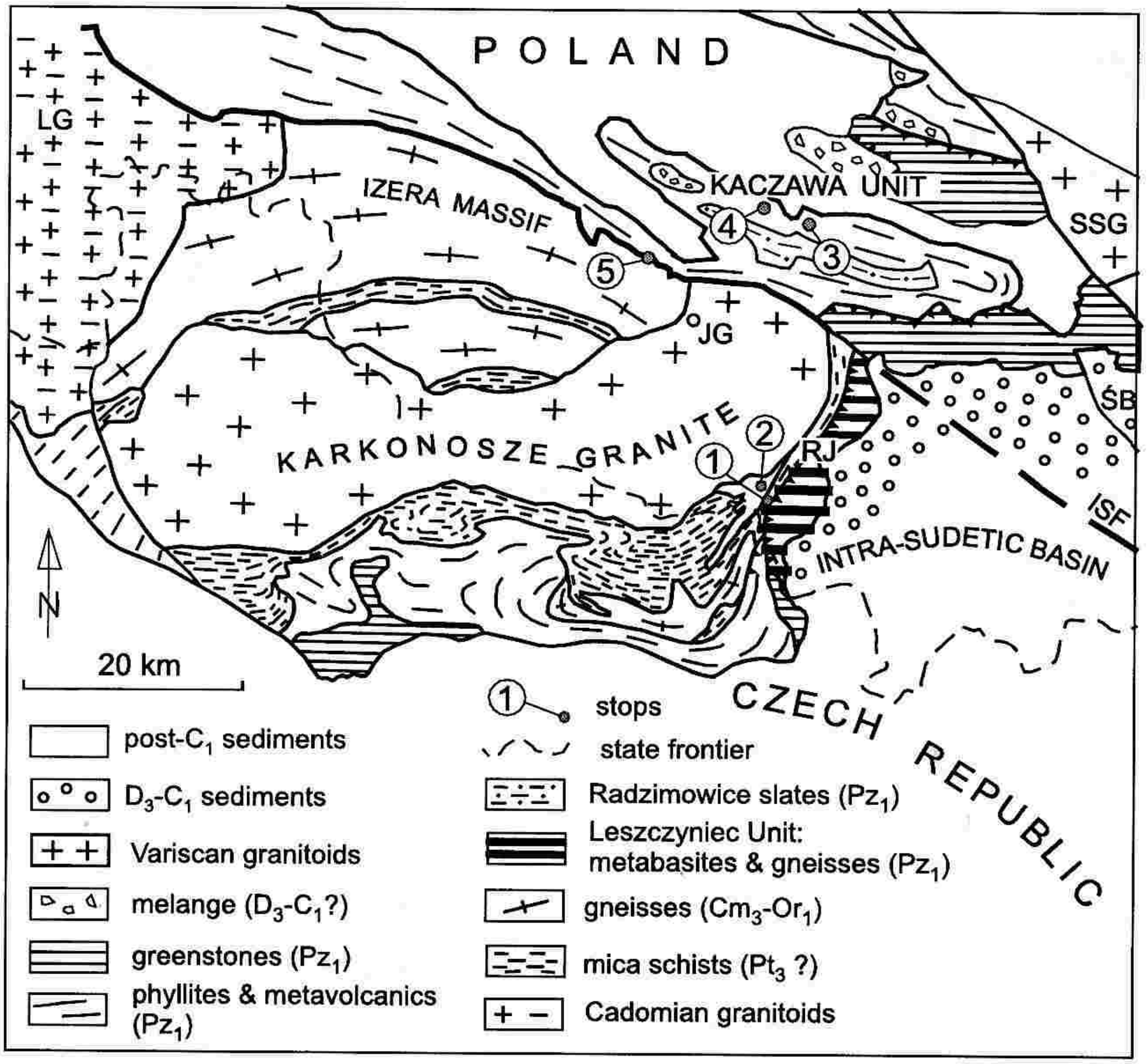

Fig. 1. Outline geology of the Karkonosze-Izera Massif and the Kaczawa Mountains. ISF - Intra-Sudetic Fault Zone; JG - Jelenia Góra; LG - Lusatian Granitoid Massif; RJ - Rudawy Janowickie Complex; SSG - Strzegom-Sobótka Granite Massif; ŚB - Świebodzice Basin. *Age assignments*: Pt_3 - Late Proterozoic; Cm - Cambrian; Or - Ordovician; D - Devonian; C - Carboniferous; Pz -Palaeozoic.

The West Sudetes consist of a mosaic of distinct, fault bounded, pre-Permian basement units and are subdivided into two units by the prominent NW-SE Intra-Sudetic fault zone. This trip runs across the two biggest structural units of the West Sudetes: the Izera-Karkonosze Massif and the Kaczawa Mountains (Fig. 1).

The Izera-Karkonosze Massif shows a heterogeneous structure, with the central position occupied by the Lower Carboniferous Karkonosze granite pluton. Its metamorphic envelope is composed of Neoproterozoic(?) mica-schists and deformed Late Cambrian-Ordovician Izera-Kowary granitoids, which are overthrust by Lower Palaeozoic to Upper Devonian low-grade metasediments and bimodal volcanics of the South Karkonosze and Rudawy Janowickie complexes, the latter two showing traces of blueschist facies metamorphism.

The Rudawy Janowickie complex is composed of two

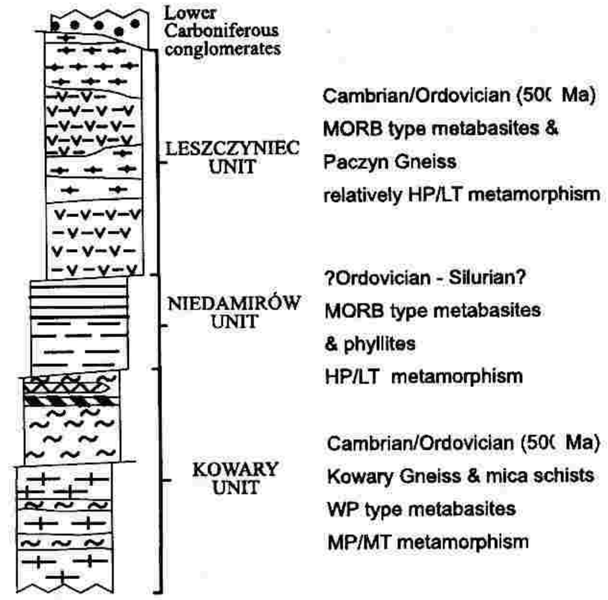

Fig. 2. Tectonic units of the eastern margin of the Izera/Karkonosze Massif.

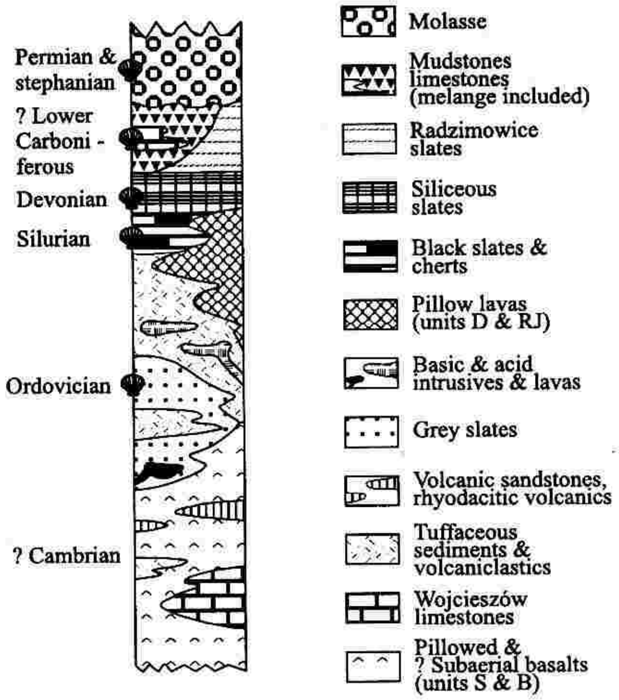

Fig. 3. Generalised lithostratigraphic log of the Kaczawa succession.

thrust sheets which rest on top of the Kowary granite-gneiss (Fig. 2) which intruded into medium-pressure, greenschist to lower amphibolite facies metasedimentary and metavolcanic rocks. The lower, Niedamirów thrust sheet consists of Lower Palaeozoic metabasalts and phyllites which bear record of blueschist metamorphism overprinted by greenschist facies. The upper, Leszczyniec thrust sheet comprises Cambrian/Ordovician basic to acidic igneous assemblage metamorphosed under relatively high pressure epidote-amphibolite facies conditions. Most basalts within both thrust units show features typical of N-MORBs, whereas the accompanying felsic plutonic rocks (which occur in the Leszczyniec unit) probably represent fractionation products of those mafic magmas. This is in contrast to the underlying Neoproterozoic envelope of the Kowary granite-gneiss, which contains alkali basalts and minor tholeiites of within-plate affinities. The metaigneous rocks of the thrust units of the Rudawy Janowickie complex are inferred to have formed in an extensional setting containing continental crustal components, probably in an immature oceanic rift.

The low-grade metamorphic (blueschist to greenschist facies) Kaczawa Complex comprises several thrust sheets composed of various fragments of a sedimentary-volcanic succession (comprising siliciclastics, volcanoclastics, carbonates, basic and acid volcanics, pelagic clayey and siliceous shales and flysch) of Cambrian(?) to Late Devonian and, possibly, Early Carboniferous age, accompanied by abundant melange bodies expected to have developed during Late Devonian / Early Carboniferous times (Fig. 3). The lower part of the succession (Cambrian? - Ordovician) is represented by a composite volcanic-sedimentary sequence (transitional alkaline/subalkaline basalts, rhyodacites and alkali basalts and trachytes of Late Cambrian/Early Ordovician age). The lavas are accompanied by volcanoclastics and sedimentary rocks, including shallow water volcanic sandstones, limestones and, locally, thick sequences of fine-grained clastics. This lower part of the succession is interpreted to have developed in an initial rift setting within continental crust. The upper part of the Góry Kaczawskie volcanic succession (mostly Silurian) is dominated by a thick monotonous sequence of pillowed basalts accompanied by minor black graptolitic slates. The basic lavas range from E-MORB to N-MORB in composition and were emplaced in an evolved rift environment, probably of an oceanic type.

The rock complexes of both major West Sudetic units described here, were metamorphosed and deformed in Late Devonian - Carboniferous times. Their metamorphic and structural evolution as well as the kinematics of the tectonic boundary between them, the Intra-Sudetic fault, are outlined in abstracts by Kryza, Aleksandrowski and Mazur in the abstract volume of this conference.

Stop 1
Eastern Margin of the Karkonosze-Izera Massif. Deformation Associated with Extensional Collapse in Quartz-muscovite Schists near the Okraj Pass

Stanislaw MAZUR

Location: Road-cut 1,5 km east of the Okraj Pass

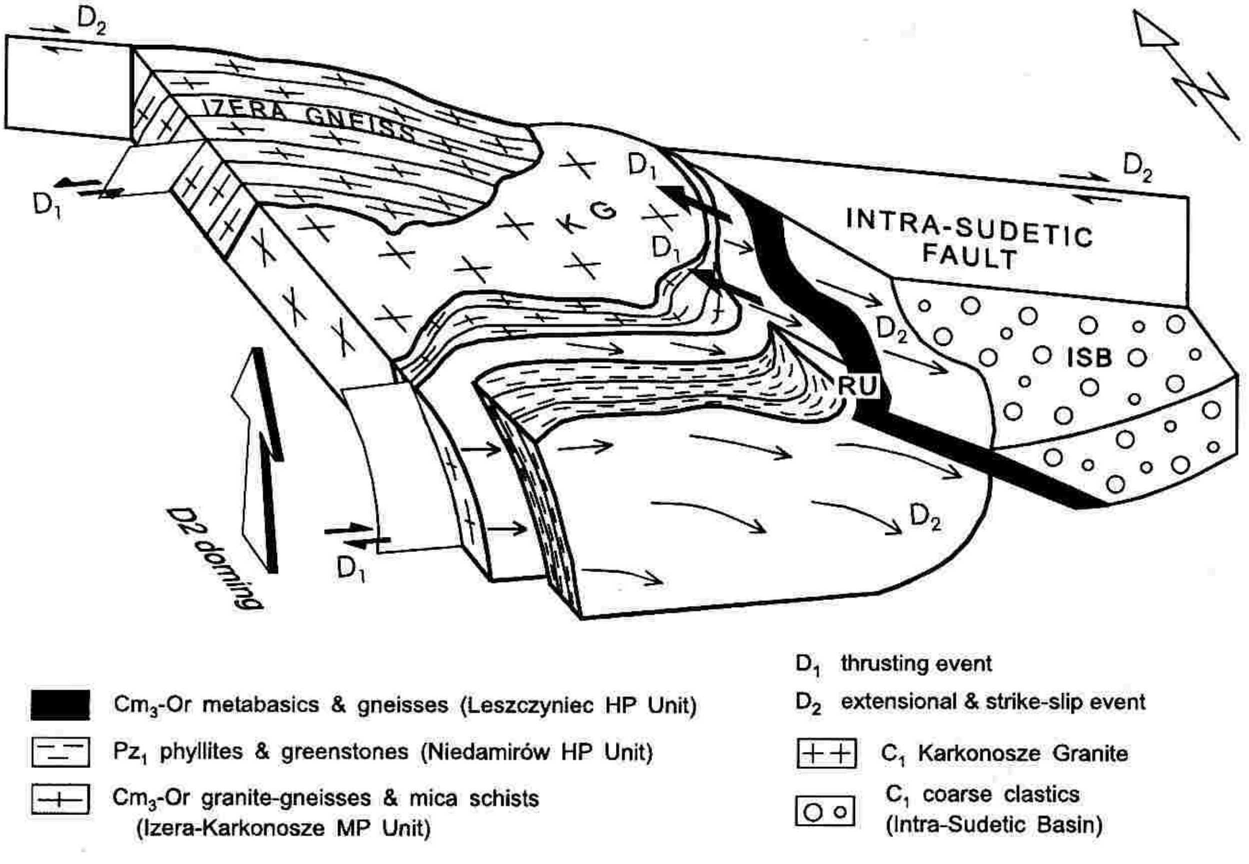

Fig. 4. Simplified block diagram showing domal shape of the Karkonosze-Izera Massif, acquired during D$_2$ extensional deformation event. The D$_1$ structures, related to NW-thrusting event, were reoriented on slopes of the dome. ISB - Intra-Sudetic Basin, KG - Karkonosze Granite Massif, RU - Rudawy Janowickie Units.

The eastern margin of the Karkonosze-Izera Massif is defined by the Rudawy Janowickie metamorphic complex which crops out in a narrow belt between the Karkonosze pluton and the Intra-Sudetic Basin (Fig. 1). Gneisses and mica schists of the Velká Úpa Group (Chaloupský 1989) referred to as the Kowary Group (Teisseyre 1973; Mazur 1995) constitute the westernmost part of the Rudawy Janowickie complex. Mica schists with intercalations of "striped" metabasites and dolomitic marbles form a narrow belt, up to several hundred metres thick, distinguished as the Czarnów Formation (Teisseyre 1973, Mazur 1995). The eastern margin of the Karkonosze-Izera Massif follows a few kilometre wide, dip-slip displacement shear zone (Fig. 4) which developed due to extensional collapse (Mazur 1995, Mazur and Kryza 1996).

Mica schists are fine-grained, thinly laminated rocks composed of quartz, white mica, plagioclase (mostly albite), chlorite and minor biotite, epidote, stilpnomelane, apatite and iron oxides. They contain abundant quartz veins parallel to the main schistosity.

Foliation in the mica schists dips steeply to ESE at an angle of 70-80°. It bears a well-pronounced stretching lineation L$_2$ defined by parallel alignment of white mica. The lineation is almost parallel to the dip of foliation and plunges to ESE at a high angle. Abundant meso-scale kinematic indicators show a top-to-ESE, normal dip-slip sense of shear. They comprise numerous foliation fishes and S-C fabric.

Foliation S$_2$ and lineation L$_2$ of the mica schists were formed due to extensional deformation which entirely obliterated the older structures S$_1$ and L$_1$. Relics of the S$_1$ foliation are preserved only as inclusion trails in albite porphyroblasts and as microscopic intrafolial folds.

Stop 2
Eastern Margin of the Karkonosze-Izera Massif. Extensional Structures Superposed upon Thrust Related Deformations in the Kowary Gneiss at Kowary Górne

Stanislav MAZUR

Location: Rocks in the Piszczak brook valley (Uroczysko), 500 m west of Kowary Górne

The Kowary Gneiss represents a 500 Ma old granite intrusion (Oliver et al. 1993) subsequently deformed under upper greenschists facies conditions (Kryza and Mazur 1995). The Kowary gneiss, together with Upper Proterozoic (?) mica schists of its envelope (*stop 1*), belongs to the Kowary tectonic unit, the lowermost unit of the Rudawy Janowickie metamorphic complex. Gneisses, more competent than mica schists, experienced only minor modifications during the extensional collapse. They preserved foliation S_1 and lineation L_1 related to the earlier thrusting event (Fig. 4).

The Kowary gneiss represents a coarse-grained rock typically with augen texture which developed around variably deformed and recrystallised K-feldspar megacrysts. Other components are plagioclase (<10% An), quartz, biotite, white mica, chlorite and accessory opaque minerals, epidote, apatite, tourmaline and zircon.

Foliation S_1 of the gneiss dips steeply to the SE or S at an angle of 60-80°. It contains two intersecting lineations L_1 and L_2. Lineation L_1, steeply inclined to the SE, is defined by elongated K-feldspar megacrysts and stretched feldspar and quartz aggregates. Lineation L_2, plunging to ESE, is oblique to L_1 at an angle of 20-30°. It is bounded by small crenulations and parallel alignment of white mica. Kinematic indicators include asymmetric tails of K-feldspars. Most of them indicate a top-to-NW, reverse sense of shear. Nevertheless, some porphyroclasts of the opposite asymmetry are also present.

In a small abandoned quarry nearby, the foliation in the gneisses is deformed by lineation-parallel folds F_2, characterised by a distinct S to SW asymmetry. Hinges of these folds parallel lineation L_2 and are oblique to L_1.

Stop 3
Diabase Sills in Ordovician(?) Slates, Blueschist Facies Metamorphism (Kaczawa Mts., Świerzawa Unit) at Wojcieszów Dolny

Ryszard KRYZA

Location: Abandoned quarry and crag on E bank of river Kaczawa, N-edge of Wojcieszów Dolny, 14 km ENE of Jelenia Góra

Numerous sills of alkaline basic rocks (diabases) occur within a thick sequence of grey slates, which represent the lower part of the Kaczawa succession (Ordovician ?). The mud-dominated metasediments display primary sedimentary structures (parallel lamination, graded bedding, convolute lamination, load casts, erosional scours etc.). The sills (up to several tens of metres thick) have rather smooth and undisturbed contacts. The texture and composition of the diabases vary systematically from aphyric margins to porphyritic cores. The field relationships and internal structures of the intrusions suggest that they are mostly sills which intruded prior to the main penetrative deformation. The primary igneous clinopyroxene and kaersutite are partly replaced by two subsequent metamorphic assemblages, including glaucophane (HP-LT event) and actinolite (MP overprint).

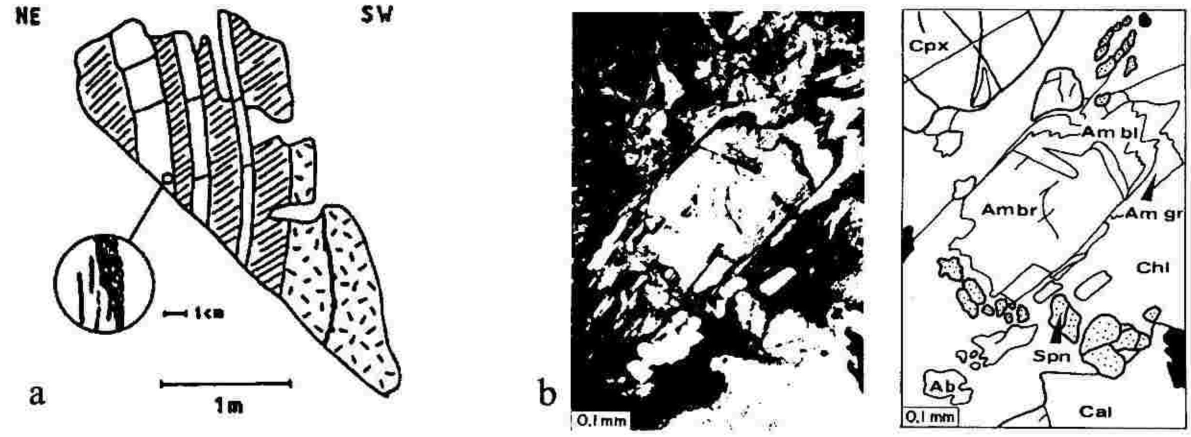

Fig. 5. (a) Contact of diabase sill (random hatching) with metasediments (parallel hatching) at Wojcieszów Dolny, a probable clastic dyke shown in the circle. (b) Photomicrograph of diabase from central part of sill. Cpx - clinopyroxene, Ambr - kaersutite, Ambl - glaucophane, Amgr - actinolite, Ab - albite, Cal - calcite, Chl - chlorite, Spn - sphene.

Stop 4

Cambrian?-Ordovician Pillowed Basalts, Primary Volcanic Structures, Bedding/Cleavage Relationships (Kaczawa Mts., Świerzawa Unit) at Okole Hill

Ryszard KRYZA

Location: Crags on E side of Okole Hill, Chrośnica village, 10 km NE of Jelenia Góra

The pillowed basalts of the Okole Hill, ca. 500 m thick, are underlain (along a tectonic contact ?) by grey slates (*stop 3*) and overlain by shallow-water siliciclastic volcanogenic sediments and variegated bimodal volcanics, emplaced in shallow-water/subaerial conditions in a rift environment. They represent the lowermost part of the Kaczawa succession.

The volcanic rocks display primary structures, e.g. pillow bodies with clear way-up indicators: convex tops, v-shaped bottoms, drain-outs and asymmetric vesicle distribution. The foliation dips at a moderate angle to NE and the subhorizontal lineation is oriented WNW-ESE. Based on bedding/cleavage relationships, the presented sequence is interpreted to occur within the steep to overturned limb of a S-verging anticline. Two generations of kinematic indicators known from the outcrops nearby suggest two deformation events: earlier, top-to--WNW thrusting, and subsequent top-to-ESE collapse.

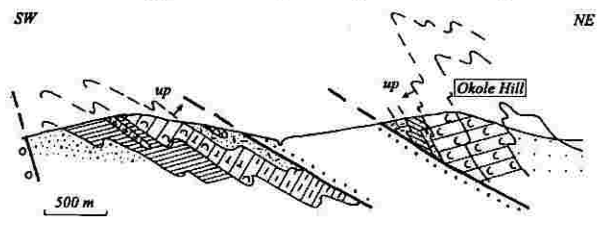

Fig. 6. Cross section through the Bolków, Radzimowice and Świerzawa units in the southern part of the Kaczawa Mts.

Stop 5
Transect Across the Intra-Sudetic Fault at Pilchowice

Pawel ALEKSANDROWSKI

Location: Pilchowice, 12 km NW of Jelenia Góra, gorge of the river Bóbr below the dam

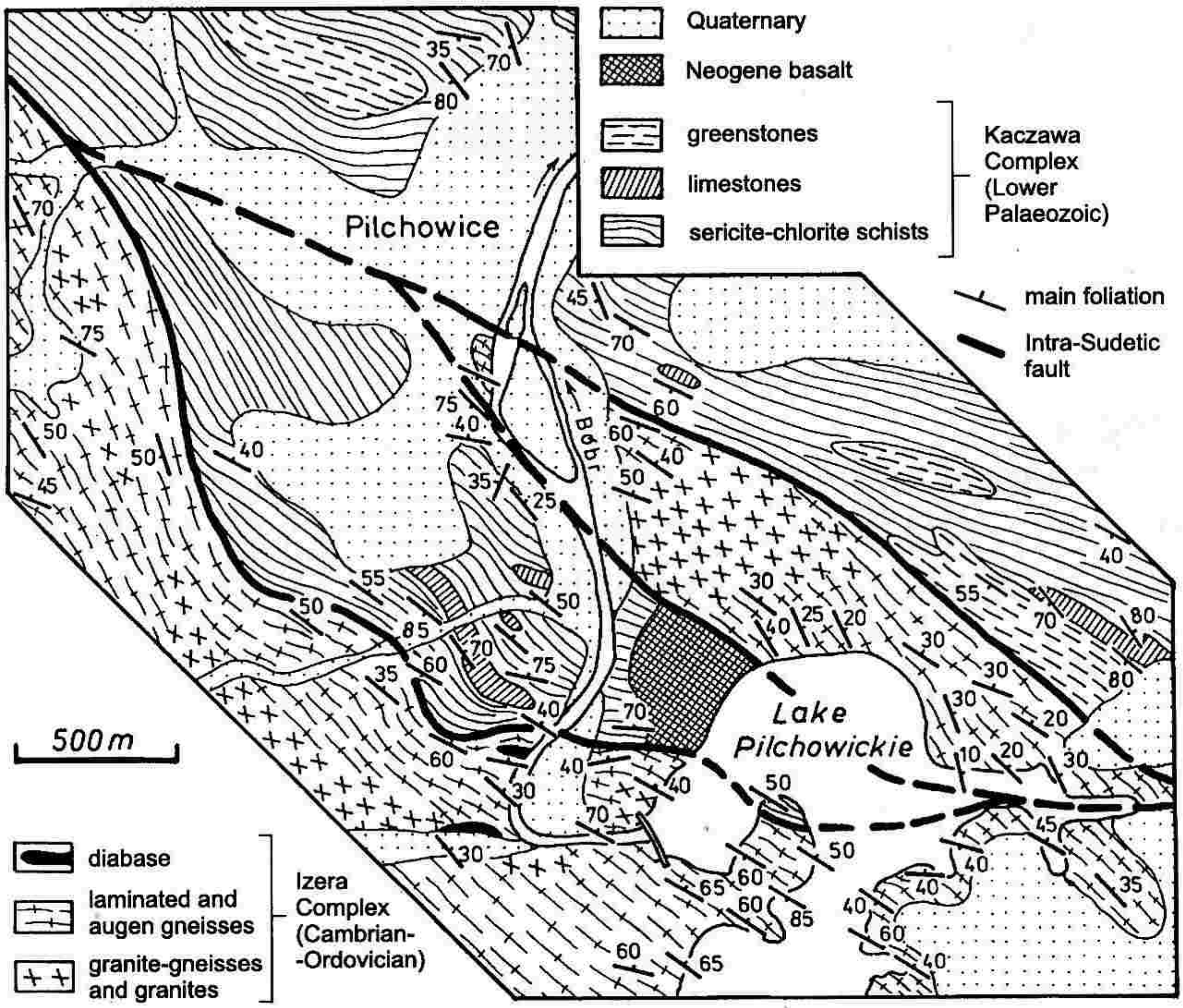

Fig. 7. Geology of Pilchowice interpreted in terms of sinistral strike-slip duplex at the transition zone between the Kaczawa and Izera metamorphic units (based on unpubl. data of Baranowski 1967, Geol. Map of the Sudetes 1 : 25 000, and author's own materials).

A relatively well exposed profile, ca. 500 m long, can be traced downstream the river Bóbr, starting from the bend of the valley 400 m below the dam. Along the left (western) slope of the valley, first the Izera granites and granite-gneisses are exposed, followed by the fault zone and phyllites of the Kaczawa Unit occurring within a horse within a map-scale left-lateral strike-slip duplex. In both metamorphic complexes the main foliation strikes WNW-ESE and dips steeply to NNE. The foliation displays stretching lineation which plunges to WNW or ESE at shallow angles. The rocks show a range of kinematic indicators developed in ductile and semi-brittle to brittle conditions (asymmetric pressure shadows, winged feldspars, mica fishes, quartz *c*-axes patterns, shear bands, bookshelf sliding of fractured porphyroclasts etc.) which point to both sinistral (at both ductile and brittle conditions) and dextral (at ductile to semi-brittle conditions) sense of the shear which occurred in the proximity of the Intra-Sudetic fault zone.

The boundary zone between the Early Palaeozoic Kaczawa phyllite/greenschist unit to the north and the Izera gneisses/granites to the south in the vicinities of Pilchowice has been the subject of a lively debate in the literature since 1920's (see e.g. Smulikowski 1974, Aleksandrowski and Żaba 1995). The structural interpretation presented here is based on a new structural study (Aleksandrowski and Żaba 1995, Aleksandrowski et al. 1997). Effects of three main deformational events have been recorded in both structural units adjacent to the Intra-Sudetic fault near Pilchowice. The oldest event D_1 (probably Late Devonian in age) resulted in a penetrative, ductile, sinistral shear fabric in the Góry Izerskie gneisses. Its present-day orientation was achieved through later reorientation of originally SE-dipping foliation, related to regional, NW-directed thrusting (Mazur 1995). The reorientation occurred on the northern slope of a domal structure which grew above the Karkonosze granite intrusion during the Visean (Aleksandrowski et al. 1997). This was post-dated by an important strike-slip dextral displacement (event D_2 - Early Carboniferous) on the Intra-Sudetic fault, which produced prominent pervasive *s-c* fabric in the Góry Kaczawskie phyllites and ductile to semi-brittle, localised shear zones in the Góry Izerskie gneisses, superimposed on the older, sinistrally oriented fabric. The subsequent sinistral movement of the event D_3 (Late Carboniferous ?) brought about sporadic semi-brittle mesoscopic structures in both gneisses and phyllites as well as a map-scale strike-slip duplex on the Góry Izerskie/Kaczawskie boundary.

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INTRODUCTION TO THE FIELD TRIP (SECOND DAY)
An Outline of the East Krkonoše Mts. Crystalline Sequence Geology

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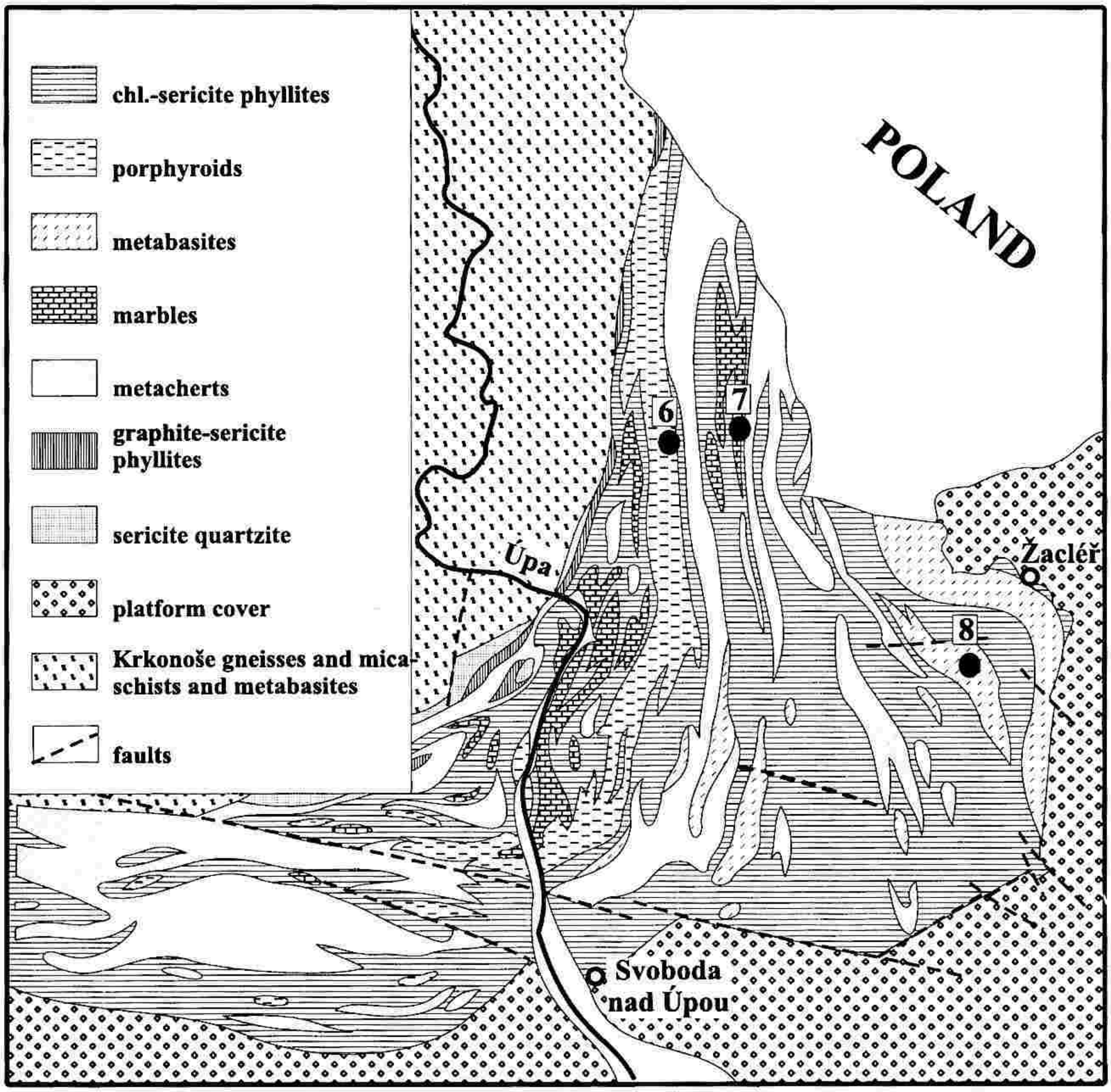

Fig. 1. Simplified geologic map of the Rýchory Mts.

The W Sudetes, constituting the NE margin of the Bohemian Massif ([13]), are a heterogeneous region composed of Proterozoic and Palaeozoic sequences affected by Cadomian and Variscan metamorphism and intruded by plutons of Cadomian and Variscan granitoids. It consists of several major units (possibly accreted terranes) which have distinct Cambrian to Carboniferous histories; their distribution and histories have been variously interpreted ([8]). The most significant magmatic and tectonometamorphic events took place along their margins ([6]; [5]; [11]; [12]; [7])

The low-to medium-grade metamorphosed Cambrian (?/Ordovician) to Early Carboniferous sequences are exposed in minor units surrounding the Krkonoše-Jizera crystalline unit from the E and S: in the East Krkonoše Mts. (i.e. the Rudawy Janowickie, Lasocki Ridge, and Rýchory Mts.), Železný Brod region, and Ještěd Mts. (Chaloupský et al. 1989). (Meta)sediments are palaeontologically dated in the Poniklá-Železný Brod region - to the Late Ordovician and Silurian (and possibly Devonian?) ([4]) - and in the Ještěd Mts. - to the Devonian and Early Carboniferous. Volcanic activity starting around the Cambrian/Ordovician boundary is indicated by U-Pb zircon age 505±5 Ma from boudins of felsic volcanic rocks of the Rudawy Janowickie Mts. ([10]) and by Rb-Sr whole rock age 501±8 Ma from bimodal volcanic suite of the Rýchory Mts. ([1]; [12]).

The onset of tectonometamorphic development of the East Krkonoše Mts. and Železný Brod crystalline sequences is identified with the oldest Variscan (Middle to Late Devonian) phases presumed in the W Sudetes ([2]; [4]). This statement is supported by U-Pb zircon and monazite as well as Rb-Sr biotite ages from non-mylonitised gneisses of the Góry Sowie Mts., ranging between 380 and 360 Ma ([14]), and Early Variscan (ca. 360 Ma) ^{39}Ar-^{40}Ar data measured on phengites from the blueschist facies metabasites of the Rýchory Mts. ([7]). The PT range of the blueschist metamorphism was T = 300°-500°C and P = 0.7-1.0 GPa ([11]). Cháb and Vrána (1979), Guiraud and Burg (1984), Narebski et al. (1986), Patočka et al. (1996) and Maluski and Patočka (1997) suggested a possible relationship of the HP-LT metamorphism in the W Sudetes to the Variscan collision of continental plates associated with subduction of a hypothetical oceanic lithosphere. However, the principal stage of Variscan orogeny in the whole Krkonoše-Jizera unit is dated to the Sudetic phase (late Viséan) ([4]); widespread HT-LP metamorphism is related to this event.

The East Krkonoše crystalline sequence (EKCS) is showing a considerable diversity in the petrography of primary rocks and in their metamorphic grade (Fig 1). The volcano-sedimentary complex forming the bulk of the EKCS S part (the Rýchory Mts.) consists of a felsic rock dominated bimodal metavolcanic suite (porphyroids and greenschists, greenstones, Stop 6) and a sequence of metasediments (phyllites, quartzites, marbles and metacherts, Stop 7). The large bodies of greenschist facies retrogressed mafic blueschists are exposed in the E part of the Rýchory Mts., (Stop 8). Amphibolites of a varied composition and related greenschists to greenstones are principal constituents of the EKCS N parts (the Lasocki Range and Rudawy Janowickie Mts.). The age of the EKCS is generally considered to be Early Palaeozoic (e.g [3]).

The EKCS is composed of strongly flattened rock bodies showing general trend SSW-NNE and dipping steeply, predominantly to E. The older generation fold axes plunge steep to E-SE, the younger ones (associated with prominent lineation) lie flat or plunge gently to NE ([3]).

In the EKCS four stages of regional metamorphism were recognised by Smulikowski (1995): (1) ocean floor related, amphibolite facies metamorphism; (2) blueschist facies, HP-greenschist facies and albite-epidote amphibolite facies (related to subduction?); (3) MP- to LP-greenschist facies accompanied by intense deformation; (4) contact metamorphism related to the Krkonoše-Jizera Pluton intrusion of the Late Viséan age. The metamorphic stages (2) and (3) may be identified with the HP-LT metamorphic event followed by the LP-HT overprint distinguished by Patočka et al. (1996) on the Rýchory Mts. mafic blueschists, and dated by ^{40}Ar-^{39}Ar geochronology at 360 and 340 Ma, respectively, by Maluski and Patočka (1997). The blueschist facies metamorphism of the EKCS PT conditions were 0.5-1.2 GPa and 300°-530°C ([11]).

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Stop 6
The Rýchory Mts. Felsic Rock-dominated Bimodal Metavolcanic Suite of the Cambrian/Ordovician Protolith Age - the Porphyroid Rock in the Dolní Albeřice Village

František PATOČKA

Location: Dolní Albeřice - Dolní Lysečiny, ca. 2 km NNE from Horní Maršov

A large porphyroid rock outcrop in the Dolní Albeřice Village is the best representative of felsic metavolcanic rock of the Rýchory Mts. crystalline sequence.

Most of the Rýchory Mts. is formed by a volcano-sedimentary group comprising a varied sequence of quartzites, phyllites (graphite-sericite types dominate), marbles, metacherts and metavolcanics, both felsic and mafic ones. Felsic metavolcanics, porphyroids (high-silica metarhyolites) (Fig. 2) are more abundant than mafic ones, represented by various types of greenschists (basalts, basic pyroclastics) (Chaloupský et al. 1989). The volcanism is dated close to the Cambrian/Ordovician boundary by a Rb-Sr WR age of 501±8 Ma (Bendl and Patočka 1995).

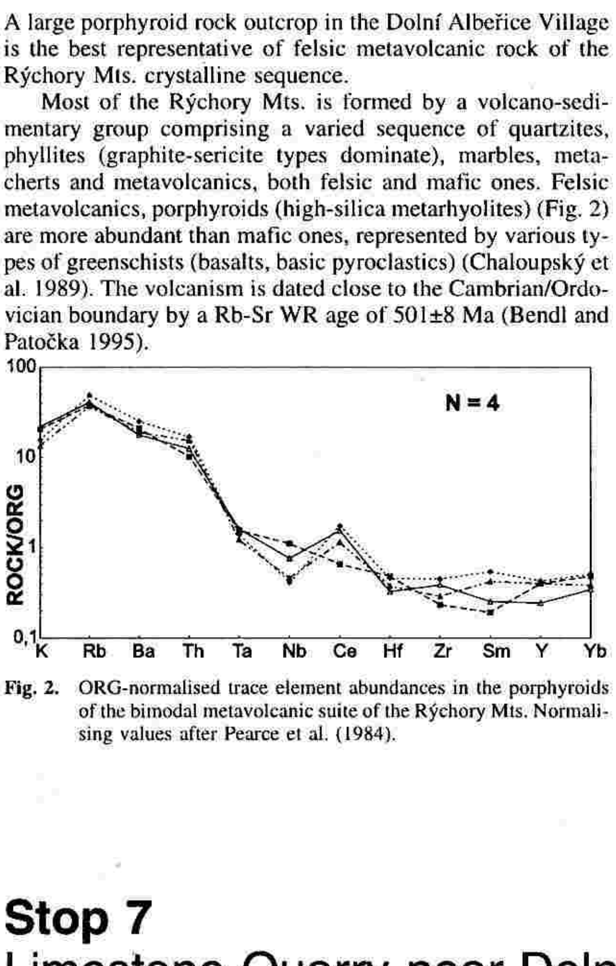

Fig. 2. ORG-normalised trace element abundances in the porphyroids of the bimodal metavolcanic suite of the Rýchory Mts. Normalising values after Pearce et al. (1984).

The trace element distribution patterns (mostly OIB-like) and Nd isotope signatures (E_{Nd500} = +3.1 to +6.6) of the greenschists indicate that their protolith origin can be related to progressive mantle upwelling associated with intracontinental rifting. A limited melting of an upwelling asthenosphere in the garnet stability field produced alkali basalts and enriched tholeiites which compositionally resembled OIBs (Patočka et al. 1997).

The Nd isotope compositions of the porphyroids and greenschists disprove a direct evolution of the rhyolites from associated mafic magma through closed-system fractionation. The values of $(^{87}Sr/^{86}Sr)_{500}$ = 0.706 and E_{Nd500} = -5±1 of the porphyroids suggest that their protolith contained a major continental crust component, reflecting either pure crustal melting of reservoirs with low Sm/Nd and moderate Rb/Sr ratios, or substantial incorporation of crustal melt during differentiation from mantle magmas (via AFC). In either case the mantle melts provided the thermal energy for partial melting at continental crust (Bendl and Patočka 1995, Patočka et al. 1997).

The geochemistry of the Rýchory Mts. metavolcanics and their association with abundant terrigenous metasediments suggest a primary origin as a felsic-mafic volcanic suite generated in an evolved rift setting, with incipient continental break-up. These processes, ubiquitous in Western and Central Europe during the Early Palaeozoic (Pin 1990), are an evidence of large-scale fragmentation of the Gondwana supercontinent northern margin.

Stop 7
Limestone Quarry near Dolní Albeřice

Jindřich HLADIL

Location: Dolní Albeřice, 2 km NE from Horní Maršov, abandoned, two-level quarry exploited occasionally for road-metal and chippings for building industry

What to see: Boudines and lithons of ooidal dolostone alternate strongly metamorphosed limestone. Seams between the both rocks are steep faults dipping at 290/60, 300/70, or 330/75. A slightly inclined thrust fault (75/35) cuts the entire structure in uppermost part of the quarry; the overlying rock is phyllonite. Its foliation is subparallel to the thrust plane, locally with kink folds, shear and crenulated cleavage. Therefore the grouping-and-slicing of carbonates must be older than cutting by phyllonites.

Ooidal dolomites with high content of calcite are massive rocks resistant to breakage; they are light grey with ecru or pinkish colour hue. The dolomitised ooids are recognisable even on the weathered surface. This is the best preserved variety. CL-microscopy allowed differentiation of three dolomite generations, which originated during early diagenesis, burial and deep burial history of the rock (up to saddle dolomite). Although relicts of old cement generations are involved, neomorphic HL-LMC calcite dominates. It consumes the dolomite and marks the uplift episodes. Besides this best preserved variety, we can find also cacao-brown dolomite, sugar-white silicified variety or foliated dolomite. Entirely silicified rocks or mica-smectite enriched varieties are not exceptional. All these rocks were formerly ooidal and experienced similar burial, low metamorphic and exhumation episodes.

Foliated crystalline limestone (marble) surrounds or alternates the oo-rocks. Tremolite was interpreted as remaining mineral from albite-epidote amphibolite conditions. The presence of garnet in other samples suggests even higher p-T conditions (V. Kachlík, unpublished message). CL investigation of the rocks showed relicts of dolo-calcite mosaics typical for the latter conditions. Older relics from times of burial and progressive metamorphosis are badly preserved, but inherited structures slightly reflect some floatstone platform carbonates (grey or dark grey) as well as superimposed progressive metamorphic crystallisation. Younger features documents retrograde metamorphosis (consummation of dolo-calcite mosaic or superimposed calcite fabrics). Most of the magnesium was evacuated during shallowing and retrograde and the new calcite aggregates exported silicates to seams and lamellae. Obviously, the crystal size was reduced and degradation continued to MP/LP-LT fluids-reduced and stress-dominated conditions (tectonomicrite and crushed crystals).

Relationship between oo-rocks and "marbles": The oo-rocks experienced medium to deep burial episodes, ranging in estimates between 5 and 12 kilometres (generations of dolomite). The "marbles" were affected by steep progressive metamorphosis (dolo-calcite mosaics, garnet). Later, the "marbles" were released to shallower positions (retrogressive calcite mosaics). Separate metamorphic history of the both rocks was joined once during the retrogressive events. The oo-rocks were split and embedded along the faults into the "marbles". Local presence of foliated contacts and, especially, the bending round the boudins (Fig. 4). suggest that this embedding passed out somewhere in lower part of brittle zone. However, both groups of carbonate rocks were affected by hydrothermal veins and metasomatism, which amalgamated the contacts.

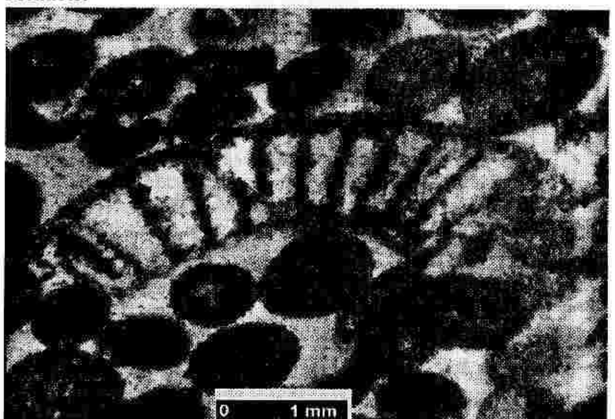

Fig. 3. Polished section of ooidal carbonate (the most common Type 1.) Reflected white light, inverted scale of grey. A very good preserved piece of rock shows part of a fossil (? Receptaculites guilinensis) and numerous ooids.

Age and events: Age of the carbonate sediments is slightly indicated by time-specific occurrence, fossils and isotopes. Wide-spread grey lagoonal floatstones (precursor of "marble") usually mark Givetian. Massive occurrence of ooidal tidalites usually indicates Late Famennian or Early Tournaisian sea-level depressions ("oo-rocks"). The ooidal rocks contains fossils (?Receptaculites guilinensis = Middle/Late Famennian (Fig. 3) ?chips of bivalvs and trilobites). "Marbles" did not provide good fossils, although occurrence of badly preserved shadows after laminated coral-stromatoporoid fossils could be considered. Derived curve of hypothetical Sr composition (oo-rocks) cut the curve for Palaeozoic marine carbonates in three points, two of them are in Famennian. To conclude, the "marbles" were formerly ?Givetian sediments (?370-380 Ma) but au-rocks were formerly ?Famennian sediments (?355-365 Ma).

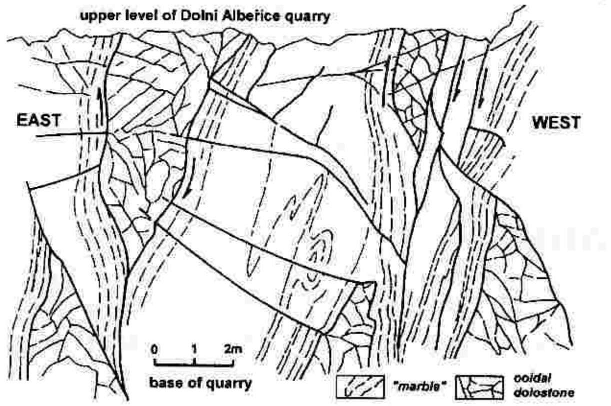

Fig. 4. Southerly view on the rock face of quarry. Lower level, north of the Dolní Albeřice quarry.

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Stop 8
The Rýchory Mts. Early Variscan Mafic Blueschists in the Sněžný Potok Creek Valley

František PATOČKA

Location: Sněžný potok Creek Valley, 1.5 km to WSW from Žacléř

The mafic blueschists are exposed in the Sněžný potok Creek Valley both as large (X0 m) outcrops and boulders in the creek-bed. Several bodies of these metabasites, generally elongated in direction NNW-SSE, occur in the eastern part of the Rýchory Mts. crystalline sequence (e.g. Chaloupský et al. 1989). As to the lithostratigraphic and tectonic position, they seem to be the southern promontory of the Leszczyniec Volcanic Fm. main body which is situated further north on the territory of Poland (Kryza et al. 1995, Patočka and Smulikowski 1997).

The mafic blueschists are composed of Na-amphibole (glaucophane, ferroglaucophane and crossite), epidote, albite, quartz, chlorite, phengite and rare garnet. Rectangular muscovite-epidote aggregates are interpreted as pseudomorphs replacing lawsonite. Two main metamorphic events affected the metabasites. In an earlier HP-LT metamorphic event the rocks experienced blueschist facies metamorphism. The HP-LT metamorphism was followed by a greenschist facies overprint (Patočka et al. 1996). The results of the ^{40}Ar-^{39}Ar geochronology on phengites from the Rýchory Mts. mafic blueschists (Fig. 5) date the end of the earlier metamorphism to 360 Ma. Around 340 Ma greenschist metamorphic event followed. The metabasite geochemistry (namely trace element and REE abundances) indicate that the protolith was comparable in composition with (1) N- to P-type MORBs and (2) tholeiitic and transitional WPBs (Maluski & Patočka 1997) (Fig. 6).

The elongated bodies of mafic metavolcanics are situated within the prominent N-S oriented Leszczyniec shear zone following the Rýchory Mts. and Rudawy Janowickie Mts. Both the geochemical affinities and the blueschist facies metamorphism of the metabasites suggest that this shear zone evolved from the Variscan suture dividing western and central terranes of the West Sudetes along which oceanic lithosphere was subducted (Narebski 1994; Cymerman et al. 1997). According to the radiometric age of the HP-LT metamorphism termination, the terranes accreted in Famennian.

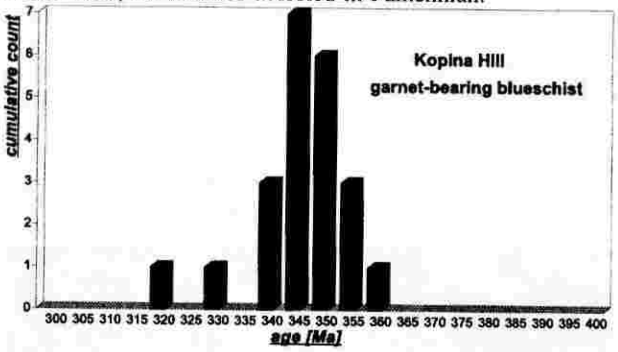

Fig. 5. Histogram of ^{40}Ar-^{39}Ar ages resulting from series of direct fusions by a laser beam, performed on single large grain of phengite (sample of the garnet-bearing mafic blueschist from the Kopina Hill, Poland) (Maluski and Patočka 1997).

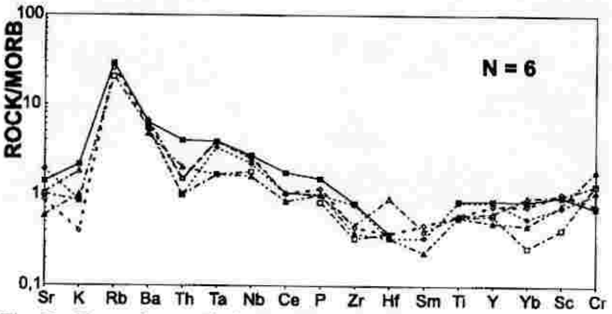

Fig. 6. Trace element (including K) compositions of the Rýchory Mts. mafic blueschists normalised by MORB composition after Pearce (1982).