DESCRIPTION OF LOCALITIES

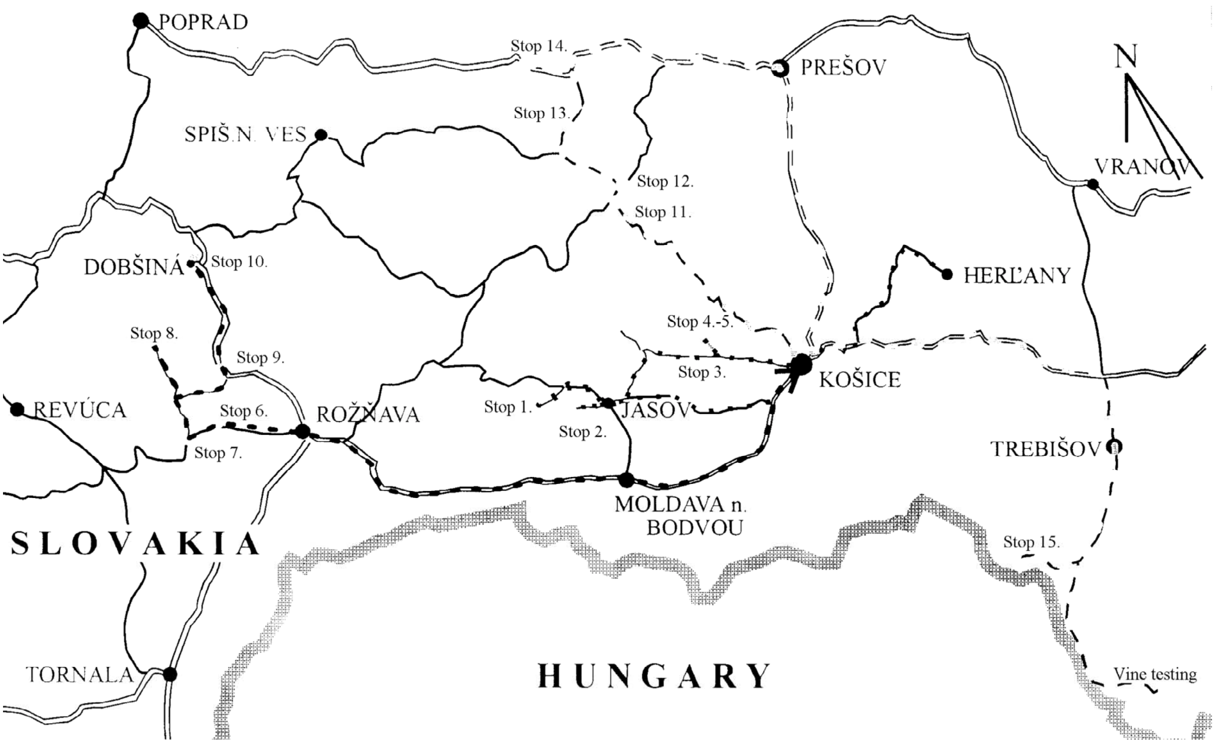
Meliata Unit

Gemericum

Southern margin of the Veporicum

Čierna Hora and Branisko

Zemplín Unit



Stop 1. Šugov Valley -Meliata unit-blueschists

S.W. Faryad

- *Location: Sheet no 37-41: Road from Košice to Medzev, 1 km before Medzev turn left and cross the railway. Continue the forest road towards the valley ca. 3 km and stop behind a small lake.*

This locality provides the best exposures of blueschists facies rocks of the Meliata unit. The most common rocks are white marbles with lenses and layers of metabasites and small amounts of phyllites. The metabasites, having transition to marble, are exposed both on the left and right sides of the Šugov valley. Relatively large exposure of metabasites and marble occur on the left slope, where σ- or δ-type clasts of primary lapilli of basaltic composition, mantled in carbonate matrix can be also observed. Besides blue amphibole of glaucophane composition, metabasites contain albite, epidote, phengite, titanite and rarely also garnet, paragonite and Na-pyroxene. At contact with marble, they may contain actinolite. Blue amphibole is zoned with purple-blue core rich in Fe^{3+} and pale-blue rim rich in Al. Na-pyroxene occurs in some coarse-grained unfoliated metabasites and it is mostly aegirine in composition. Maximum jadeite content found in pyroxene from this locality is 53 mol %. Garnet is strongly zoned with increase of almandine and decrease of spessartine contents from core to rim of grains (Alm_{25-62}, Mn_{47-8}, Ges_{21-23}, Py_{0-1}, Adr_{6-5}). Marbles and metabasites are rich in hematite, which usually forms small veins.

The marbles and metabasites with black phyllites in the bottom are called as Upper complex which tectonically overlies quartz phyllites of the Lower complex (next stop). The black phyllites have tectonic contact with marble and metabasites and exposed in stream bed of the valley. They are strongly mylonitized and consist of white micas, chlorite, quartz, chloritoid, graphitic mater and pseudomorphs after glaucophane. Some rectangular pseudomorphs, filled by white mica, appear to be after lawsonite. Strain shadows of the pseudomorphs are filled by quartz, white mica and chlorite. White mica in the matrix as well as in the pseudomorphs is phengite in composition. ^{40}Ar-^{39}Ar data from phengite in garnet-bearing metabasite from this locality gave 152 Ma age for blueschist facies metamorphism.

Stop 1a. Šugov valley – the base of the Bôrka nappe

A. Vozárová

Location: Šugov valley, ca. 200 m south from the last pool

Metapelites with intercalations of metasilstones and fine-grained metasandstones are lying below the huge complex of white marbles and glaucophanites. These metasediments are integral part of the Bôrka Nappe. They represent the basal part of the Bôrka Nappe rock complex in this area, which overthrusted the Permian sediments of the Gočaltovo Group. The stratigraphic proofs of this metasedimentary formation are unclear and insufficient. Formerly, based on the very poor and inaccurate palynological data, the stratigraphic age of this metasediments was considered as Upper Permian - Lower Triassic (Mello at al., 1983). The last geological data support the Middle Triassic – Jurassic age as the most probable (Mello et al., 1997).

The metapelite metamorphic mineral assemblage is quartz + muscovite + albite + paragonite, with small amount of pyrophyllite and chlorite. This assemblages is to be referred to the greenschist facies, as data on the illite crystallinity (sensu Kubler, 1968) indicate (Árkai & Kovács, 1986). The geobarometric estimations were based on the white mica $b_{331,060}$ values measured in 27 samples (Mazzoli et al., 1992). Two group of samples were considered from the area of the Šugov valley: paragonite-pyrophyllite-bearing and paragonite-pyrophyllite-free. The paragonite-pyrophyllite-bearing phyllites muscovite *b* values are around 9.009 °A. As regards the second group of samples, they present *b* values of 9.018 °A. Basing of this values, the average reflect medium to higher pressure conditions: T = 470°C and pressure about 10 Kb.

Stop 2. Jasov -Meliata unit quartz phyllites

S.W. Faryad

- *Location: Sheet no 37-23: From road Medzev – Košice turn to right in the Jasov Village (at curve) to left. Cross the railway and continue to the Teplica valley (for entering the valley permission should be obtained from the Forest office in Jasov). Continue the forest road along the valley to end.*

This locality is a junction of three different metamorphic units: 1) unmetamorphosed carbonatic rocks of the Triassic Silica nappe form a huge cliff on left side of the valley, 2) low-grade high-to medium-pressure phyllites of the Permian Gočaltovo Group (Lower complex – Jasov Formation) occur along the stream bed and 3) early Paleozoic greenschist facies rocks of the Gemericum are partly exposed on the right side of the valley. Relatively well exposures of quartz phyllites (metapsammites and metaconglomerates) of the Gočaltovo Group occur at end of the Valley, mainly on the right side. Preserved sedimentary textures include bedding, laminations and small pebbles, usually of quartz, in metaconglomerates. Similar to phyllites, adjacent to marbles (Upper complex), they are foliated with penetrative cleavage. The quartz phyllites in small quarry and surrounding exposures consist mainly of quartz and white mica. Chloritoid-bearing phyllites are exposed on the top on the range. Chloritoid forms radial aggregates or small porphyroblasts and some chloritoid crystals may enclose rutile oriented parallel to the schistosity. It is partly replaced by chlorite and mixed-layer silicate. No glaucophane or garnet was observed, although some indications of pseudomorphs after garnet can be found. The only high-pressure mineral is phengite with Si = 3.3-3.5 a.f.u which associates with paragonite and chloritoid. ^{40}Ar-^{39}Ar data obtained from phengite in chloritoid-free phyllite gave 210 Ma with 90 Ma low-temperature overprint. P-T conditions of 0.8-1.0 GPa at 300-350 ^{o}C are estimated for quartz phyllites.

Stop 2b. Jasov- the Permian Jasov Formation

A. Vozárová

- *Location: Sheet no 37-23: West from Jasova in the Teplica Valley. Outcrop on the forest way, 350 m WJW from altitude. 317.0*

The Lower Permian age of the Jasov Formation has not been demonstrated biostratigraphically, but only determined through regional correlation with underlying Lower Permian deposits of the Southern Gemeric Unit, a part of which was classified on the basis of palynological data (Planderová, 1980). The dominant rock types in the Jasov Formation are coarse-grained metasandstones with intercalations of oligomictic metaconglomerates and metapelites in the uppermost part. A characteristic feature of the Jasov Formation is distinct decrease upwards of the grain-size. Small amounts of metarhyolites and rhyolitic metatuffs are associated with the coarse-grained metasediments. The metasediments show a distinct foliation strongly influenced by the different compositional layer. In massive rocks, such as originally conglomerates and coarse-grained sandstones, a spaced foliation is developed. Cleavage is discontinuous, due to the patchy distribution of oriented phyllosilicates which are bound to or wrap the coarser grains. A lineation can be observed on the foliation planes, and consists of preferred orientation of prismatic grains or polycrastalline aggregates. Common structural lineation is defined by trails of micro-boudins. The main foliation cross-cuts the older one, that can be recognised as limbs of symmetric and asymmetric microfolds related to a crenulation cleavage.

The following metamorphic mineral assemblages have been recognised in metasediments: muscovite + paragonite + albite; chloritoid + chlorite + muscovite + paragonite. Quartz, pyrophyllite, graphite and minor rutile and sphene are common additional phases. Radial aggregates of the postkinematic chloritoid occur in the Al-richer metapelites. Unfortunatelly all the metapelite samples from the Jasov Formation area turned out to be paragonite-pyrophyllite-bearing. This fact means that these Permian metapelites are not suitable for geobarometric purposes, according to Sassi (1972) and Sassi & Scolari (1974). In fact, Mazzoli et al. (1992) observed, that the muscovite *b* values range around 9.006 °A. This average value is certainly lower than those found in the high-pressure metamorphic area, but still is in the *b* range of the intermediate-pressure metamorphism (Sassi et al., 1976; Guidotti & Sassi, 1986). Recalling that systematically lower *b* values are obtained from the paragonite-pyrophyllite-bearing metapelites (Gomez-Pugnaire et al., 1978; Sassi & Vozárová, 1987), the above value certainly reflects a relatively high pressure within the range of the intermediate-pressure metamorphisms.

Stop 3. Hýľov – Early Paleozoic metavolcanites of the Gemericum

S.W. Faryad

- *Location: Sheet no 37-24: Road from Zlatá Idka-Košice, road cut near dam, ca. 1 km before Hýľov village*

Metavolcanites of rhyodacite composition (usually called as porphyroids) are a part of the early Paleozoic Gelnica unit which is dominant by phyllites and metamorphosed acidic- to intermediate volcanic rocks. The metavolcanic rocks originated mostly from tuff, pyroclastic and rarely lavas. In the Hýľov locality, metadacite occur which are characterized by the presence of relic phenocrysts of plagioclase, rarely also K-feldspar (up to 1.5 cm in size). The fine-grained matrix consists of quartz, white mica, chlorite with small or accessory amounts of epidote, titanite, biotite, zircon and apatite. The rocks are foliated in a different degree and the strongly foliated varieties are usually fine-grained. Phenocrysts of plagioclase are replaced by albite, phengite and may contain also epidote. Maximum Si content in analysed phengite is 3.33 a.f.u. P-T conditions estimated for the assemblage K-feldspar-chlorite-phengite-biotite are 350 °C at 0.5 GPa

Stop 4. Klátov - early Paleozoic greenschist Rakovec unit

S.W. Faryad

- *Location: Sheet no 37-24, Road from Hýľov to Klátov (road cut on the right side, 100 m before coming to Klátov)*

This locality as well as the next one provide a good opportunity to see difference in metamorphic grade between the early Paleozoic Rakovec unit, which is metamorphosed in greenschist facies conditions and tectonically overlying amphibolite facies rocks. The Rakovec unit is mostly represented by phyllites and metabasites. The metabasites exposed at Klátov are strongly mylonitized and consist of albite, chlorite, epidote and relic actinolite. The mineral assemblages with actinolite which usually occur in metagabbro and metadolerite is characteristic for the whole ca 70 km long greenschist belt of the Rakovec unit. Only at the type locality "Rakovec" some metabasalts contain taramite. Temperature, calculated using thermometry of Triboulet (1992) for actinolite bearing assemblages are about 330-360 °C.

Phyllitic rocks contain quartz, white mica, chlorite and albite. Pseudomorphs after biotite and garnet were found in some quartz phyllites from shear zones adjacent to amphibolites.

Stop 5. Klátov - Early Paleozoic amphibolite facies rocks
S.W. Faryad and J. Spišiak

- *Location: Sheet no 37-24: Coming to Klátov turn right, follow the road till farm. Stop bus and walk ca. 300 m NW to the amphibolite quarry.*

Amphibolites in the quarry as well as partly exposed on surface are a part of the so-called gneiss-amphibolite complex (Dianiška and Grecula, 1979, Faryad, 1990) or Klátov nappe (Hovorka et al., 1984). This tectonic unit which overthrusts the greenschist facies Rakovec unit along its eastern and northern boundary, consists of gneisses and amphibolites with small amount of serpentinites in its lower part (Fig. 21). Amphibolites are mostly fine- (1-2 mm), locally medium-grained (3 mm) rocks with schistose fabrics. Besides massive variety, some banded amphibolites with few mm thick bands formed by plagioclase are also present. Porphyroblastic types with plagioclase (up to 5 mm, in places 7 mm) and garnet (3-5 mm - 7 mm) are abundant. Up to 1 m thick layer of carbonate rocks were also found in amphibolites. The amphibolite consists of magnesiohornblende, edenite, plagioclase (to An_{32}) quartz and titanite. Epidote, actinolite and chlorite are common in some retrograde or mylonitized varieties.

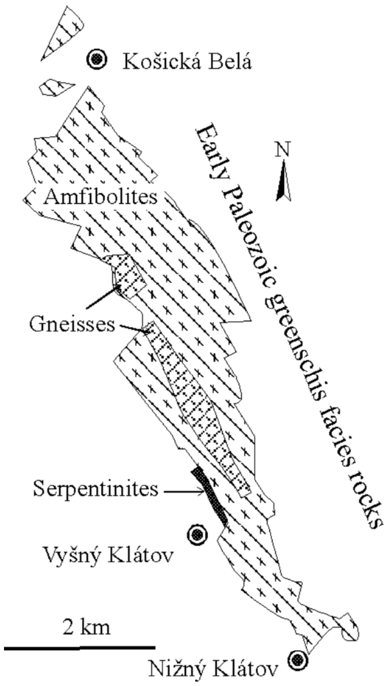


Fig. 21. Schematized geological map of the gneiss-amphibolite complex (Klátov nappe) at Klátov (Dianiška and Grecula, 1979).

Gneisses are rich in plagioclase and they may also contain biotite, garnet, magnesiohornblende, cummingtonite. P-T conditions calculated for amphibolites and gneisses from different localities are 500-700 °C and 0.5-1.0 GPa. Mylonitization and some retrograde reactions in amphibolite and in gneisses are mostly referred to Alpine overprint. Besides epidote, chlorite, white mica and albite, the younger metamorphic mineral is also Ca-rich garnet which rims amphibolite facies garnet. The gneisses and amphibolites are lithologically comparable with that in Rudník which suffered Alpine blueschist facies metamorphism (Faryad, 1988).

Ultramafic rocks adjacent amphibolites consist mainly of antigorite with small amounts of tremolite, Mg-chlorite, talc and relics of brown spinel. This phase is only one, which represent remnant of the original mineral assemblage. Based on the presence of spinel as well as on chemical composition, the antigorite serpentinites and listvenites were derived from spinel peridotites.

2nd Day:

Stop 6. Honce - Blueschists facie rocks, Meliata Unit
P.Ivan and S.W. Faryad

- *Location: Sheet no 37-32: cca 1.3 km SW from the Honce village, small valley, in front of the Gerlašská skala hill.*

Two small bodies of metabasalts (up to tens meters in size) are exposed on the NE and SW side of the valley. They associate with white marble and phyllites which also underwent blueschist facies metamorphism. Following Mello et al. (1996) the blueschist facies rocks and nearby Triassic dark gray limestones represent a block in the Jurassic olistostrome of the Meliata Unit. Matrix of the olistostrome consists of dark gray to black sandstones, shales and small amount of radiolarites.

The metabasalt body exposed on SW side of valley reminds pillow lava structure and it is crossed by veins of calcite and rarely of epidote. The metabasalt on the NE side of the valley is characterized by the presence of well preserved variolitic, intersertal or ophitic textures. Metabasalts with variolitic and intersertal textures contain sporadic skeletal phenocrysts of igneous plagioclase, clinopyroxene and olivine. The ophitic variety may contain clinopyroxene which is partly replaced by sodic pyroxene. Metamorphic mineral in both metabasalt bodies are glaucophane, titanite and accessory chlorite and epidote. Regarding textures and geochemical compositions (N-MORB; Ivan, 1996), the metabasalts are comparable with very low-grade and unmetamorphosed basalts from Dobšinská Ľadová Jaskyňa and Jaklovce that also belong to the Meliata Unit.

Phyllitic rocks from this locality correspond to metapelites and metapsammites. Some fine- grained pelitic rocks contain lithoclasts of relatively coarse- grained quartz rich varieties. Metamorphic minerals in phyllites are Si-rich phengite, chloritoid and pseudomorphs columnar grains (glaucophane ?) formed by white mica, chlorite and mixed layer phyllosilicates. Chloritoid and pseudomorphs are present both in the matrix and lithoclasts.

Stop 7. Štítnik - Metabasalts of CAB type, Meliata Unit (Bôrka Nappe), Nižná Slaná Formation
P. Ivan.

- *Location: Sheet no 7-32: cca 1km NE from the settlement Maša, in the valley of small left tributary of the Štítnik brook*

Metamorphosed basic rocks of this locality differ from all previously visited blueschists of the Bôrka Nappe in geodynamic setting, lithology, metamorphic evolution and probably also in age. In the geological maps (Bajaník et al., 1984; Mello et al. 1996) they were marked as chlorite-sericite phyllites with intercalations of crystalline limestones and metabasic rocks (mostly metatuffites) Triassic in age. Based on our studies the multistage metamorphosed basic rocks together with variable types of phyllites represent an individual lithostratigraphic unit preliminary designated the Nižná Slaná Formation (Ivan and Kronome, in prep.). In the Bôrka Nappe regarded in our concept as nappe pile, Nižná Slaná Fm. forms individual tectonic subunit - nappe or slice.

Metamorphosed basic rocks are exposed at this locality as cca 150 m long range of small cliffs and debris fields. There are three main petrographic types of rocks: (1) massive, medium grained green or blue-green metabasic rocks, (2) green or blue-green metabasic rocks with slight to strong oriented fabric containing small yellow spots or lenses and rarely also (3) green and yellow spotted coarse grained metabasic rocks. Massive rock type is composed of haphazard oriented aggregate of long columnar bluish-green Ca-amphibole (edenite), epidote, less amount clinozoisite and also rutile rimmed concentrically by ilmenite and titanite. Ca-amphibole is locally replaced by pale coloured Na-amphibole. Rock type with observable macroscopic spots contains in the same type of the aggregate some rectangle- or lens-shaped areas formed by clinozoisite, less epidote, amphibole or white mica, which were probably created at the expense of plagioclase phenocrysts. The same areas together with coarse-grained amphibole blasts compose the third rock type - spotted coarse grained metabasic rocks.

Protolith of all above mentioned rocks was predominantly porphyric basalts, in less amount also coarse-grained gabbroic rocks. They are geochemically close to calc-alkaline basalts (Ivan, 1996) and Paleozoic in age as follows from preliminary data on their analogues from Zadielska dolina valley (Faryad and Henjes-Kunst, 1997). Metabasic rocks of this locality bear the record at least of two metamorphic events. The older metamorphic stage in the epidote amphibolite facies conditions is overprinted by younger one in the blueschist conditions.

Metabasalts at this locality are accompanied by metamorphosed volcaniclastic rocks (grey-green phyllites with amphibole porhyroblasts). This type of rock will be studied at one of the next localities (Stop No. 9).

Stop 7b. Slavoška – Bôrka Nappe
A. Vozárová

- *Location: Sheet no M-34-113: Old quarry on the west side of the Hankovský creek valley ca. 1.100 m south from settlement of Slavoška*

The Bôrka Nappe outliers with medium/high pressure metamorphic rocks are extended in tectonic overlier of the Early and Late Paleozoic rock complexes of the Southern Gemeric Unit in the area of the Nižná Slaná Depression. In the frame of very complicated Alpine fabric the Bôrka Nappe overthrusts Early Palaeozoic Basement (Gelnica Terrane according to Vozárová & Vozár, 1996) with its sedimentary cover (the Lower Permian – Lower Triassic Gočaltovo Group) and it is overriden by the succession of higher nappes (the Turňa and Silica Nappes). In the area of the Nižná Slaná Depression, the whole sequence of the Bôrka Nappe consists of several lithostratigraphic units, showing very specific lithological features. Metapelites, metasandstones, metaconglomerates with less amounts of acid metavolcanoclastics are a part of the Jasov Formation.

Metarhyolites and their metavolcanoclastics mixed with small amount of metasandstones and metaconglomerates are the main components of the Bučina Formation. Both formations are very probably Permian in age, what is supported by similarity of their lithologic composition to the autochtonous south-Gemeric Permian deposits. The Dúbrava Formation as a part of the Hačava sequence, which are the most characteristic lithostratigraphic units of the Bôrka Nappe consist, from bottom to the top, of grey and yellow dolomites and rauhwackes, white marbles with some basic volcanoclastic intercalations, followed by a horizon of metabasalts, basaltic metavolcanoclastics associated with metapelites and a few fine-grained metasandstones.

Metamorphic mineral assemblages in metabasalts and metabasaltic tuffs:

As regards metamorphic evolution, two metamorphic stage have been recognised. The mineral assemblages listed below have been related to the older crystallisation stage: Gln + Chl + Ep + Ab + Ttn + Phn; Na–Px + Gln + Chl + Ep + Ttn + Phn; Gln + Ep + Chl + Ab + Act; in small quarry SW from village Slavoška mineral assemblages corresponding to the greenschist-blueschist transition can be recognised: they are represented by Chl + Ep + Ab + winchite. The younger metamorphic stage is recorded by the Act + Chl + Ep + Ab + Ttn.

Metamorphic mineral assemblages in metapelites:

The older stage of metamorphism is characterised by the $Cld_{(I.)}$ + Chl + Ab + Phn ± Pg and Grt + Ab + Phn ± Pg. A younger stage destabilised Gln, which was replaced by Chl + Qtz ± Ab. The Grt + Chl + Ms + Bt + Ab and $Cld_{(II.)}$ + Chl + Ms + Ab mineral assemblages crystallised in the matrix during the second stage.

Combining the chemical composition of the phases with microstructural reasoning in metabasites and metapelites, significant constraints were obtained on the PT conditions during metamorphism and on the PT path.

As concerns the ***older metamorphic stage***, mineral assemblages give hints on the possible phase-forming reactions, which give the following constraints for P and T conditions (Mazzoli & Vozárová, 1998).

-*Pressure*. The maximum jadeite content in pyroxene (35%Jd) suggests a minimum pressure 1.0 GPa at 500°C. As most of the glaucophane-bearing rocks are actinolite-free, most probably glaucophane producing reaction is Gln + Pg + H_2O = Qtz + Chl + Ab, which gives a minimum pressure of 1.3 GPa at 500°C.

-*Temperature*: The garnet-producing reaction is probabbly Gln+Qtz+Pg = Ab+Grt+H_2O, which gives the maximum temperature of 560°C for the metamorphic peak.

As concerns the ***younger metamorphic stage***, it must be referred to a lower pressure due to the presence of actinolite at the rims of glaucophane. The following reactions confine P and T for this stage:

-*Pressure.* Rection Czo + Gln + Qtz + H_2O = Chl + Ab + Act , which is probably the actinolite-producing reaction for these rocks, suggest a maximum pressure of 0,6 GPa for this matamorphic stage.

-*Temperature.* The presence of Act + Czo and absence of Pmp + Chl ± Prh, indicates that temperature exceeded 350°C during this stage. The T = 326±23°C, obtained using the geothermeter of Cathelineau (1988) based on the Al^{IV} content in chlorite, may represent a later re-equilibration stage.

These features are consistent with a scenario involving subduction of an oceanic crust followed by a rapid exhumation along an isothermal path (Mazzoli & Vozárová, 1998).

Stop 8.Hanková village - Alpine metamorphism and deformation of the Permian cover rocks, the Veporic unit

B. Lupták, M. Janák, D. Plašienka

- *Location: Sheet no 37-13: Defile across the "Lubeník line" with footwall Veporic and hangingwall Gemeric complexes will be presented here. Stop at the church in the centre of the village, then follow by foot a field road towards the north down the valley. Turn left upstream and follow abandoned forest road. Exposures are in the road cut.*

The first outcrop exposes Lower Paleozoic low-grade metasediments of the Gemericum, note the east-dipping shear bands ("ecc" and/or C'). In the footwall, the Veporic Permian metasediments exhibit similar fabric. The boundary fault is generally treated as the "Lubeník line", a thrust fault superposing the Gemericum over the Veporicum. However, here it is obviously a low-angle, east-dipping normal fault reactivating the original thrust contact (Fig. 25). The contact runs NNW-SSE and marks the eastern boundary of the Veporicum metamorphic dome, so forming an extensional ramp. In the "classic" SW-NE trending sector of the Lubeník line, the original thrust contact is overprinted by strong sinistral transpression, partly coeval with extensional unroofing of the Veporic core. Hence the succession of tectonic events should have been as follows:

(1) collisional stacking in the footwall of the Meliatic suture (latest Jurassic – earliest Cretaceous);

(2) thermal relaxation and metamorphism in the deeply burried Veporicum, its thermal softening (Early Cretaceous);

(3) continuing contraction, exhumation of the Veporicum by orogen-parallel extension with contemporaneous top-to-the-East low-angle normal faulting above and sinistral transpression along the SE margin of the exhumed domain (Late Cretaceous).

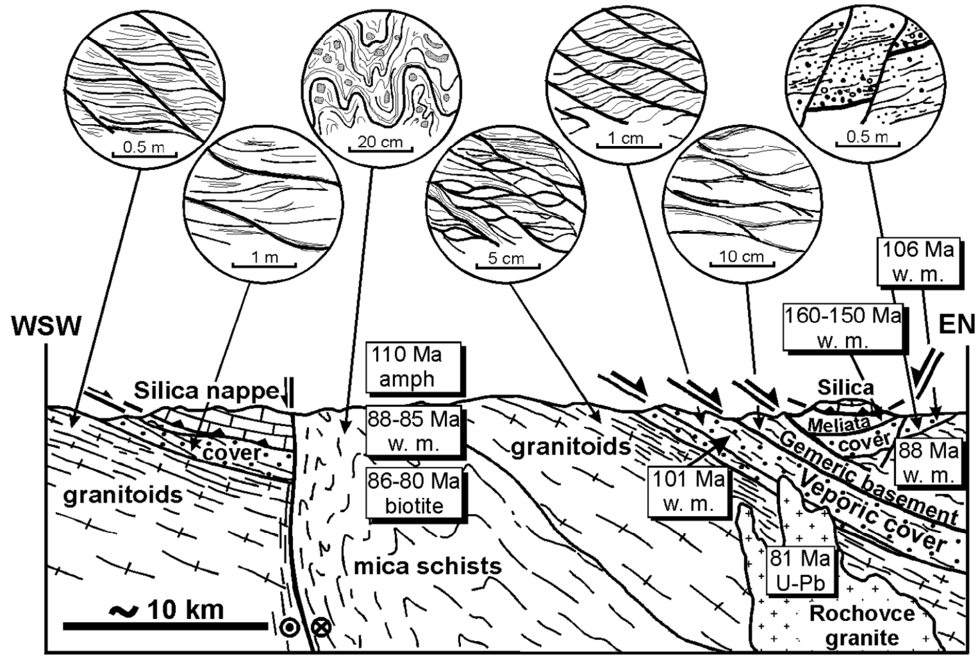


Fig. 25: Geological section across the Veporic core parallel to the regional trend of the stretching lineation. Dominant structures related to east-vergent unroofing and important Ar/Ar thermochronoligic data are shown. The Rochovce granite is dated by U-Pb method on zircons (Hraško et al., 1995).

Besides of metasandstones and metaconglomerates, the Permian sequence contains also Al-rich metapelitic layers, transformed to chloritoid- and kyanite-bearing schists. They are composed of chloritoid, kyanite, phengitic white mica, chlorite, quartz, rutile and ilmenite. In some cases, paragonite and margarite have been also identified among the white micas. Chloritoid porphyroblasts are aligned parallel to the Alpine (S_1) foliation, being often transposed into the extensional (C') shear-bands. Chloritoid composition shows increasing Mg/(Mg+Fe) ratios from the core to the rim, suggesting a prograde, continuous growth, as well as exchange reactions with chlorite. The intersections of chloritoid-kyanite-chlorite equilibria, calculated by the PTAX (updated version of Berman et al., 1987) and THERMOCALC (Holland and Powell, 1990) programs, yield the temperature conditions of 460–480°C at a pressure of 6–8 kbar. Relatively high pressure is also indicated by up to 6.5 Si p.f.u content in white mica, as well as the absence of biotite, consistent with petrogenetic grid of Droop and Harte (1995). On the other hand, according to the grid of Spear and Cheney (1989), coexisting chloritoid + biotite ought to be stable at high pressure. However, we considered the phengitic white mica rather than biotite to be stable at low-temperature and high-pressure conditions, as discussed also by Spear (1993). Reverse zoning of some chloritoid in contact with Fe-enriched chlorite indicates that continuous retrograde reaction between chloritoid and chlorite took place during cooling.

Stop 9. Nižná Slaná - Metamorphosed sedimentary and volcanic rocks, Meliata Unit, Nižná Slaná Formation

P. Ivan

- *Location: Sheet no 37:13: ca. 1 km SW from village, road-cut at the road No.587 Nižná Slaná - Roštár*

Phyllitic rocks exposed in the road-cut have been regarded as a part of Triassic rock complexes of the Bôrka Nappe (Bajaník et al., 1984; Madarás et al., 1995). Based on our results these rocks belong to the multi-stage metamorphosed Paleozoic volcano-sedimentary complex forming individual lithostratigraphic unit preliminary designated Nižná Slaná Formation. It represents also individual tectonic unit (nappe, slice) in the nappe pile recently referred to as Bôrka Nappe.

Metasedimentary and metavolcaniclastic rocks only are exposed along the profile in the road-cut. They are represented by variable petrographic types of phyllites alternating in detail (cm to dm), hardly discernable by naked eye. Most of them can be macroscopically described as black, bluish-black, gray-green or green mostly evenly surfaced phyllites. Small pinky spots of rutile as well as long-columnar amphibole crystals (up 2 cm long in greygreen sericite phyllites) are typical. There are many petrographic types of phyllites discernable under microscope which seem to be a variable mixture of originaly sedimentary and volcanogenic material (Ivan, 1996). Rocks with the prevailing sedimentary material are composed mainly of quartz, white mica, less amphibole and/or chlorite, Ti-minerals and black graphitic (?) pigment. Relic pelitic texture is preserved in the form of alternating of thin quartz- and mica-rich layers and detailed lamination formed by the black pigment. The admixture of the volcanic material displays by increase in amphibole and/or chlorite and Ti-minerals contents. Originally tuffaceous layers are composed of amphibole, albite, chlorite, clinozoisite, garnet, chlorite, biotite and Ti-minerals. The amphibole is prevailing component. Texture of such rock types is porphyroblastic - blasts are formed by garnet and in places also by amphibole. Garnet composition is $Alm_{56-70}Grs_{22-25}Prp_{5-8}Spess_{1-11}$.Amphiboles in all types of these rocks are represented by bluisch-green or green Ca-amphiboles (mostly edenite) and/or Na-amphibole (pale colored glaucophane).

The rocks of this locality underwent multi-staged metamorphic alteration. The older metamorphic stage in the epidote amphibolite facies conditions were overprinted by younger blueschist facies event and locally also by final greenschist facies event.

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Stop 10. Dobšiná brook valley - Veporicum

D. Plašienka and M. Janák

- *Location: Sheet no 37-13*: *Basement granitoids and Permotriassic cover complexes of the Veporicum with penetrative stretching fabric will be shown. Proceed from the Dobšiná town west upstream the Dobšinský potok brook, pass Vyšná Maša (Foederata) settlement and water reservoir and stop at the crossing with a subsidiary forest road branching left. Then follow this road by foot, outcrops occur in the forest road cuts.*

In the Dobšinský potok brook valley, there is the largest exposure of the otherwise poorly preserved metamorphic Permotriassic cover of the Southern Veporic basement – the Foederata unit which was given its name after the original German name of the near settlement Vyšná Maša by Rozlozsnik (1936). From the bottom to the top, the following rock complexes will be examined:

(1) two-mica porphyric Variscan granitoids of the Veporic basement, overlain by paraautochthonous Permomesozoic cover rocks;
(2) Upper Permian arcosic sandstones;
(3) Scythian quartzites and slates;
(4) Middle – Upper Triassic carbonate sequence;
(5) Paleozoic metavolcanosedimentary complex of the Veporic Markuška nappe;
(6) Upper Carboniferous micaceous sandstones, siltstones and conglomerates of the Gemeric nappe sheet.

All Veporic complexes are strongly affected by deformation fabric developed under the greenschist conditions. The Early Cretaceous stacking event (AD_0) is recorded probably only in the Foederata limestones by small-scale, north-verging asymmetrical folds which were strongly flattened and stretched parallel to axes later. The pervasive ductile mylonitic fabric AD_1 in basement granitoids and sedimentary cover nucleated in coaxial regime (vertical flattening and/or pure shear with W-E elongation, as revealed by only indistinctly asymmetrical porphyroclasts in mylonitic granitoids) during the peak P-T conditions (in excess of 8 kbar and 400 °C). Exhumation is recorded along the cooling path by more brittle structures (mostly shear bands) localised within low-angle noncoaxial shear zones with clear top-to-the-East kinematic indicators. Orogen-parallel unroofing was accompanied and followed by N-S contraction producing SW-NE trending sinistral transpressional zones (AD_2) and sometimes important northward thrusts juxtaposing rock units with different thermal and structural memories.

Variscan granitoids of the Vepor pluton are mostly sheared, forming augengneisses to ultramylonites, especially at the contact with the overlying cover rocks. Magmatic minerals were mostly recrystallized during Alpine metamorphism; the assemblages contain K-feldspar, albite, white mica, biotite, quartz, garnet and epidote. Phengitic white mica contains up to 6.7 Si p.f.u. which corresponds to pressures of 8–10 kbar at 450–550°C, according to the geobarometer of Massone and Schreyer (1987). Garnet is grossular-rich (50–60%), in some cases, the almandine (60–70%) and spessartine (25–30%) core (probably magmatic) is overgrown by a grossular rim that also contains inclusions of epidote. The origin of grossular-rich garnet in the Veporic metagranitoids has been attributed to the Alpine recrystallization (Vrána, 1966; 1980), or post-magmatic autometasomatism (Korikovskij et al., 1989a).

Scythian quartzites show pervasive mylonitic fabric with CPO pointing to basal <a> glide in quartz during a non-coaxial shear regime with top-to-the-East asymmetry. Calcite marbles, in spite of strong mesoscale deformation (intrafolial isoclinal folds), exhibit annealed granoblastic microfabric formed by static recrystallization during the temperature peak. Nevertheless, small-scale top-to-the-East shear bands with grain-size reducing clastomylonitic fabric are present, too.

3rd Day:

Stop 11. Jaklovce - Meliata unit
J. Spišiak and A. Biroň

- *Location: Sheet no 37-21: cca 150 m eastward from the monastery in the Jaklovce village, at a road cut*

In general, the Folkmár suture zone represents a Jurrassic melange with a block of Middle Triassic serpentinites, spilitized basalts, fuchsite-quartz-carbonate rocks (listvenites) and limestones. Original space relations of limestones and members of the ophiolite complex are difficult to reconstruct. Characteristic rock types are red pelagic limestones of the Anisian age occurring namely in the Jaklovce area (Kozur and Mock, 1985). Ladinian stage is represented by red ribbon radiolarites and red radiolarian shales. Such rock sequences, originally described from the Jaklovce village area (l.c.), are present along the whole Folkmar suture zone (Kozur and Mock, 1997). Along with typical ocean rock sequences of the Meliaticum also other types occur in the discussed geological unit. Among them Upper Triassic cherty limestones and namely Middle Jurassic deep water sediments, e.g. limestone breccias with belemnites and greenish through dark grey shales, and marly shales are characteristic. Slightly recrystallized limestones of Lower Anisian age, that originated during pre - rift stage are also present here. In several places reddish pelagic limestones fill numerous large fissures in the underlying crystalline limestones.

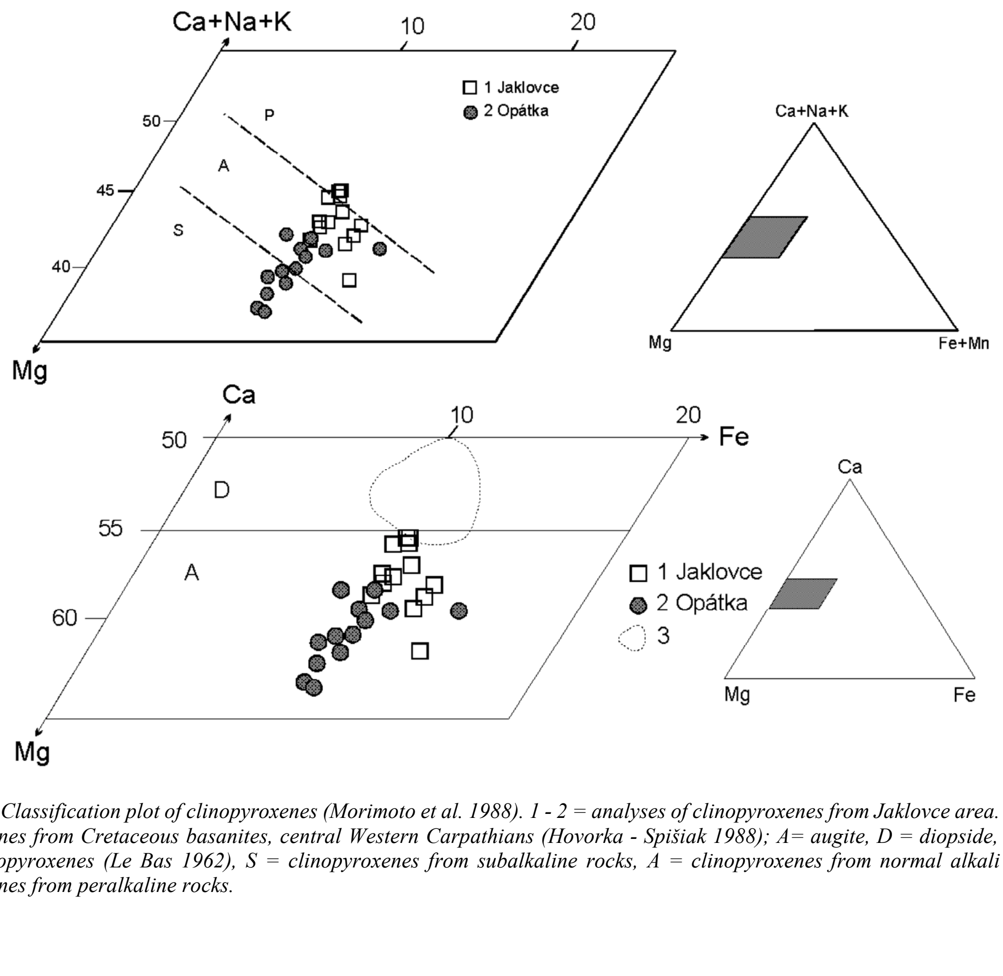

Fig. 22. a - Classification plot of clinopyroxenes (Morimoto et al. 1988). 1 - 2 = analyses of clinopyroxenes from Jaklovce area. 3 = field of clinopyroxenes from Cretaceous basanites, central Western Carpathians (Hovorka - Spišiak 1988); A= augite, D = diopside, b - Ternary plot of clinopyroxenes (Le Bas 1962), S = clinopyroxenes from subalkaline rocks, A = clinopyroxenes from normal alkali rocks, P = clinopyroxenes from peralkaline rocks.

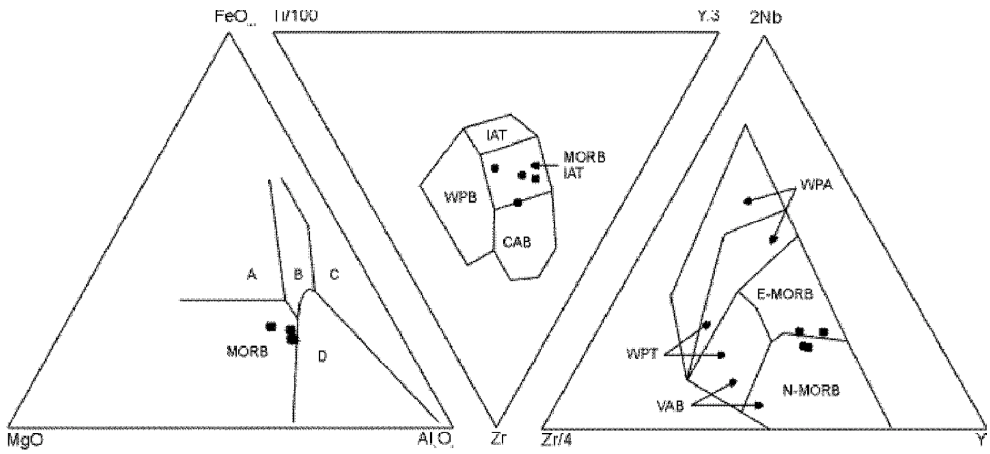

Fig. 23. Ternary diagrams for basalts from various tectonic setting a- FeO:MgO: Al2O3 (Pearce et al. 1977), b - Ti/100:Zr:Z.3 (Pearce and Cann 1973), c - 2Nb:Z:Zr/4 (Meschede 1986).

Based on the present data the evolution of the Meliata - Hallstatt ocean began in the upper part of the lower Anisian opening caused by collapse of the carbonate platform. The closing of this oceanic domain is documented to happen in the middle Oxfordian (Kozur 1991a, b). During the final phase of the Cimmerian development of the southern branch of the Meliaticum a subduction and the originating of blueschists (160-150 Ma, Maluski et al. 1993, Faryad and Henjes-Kunst 1997) are documented.

In only one place, i. e. 150 m eastward from a mansion in the Jaklovce village, at a road cut, tectonically intensively reworked pillows are observable. Within all the other known occurrences basalts have character of a massive block (olistoliths) in Middle Jurassic shales. The basalts from the Jaklovce development of the Meliata group are massive small-size-grained through macroscopically aphanitic types of dark-green through green-black colour. With some bodies, intensive tectonic crushing disintegrated the rock into sharply angular detritus. Local superimposed processes caused, above all, diffusion epidotization - in these cases, altered basalts show lighter colour shades.

The textures of the basalts of this geological position are predominantly massive. Rare local amygdaloidal textures (0.5, sporadically up to 1 mm) document a considerable height of the water column in the basin. Mineral composition of the basalts is simple. Among the abundant phases there are plagioclases, clinopyroxenes and volcanic glass (and/or products of its hydration). Magnetite/ilmenite is a typomorphic mineral in accessory amounts. Cpx are typical for oscillation and sector zonings (more rare). Oscillatory zoning is accompanied by inceasing TiO_2, Al_2O_3, FeO, MnO a Na_2O and/or decreasing SiO_2, MgO towards the rim. On the basis of Cpx classification (Fig. 22, Morimoto et al. 1988) they correspond to augites. The compositions of Cpx from the studied rocks and those from MORB are all similar. Detailed study of main and trace elements (incl. REE) quite clearly documents the affiliation of the studied basalts to MORB (Fig. 23, 24).

The age of the basalts can be well identified from the occurrence of Ladinian radiolarites which overlay over them, and/or locally they also occur between individual layers of basalts.

Owing to the other geological, stratigraphic and petrographic data it seems probable that these are not MORB basalts from typical mid-oceanic ridge, but MORB from back-arc basin (E-MORB), and/or basalts from incipient ocean ridge.

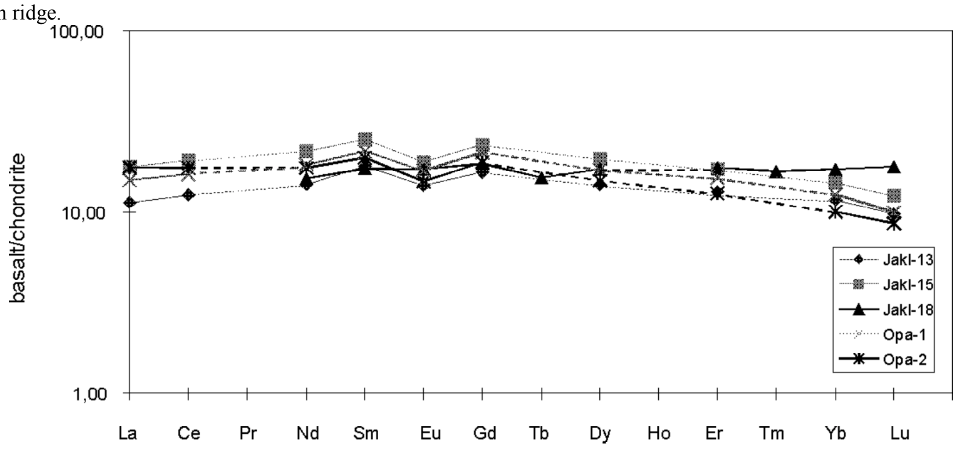

Fig. 24. REE pattern of the basalts normalized to chondrites (Taylor and McLennan 1985).

Stop 12. Margecany - Metamorphism and deformation of the Veporic basement rocks within Margecany shear zone (MSZ).
S. Jacko

- *Location: Sheet no 37-21 reversible road - cut on the Košice-Krompachy national road at the Margecany village church.*

At the road-cut between Margecany and Jaklovce villages three the Alpine megastructural units of the Western Carpathian Internides – i.e. the Veporicum unit, the Gemericum unit and the Jaklovce branch of the Meliatikum unit tectonically (from the bottom to the top) overlay each other.All the units have NW-SE direction a moderate dip to the SW and they are more or less intensively sheared within the MSZ of the same spatial orientation. Southeastern continuation of the units is modified by kinematically composite, steeply dipping Klenov fault of NE-SW strike.

Veporicum unit of the Čierna hora Mts. forms highly sheared, the Alpine fold structures of NW-SE direction. Their antiformal core consists of crystalline basement rocks, rimmed by Late Carboniferous, Permian and Early Triassic to Late Jurassic cover formations. They are locally overlain by Choč nappe klippes and surrounded by transgressive successions of the Inner Carpathian Paleogene and /or Eastern Slovakian Neogene basin infilling respectively.

The basement consists of three lithostratigraphical complexes (Jacko, 1985). The lowermost – the Lodina complex, forms the central- i. e. the axial part of the antiform. It is mainly composed of diaphtoritic gneisses (incl. phyllonites) subordinately intercalated by thin amphibolite bodies. Tectonically overlying – the Miklušovce complex building up mainly NE flank of the antiform consists of migmatites and local aplitic - granite intrafolial bodies. The highest one – the Bujanová complex, rimming prevailingly the SW limb of the antiform, is mainly composed of tabular granodiorite bodies intruded into gneissose – migmatitic ± amphibolitic country rocks.

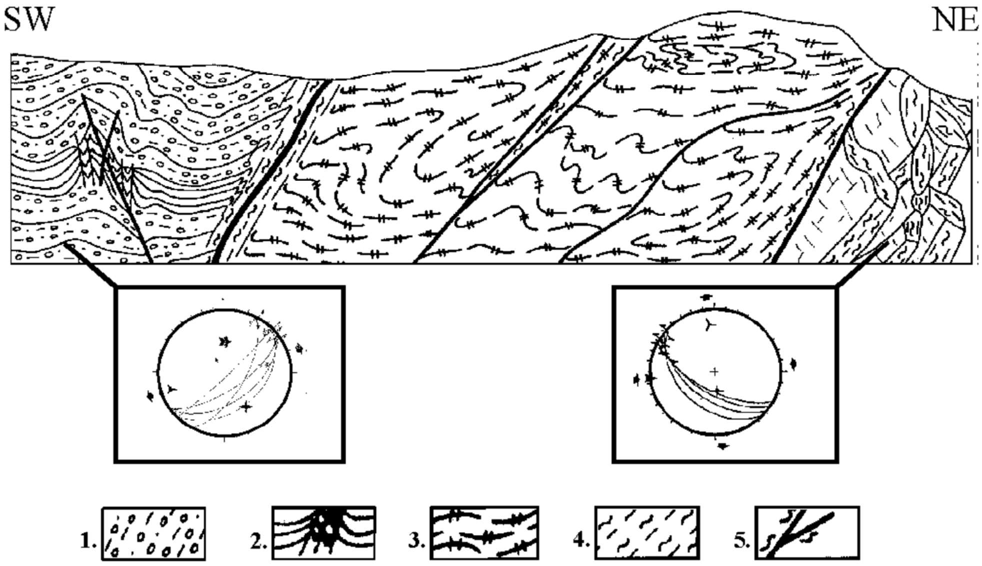

Fig. 26. Road–cuts cross-section of the Margecany shear zone at the Margecany church. 1-2 Hámor formation (Wesphalian C-D) of the Gemericum unit, 1-oligomict conglomerates, 2-black arenites. 3-4 Bujanová complex of the Veporicum unit (Early Palozoic), 3-migmatic amphibolites, 4-chlorite-muscovite phyllonites, 5-shear zones.

The road-cut directly exposes the tectonic contact (i.e. the MSZ) of the Bujanová complex diaphtoritic metamorphites with overlying Carboniferous oligomictic conglomerates of the Gemericum unit (Fig.26) Carboniferous conglomerates intercalated by arenite layers are conjugately folded and/or sheared. The former sequence starts with migmatitic amphibolites immediately underlying the MSZ. They are floored by chlorite – muscovite phyllonites created from migmatitic biotite – muscovite gneisses.

Alpine metamorphic parageneses of the mentioned rocks comprise:

Quartz - phengite (?)-chlorite-albite ± calcite ± ilmenite (conglomerates),
Chlorite – calcite-quartz-phengite (?) – albite (migmatitic amphibolites),
Chlorite – phengite (?) – calcite – quartz – ilmenite (phyllonites).

Three tectonometamorphic events has been distinquished at this locality.

1. The Late Paleozoic (i.e. 329,6 ± 0,2 Ma, Ar/Ar from phyllonite muscovites, Dallmeyer, pers. inf.) - very probably southvergent, thrusting of the Miklušovce and Bujanová complexes onto the Lodina one. Both a common presence of secretional quarts pebbles within cover Late Carboniferous conglomerates and the Alpine refolding of the secretional quartz folds also confirm this event, Metamorphic paragenese of the event comprises: *quartz – coarse-platy muscovite- chlorite-epidote-ilmenite (gneisses).*

2. The second event (following previous – the Early Cretaceous nappe shortening of both i.e. the Gemericum and Veporicum units and their refolding into NW-SE fold structures),comprises regional strike-slip shearing of the same direction. It is confirmed by formation of 10 metres thick mylonite zones dipping to SW. They were preferentially droved on both NW limbs of the mentioned fold structures and competently contrasting lithostratigraphical boundaries. S/C structures, mica-fishes and shear bands prove sinistral displacement in the zones. Evidences for relatively older – dextral shearing in the zones have not been find in this outcrop.

3. Tertiary ENE-WSW extension of the third deformation event has brought kinematically composite movement picture. Normal faulting according to steeply dipping faults of SE-NW direction prevails at the regional scale (e.g. Klenov fault, Branisko horst). Striations on both mesoscale dislocations and filled extensional veins show however predominantly strike-slip movements (Fig. 26).

Stop 13. Miklušovce komplex – a lower part of the Upper lithotectonic unit of the Tatric a Veporic basement.
S. Jacko

- *Location: Sheet no 37-21, 2nd. class road between Kluknava and Široké villages, western side at the SE end of Dolina valley, SW end of Dolina settlement.*

Basement rocks of the Miklušovce crystalline complex together with overlying Bujanová complex suite have been included into the Upper lithotectonic unit of the Variscan structure of the Tatric and Veporic basement block of the Western Carpathians (Jacko et al. 1995, Bezák et al., 1997). The Miklušovce complex consits of migmatites containing subordinate gneissic and amphibolite restites and of smal intrafolial aplitic - granite bodies.

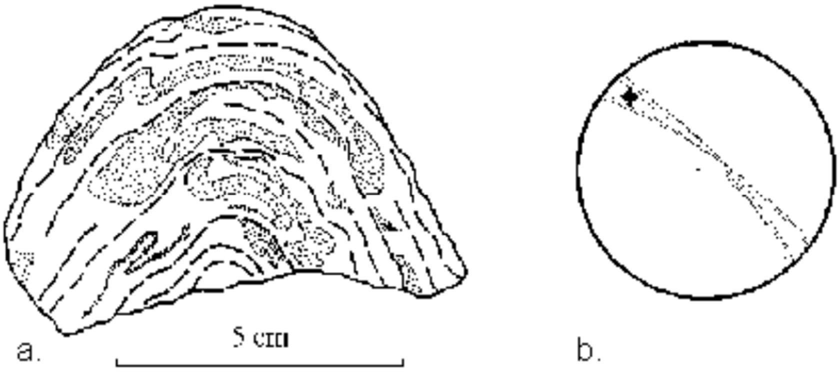

Fig. 27. a-Variscan isoclinal folds refolded by Alpine NW-SE fold structures, dotted-leucosome of migmatites, b-limbs and fold axis (the star) spatial position of the Variscan fold at the SE limb of the Alpine NW-SE fold.

The Miklušovce complex is here represented by relatively well-preserved Variscan stromatitic – nebulitic migmatites. ***Their melanosome comprises*** *biotite-plagioclase 1 (An_{27}-$_{33}$) – K-feldspar 1- quartz 1 ± garnet ± sillimanite ± apatite ± zircon ± ore minerals.* Fibrolitic sillimanite localy replaces biotite. ***Leucosome consists*** of *microclinised and/or perthitised K-feldspar 2-quartz 2-plagioclase 2 (An_{20-25}) and ± muscovite.* Metamorphic PT conditions have been estimated to 570-610^0 C and 400-500 MPa (Korikovskij in Krist et al., 1992).

More intensively sheared migmatite zones obviously have protomylonitic features. At the contact zone with underlying the Lodina complex diaphtoritic gneisses (belonging to the Middle Variscan lithotectonic unit l.c.) metric phyllonite zones developed from migmatites of the complex. Isoclinal folds – the only Variscan structures of these rocks, are intensively modified by the Alpine refolding into NW-SE fold set. Representative structural paragenese of the complex reveals from this reason exclusively Alpine structures in this the Late Variscan thrust sheet. Hence, scarcely preserved Variscan folds (Fig. 27) do not allow any imagination about their primary orientation.

Stop 14. Branisko -amphibolites and gneisses of Tatric andVeporic basment

S.W. Faryad, A. Vozárová and S. Jacko

- *Location: Sheet no 37-21: Road from Prešov to Poprad, cross the first motorest ca 2 km from Široke village (direction to Poprad) and stop on the next motorest ca 1 km on the left side of the road.*

Amphibolite are exposed on right side of the roadcut near motorest. They are medium to coarse-grained with or without garnet. Occasionally banded amphibolites with bands of plagioclase- and quartz (x cm in width) also occur. Besides hornblende and plagioclase, the amphibolite may contain biotite and accessory apatite, zircon, titanite and epidote. Amphibole is magnesio-hornblende in composition with X_{mg} = 0.59-0.65. Garnet is rich in almandine (Alm_{50-57}, Grs_{25-30}, Prp_{12-22}, Sps_{1-4}, And_{1-4},) and it is slightly zoned. The Mg content decrease and Mn and Fe increase towards rim. A decrease of $Mg/(Mg+Fe^{2+})$ ratio from 30 % to 19 % from core to rim can be also observed. Plagioclase, analyzed in garnet- and hornblende-bearing assemblage, has anorthite content ranging from 33 to 38 %.

The gneisses can be easily reached ca 100 m westwards from motorest in a small quarry on the right side of the road. They are mostly migmatized. In addition to plagioclase, quartzbiotite, some gneisses contain also garnet, muscovite, occasionally also sillimanite and kyanite. Biotite, muscovite and long-shaped quartz grains define schistosity in the rock. Garnet is rich in almandine (Alm_{71-73}. Sps_{9-10}, Grs_{1-4}, Prp_{13-15}) and indicated no compositional zoning. Plagioclase from garnet biotite gneiss has about 25 % anorthite contents. A fibrolitic sillimanite occurs in muscovite, rarely also in plagioclase.

P-T conditions of 0.8-1.0 GPa at 650-700 ^{o}C are calculated based on mineral composition and available thermobarometries for gneisses and amphibolites. Textural relations and mineral zonations reveal decrease of pressure and temperature to 0.4-0.6 GPa and 500-600 °C.

Stop 15. Byšta - basement rocks of the Zemplin unit

S.W. Faryad and A. Vozárová

- *Location: Sheet no 38-31: Stop the bus in the Byšta Spa and continue (ca 1.5 km) along the forest way on the north foots of the Veľká and Lysá hora (hills).*

Mylonitized quartz micaschists and biotite gneisses of the Zemplin basement unit are exposed along the of forest roadcut before coming to Lysa hora. The micaschists/muscovite gneisses suffered a particularly strong mylonitic overprint. They consist mainly of plagioclase, quartz and muscovite, but may contain also pseudomorphs of biotite, sillimanite, staurolite or kyanite. Kyanite from muscovite gneiss was reported by Pantó et al. (1965) and Kisházi and Ivancsics (1988) from boreholes, and by Magyar (1969) from the Lysá hora area. The rocks exposed on surface are strongly mylonitized and consists of quartz, white mica, chlorite, some plagioclase and accessory tourmaline, zircon, monazite and Fe-Ti phases. Some muscovite grains contain numerous Fe-Ti phases and seem to have replaced earlier biotite.

Crossing the S-N directed fault between the Veľká and Lysa hora biotite gneisses are exposed. Biotite-amphibole gneisses and amphibolites can be found along the fault ca 100 m south from the forest way. Beside biotite, the most common phase in gneisses are plagioclase and quartz. In gneisses from borehole BB-1 garnet and sillimanite were also found. Similar to muscovite gneisses they underwent mylonitization; garnet, biotite and feldspars are replaced by chlorite and fine-grained mica, respectively.

Amphibolites forming up to 10 m thick layers within gneisses, occur in the eastern part of Lysá hill and are found in boreholes BB-1. Based on their chemical composition, including trace elements and REE distribution, they correspond to basaltic andesites and basalts which can be compared with anorogenic or initial stage of island-arc basalts. Some amphibolite with high amounts of amphibole (ca. 95 vol. %) have relatively high MgO and CaO and low SiO_2 and TiO_2 contents and they were probably formed from melano-gabbro. Amphibolite indicate weak foliation that is defined by hornblende and biotite. Additional to amphibole, plagioclase they may contain garnet. Accessory tourmaline, apatite, zircon, titanite, rutile, calcite and chlorite are also found in amphibolites. Chlorite, epidote and calcite replace one or more of the minerals: plagioclase, biotite, garnet and hornblende.

Stop 16. Pre-Neogene basement units of the Eastern Slovakia (Neoalpine sub-greenschist and greenschist metamorphism).

Biroň A., Kotulová J., Magyar J., Soták J., Spišiak J.

Geology. Pre-Neogene basement of the Eastern Slovakia is formed mainly by the Iňačovce-Krichevo unit. This subsurface unit comprises mostly of metasedimentary formations with distinct similarities to the Penninic Zone of the Alps. At the base of the complexes there are variegated phyllites, phyllitic marbles and marbles which can be correlated with the red-bed formations, in Alpine region known as „Quartenschiefer“. Their Upper Triassic age has been determined biostratigraphically. Above them a thick „Bündnerschiefer“-like formations follow containing green or dark phyllites, metasandstones and metasiltstones. Oceanic lithology of these metasediments has been proved by the presence of metaultramafic rocks, metabasalts and metatuffites. In the upper part, „Bündnerschiefer“ formations pass into the more arenaceous sequences. The Upper Cretaceous sediments are probably represented by turbiditic sequences of dark schists and metasandstones. The youngest sediments (Middle Eocene) are formed of black phyllitic schists intercalated by Nummulites-bearing metasandstones. Considering that, the latest phases of syntectonic low-temperature metamorphism, were taking place probably after Middle Eocene.

Metamorphism. The lowest degree of metamorphism has been determined in the youngest Middle Eocene metasediments. These rocks are lacking in diagnostic metamorphic assemblages, since they are composed of illite/muscovite, quartz, chlorite, albite, dolomite, pyrite and organic matter. Using phyllosilicate „crystallinity“ and coal rank data their degree of metamorphism corresponds to the higher anchizone or lower epizone, respectively (IC=0.31°Δ2Θ, $ChC_{(002)}$=0.26°Δ2Θ, Ro_{max}=5.75%; Fig. 28 A, B, C).

The peak metamorphic conditions are documented by assemblages encountered in high alumina metasedimentary rocks: muscovite + quartz + pyrophyllite + paragonite + intermediate Na-K micas ± chlorite ± chloritoid. Accordingly, a peak metamorphic temperatures were between the upper stability limit of kaolinite + quartz and the upper stability limit of pyrophyllite + quartz pairs, presumably between 350 and 400°C.

Metamorphic mineral assemblages of metabasic rocks can be summarized as follows: calcite + chlorite + biotite + phengite + stilpnomelane + titanite + quartz (ophicalcites), epidote + chlorite + biotite + phengite + titanite + albite + quartz (metabasalts), and magnesioriebeckite + winchite + actinolite + quartz, occurring exclusively in folded quartz bands within basic metatuffites, while rock matrix consists of chlorite, biotite, phengite, titanite, albite, quartz and hematite. Co-existence of Na and Ca amphibols is considered here as a relic of earlier, higher pressure metamorphic event (greenschist to blueschist transition zone, p ≈ 7-8 kbar). During younger phase of metamorphism normal greenschist assemblages occurred (chloritoid in metapellites and biotite in metabasalts) at a pressures <5 kbar (phengite geobarometry; Fig. 28 D).

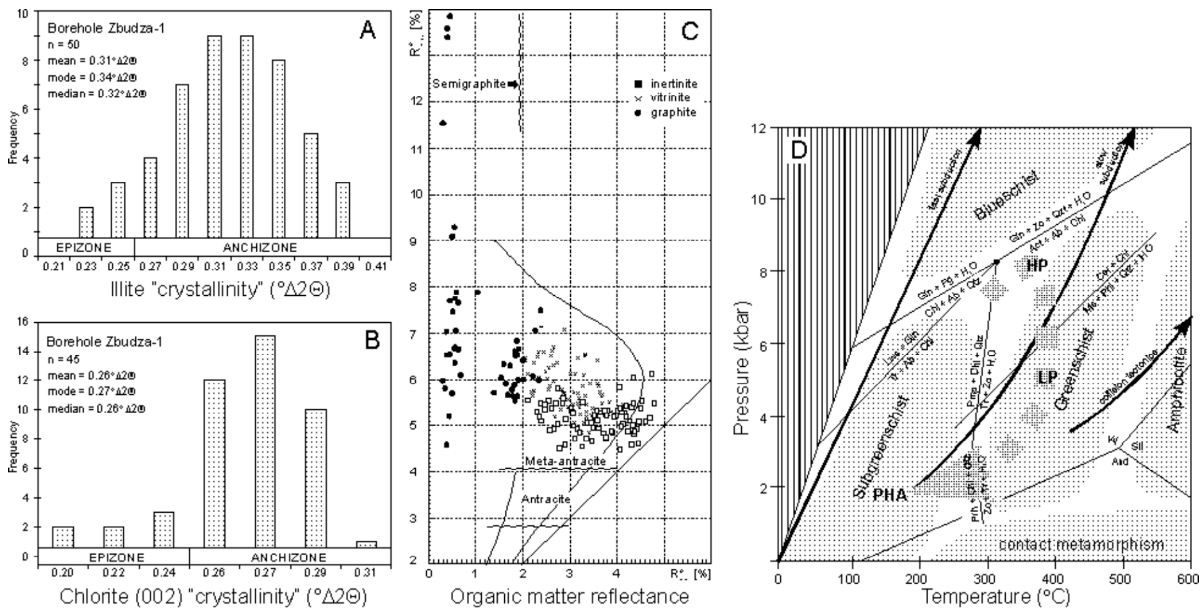

Fig. 28. Histograms of illite (A) and chlorite (002; B) "crystallinity" data and plot of coal rank data (Teichmüller et al. 1979, C) obtained from the Middle Eocene metapelites (Zbudza-1 borehole). Both methods indicate that these rocks experienced metamorphism with at least higher anchizonal temperature conditions. D - Preliminary p-T path showing metamorphic evolution of Iňačovce-Krichevo Unit. Metamorphic phacies as well as model reactions are taken from Bucher and Frey (1994). HP - higher pressure event, LP - lower pressure event, PHA - postmetamorphic hydrothermal alteration.

Postmetamorphic cooling of the Iňačovce-Krichevo Unit is recorded by zircon fission track data. This unit passed through a zircon fission track blocking temperature in Early Miocene (20 ± 0.9 Ma). The structural unroofing and uplift have been accompanied by distinctive processes of retrograde alteration, which occurred on the regional basis. The most remarkable there is a kaolinitization of muscovite, chlorite and chloritoid. Direct precipitation of kaolinite, dickite, illite/smectite as well as tosudite within microfissures has been also recorded. The appearance of these hydrated minerals can be explained by the reaction of the fluids and prograde minerals at a temperature lower than peak of metamorphism (rehydration).