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Obsah – Content

Na úvod

Geovestník ako súčasť časopisu Mineralia Slovaca vychádza od roku 1993. Vytvorenie tohto spravodaja pre geológiu, baníctvo, úpravníctvo a životné prostredie bolo motivované snahou o poskytnutie aktuálnych informácií o dianí na poli geovied na Slovensku. Tieto informácie v iných periodikách dlhodobo absentovali a stále absentujú.

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Veríme, že súčasná reštrukturalizácia časopisu Mineralia Slovaca so zvyšovaním nárokov na vedeckú kvalitu a citačný potenciál pôvodných vedeckých článkov – a tiež oddelením informačnej časti časopisu – prispejú k adekvátnym scientometrickým hodnoteniam a patrične zvýšia jeho citačný „impakt".

Zoltán Németh
vedecký redaktor

10th CETeG 2012 meeting in Slovakia – Tectonic phenomena of the Eastern Slovakia

10. stretnutie CETeG – Tektonické fenomény východného Slovenska

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Abstract: *The article reports about the 10th CETeG meeting held in the Eastern Slovakia on 2.–5. May 2012. The conference was preceded by the whole-day field excursion devoted to lithology and tectonic overprint of Paleozoic sequences of Gemericum and partly Veporicum, as well as Mesozoic sequences in the nappe outlier of Meliaticum (the Bôrka nappe). Two conference days were devoted to tectonic topics of the crystalline basement and Paleozoic/Mesozoic sequences of Variscan and Alpine realms, as well as the tectonics of the Pieniny Klippen Belt and Outer Western Carpathians. At the end of the second day of the conference, the field excursion to Zemplinicum and the Neogene extrusive volcanic body Borsuk in the Zemplínske vrchy Mts. was held. The scientific event terminated with the whole-day post-conference field trip to Pieniny Klippen Belt in the Eastern Slovakia, presented along a cross-section between the Jarabina and Litmanová villages.*

Key words: *CETeG, tectonics, structural geology, tectonometamorphism, Gemericum, Veporicum, Meliaticum, Eastern Slovakia*

The 10th meeting of the Central European Tectonic Studies Groups (CETeG) was held in Eastern Slovakia this year (Fig. 1). It represented the third meeting, held in territory of Slovakia. The previous two CETeG meetings were held in the Borsuk area of the town of Lučenec (2004 – 2nd meeting) and in Upohlav (2008 – 6th meeting). This year's meeting in the locality Medvedia hora at the Zemplínska Šírava water reservoir and the field trips were organized by J. Kobulský, Ľ. Petro, Z. Németh, M. Kováčik, Ľ. Gazdačko and P. Bačo, as well as logistics by K. Žecová and Z. Bačová, all being the employees of the State

10. stretnutie Skupín stredoeurópskych tektonických štúdií (CETeG – Central European Tectonic Studies Groups) sa konalo tohto roku na východe Slovenska (obr. 1). Bolo to v poradí tretie stretnutie uskutočnené na Slovensku. Prvé stretnutie sa konalo v oblasti Lučenca (2004 – 2. stretnutie CETeG) a druhé v Upohlave (2008 – 6. stretnutie). Tohtoročné stretnutie na Medvedej hore v oblasti Zemplínskej Šíravy zorganizovali pracovníci košickej pobočky Štátneho geologického ústavu Dionýza Štúra (ŠGÚDŠ) J. Kobulský, Ľ. Petro, Z. Németh, M. Kováčik, Ľ. Gazdačko a P. Bačo. Vedeckým

Fig. 1. Participants of the 10th CETeG meeting 2012 in front of the conference site in locality Medvedia hora at the Zemplínska Šírava water reservoir in the Eastern Slovakia. In the middle of the upper row: Branislav Žec – Director of ŠGÚDŠ, the low row right: Ľubomír Petro – the Head of ŠGÚDŠ – Regional centre Košice, providing the logistics of the meeting. Photo Z. Németh.

Obr. 1. Účastníci 10. stretnutia CETeG 2012 na Medvedej hore pri Zemplínskej Šírave na východnom Slovensku. V hornom rade v strede: B. Žec – riaditeľ ŠGÚDŠ, v dolnom rade vpravo: Ľ. Petro – vedúci ŠGÚDŠ – Regionálne centrum Košice, zabezpečujúci logistiku podujatia. Foto Z. Németh.

Geological Institute of Dionýz Štúr (ŠGÚDŠ), Regional centre Košice. Scientific guarantee of the conference was Prof. D. Plašienka from the Faculty of Sciences, Comenius University Bratislava. The meeting was attended by 69 specialists from the area of structural geology, tectonics, tectono-metamorphism, but also sedimentology, engineering geology and the software processing of tectonic data and GIS.

The cycle of the CETeG international conferences began in April 2003 at the castle Hrubá Skála in the Czech Republic. Although the so far circulation of conferences was carried out only in the states of so-called Višegrád Four, the conference is attended also by geologists from other European countries, or even overseas. In line with this trend, also the territorial scope of presented geological-tectonic results is extended. The attractiveness of the meeting, in addition to many high quality lectures and posters, is enhanced by the field trips, focused on geological and tectonic peculiarities of the host countries or visited regions.

2. May 2012
Pre-conference field trip to the region of Gemericum

The traditional pre-conference excursion was in this year's meeting focused on the region of the Spiš-Gemer Ore Mts. with the emphasis on lithology and tectonometamorphic overprint of a part of Paleo¬zoic sequences of Gemericum, as well as surrounding units – Meliaticum, and partly Veporicum in the eastern contact zone with Gemericum. In accordance with the description of individual localities (published in following paper), the often multiple tectonic overprint of the Lower Paleozoic sequences was presented in localities Opátka, Gelnica and – during the transport – in locality Smolník, similarly as in the contact of Gemericum with Veporicum (Margecany). The excursion stop in the saddle on the Folkmársky kopec hill above the village of Veľký Folkmar provided the sceneric view towards NNW on tectonic units Gemericum, Meliaticum in the North-Gemeric zone, but also Veporicum and Tatricum in the Branisko Mts. Towards the E the view on Veporicum and its Permian-Triassic-Jurassic cover was extended also on Carboniferous and Permian sequences in the nappe outliers of Hronicum in apical parts of hills built by Veporic lithology. Moreover – the view to the S presented the Silicicum of the Murovaná skala hill. The locality Folkmársky kopec hill allowed the very instructive presentation of the geology and tectonic setting in the Eastern part of the Gemeric region.

The different tectonometamorphic overprint of two types Upper Paleozoic of conglomerates in the North-Gemeric zone – the Carboniferous Rudňany Conglomerates of the Dobšiná Group and the Permian cover Muráň Conglomerates of the Krompachy Group was presented in locality Závadka at the village of Nálepkovo (Fig. 8). Besides the presentation of exhumed lithologies of Meliaticum in the North-Gemeric zone in the Jaklovce area, also those in the Šugovská dolina valley in the South-Gemeric zone were presented. The high--pressure Meliatic sequences are included into the so-called Bôrka nappe. The particular overprints of sequences, presented during the whole-day field trip, were classified using the concept of two Variscan deformation phases (VD_{1-2}) and three Alpine deformation phases (AD_{1-3}), including their sub-phases. The excursion guide-text is available in following paper.

3. May 2012
First conference day

The conference (Fig. 2) was opened by the welcome speech presented by the Director of ŠGÚDŠ Branislav Žec (Fig. 3). Wish of the high quality presentations and the support to this traditional scientific event were expressed also by Zdeněk Venera, the Director of the Czech Geological Survey, who was personally present also at the pre--conference excursion as well as the first two days of the conference.

The scientific program of the first conference day started with the invited lecture of Prof. W. Zuchiewicz (Fig. 4) from AGH University of Science and Technology, Cracow, Poland, presenting the neotectonics of the Outer Carpathians in the frame of tectonic geomorphology. Next lectures were devoted to crystalline basement, Paleozoic and

garantom konferencie bol prof. D. Plašienka z Prírodovedeckej fakulty Univerzity Komenského v Bratislave. Logistiku zabezpečovali okrem Ľ. Petra aj K. Žecová a Z. Bačová zo ŠGÚDŠ – Regionálneho centra v Košiciach. Stretnutia sa zúčastnilo 69 špecialistov zaoberajúcich sa z problematikou štruktúrnej geológie, tektoniky, tektonometamorfózy, ale aj sedimentológie, inžinierskej geológie a softvérového spracovania tektonických dát a GIS.

Cyklus medzinárodných tektonických konferencií CETeG sa začal v apríli 2003 na hrade Hrubá Skála v Českej republike. Aj keď sa konferencie doposiaľ uskutočňovali len v štátoch tzv. Vyšehradskej štvorky, účastníkmi podujatia sú nezriedka geológovia aj z ďalších európskych štátov, či zámoria. V súlade s týmto trendom sa rozširuje aj teritoriálny záber prezentovaných geologicko-tektonických výsledkov. Atraktívnosť stretnutí popri množstve kvalitných prednášok a posterov umocňujú aj hodnotné exkurzie orientované na geologicko-tektonické osobitosti hostiteľských krajín či navštívených regiónov.

2. máj 2012
Predkonferenčná exkurzia do regiónu gemerika

Tradičná predkonferenčná exkurzia bola v prípade tohtoročného stretnutia zameraná na región Spišsko-gemerského rudohoria s dôrazom na litológiu a tektonometamorfné pretvorenie časti paleozoických sekvencií gemerika, ale aj priľahlých jednotiek – meliatika a čiastočne veporika vo východnej kontaktnej zóne s gemerikom. V súlade s popisom jednotlivých lokalít (publikovaným v nasledujúcom príspevku) boli prezentované spodnopaleozoické sekvencie a ich často viacnásobný tektonický prepis v lokalitách Opátka, Gelnica a počas presunu Smolník, rovnako ako na kotakte gemerika s veporikom (Margecany). Zastávka v sedle na Folkmarskom kopci nad obcou Veľký Folkmar poskytla v smere na SSZ scenerický výhľad na tektonické jednotky gemerikum a meliatikum v severogemerickej zóne, ale tiež veporikum a tatrikum v pohorí Branisko. V smere na východ sa k nim pridával pohľad na veporikum a jeho permsko-triasovo-jurský obal, a tiež na karbónske a permské sekvencie v príkrovových troskách hronika vo vrcholových častiach kopcov budovaných litológiou veporika. Navyše – smerom na juh pristupoval výhľad na silicikum Murovanej skaly. Lokalita Folkmarský kopec umožnila názorne prezentovať úvod do geologickej a tektonickej stavby východnej časti gemerického regiónu.

Rozdielny tektonometamorfný prepis dvoch typov zlepencov v severogemerickej zóne – karbónskych rudnianskych zlepencov a obalových permských muránskych zlepencov knolského súvrstvia – bol prezentovaný v lokalite Závadka pri Nálepkove (obr. 8). Popri prezentácii exhumovaných litológií meliatika v severogemerickej zóne v oblasti Jakloviec bol v oblasti Šugovskej doliny prezentovaný výskyt vysokotlakových sekvencií meliatika v juhogemerickej zóne (tzv. príkrov Bôrky). Pri vysvetľovaní jednotlivých tektonických prepisov daných sekvencií bola použitá koncepcia dvoch variských deformačných štádií (VD_{1-2}) a troch alpínskych deformačných štádií (AD_{1-3}), vrátane subštádií. Exkurzného sprievodcu publikujeme v nasledujúcom príspevku.

3. máj 2012
Prvý konferenčný deň

Konferenciu (obr. 2) otvoril riaditeľ ŠGÚDŠ Branislav Žec úvodným prejavom (obr. 3). Prianie kvalitných a prínosných prezentácií a podporu tomuto tradičnému vedeckému podujatiu vyslovil následne aj riaditeľ Českej geologickej služby Zdeněk Venera, ktorý bol osobne prítomný na predkonferenčnej exkurzii aj počas prvých dvoch konferenčných dní.

Odborný program prvého konferenčného dňa začal vyzvanou prednáškou prof. W. Zuchievicza (obr. 4) z AGH Univerzity pre vedu a technológiu z Krakova (Poľsko), prezentujúcou neotektoniku Vonkajších Karpát na pozadí tektonickej geomorfológie. Ďalšie prednášky boli venované kryštalinickému fundamentu, paleozoickým


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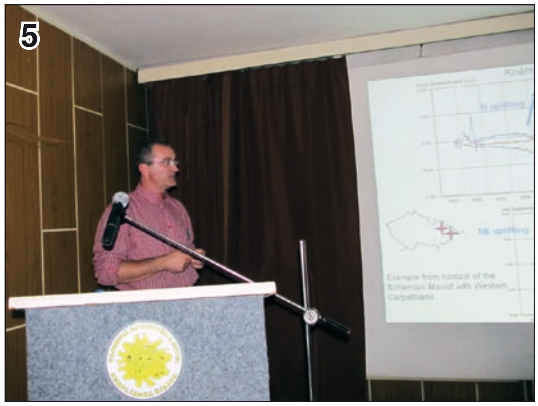
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Fig. 2. Opening ceremony of the conference. From the left: Z. Németh – ŠGÚDŠ, organizer of the scientific and excursion program of the whole meeting, Z. Bačová – ŠGÚDŠ, logistics, B. Žec – Director of ŠGÚDŠ, Z. Venera – Director of the Czech Geological Survey and Ľ. Petro – ŠGÚDŠ, the chief of the meeting logistics. Photo M. Kohút.

Obr. 2. Otvárací ceremoniál konferenčnej časti stretnutia. Zľava: Z. Németh – ŠGÚDŠ, zostavovateľ vedeckého a exkurzného programu stretnutia CETeG 2012, Z. Bačová – ŠGÚDŠ, logistika, B. Žec – riaditeľ ŠGÚDŠ, Z. Venera – riaditeľ Českej geologickej služby a Ľ. Petro – ŠGÚDŠ, logistické zabezpečenie. Foto M. Kohút.

Fig. 3. In his introductory speech the Director of ŠGÚDŠ B. Žec wished the participants the successful course of the conference and field trips during the CETeG meeting in Slovakia. Photo M. Kohút.

Obr. 3. Riaditeľ ŠGÚDŠ B. Žec v úvodnom prejave poprial účastníkom úspešný priebeh konferencie a exkurzií v rámci tohtoročného stretnutia CETeG na Slovensku. Foto M. Kohút.

Fig. 4. First day of conference started with invited lecture by Prof. W. Zuchiewicz from Poland. Photo Z. Németh.

Obr. 4. Prvý konferenčný deň začal vyzvanou prednáškou prof. W. Zuchievicza z Poľska. Foto Z. Németh.

Fig. 5. The introduction into the second day of the conference represented the invited lecture by J. Stemberk (Czech Republic) about the recent movements on disjunctive structures in the Bohemian Massif. Photo Z. Németh.

Obr. 5. Úvodom do druhého konferenčného dňa bola vyzvaná prednáška J. Stemberka (Česká republika) o recentných pohyboch na disjunktívnych štruktúrach v Českom masíve. Foto Z. Németh.

Fig. 6. Prokop Závada (Czech Republic) – the winner of the Radek Melka price 2012 for the best scientific article of the author younger than 35 years immediately after the announcing the results. Photo Z. Németh.

Obr. 6. Prokop Závada (Česká republika) – víťaz Ceny Radka Melky v roku 2012 za najlepší vedecký článok autora do 35 rokov bezprostredne po vyhlásení výsledkov. Foto Z. Németh.

Fig. 7. Lenka Kociánová (Czech Republic; left) as the winner of the category "The best student poster presented in the CETeG conference in 2012". The price was awarded by Z. Venera (in the middle) and O. Lexa (right). Photo Z. Németh.

Obr. 7. Víťazom kategórie o Najlepší študentský poster prezentovaný na konferencii CETeG sa v roku 2012 stala Lenka Kociánová (Česká republika; vľavo). Výhru odovzdali Z. Venera (v strede) a O. Lexa (vpravo). Foto Z. Németh.

Fig. 8. The lunch break during the pre-congress field trip in the region of Gemericum. Outcrops of the Permian cover Muráň Conglomerates. The Knola Formation of the Krompachy Group, at the Závadka village on the ridge north of the Hnilecká dolina valley. Photo Z. Németh.

Obr. 8. Obedňajšia prestávka počas predkongresovej exkurzie v regióne gemerika. Odkryvy permských obalových muránskych zlepencov knolského súvrstvia krompašskej skupiny pri obci Závadka na hrebeni severne od Hnileckej doliny. Foto Z. Németh.

Fig. 9. Familiarization with the lithology and tectonics of Zemplinicum – Carboniferous rhyolite-rhyodacite volcaniclastics of the Šimonov vrch Formation at the village of Malá Tŕňa. Photo Z. Németh.

Obr. 9. Oboznamovanie sa s litológiou a tektonikou zemplinika – karbónske ryolitovo-ryodacitové vulkanoklastiká súvrstvia Šimonovho vrchu pri obci Malá Tŕňa. Foto Z. Németh.

Fig. 10. Lecture about the forms of Neogene volcanism in the area of Zemplínske vrchy Mts. before the descent to underground spaces in the extrusive body Borsuk. From the right: P. Bačo – lecturing volcanologist, Ľ. Gazdačko and J. Kobulský (ŠGÚDŠ). Photo Z. Németh.

Obr. 10. Prednáška o formách neogénneho vulkanizmu v oblasti Zemplínskych vrchov pred zostupom do podzemných priestorov v extruzívnom telese Borsuk. Sprava: P. Bačo – prezentujúci vulkanológ, Ľ. Gazdačko a J. Kobulský (ŠGÚDŠ). Foto Z. Németh.

Fig. 11. Post-congress field trip in the segment of the Pieniny Klippen Belt between villages Jarabina and Litmanová. D. Plašienka (middle in front of the map) familiarizes the participants with the general tectonic and geodynamic aspects of the Pieniny Klippen Belt. The valley of the Hlboký potok brook – one of the type localities of the Gregoriánka Breccia. Photo Z. Németh.

Obr. 11. Pokongresová exkurzia v segmente bradlového pásma medzi obcami Jarabina a Litmanová. D. Plašienka (v strede pred mapou) oboznamuje účastníkov so základnými tektonickými a geodynamickými aspektmi bradlového pásma. Údolie Hlbokého potoka – jednej z typových lokalít gregoriánskych brekcií. Foto Z. Németh.

Mesozoic sequences of Variscan and Alpine terranes. The morning session chairman was D. Plašienka. The lectures were ordered successively according to the age of studied tectonometamorphic sequences, as well as applied methodology of investigation. In the first lecture of this section V. Kusbach et al. evaluated the heterogeneous nature and the evolution of the Variscan lower continental crust in the area of the Bohemian massif. The nature, probable genesis and tectonic overprint of Paleoproterozoic (~2.1 Ga) Světlík orthogneisses were presented by J. Trubač et al. and the mineralogy of the granite Říčany type (Central Bohemian Plutonic Complex) V. Janoušek et al. The Variscan polyphase structural and metamorphic evolution of the Teplá-Barrandian unit were treated by V. Peřesný et al.

The lectures about the Bohemian Massif were followed by the block of lectures dealing with the Western Carpathians. M. Kohút summed up until knowledge about the genesis and isotopic geochemistry of Gemeric granites. R. Demko et al. presented the genesis of U-Mo mineralization in the locality Kurišková in Permian sequences of Gemericum. Z. Németh et al. presented new proofs about the allochthonity of Meliatic occurrences in the Jaklovce area in the North--Gemeric zone. M. Śmigielski et al. presented new geochronological data about the Neogene exhumation of the Tatry Mts. F. Marko et al. have reconstructed the continuation of the Muráň fault into the area of the Levočské vrchy Mts.

Following block of lectures from regions besides the Western Carpathians (Chairman Z. Németh) started with the lecture by L. Fodor about the stress field parameters in the Pannonian basin from the Mesozoic to Quaternary. M. Reiser at al. drew the attention of listeners on new structural and geochronological data from the Apuseni Mts. in Romania, A. Żelaźniewicz reconstructed the tectonic evolution of the regional Ailao Shan-Red River shear zone in NW Vietnam from a view of geodynamics of lithospheric plates. The end of the first conference day belonged to computer visualization of the Paleozoic drift and amalgamation of lithospheric plates by J. Barmuta and J. Golonka.

The scientific program of the first conference day was enlarged by 21 posters devoted to Bohemian Massif, Western Carpathians and the software processing of the tectonic, sedimentological and GIS data.

4. May 2012
Second conference day, field trip into the area of Zemplinicum and the Neogene volcanic body Borsuk

Second conference day was devoted to Tertiary and Quaternary tectonics, dominantly in the Klippen Belt and the Outer Western Carpathians. The scientific presentations started with invited lecture by J. Stemberk (Fig. 5) from Academy of Sciences of the Czech Republic about the recent displacements on disjunctive structures in the Bohemian Massif, being registered by dilatometers TM71 with possibility of the 3D reconstruction of the registered movements. The results of such monitoring in Slovakia were presented in following lecture by Ľ. Petro et al.

The section about the Klippen Belt and the Outer Western Carpathians (Chairman A. Tokarski) started with the lecture by D. Plašienka about the structural evolution of the Pieniny Klippen Belt, based on new data from its East-Slovakian segment. E. Márton et al. provided new data about the paleomagnetism, registered in the Upper Cretaceous marlstones of the Pieniny Klippen Belt, and added also the tectonic interpretation of results. The tectonics of the western part of the Pieniny Klippen Belt was treated by I. Pešková et al. The origin of the curved traces of the regional thrusts and fault-related folds in the light of the analogue modelling was documented by M. Rauch et al.

This section was enlarged by 11 posters, devoted prevailingly to Outer Western Carpathians.

The field trip in afternoon and evening hours was focussed on the Zemplínske vrchy hills and Neogene volcanic body Borsuk. The excursion was led by J. Kobulský, Ľ. Gazdačko and P. Bačo. The visit of two principal outcrops in the Carboniferous rhyolite--rhyodacite volcaniclastics of the Šimonov vrch Fm. in the Malá Tŕňa area (Fig. 9) and the Upper Permian claystones with intercalations of conglomerates and sandstones of the Černochov Fm. in the Malá Bara area were followed by the excursion in the newly built wine cellars in

a mezozoickým sekvenciám variských a alpínskych teranov. Predsedajúcim dopoludňajšej sekcie bol D. Plašienka. Prednášky boli radené sukcesívne podľa veku študovaných tektonometamorfných sekvencií a podľa aplikovanej metodiky výskumu. V prvej prednáške tejto sekcie V. Kusbach et al. hodnotili heterogénnu povahu a vývoj variskej spodnej kontinentálnej kôry v oblasti Českého masívu. Povahu, pravdepodobnú genézu a tektonické prepracovanie paleoproterozoických (~2.1 Ga) ortorúl typu Světlík prezentovali J. Trubač et al. a mineralógiou granitu typu Říčany (Stredočeský plutonický komplex) V. Janoušek et al.. Variským polyfázovým štruktúrnym a metamorfným vývojom jednotky Teplá-Barrandien sa zaoberali V. Peřesný et al..

Po prednáškach z Českého masívu nasledoval blok prednášok z problematiky Západných Karpát. M. Kohút zrekapituloval doterajšie poznatky o genéze a izotopovej geochémii gemerických granitov. R. Demko et al. prezentovali genézu U-Mo zrudnenia v lokalite Kurišková v perme gemerika. Z. Németh et al. uviedli nové dôkazy o alochtonite výskytov meliatika v oblasti Jakloviec v severogemerickej zóne. M. Śmigielski et al. prezentovali nové geochronologické dáta o neogénnej exhumácii Tatier. F. Marko et al. rekonštruovali pokračovanie muránskeho zlomu do oblasti Levočských vrchov.

Nasledujúci blok prednášok z regiónov mimo Západných Karpát (predsedajúci Z. Németh) začal L. Fodora prednáškou o parametroch napäťového poľa v Panónskom bazéne v období od mezozoika po kvartér. M. Reiser et al. upriamili pozornosť poslucháčov na nové štruktúrne a geochronologické dáta z pohoria Apuseni v Rumunsku, A. Żelaźniewicz rekonštruoval tektonickú evolúciu regionálnej strižnej zóny Ailao Shan v SZ Vietname z pohľadu geodynamiky litosférických platní. Záver prvého dňa prednášok patril počítačovej vizualizácii paleozoického driftu a amalgamácie litosférických platní autorov J. Barmuta a J. Golonka.

Vedecký program prvého konferenčného dňa rozširovalo 21 posterov venovaných Českému masívu, Západným Karpatom a softvérovému spracovaniu tektonických, sedimentologických a GIS dát.

4. máj 2012
Druhý prednáškový deň, exkurzia do oblasti zemplinika a neogénneho vulkanického telesa Borsuk

Druhý prednáškový deň bol venovaný terciérnej a kvartérnej tektonike, bradlovému pásmu a Vonkajším Západným Karpatom. Odborné prezentácie sa začali vyzvanou prednáškou J. Stemberka (obr. 5) z Akadémie vied Českej republiky o recentných pohyboch na disjunktívnych štruktúrach v Českom masíve, zaregistrovaných dilatometrami TM71 s možnosťou trojrozmernej rekonštrukcie charakteru nameraných pohybov. O výsledkoch takéhoto monitoringu na Slovensku zreferovali v nasledujúcej prednáške Ľ. Petro et al..

Sekcia o bradlovom pásme a Vonkajších Západných Karpatoch (predsedajúci A. Tokarski) začala prednáškou D. Plašienku o štruktúrnom vývoji bradlového pásma, opierajúcou sa o nové údaje získané z jeho východoslovenského úseku. E. Márton et al. poskytli nové výsledky z meraní paleomagnetizmu vrchnokriedových slieňovcov bradlového pásma a tiež tektonickú interpretáciu výsledkov. Na tektoniku západnej časti bradlového pásma bola zameraná prednáška I. Peškovej et al.. Vznik zakriveného priebehu regionálnych zlomových a prešmykových štruktúr na základe analógového modelovania zdokumentovali M. Rauch et al..

Danú sekciu obohatilo 11 posterov, venovaných prevažne Vonkajším Západným Karpatom.

V popoludňajších hodinách sa uskutočnila terénna exkurzia v oblasti Zemplínskych vrchov a neogénneho vulkanického telesa Borsuk. Vedúcimi exkurzie boli J. Kobulský, Ľ. Gazdačko a P. Bačo. Po oboznámení sa s dvoma podstatnými odkryvmi (umelými zárezmi) v karbónskych ryolitovo-ryodacitových vulkanoklastikách súvrstvia Šimonovho vrchu v oblasti Malej Tŕne (obr. 9) a vo vrchnopermských ílovcoch s preplástkami zlepencov a pieskovcov černochovského súvrstvia v oblasti Malej Bary sa účastníci presunuli *the Viničky area, penetrating the Neogene extrusive body of Borsuk hill. The individual volcanological phenomena were presented by P. Bačo (Fig. 10).*

The excursion guide-texts about the Zemplinicum and the volcanic body Borsuk are published in a full range behind the guide-text to pre--congress field trip in Gemericum.

The scientific program of the meeting CETeG 2012 culminated by the announcement of the winner of the Radek Melka price for the best scientific article published in 2011 by the author younger than 35 years. The 2012 winner was Prokop Závada (Czech Republic; Fig. 6) for the article: Závada, P., Dědeček, P., Mach, K., Lexa, O., & Potužák, M., 2011: Emplacement dynamics of phonolite magma into maar-diatreme structures – Correlation of field, thermal modeling and AMS analogue modeling data. Journal of Volcanology and Geothermal Research, 201, 1–4, 210–226.

The winner of the category "The best student poster presented in the CETeG conference in 2012" was Lenka Kociánová (Czech Republic) with the poster Analysis of 3D structures in GIS (Fig. 7).

Both prices were given to winners in the untraditional atmosphere of the wine cellar inside the extrusive volcanic body Borsuk. After the ceremony, A. Żelaźniewicz (Poland), on behalf of the participants, addressed thanks for the organizers of the GETeG meeting for the high quality scientific program and the instructive field trips. Followingly L. I. Fodor invited the participants for the next CETeG meeting 2013, being organized in Hungary.

5. May 2012
Field trip along the East-Slovakian segment of the Pieniny Klippen Belt

The field trip was focussed on lithological and tectonic relations in the wider area of the Pieniny Klippen Belt between villages Jarabina and Litmanová. The leaders of the trip were D. Plašienka, R. Vojtko and J. Madzin (Fig. 11). Eight excursion localities are characterized in the contribution by Plašienka et al., published as the second article in this issue of Minerala Slovaca. First part of the field trip – localities in the valley of the Hlboký potok brook – presented the tectonites of so-called Gregoriánka Breccia and the litho-biostratigraphic profile through the Czorsztyn Succession. Subsequently, the participants moved along individual klippes above the quarry at the village of Jarabina into the Jarabina Narrows. The eastern slopes the gorge above the Malý Lipník brook, in combination with the lithology of nearby quarry, allowed the interpretation of the duplex setting of the Subpieniny nappe. The location of the borehole Jar-1 and the relation of the Subpieniny nappe and the Šariš unit were presented in the area of klippes situated west of the Jarabina Narrows. In the area of the ski resort near Litmanová the participants became familiar with the facies of Milpoš carbonate breccia, situated in the environment of turbiditic sandstones and shales of Jarmuta-Proč Formation.

do novovybudovaných vinárenských zariadení vo Viničkách. Súčasťou exkurzie bola aj prehliadka nových pivníc na uskladňovanie vína vyrazených v neogénnom extruzívnom telese Borsuk. Jednotlivé vulkanologické fenomény boli prezentované P. Bačom (obr. 10).

Texty exkurzných sprievodcov po zempliniku a telese Borsuk publikujeme v plnom rozsahu za sprievodcom k predkongresovej gemerickej exkurzii.

Vyvrcholením odborného programu stretnutia CETeG 2012 bolo vyhlásenie víťaza Ceny Radka Melky za najlepší vedecký článok autora do 35 rokov, publikovaný v roku 2011. Víťazom tohtoročnej ceny sa stal Prokop Závada (obr. 6) za článok: Závada, P., Dědeček, P., Mach, K., Lexa, O. & Potužák, M., 2011: Emplacement dynamics of phonolite magma into maar-diatreme structures — Correlation of field, thermal modelling and AMS analogue modelling data. Journal of Volcanology and Geothermal Research, 201, 1 – 4, 210 – 226.

Víťazkou kategórie Najlepší študentský poster prezentovaný na konferencii CETeG sa v roku 2012 stala Lenka Kociánová s posterom Analysis of 3D structures in GIS (obr. 7).

Obidve ceny boli odovzdané výhercom v štýlovom prostredí vínnej pivnice v extruzívnom telese Borsuk vo Viničkách. Po odovzdávaní cien sa A. Żelaźniewicz (Poľsko) v mene účastníkov poďakoval organizátorom podujatia za kvalitný vedecký program a inštruktívne exkurzie. Následne L. I. Fodor pozval účastníkov na ďalšie stretnutie CETeG 2013, ktoré sa uskutoční na budúci rok v Maďarsku.

5. máj 2012
Exkurzia do oblasti východoslovenského úseku Pieninského bradlového pásma

Exkurzia bola zameraná na litologické a tektonické vzťahy širšej oblasti bradlového pásma medzi obcami Jarabina a Litmanová. Vedúcimi exkurzie boli D. Plašienka, R. Vojtko a J. Madzin (obr. 11). Osem exkurzných lokalít je charakterizovaných v príspevku autorov Plašienka et al., publikovanom ako v poradí druhý článok tohto čísla časopisu Mineralia Slovaca. Prvá časť exkurzie – lokality v údolí Hlbokého potoka – prezentovala fáciu tektonitov, tzv. gregoriánske brekcie a lito-biostratigrafický profil cez czorsztynskú sukcesiu. Účastníci následne pretraverzovali pozdĺž jednotlivých vystupujúcich bradiel ponad kameňolom pri obci Jarabina do Jarabinského kaňonu. Východné svahy kaňonu nad tokom Malého Lipníka, v kombinácii s litológiou v neďalekom kameňolome, umožnili interpretáciu duplexnej stavby subpieninského príkrovu. Lokalizácia vrtu Jar-1 a prezentácia vzťahu subpieninského príkrovu a šarišskej jednotky boli prezentované v oblasti bradiel situovaných západne od Jarabinského kaňonu. V oblasti lyžiarskeho areálu pri Litmanovej sa účastníci oboznámili s fáciou karbonatických milpošských brekcií, situovaných v prostredí turbiditných prieskovcov a bridlíc jarmutsko--pročského súvrstvia.

Variscan tectonic setting vs. Alpine overprint in Gemericum (Inner Western Carpathians): Their role in the recent distribution of tectonic units in the eastern part of the territory as expressed in significant localities

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Abstract

Eight localities in the eastern part of Gemericum (Inner Western Carpathians) are presented for explaining the multiple tectonic overprints of Paleozoic and Mesozoic rock sequences.

The south-vergent Variscan collisional closure of the Lower Paleozoic basin caused the origin of the *Rakovec suture zone* with exhumed dismembered ophiolitic suite. The Westphalian age of the collision was supposed by geological criteria, as well as the Westphalian cooling age of clastic mica in the post-collisional Upper Carboniferous (Stephanian) detrital sequence in the North-Gemeric zone.

Two principal Variscan deformation phases are distinguished in the Gemeric domain: VD_1 – the south-vergent Carboniferous exhumation and obduction in the North Gemeric zone (323–275 Ma; origin of the Rakovec geosuture). This phase ended after the pressure release by an extension episode with a less distinct north-vergent sliding/unroofing (275–262 Ma) and the establishing of the Permo-Mesozoic sedimentary basin in the North-Gemeric zone. The following era of dominant south-vergent unroofing (VD_2 phase, 262–216 Ma) resulted in the origin of extended Mesozoic Meliata-Hallstatt basin in the South-Gemeric zone.

The closure of the basin in the South-Gemeric zone (AD_1 phase; Lower Cretaceous; 141–114 Ma) caused the north-vergent imbrication of the Gemeric sequences, overthrusting of Gemericum as a basement nappe on Veporicum, but also a north-vergent transport of superficial nappes including the Meliatic nappe (Bôrka nappe) and Silicic nappe. The transpression kinematics at the beginning of the AD_1 collision prevailed, and the suture zone (Rožňava discontinuity zone) originated. The overthrusting of the basement nappe of Gemericum on Veporicum and the thermal consequences of the thickened crust caused the south-vergent unroofing of the overthrusted Gemeric sequences from Veporicum in the Upper Cretaceous phase AD_2 (107–82 Ma). Due to the recent arc-bending of the contact zone between both megaunits, caused by conjugate shearing in AD_3 phase (76 Ma-recent), the meso- and microstructural evidences of AD_2 unroofing demonstrate apparently opposing vergence – in the western contact zone the unroofing is towards the E and SE, and in the eastern contact zone to the SW. Among the principal conjugate AD_3 shear zones in the eastern part of Gemericum belong the sinistral ENE–WSW trending Transgemeric shear zone and the dextral NW–SE trending Košice–Margecany shear zone, playing the most important role in the recent tectonic setting of this territory.

Key words: tectonics, Variscan, Alpine, Rakovec suture zone, Rožňava discontinuity zone, Opátka, Margecany, Jaklovce, Gelnica, Závadka, Smolník, Šugovská dolina valley, Gemericum, Veporicum, Meliaticum, Silicicum, Western Carpathians

Short review of the geological and tectonic research in the Gemeric domain and its principal results

Long-lasting research in the territory of the Spiš-Gemer Ore Mts., done from the time of the famous Slovak geologist Dionýz Štúr (1868), resulted in the 1980s in establishing of two interpretations of the geological setting of Gemericum.

The results of the first research stream were summarized in the Explanations to the geological map of the Slovak Ore Mts. – Eastern part in the scale 1 : 50 000 (Bajaník and Vozárová, eds., 1983). The early evolution of Paleozoic sedimentary basin is characterized with cyclic flyschoid sedimentation accompanied with synchronous acid, resp. bimodal volcanism during Upper Cambrian to Lower Devonian. Products of this early evolutionary stage were included into the **Gelnica Group (Vlachovo, Bystrý potok and Drnava Fms.).** Younger Devonian-Lower Carboniferous? **Rakovec Group (Štós, Smrečinka and Sykavka Fms.)** consists of rocks originating during changed paleogeographic conditions of prevailing basalt volcanic activity. The volcanosedimentary evolution of the basin has been interrupted in Bretonian phase. Following Carboniferous transgression with shallow-marine sedimentation in the environment of delta fans was reflected in the **Črmeľ** and **Dobšiná Groups** (**Ochtiná, Rudňany, Zlatník** and **Hámor Fms.**), present in the area of the North Gemeric zone. Deepening of the sedimentary basin has activated the volcanic activity with the effusions of paleobasats and volcaniclastics. The termination of the Carboniferous sedimentation with the parallic sequences of **Hámor Fm.** was caused by Asturian phase of epeirogenic character. In Permian (**Krompachy Group; Knola, Petrova hora** and **Novoveská Huta Fms.**), the coarse--detritic material with two horizons of acid volcanism has deposited in differentiated basins in continental conditions. The end of the Permian sedimentation of lagoonal character was followed by the shallow marine sedimentation **(Stratená Group)** in the environment of stable shelf with locally developed zones of pelagic sedimentation.

Upper Paleozoic sedimentation on the south of **Gemericum (Rožňava Fm. of the Gočaltovo Group)** had firstly the character of wild rivers ramifying into alluvial lowland. The margin of the basin **(Štítnik Fm.)** was situated on faults with the occasional volcanic activity. The coastal sedimentation in the conditions of stable shelf continued till the Middle Anisian. In Pelsonian there occurred first tectonic activity, deepening of the sedimentary basin, basic volcanism and gradual sedimentation of rocks included into **Meliata Group**.

Recently the above described research stream has applied the terrane concept (Vozárová and Vozár, 1993, 1996; Vozár et al., 2010). According this, the Gemericum consists of the **Spiš Composite Terrane**, representing a relict of subducted oceanic to intermediate crust, and the **Gelnica Terrane**, being a relic of the forearc basin associated with ensialic volcanic arc on an active continental margin. Lithology and stratigraphy of the Carboniferous-Permian basins reflects the Late Variscan collisional events and southern polarity of Variscan orogeny in the Western Carpathians.

Synchronously with the above presented concept a model of continual Lower Paleozoic riftogenesis on continental crust with the stages of marine transgression, shelf development, rift activation

Fig. 1. The route focussed on Lower Paleozoic sequences of Gemericum (localities 1, 5, 7 – Opátka, Gelnica, Smolník), as well as the multiple overprint in the contact zone of Gemericum with Veporicum (3 – Margecany). The loc. 2 above the Veľký Folkmar village allows a general explanation of general tectonic setting with sceneric view on majority of tectonic units. The differing tectonometamorphic overprint of two types of conglomerates in the North-Gemeric zone is on display at Závadka village (loc. 6). The instructive localities of exhumed Meliaticum are accessible at Jaklovce village (4) in the North-Gemeric zone, as well as in the Šugovská dolina valley (8) in the Southern Gemericum. The base-map is taken from the Google Earth.

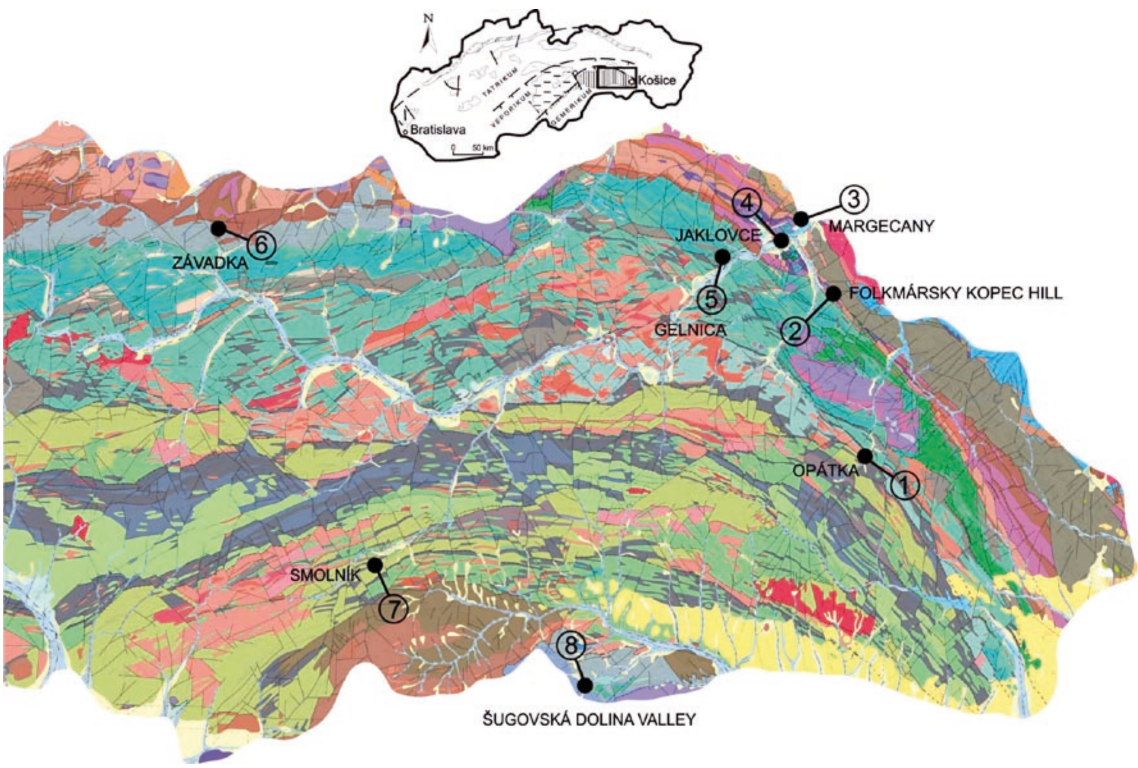


Fig. 2. Position of important geological localities of the eastern Gemericum in the General geological map of the Spiš-Gemer Ore Mts. (Grecula et al., 2009).

and rapid rifting has been developed (Grecula, 1982). Batygenetic phase has finished with volcanic phase. The ground for riftogenic model (l.c.) has been based on time-synchronization of the Lower Paleozoic sedimentary-volcanic activity with generally uniform facial development in the single Lower Paleozoic **Volovec Group**. Geodynamic evolution of sedimentary basin has been reflected in the uniformly distinguished formations for the whole sedimentary space. Lower **Betliar Fm.** is detritic, consisting from the black laminated pelitic-silty phyllites, with lydites and carbonates in the upper part of the formation **(Holec Beds)**. Middle, **Smolnik Fm.** consists of variegated green phyllites and flysch psammitic-pelitic sediments. Volcanic rocks of basalt-keratophyre formation are present at the base of the Smolnik Fm. (Lower Variegated Volcanic Complex). Upper, volcanic **Hnilec Fm.**, is formed with Upper Variegated Volcanic Complex at the base and spatially differentiated volcanic horizon in upper parts. On the north of Gemericum the basic volcanic products prevail, while in the middle and south of the territory the acid and intermediate volcanics of rhyolite, dacite and andesite nature are preferably present. The concept was made more detail in the General geological map of the Spiš-Gemer Ore Mts. at a scale 1 : 50 000 (Grecula et al., 2009) and accompanied Explanations to geological map (Grecula and Kobulský, 2011). The Volovec Group was upgraded to **Volovec Supergroup** consisting of Rakovec Group and Gelnica Group, though the lithological division on Betliar, Smolník and Hnilec Formations in both groups remained preserved after earlier concept (Grecula, 1982 a following works). This division we will apply in the following text.

The south-vergent collisional closure of the Lower Paleozoic basin caused the origin of the Variscan *Rakovec suture zone* (Németh, 2002) with exhumed dismembered ophiolitic suite of the central part of former basin. The Westphalian age of the collision is supposed by geological criteria, as well as the Westphalian cooling age 314.1 Ma of detrital mica in post-collisional Upper Carboniferous (Stephanian) detrital sequence near the town of Dobšiná (Dallmeyer et al., 2006).

Two principal deformation phases were distinguished in the Variscan evolution of the Gemeric domain (Németh in Radvanec et al., 2007), being indicated by the monazite-uraninite isochrones (Konečný, ibid.): VD_1 – the south-vergent Carboniferous exhumation and obduction in the North Gemeric zone (323–275 Ma; origin of the Rakovec geosuture). At the end of this phase after the pressure release an extension episode initiated a less distinct north-vergent sliding/unroofing, revealed by microstructures (Németh in Radvanec et al., 2007; 275–262 Ma). It also indicated the beginning of the origin of the Permo-Mesozoic sedimentary basin in the North-Gemeric zone. The following era of dominant south-vergent unroofing (VD_2 phase, 262–216 Ma) resulted in the origin of extended Mesozoic sedimentary basin (Meliata-Hallstatt basin) in the South-Gemeric zone (Németh in l.c.).

As revealed by overprinting relations and geochronological data, the closure of the basin in the South-Gemeric zone (AD_1 phase; Lower Cretaceous; 141–114 Ma) caused the north-vergent imbrication of the Gemeric sequences, overthrusting of Gemericum as a basement nappe on Veporicum, but also a transport of superficial nappes including the Meliatic nappe (Bôrka nappe) and Silicic nappe. The sinistral transpression kinematics at the beginning of the AD_1 collision prevailed, and the suture zone (Rožňava discontinuity zone) originated. The overthrusting of the basement nappe of Gemericum on Veporicum and the thermal consequences of the thickened crust caused the south-vergent unroofing of the overthrusted Gemeric sequences from Veporicum in Upper Cretaceous phase AD_2 (107–82 Ma; cf. Maluski et al., 1993; Dallmeyer et al., 1996, 2006, a.o.). Because the recent arc-bending of the contact zone between both

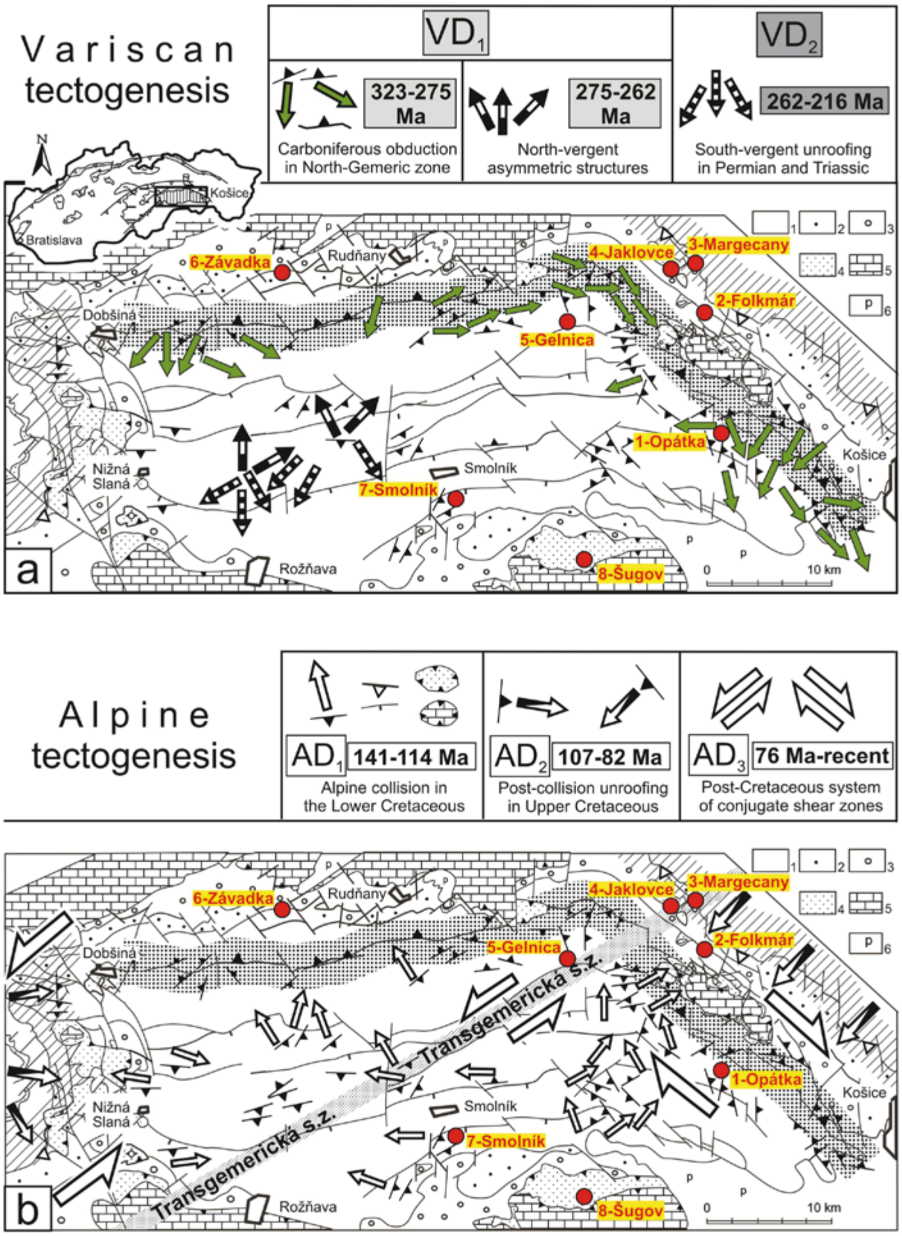


Fig. 3. Kinematics of Variscan and Alpine tectogeneses (Németh in Radvanec et al., 2007) and the position of instructive localities, related to Variscan and Alpine tectonic setting. 1 – Lower Paleozoic sequences of Gemericum; 2 – Carboniferous rocks of Gemericum and in the contact zone of Gemericum with Veporicum; 3 – Permian rocks of Gemericum; 4 – Upper Paleozoic and Mesozoic rocks of Meliaticum; 5 – Mesozoic rocks of Silicicum; 6 – Paleogene.

megaunits, caused by conjugate shearing in AD_3 (76 Ma-recent), the meso- and microstructural evidences of AD_2 unroofing demonstrate apparently contradicting vergence – in the western contact zone the unroofing is towards east and south-east, but in eastern contact zone towards the south--west (Németh, 2002). From the conjugate AD_3 shear zones in presented area of the eastern part of Gemericum the sinistral ENE–WSW trending Transgemeric shear zone and the dextral Košice–Margecany shear zone trending NW–SE (cf. Grecula et al., 1990) play the most important role in the recent tectonic setting of this territory.

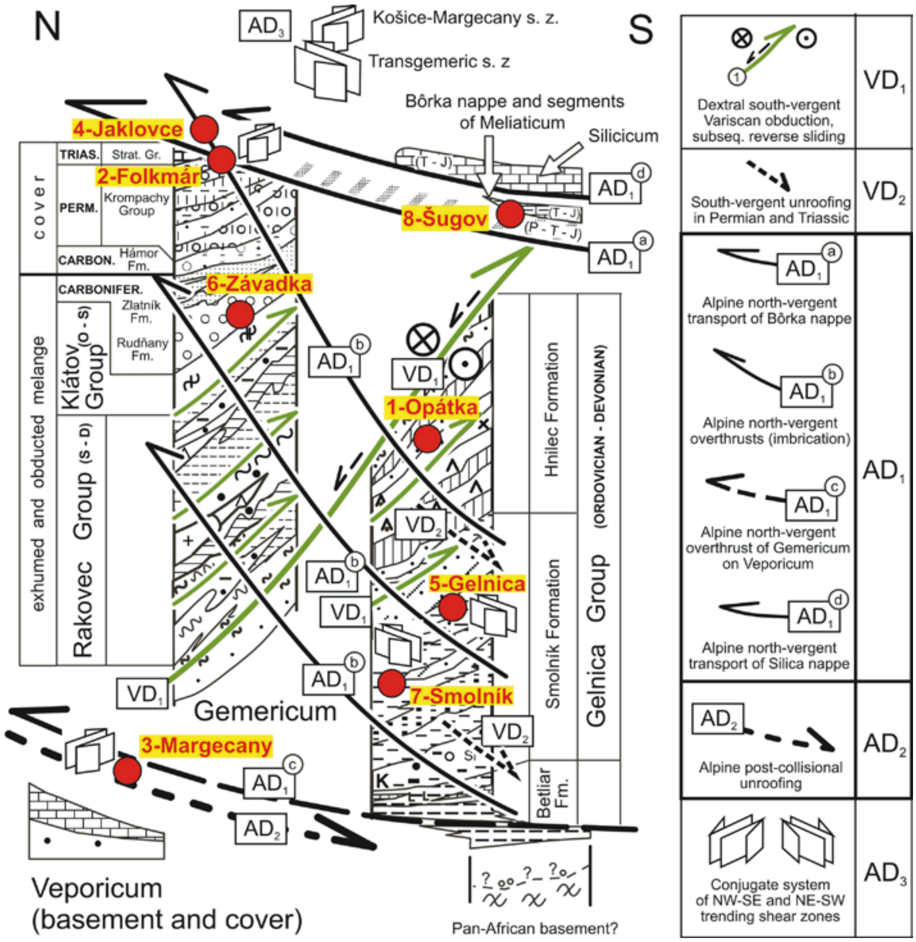


Fig. 4. Lithotectonic relations in the Gemeric domain (modified after Németh, 2005, and Németh in Radvanec et al., 2007) and position of instructive localities covering a wide range of lithotectonic relations.

Important localities demonstrating the geological and tectonic evolution of the eastern part of Gemeric domain

1 – Opátka village – Outcrops of tectonized Lower Paleozoic metapyroclastics of intermediate and acid volcanism of the Hnilec Formation of Gelnica Group in closeness of the Rakovec suture zone. Location at the southern end of the village, 48°47'02.03'' S, 21°03'15.04'' E.

The rocks are located in the footwall position close to the Variscan overthrust plane of exhumed Rakovec Group. The Variscan exhumation is reflected in the NNE to NE dip of primary foliation with ESE trending lineations (VD_1). Numerous asymmetric structures produced in ductile régime demonstrate the dextral south-vergent exhumation. The Alpine AD_1 imbrication is relatively poor due to the rigid overprinted lithology and is observable by rare faults dipping to SW (Fig. 5).

2 – Folkmarský kopec hill – The saddle between the Ružín water reservoir and the village of Veľký Folkmar, the sceneric view from both sides of the state road, 48°50'58.13'' N, 21°01'54.72'' E (Fig. 6).

The view towards the NNW visualizes the position of four principal megatectonic units of the Western Carpathians: Gemericum (the surrounding of observation point), Meliaticum in the North-Gemeric zone in allochthonous position, as well as Veporicum and Tatricum in the backside (the Branisko Mts.). The view to E manifests the Veporicum with its Permo-Triassic and Jurassic cover, as well as Carboniferous and Permian sequences in the outliers of Hronicum located on Veporicum in the apical parts of the hills. The contact between both megaunits – Gemericum and Veporicum – demonstrates multiple overprint by the AD_1 (NE-vergent overthrusting) and AD_2 (SW-vergent unroofing) phases, and moreover it is sheared by the dextral Košice–Margecany (Fig. 7) shear zone of AD_3 phase. In classical interpretations the dividing line between both megaunits was represented by the Lubeník–Margecany line (e.g. Maheľ, 1986), having attributed only overthrusting kinematics (of AD_1 phase).

3 – Margecany – The immediate contact of overthrusted cover sequences of Gemericum on Veporic crystalline basement. The Veporic cover was removed by tectonic reduction during three deformation phases AD_{1-3}. The cut of the state road between Jaklovce and Krompachy near the Margecany church, 48°53'13.39'' N, 21°00'22.27'' E (Fig. 8).

The Veporicum of the Čierna hora Mts. manifests the highly sheared Alpine fold-thrust setting of NW–SE trend. The antiformal core consists of crystalline basement rocks, rimmed by the Upper Carboniferous, Permian, Triassic and Upper Jurassic cover formations. They are overlain by the Choč nappe (Carboniferous-Triassic of

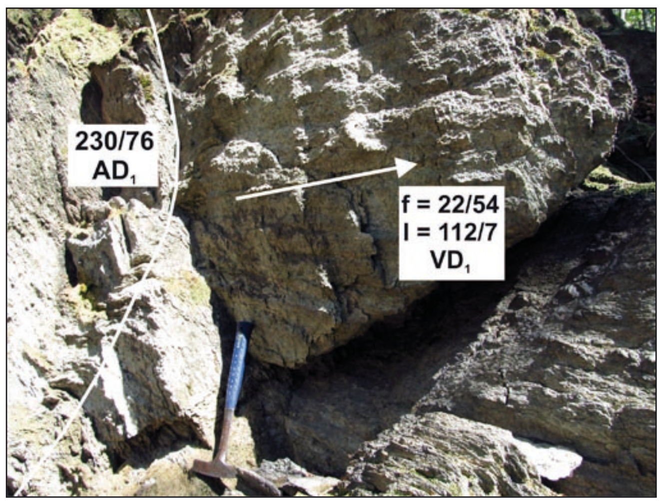


Fig. 5. Ductile VD_1 stretching lineations indicating tectonic transport to SE and brittle-ductile AD_1 faults penetrating earlier setting. Tectonized metapyroclastics of the upper parts of Gelnica Group at the southern end of Opátka village. Photo Z. Németh.

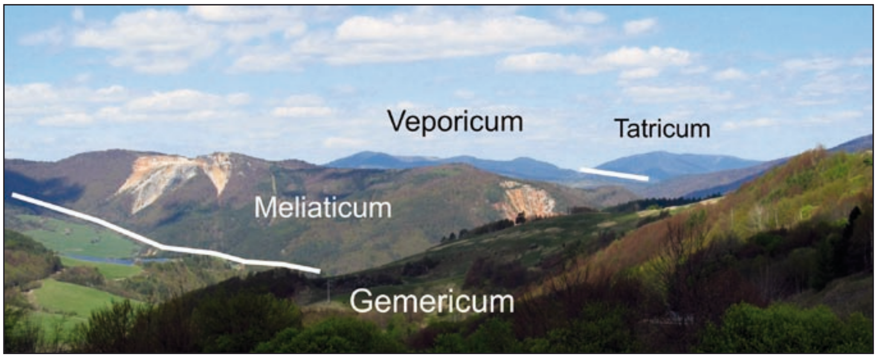


Fig. 6. Panoramatic view to NNW from the Folkmárský kopec hill demonstrates the zonality of the main megatectonic units of the Alpine setting of the Western Carpathians – the nappe outlier of Meliaticum in the North-Gemeric zone, as well as Veporicum and Tatricum in the Branisko Mts. Photo Z. Németh.

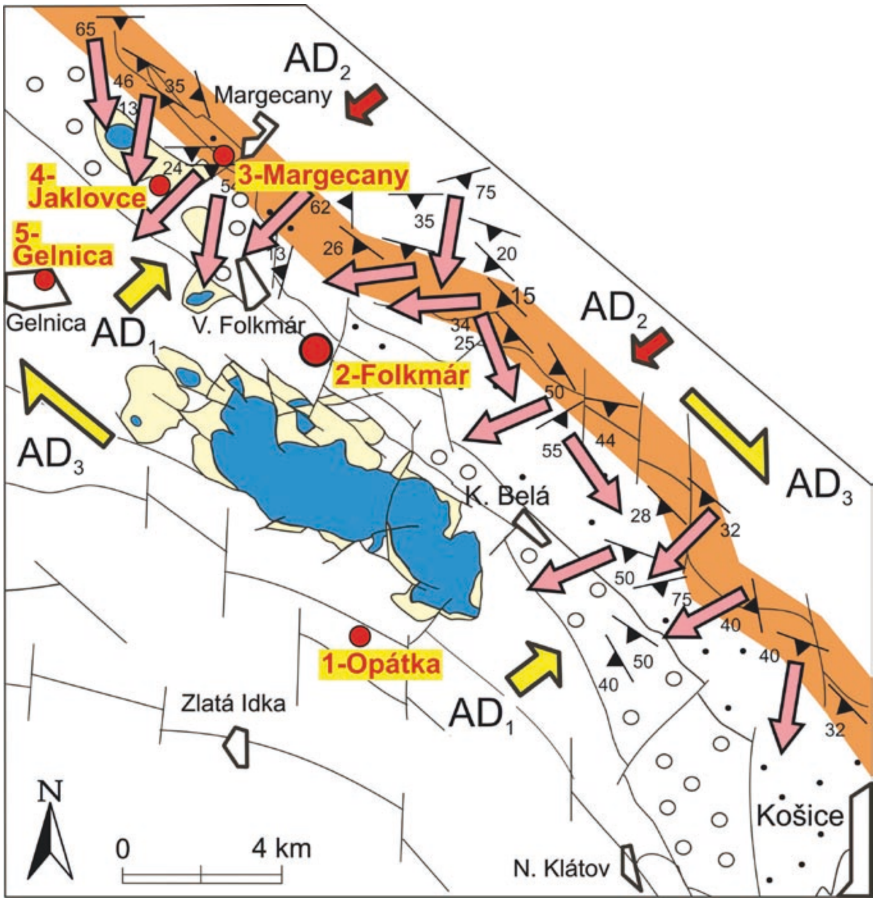


Fig. 7. The study of asymmetric mesostructures and microtectonic indicators, including the LPO of quartzites and calcitic marbles, has revealed the unroofing kinematics of the AD_2 phase, as prevailing ductile deformation regime in the monomineral lithologies of the Veporic cover (Németh, 2001). The lithology in the map corresponds with that in Fig. 3. Locality 2 – Folkmarský kopec hill is visualized by the red circle.

Fig. 8. The overthrust of Gemericum on Veporicum during AD_1 as manifested in the road cut trending SW–NE, i.e. being transversal to the contact zone. The overthrusting is indicated by pervasive mylonitization (S/C structures, porphyroclasts, mica-fishes, shear bands). Despite, also post--collision AD_2 unroofing is observable by asymmetric structures, but the dominating is the dextral shearing during AD_3 reactivating the earlier disjunctive structures. Veporic crystalline basement consists of the Bujanová Complex gneissose diaphtorites and migmatitic amphibolites, having locally preserved Variscan ductile deformation. The Gemericum in the cross-cut (left – SW part of the picture) is built of Upper Carboniferous conglomerates of Hámor Fm., intercalated by greywackes, sandstones and black schists. Height of the view is 6 m.

Fig. 9. In the SE part of the elongated outcrop near the directorate building of the lime-producing factory at the Jaklovce village, the exhumed Meliatic suite is affected by the AD_3 shearing trending ENE–WSW and dipping to SSE (148/60°). Contrary to this, the outcrop located 200 m to SW, as well as the suite in the upper parts of the sequence manifest the older cleavage dipping to NW (318/55°) and corresponding with the bedding and secondary foliation in the quarry in the upper part of the Kurtová skala hill (gen. 330/55°), having proved the position of the allochthonous outlier of Meliaticum (cf. Németh et al., 2012). Orientation of photographs is top to W. Photos by Z. Németh.

Hronicum). The position of this outlier indicates the most probable primary sedimentary area of the Hronicum in the suture between Gemericum and Veporicum, or less probable south of Gemericum.

The Veporic crystalline basement consists of three lithostratigraphical units (Jacko, 1985). The lowermost Lodina Complex is composed mainly of diaphtoritic gneisses (incl. phyllonites) intercalated by thin aphibolite bodies. The Miklušovce Complex is in tectonic overlier, consisting of migmatites and local aplitic-granite bodies. The highest positioned is the Bujanová Complex, rimming prevailingly the SW limb of the antiform (towards the Gemericum), and composed mainly of tabular granodiorite bodies intruded into the gneissose-migmatitic bodies and amphibolites.

Despite the strong Alpine shearing, also the Lower Paleozoic Ar/Ar plateau age was revealed from phyllonite muscovites (Dallmeyer et al., 2006; sample G-9 ibid.; 329.6 ± 0.2 Ma), indicating the preserved remnants of the Variscan south-vergent thrusting inside the crystalline basement – the overthrusting of the Miklušovce and Bujanová complexes on the Lodina Complex. The metamorphic paragenesis of the sample was quartz-muscovite-chlorite-epidote--ilmenite (diaphtorite of gneiss).

4 – <u>Jaklovce</u> – The artificial railway cut in the vicinity of the directorate building of the lime-producing factory, 48°52' 45.87'' N, 20°59'47.45'' E (Fig. 9).

The melange of Meliaticum in the North-Gemeric zone, consisting of ultramafic rocks, gabbros and basalts in the environment of radiolarites and marbles. The allochthonous position of the sequence in the area of the Kurtová skala hill was recently proved by paleopiezometry (Németh et al., 2012), as well as by the principal angular discordance of its NW-dipping exhumation setting, contrasting with the general NW–SE trending AD_{1-3} tectonic plan (l.c.). The internal setting of the succession of silicitic schists with basalt and diastrophic breccia in the Meliatic Jurassic accretion prism cropping out in the presented locality was published by Putiš et al. (2011), providing the new zircon U-Pb SIMS SHRIMP data.

The Middle Triassic beds of reddish and greenish cherty schists, marbles and radiolarites contain thin basaltic tuff interbeds and 3 m thick basaltic bed in the upper part of the sequence. A zircon concordant age of 359 ± 7 Ma is interpreted (l.c.) as the Lower Carboniferous source age of zircon grains, present in this Middle Triassic basalt, because its age is well constrained with the findings of Middle Triassic radiolarites in the hosting Middle Triassic cherty beds. Zircon morphology indicated the S-type (Gemeric) granites as the source rocks. Metabasalts, metadolerites and metacherts, with still preserved magmatic ophitic or amygdaloidal textures, contain actinolite rimmed by ferrowinchite/winchite/riebeckite in metamorphic veins. It indicates a higher-pressure metamorphic overprint that is well-known and dated from the Meliatic Bôrka nappe as the Upper Jurassic (l.c.). Similarly, the thin veinlets with the blue sodic amphibole compositionally close to magnesioriebeckite in this rock sequence were found by Ivan et al. (2009). Probably a short-lasting individual metamorphic phase at elevated pressure (~600 MPa) was responsible for the formation of the magnesioriebeckite/riebeckite veinlets, followed by the pressure relaxation and short metamorphic overprint in the greenschist facies conditions (300 MPa; l.c.). This metamorphic evolution can be interpreted as a manifestation of the Meliata ocean subduction in the Upper Jurassic, when the oceanic rocks were involved into the uppermost part of the subducting slab and subsequently exhumed and tectonized. Moreover, the concept of subduction, exhumation and transport of the rock sequence, recently located as a Meliatic outlier at the village of Jaklovce, is well confirmed by the finding of the highest until revealed differential stresses in calcitic marbles in this suite, reaching 429.55 MPa (Németh et al., 2012).

5 – <u>Gelnica</u> – Plastic deformation of the Lower Paleozoic chlorite-sericite phyllites of the greenschists facies of the Smolník Fm., Gelnica Group, reflects the sinistral shearing directly in the Transgemeric shear zone trending ENE–WSW. Extended outcrop with numerous kinematic indicators, including a-tectonites, allows to study mesostructures in two nearly perpendicular sections – parallel with the AD_3 shearing and perpendicular to this shearing. Road cut 360 m to SW of the main railway station in the town of Gelnica, 49°51'24.43'' N, 20°56'41.34'' E (Fig. 10).

6 – <u>Závadka</u> – Strongly contrasting tectonometamorphic overprint of two conglomeratic facies: the Carboniferous Rudňany Conglomerates (Westphalian) of the Rudňany Fm. of Dobšiná Group exhumed in VD_1 and the cover Permian conglomerates (Knola Fm., Krompachy Group), deformed during Alpine AD_1 imbrication. Outcrops at the Závadka village, north of the village of Nálepkovo. Old quarry in the Rudňany Conglomerates is located at the state road to SE of Závadka, 48°51'42.58''. Extended outcrops of the Permian conglomerates are located to SSW of Závadka, 48°51'42.51'' N, 20°36'53.54'' E (Figs. 11 and 12).

The peculiarity of the polymict Carboniferous Rudňany Conglomerates is their higher pressure metamorphism (Radvanec, 1998) and strong recrystallization, which is striking also in visited locality. In numerous cases the differences among particuliar clasts and the matrix are obscured to such level that a rock obtains an appearance resembling e.g. basalt. The conglomerate consists of clasts of crystalline basement (e.g. gneisses, mica-schists, amphibolites; the most probable is the Veporic basement), as well

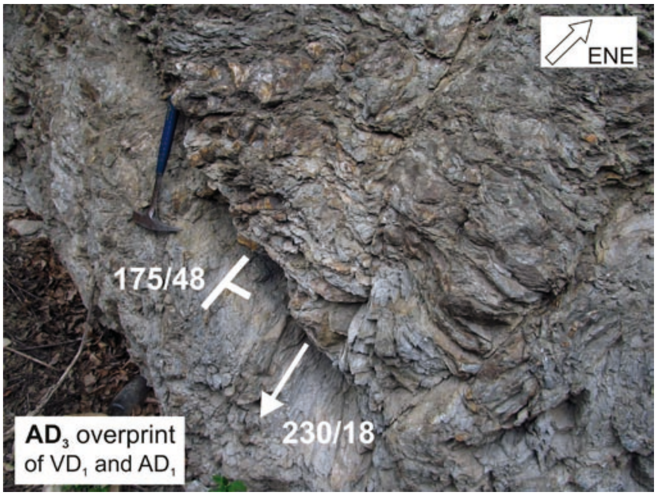


Fig. 10. Alpine AD_3 overprint of former Variscan VD_1 deformation, related to the ESE-vergent overthrusting of the exhumed Rakovec mélange in the hanging wall, and, moreover, being imbricated by the AD_1 north-vergent thrusting. Locality Gelnica. Photo Z. Németh.

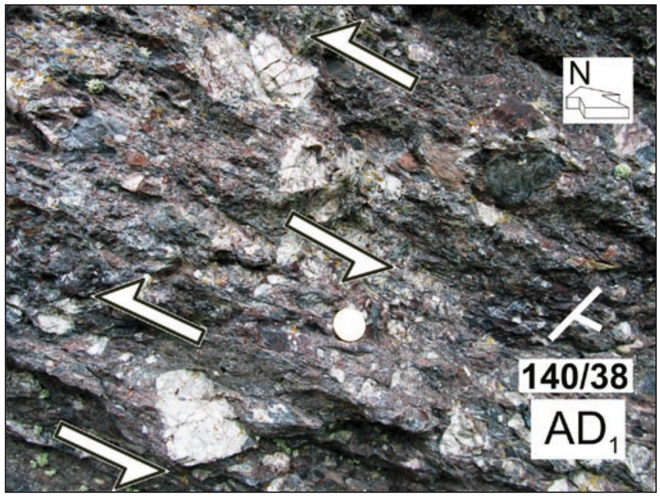
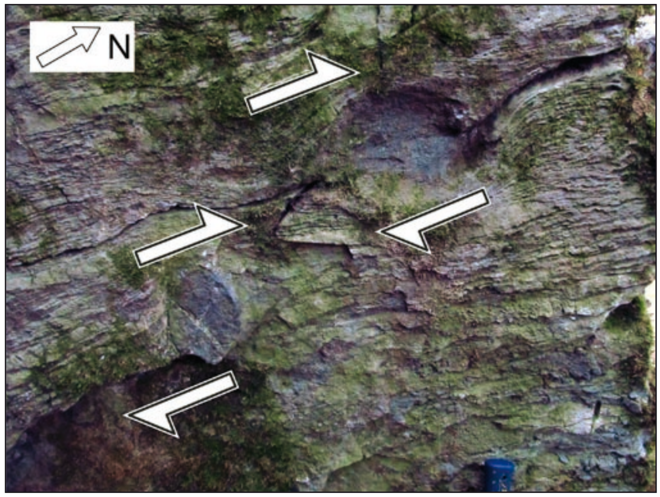


Fig. 12. Brittle-ductile Alpine overprint in Permian cover conglomerates indicates top-to-the NW tectonic imbrication during AD_1 phase Závadka.

Fig. 13. Rotated porphyroclasts of glaucophanites in the calcitic marbles. Besides blue amphibole of glaucophane composition the metabasites contain albite, epidote, phengite, titanite and rarely also garnet, paragonite and Na-pyroxene. At the contact with marble they usually 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 of aegirine composition. Maximum jadeite content found in pyroxene in this locality was 53 mol.% (Faryad and Henjes-Kunst, 1995). Locality Šugovská dolina valley. Photo Z. Németh. ▶



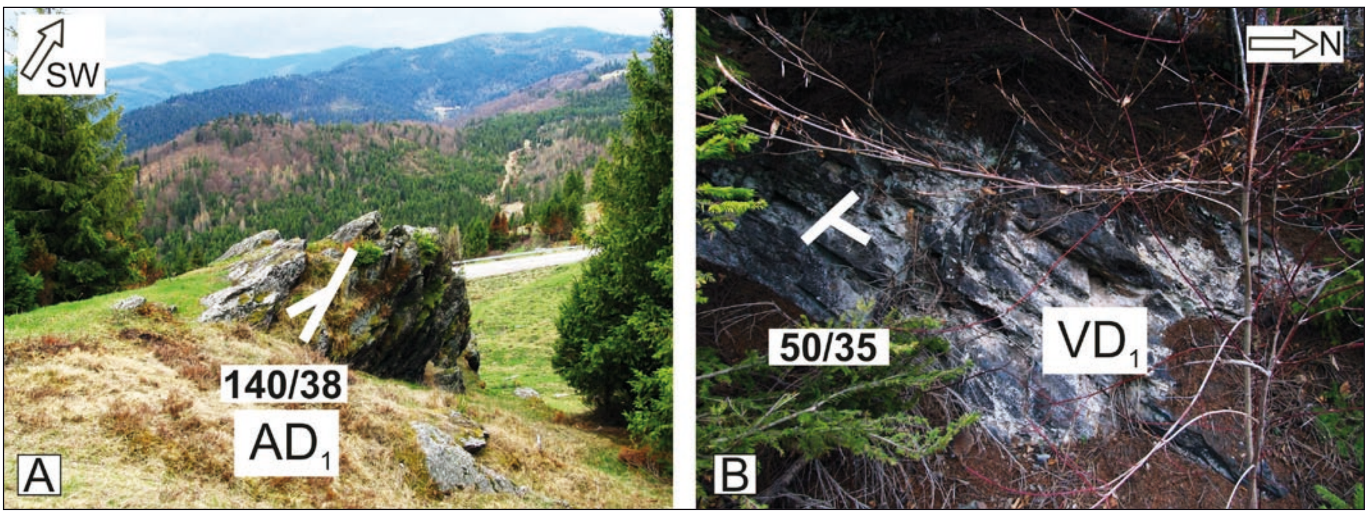


Fig. 11A, B. Contrasting dip of secondary foliation in the Permian conglomerates of the Knola Fm. (**A;** 140/38; imbrication during AD_1), and Carboniferous strongly recrystallized conglomerates of Rudňany Fm. (**B;** 50/35, deformation during Wesphalian exhumation). Locality Závadka.

as lithology close to Rakovec oceanic zone of Gemericum (basalts, green schists), but also of Lower Paleozoic Gelnica Group (e.g. quartz pebbles). The metaconglomerate occurs in two modes of mineral assemblages (l.c.): The first one of M1 metamorphism (Grt_{Alm} + Hbl + Png_1 + Pl_1 + Chl_1 + Rtl_1 + Spn_1 + Ilm_1 + Tur_1 + C + Ap + Qtz) is present in clasts. This mineral assemblage was stable in the younger M2 metamorphism. The second and younger mineral assemblage M2 (Act + Png_2 + Pl_2(Ab) + Chl_{2-3} + Hem + Ti-Hem + Psb + Psr + Ilm_2 + Rtl_2 + Spn_2 + inclusions of Cal in Hem + Tur_2 + Qtz) crystallized in the high-pressure metamorphism of P-T conditions around 12 Kbar, 600–550 °C. The retrograde metamorphism M2 stopped at 8 Kbar and 520–530 °C (l.c.).

There is necessary to mention that in the eastern part of Gemericum also facies of the Rudňany Conglomerates occur, which underwent only diagenesis and a weak metamorphic overprint of greenschists facies. The changes of metamorphic gradient along the strip of Rudňany Conglomerates agree with the concept of non--linearity of geological (convergent) boundaries (Németh, 2003), and indicate their M2 metamorphism as subduction one and a trench as the place where their detritus was cumulated.

7 – Smolník – The Lower Paleozoic chlorite-sericite schists of Smolník Fm. of Gelnica Group in the southern Gemericum, overprint by Alpine shearing and origin of steeply dipping secondary foliation. Outcrops at chapel near the state road app. 500 m south of the town of Smolník; 48°43'26.32'' N, 20°43'59.02'' E.

The outcrop behind the chapel manifests moderate dip to south (180-190/0-30) and numerous kinematic indicators. The double overprint relates to deformation phases VD_1 and AD_1. Following the road to SE the steeply dipping chlorite-sericite quartzy schists are observable of ENE–WSW trend (150/65-90). This position relates with a disjunctive shear zone of AD_3 phase.

8 – Šugovská dolina valley – Exhumed Mesozoic Meliatic suite of glaucophanites and marbles. Rotated glaucophanite porphyroclasts (diameter up to 12 cm) in marbles demonstrate the top-to-the north shearing. Termination of the Šugovská dolina valley app. 600 m to SSE of the Šugov ranch; 48°40'12.43'' N, 20°52'42.43'' E (Fig. 13).

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New knowledge about the geological setting of Zemplinicum in the Zemplínske vrchy Mts.

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Abstract

Article presents new geological and tectonic setting of Zemplinicum, the tectonic unit cropping out in the Zemplínske vrchy Mts. in the southern part of the easternmost Slovakia. The main emphasis is given on lithostratigraphy of the Upper Carboniferous-Permian-Mesozoic cover sequences and Neogene prevailingly extrusive volcanic bodies. The geological setting of the Zemplínske vrchy Mts. is interpreted without the partial nappes, as well as without the lower and upper tectonic slices in the Ladmovce area. The repetition of the Carboniferous and Permian fms. in the deep boreholes in the E side of the territory is interpreted by the faults of the NNW–SSE trend of the overthrust character with steep dip to WSW. Different situation is in the N and NW part of the territory, where in the anthracite deposit Veľká Tŕňa the steep backward thrusts of NNW–SSE trend dipping to ENE were verified. The Zemplinicum in the Zemplínske vrchy Mts. has a block tectonic setting with segmentation by the above mentioned NNW–SSE trending faults, as well as the younger fault system of NE–SW (to ENE–WSW) trends with variegated displacement amplitude.

Key words: lithology, tectonics, Zemplinicum, Zemplínske vrchy Mts., Western Carpathians

The horst of Zemplinicum, cropping out in the Zemplínske vrchy Mts., is located in the southern part of the easternmost Slovakia (Fig. 1). The horst is surrounded by the Neogene molasse sediments, and locally, at the margins and depressions also by the volcanic sequences (Baňacký et al., 1988, 1989).

Zemplinicum consists of crystalline basement and the Upper Paleozoic and Mesozoic cover (Figs. 2–4). The crystalline basement is cropping out only in the area of the Byšta village – the Byšta Complex of the Upper Proterozoic(?) to Lower Carboniferous age. It consists of metamorphosed rocks (gneisses, amphibolites, migmatites), usually tectonized and forming blastomylonites. The non-metamorphosed Upper Paleozoic cover sequences are peculiar in comparison with those in other units of the Western Carpathians (Grecula et al., 1982; Együd et al., 1985; Kobulský et al., 1989, 1992,

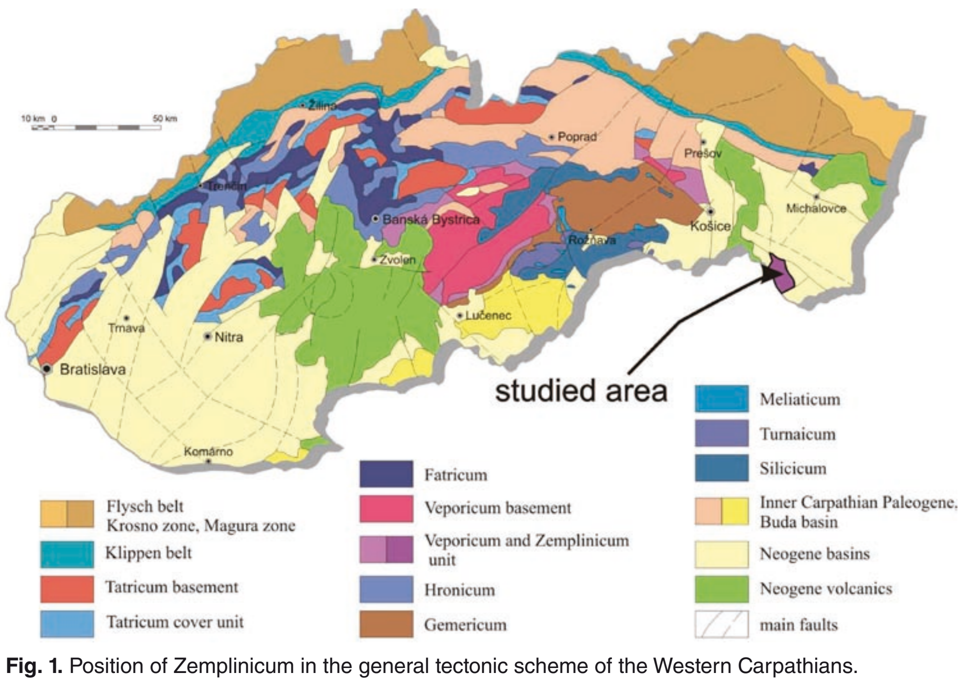

Fig. 1. Position of Zemplinicum in the general tectonic scheme of the Western Carpathians.

2011). The lowermost of the Upper Paleozoic sequences (Fig. 4) are represented by the Čierna hora Fm. (Westphalian C–D). They consist of cyclic alternation of the fine-grained conglomerates, sandstones and schists with interbeds of rhyolite volcaniclastics. The higher deposited Čerhov Fm. is characterized by the cyclic alternation of coarse-grained conglomerates, sandstones and schists, locally with the coal seams (Westphalian C–D) and the Tŕňa Fm. of coal cycles and cyclothemes, where the fine-grained conglomerates, sandstones and schists alternate with the metaantracite seams (Stephanian A–B). The supreme part of the Uppermost Carboniferous was formed by the volcanosedimentary Šimonov vrch Fm. of prevailing sandstones and schists with conglomerates and often rhyolite and rhyodacite volcaniclastic interbeds (Stephanian C–D).

The Lower Permian (Fig. 4) is represented by the Kašov Fm. with characteristic presence of variegated sandstones and shales with conglomerate and rhyodacite volcanic and volcaniclastic interbeds. The Upper Permian is formed with Bara Fm. – polymict

Fig. 2. Tectonic scheme of the Zemplínske vrchy Mts. (Kobulský and Gazdačko in Kobulský et al., 2011) with position of localities 1 and 2, as well as the position of volcanic body Borsuk. Tectonic scheme indicates the principal overthrusts and faults. Two dominating trends of faults were revealed: Faults of NW–SE direction: a – Somotor fault; b – Viničky fault; c – Tŕňa fault; d – Čerhov fault. Faults of NE–SW direction: A – Poľana fault; B – Kapušany fault; C – Zemplín fault; D – Cejkov fault; E – Kašov fault; F – transversal Hrčeľ fault. The detail information about the lithology is available comparing two cross-sections in Fig. 3.

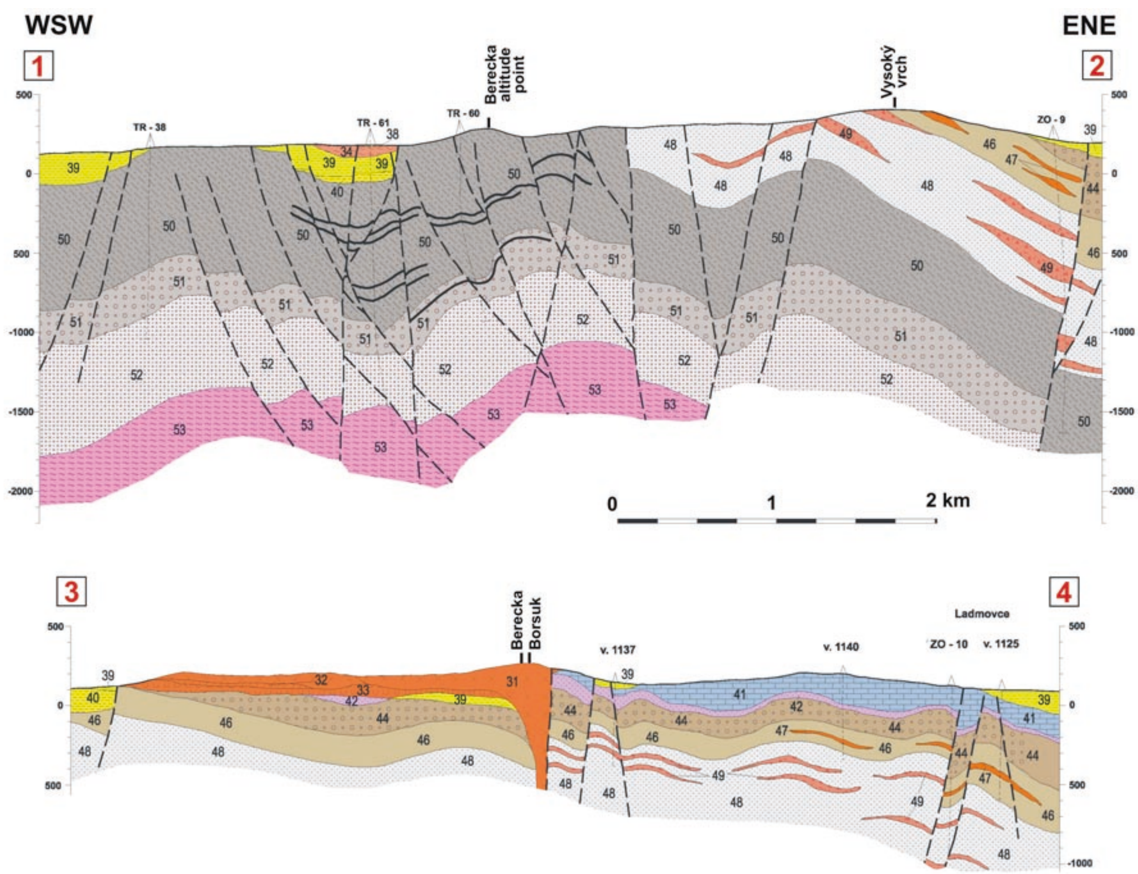

Fig. 3. The cross-sections trending WSW–ENE through the Zemplinicum in the Zemlínske vrchy Mts. (Kobulský and Gazdačko in Kobulský et al., 2011). The numbers of distinguished sequences in the cross-section corresponds with the description at the lithostratigraphic columns in Figs. 4 and 5.

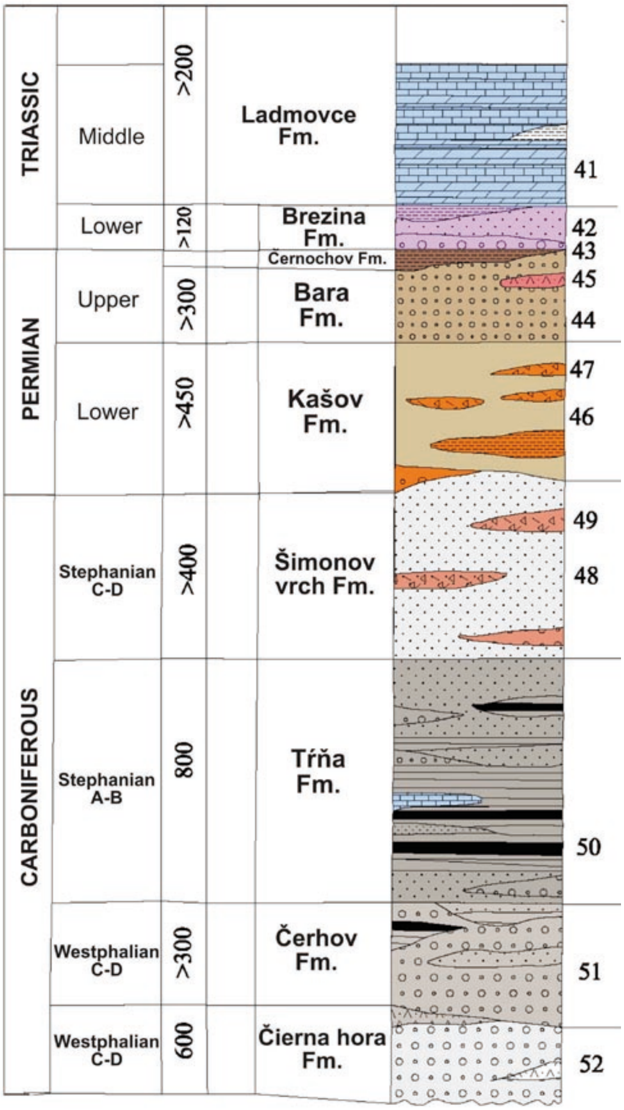

Fig. 4. Lithostratigraphic column of the Zemplinicum cover sequences in the area of the Zemplínske vrchy Mts. (Kobulský and Gazdačko in Kobulský et al., 2011). Lithology: **Ladmovce Fm.** (Anisian – Ladinian): 41 – dark-grey limestones, dark and light dolomites, locally with interbeds of clayey and marly shales, rauchwackes and breccia, **Brezina Fm.** (Lower Triassic): 42 – sandstones, quartzstones, conglomerates, variegated clayey shales, in the upper position the interbeds of dolomite, calcareous shales and gypsum, **Černochov Fm.** (Upper Permian): 43 – Thin-bedded brown-red silty claystones, rare interbeds of conglomerate, sandstone and siltstone, **Bara Fm.:** 44 – polymict conglomerates, variegated sandstones and shales with U-bearing horizon; 45 – interbeds of volcaniclastics (Upper Permian); **Kašov Fm.** (Lower Permian): 46 – variegated sandstones and shales with conglomerate interbeds; 47 – interbeds of rhyolites and their volcaniclastics; **Šimonov vrch Fm.** (Stephanian C–D): 48 – sandstones and shales with interbeds of conglomerates; 49 – interbeds of rhyolites with rhyolite-dacite volcaniclastics; **Tŕňa Fm.** (Stephanian A–B): 50 – cyclic alternation of fine-grained conglomerates, sandstones and dark-shales, often with the coal seams; **Čerhov Fm.** (Westphalian C–D): 51 – cyclic alternation of coarse-grained conglomerates, sandstones and schists, rare coal seams; **Čierna hora Fm.** (Westphalian C–D): 52 – cyclic alternation of fine-grained conglomerates, sandstones and shales with interbeds of rhyolite volcaniclastics.

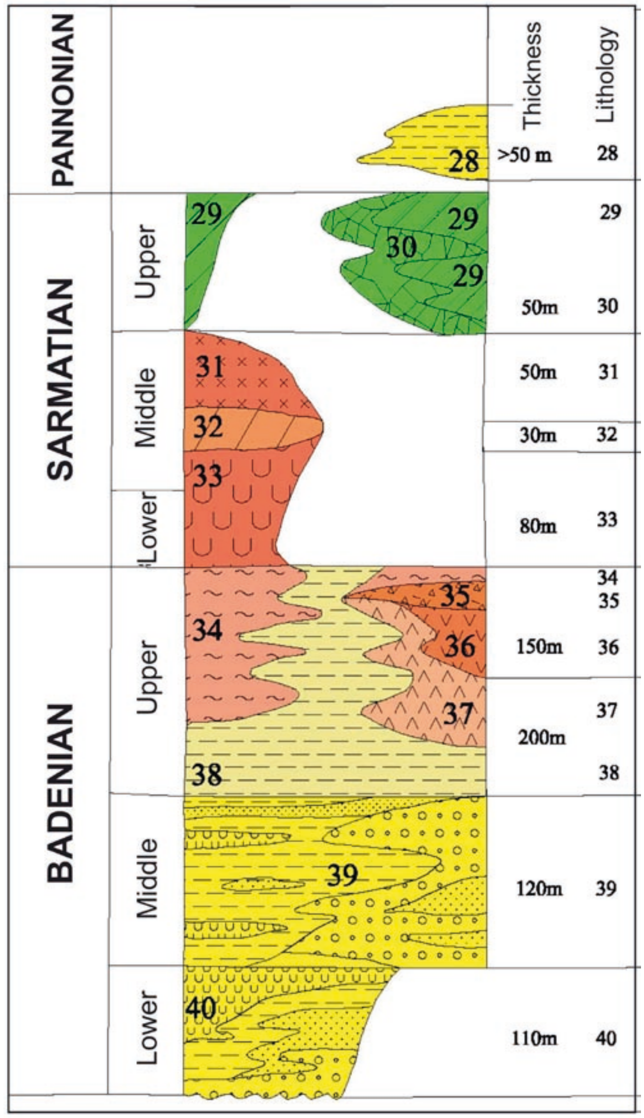

Fig. 5. Lithostratigraphic column of Neogene in the area of the Zemplínske vrchy Mts. (Kobulský and Gazdačko in Kobulský et al., 2011). Pannonian: 28 – **Sečovce Fm.** – grey, brown-grey and patchy clays, calcareous clays; Sarmatian: 29 – lava flows of basaltic pyroxene andesites; 30 – hyaloclastite breccia of pyroxene andesites; 31 – rhyolite extrusions with transition into the lava flows; 32 – perlite; 33 – rhyolite volcaniclastics; Badenian: 34 – rhyodacite pumice tuffs; 35 – redeposited rhyodacite volcaniclastics; 36 – extrusions of coarse-porphyric rhyodacite; 37 – extrusions and lava flows of fine-porphyric rhyodacite; 38 – **Lastomírov Fm.** – calcareous claystones with interbeds of sandstones and siltstones, interbeds of tuffites; 39 – **Vranov Fm.** – calcareous siltstones, sandstones, interbeds of conglomerates, claystones or clays and tuffs; 40 – **Nižný Hrabovec Fm.** – siltstones with interbeds of sandstones and conglomerates, claystones and tuffs.

conglomerates, variegated sandstones and shales with uranium--bearing horizon and rare interbeds of volcaniclastics. The transition from the Upper Permian into the Lower Triassic is represented by the Černochov Fm. with the brown-red silty claystones, locally with intercalations of conglomerates, sandstones and siltstones. The base of Mesozoic is formed by the Brezina Fm. (Lower Triassic) – sandstones, quartzstones, conglomerates, variegated clayey shales, upper interbeds of dolomite, calcareous shales and gypsum. The youngest Middle Triassic Ladmovce Fm. is composed of limestones and dolomites, locally with interbeds of shales. In the SE margin of the Zemplínske vrchy Mts. at the village of Nová Vieska near Bodrog river, the Upper Cretaceous to ?Paleogene age were determined in the Neogene underlier by the borehole, though their enlistment into the Zemplinicum is recently uncertain.

Zemplinicum is covered with the Neogene sediments (Fig. 5) of the Nižný Hrabovec (Lower Badenian), Vranov (Middle Badenian), Lastomírov (Upper Badenian) and Sečovce (Pannonian) formations (calcareous and non-calcareous claystones, siltstones, sandstones, conglomerates, locally with interbeds of tuffs, tuffites, sands, silts, clays and the coal clays).

Besides Carboniferous-Triassic sediments, the geological setting of the territory is formed also by Neogene volcanics, being buried and/or cropping out in the form of extrusions, lava flows and necks: extrusions of coarse-porphyric rhyodacite and rhyodacite pumice tuffs (Upper Badenian); extrusions and lava flows of fine-porphyric rhyodacite and rhyodacite pumice tuffs (Upper Badenian); rhyolite volcaniclastics, rhyolite extrusions with transitions to lava flow, locally perlitized (Lower – Middle Sarmatian); lava flows of basaltic andesites and hyaloclastic breccia (Upper Sarmatian).

The Quaternary cover consists of eolitic and proluvial sediments of the Riss and Wűrm, as well as the fluvial and deluvial sediments of Holocene.

The geological setting of the Zemplínske vrchy Mts. we interpret without the partial nappes as were previously distinguished by Grecula et al. (1982; the Cejkov, Ladmovce and Borša nappes) or by Felber (1991) as the lower and upper slices in the Ladmovce area.

Fig. 6a. Volcaniclastic horizon of the Šimonov vrch Fm. dipping to ENE (72/50), being penetrated by the cleavage system of cm to dm order (175/75). The height of the outrop is 4 m. The road cut south of the village of Malá Tŕňa (Locality 1). Photo Ľ. Gazdačko.

Fig. 6b. Rhythmic alternation of volcaniclastic and siliciclastic beds in the Carboniferous Šimonov vrch Fm. in the road cut south of the village of Malá Tŕňa (Locality 1). Photo Ľ. Gazdačko.

Fig. 6c. Brown-red silty claystones of the Upper Permian Černochov Fms. in the quarry south of the village of Malá Bara (Locality 2). Photo Ľ. Gazdačko.

Fig. 6d. Intercalations of polymict conglomerates in claystones of the Černochov Fm. in the quarry south of the village of Malá Bara (Locality 2). Photo Ľ. Gazdačko.

The repetition of the Carboniferous and Permian fms. in the deep boreholes in the E side of the territory we interpret by the faults of the NNW–SSE trend of the overthrust character with steep dip to WSW (Figs. 2 and 3).

Different situation is in the N and NW part of the territory, where in the anthracite deposit Veľká Tŕňa the steep backward thrusts of NNW–SSE trend dipping to ENE were verified (Kobulský et al., 1992). The Zemplinicum in the Zemplínske vrchy Mts. has a block-type tectonic setting with segmentation by the NNW–SSE trending faults, as well as the younger fault system of NE–SW (to ENE–WSW) trends with variegated displacement amplitude (Kobulský et al., 2011).

To observe the lithology, two localities are suggested as the most instructive:

1 – Malá Tŕňa – outcrop of Carboniferous rhyolite-rhyodacite volcaniclastics of the Šimonov vrch Fm. (Stephanian C-D)

Outcrop of volcaniclastic rocks long ca 60 m is located ca 750 m south of the village of Malá Tŕňa in the western side of the Zemplínske vrchy Mts. (Figs. 6a, b). The beds thick 10 to 30 cm are formed with the light-grey, grey-brown and light-brownish, rarely light-greenish, volcaniclastics (tuffs, ignimbrites, tuffites) and siliciclastics (fine-grained quartzites with thin beds of sericite-, locally sandy shales).

Volcaniclastics – tuffs and tuffites – are formed with very fine-grained and solidified ash with fragments of volcanic class. Fabric is ashy to vitrophyric. The tuffs and tuffites locally contain increased content of sericite. Locally the volcaniclastics have the coarse-grained structure. Matrix was recrystallized at the beginning of vitrification. The rock can be classified as tuffite – ignimbrite. The beds are rarely formed with the crystalloclastic tuff with partially recrystallized matrix. They have angular disintegration.

Siliciclastics are represented by the sericite schists and quartzy sandstones. Schists consist of sericite (ca 80 %, which originated by the recrystallization of illite) and quartz (ca 20 %). Quartzy sandstones are formed of quartz (85 %) and rare plagioclase fragments (5 %). Pebbles are located in the clayey intergranular matrix. The quartz pebbles are rounded to semi-rounded and consist of several types. The quartzy sandstones contain the small pebbles of volcanites, formed with recrystallized volcanic class with small porphyroclasts of plagioclase.

Bedding: 72/50° to 82/30. Penetrative cleavage of cm to dm order and dip 175/75. The joint system 10/85 forms a fan structure. In the outcrop, located more to the south, the penetrative normal fault 216/70 (dip of beds by 25 cm) is accompanied with a complementary system 282/85.

2 – Malá Bara – outcrop of the brown-red claystones with the interbeds of conglomerates and sandstones of the Černochov Fms. (Upper Permian)

Old quarry and a new road cut (with a length ca 60 m) is located ca 400 m to SE of the village of Malá Bara at the SW side of the Zemplínske vrchy Mts.

In the lower part of the quarry the brown-red silty claystones of the Černochov Fm. are prevailing (Fig. 6c), containing dm interbeds of conglomerates (pebbles of quartz and black silicites of 3 cm diameter) and transiting upwards into the medium- to fine-grained sandstones. The upper part of the small cycle with normal gradation is terminated with cm intercalations of the red and green sandy claystones. The supreme parts of the formation in the southern part of the quarry are represented by claystones and siltstones of the redbrown and red colours with rare small concretions of the pink carbonates and thin veinlets of the leafy chlorite.

Conglomerates are fine-grained and formed with semi-rounded to rounded pebbles of quartz, plagioclase and quartzite (65 %; diameter up to 0.5 cm, sporadically up to 3 cm) in the clayey matrix (Fig. 6c). Also rare agate clasts were found. Matrix is clayey with disseminated hematite.

Clayey shales are fine-grained recrystallized hematitic pelites of the brown-red colour without distinct lamination. The matrix contains the small quartz fragments (up to 0.3 mm) and flakes of fine-grained muscovite–sericite. Rarely the clayey shales contain clusters formed by larger grains of quartz and sericitized plagioclase cemented by the clay with small ratio of hematite pigment.

The dip of bedding is 178/45, 164/42 and in southermore occurrences 188/55. Joints: AC_1 = 232/75 to 264/65 – slickensides without lineations, the complementary system AC_2 = 68/85. In the southern part of the outcrop on plane 180/90 a fan structure was found. In the joint 14/60 the striations inclined 6° to west were found.

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Geological evolution of the rhyolite extrusive body of Borsuk – central part – based on documentation of the workings in the wine cellar at the village of Viničky (Zemplínske vrchy Mts., Eastern Slovakia)

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Abstract

Article presents newly excavated underground spaces in the Neogene rhyolite extrusive body of Borsuk in the Zemplínske vrchy Mts., mined for the wine cellars. Numerous volcanological phenomena are shown in photodocumentation with their precise location inside the extrusive body, applying the 3D visualization of underground spaces.

Key words: rhyolite extrusive body, pyroclastic surges, phreatomagmatic pyroclastic flows, autoclastic breccia, lapilli, Neogene, Viničky area, Zemplínske vrchy Mts.

The rhyolite extrusive body Borsuk (altitude point 267 m a.s.l.) is located in the south-eastern part of the Zemplín horst (Fig. 1), north of the Viničky village (Fig. 2). The workings (wine cellars) were dug out for the Tokaj Company Viničky in the basal parts of this extrusive body, built of the horizon of volcaniclastic rocks deposited on their pre-Tertiary basement.

Exploited galleries, regarding their relation to deposit conditions of the volcaniclastic rocks, can be characterized as cross-cuts, directional galleries, inclined galleries, exploitation shaft and “domes” (Fig. 3).

Domes represent atypical workings of the cylindrical shape with a diameter up to 3.5 m, height up to 3 m and approximately hemispherical ceiling. The total length of mined workings located in four horizons is 805.49 m, and, concerning the documentation, also 116.0 m^2 of excavation faces in a total number 17 must be added to this number. The length of the exploitation shaft is 28.5 m (Tab. 1A, B, C, D).

Workings have penetrated the volcaniclastic and extrusive--intrusive rhyolite bodies. A substantial part of the workings was mined in volcaniclastic rocks. Three principal eruption activities, derived from various, distant centres, with relatively numerous particuliar eruption phases were identified, being represented prevailingly by the formation of fallen and flow pyroclastic deposits. They are divided by the hiatus, forming the erosive paleorelief and partial flooding of the former surface. They represent a time boundary between the distinguished 2nd and 3rd stages of volcanic activity.

Among the volcaniclastic rocks the pyroclastic rock types are distinctly dominating. They are represented by the sequences of pyroclastic pumice fluxes in a typical development (Fig. 4). Their total thickness is preliminarily estimated to 15 m. In the stratigraphic underlier of these volcanic surges mainly the thick beds of mainly ashy tuffs occur with thin interbeds of pumice lapilli tuffs (Fig. 5).

In the ash tuffs of the second eruption activity (Fig. 6), the accretionary-enveloped (Figs. 7a, c) as well as armored (Figs. 7b, d) lapilli were identified.

This finding documents the phreatomagmatic type of eruption and deposition in the proximal to distal positions in relation to the eruption centre.

The time hiatus among individual volcanic phases in terrestrial environment (with local occurrence of fluvial environment), are documented by the erosion surface of older volcaniclastic sediments and the occurrence of flora casts in fine-grained tuffitic micaceous sandstones (Fig. 8).

The phreatomagmatic volcaniclastics were deposited on the sand (Fig. 9), consisting of pyroclastic flows and surges – ashy--pumice, debris-flows as well as gravitation flows – avalanches. The dip of the slope of initial conus was 25° to 30°. Characteristic is the presence of polymict fragments, rarely even boulders of underlying Permian sediments (Fig. 10). We suppose that the complex of volcanic and pyroclastic rocks probable belonged to a smaller separate volcano, being later distinctly eroded and covered after the final penetration of the extrusive dome, as well as having probable transition into the lava flow in the direction from the E (NE) to the W (SW).

In the mining spaces, the syngenetic decomposition of the marginal parts of the extrusive dome and its autoclastic breccia has occurred with their subsequent gravitation collapse (Figs. 11 and 12). During these processes, the underlying parts of older pyroclastic sediments were often incorporated in the form of fragments boulders and blocs. Their margins manifest the thermic effects of the surrounding flaming gravitation flow. The origin of perlites in individual fragments and blocks indicates the subaquatic environment during the evolution of the extrusive body.

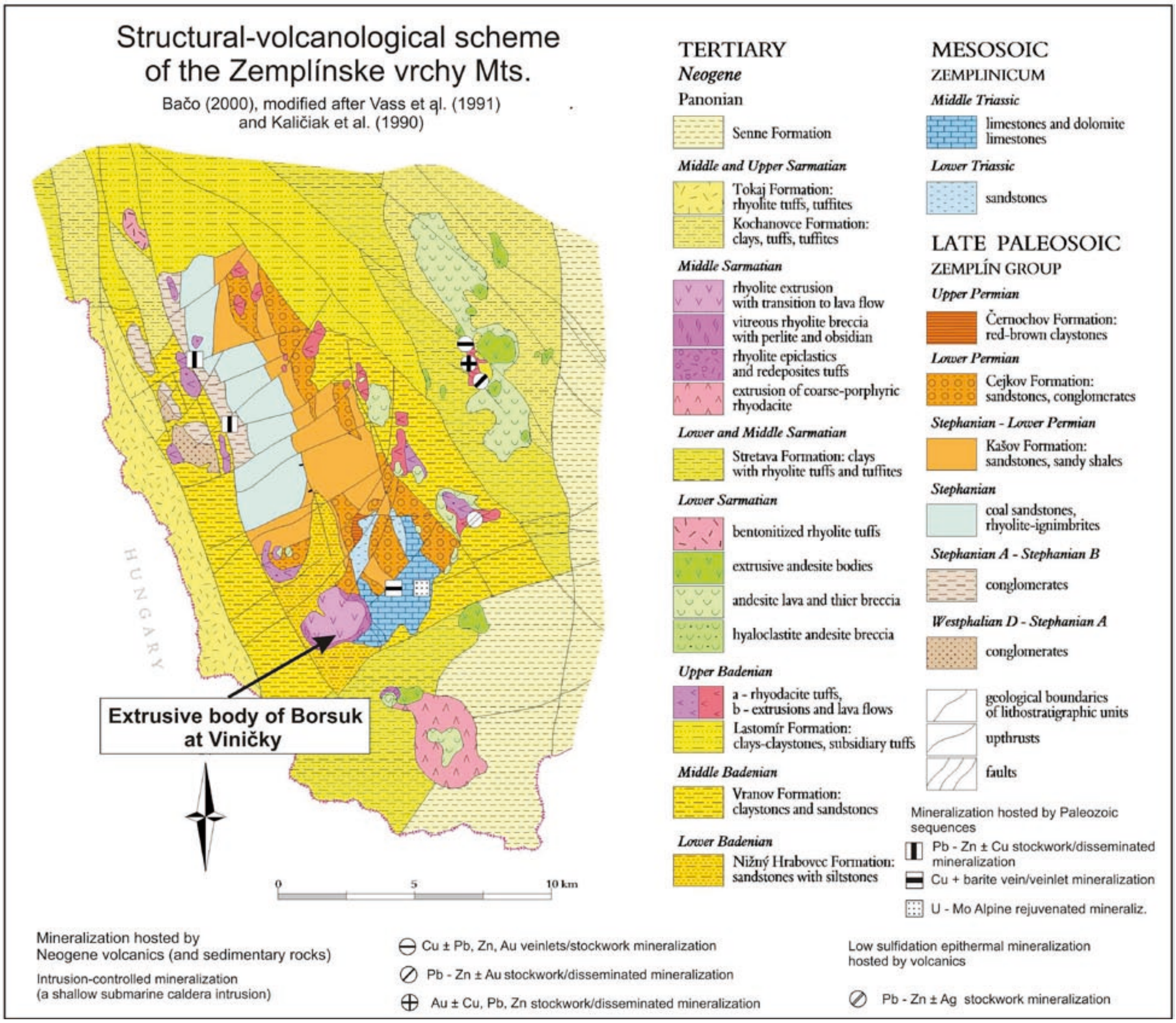


Fig. 1. Position of the extrusive body of Borsuk at the village of Viničky visualized on structural-volcanological scheme of the Zemplínske vrchy Mts. (Bačo, 2000, modified after Vass et al., 1991, and Kaličiak et al., 1990).

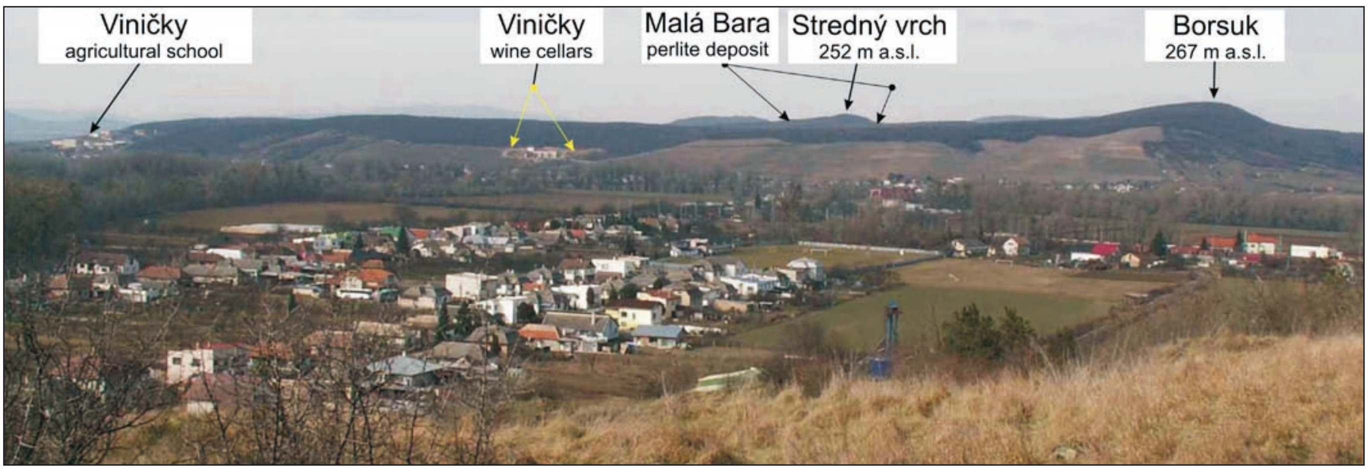


Fig. 2. Sceneric view on extrusive body Borsuk from the south northward. The village of Streda nad Bodrogom is located in the foreground, the village Viničky in the background. Photo P. Bačo.

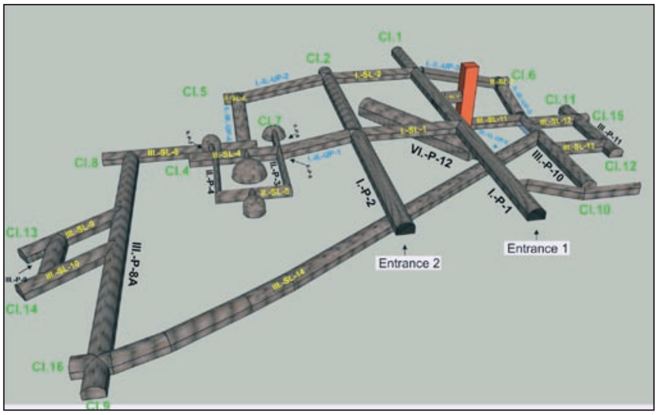


Fig. 3. Viničky – wine cellars. Designation and the space distribution of workings in 3D visualization.

Fig. 4. Sequence of pyroclastic surges. The pyroclastic surge contains a bed of fallen ash with a base surge. Location – Viničky, cellar, III.-SL-14B, left side, 24 m. Photo P. Bačo.

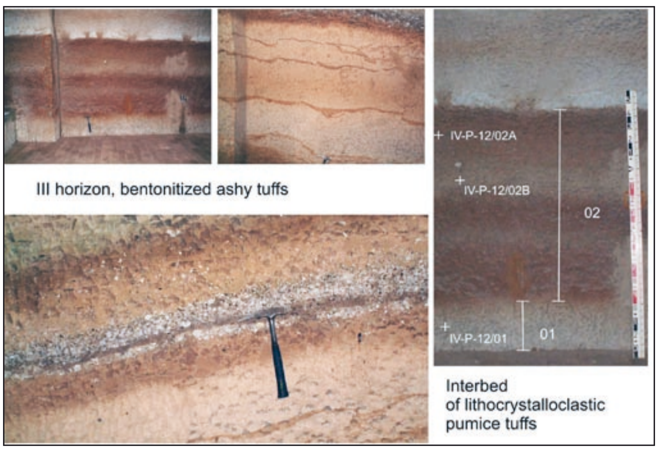
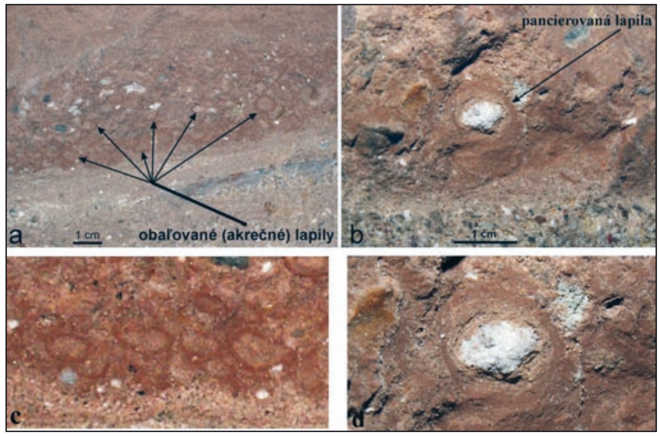


Fig. 5. Bentonitized ashy and pumice-ashy tuffs with distinguished eruption phases. Individual phases are highlighted by the solidification paleosurface. Photo P. Bačo.

Fig. 6. Succession of ashy and pumice–ashy pyroclastic deposits with the presence of accretionary lapilli. Location – Viničky, cellar, III.-SL-8 – Cl8. Photo P. Bačo.



Figs. 7a, b, c, d. Various types of lapilli in the ashy horizon. Location – Viničky, cellar, III.-SL-8 – Cl8. Photo P. Bačo.

Fig. 8. Erosion surface of the underlying ashy rhyolite tuffs. In the tight overlier the tuffitic micaceous sands with the flora casts occur. Location – Viničky, cellar, III.-P-8A3, right side, 10.5 m. Photo P. Bačo.

Fig. 9. Phreatomagmatic pyroclastic flows, surges and dry gravitation flows – avalanches. Dip of the cone slope was 25°. Location – Viničky, cellar, III.-P-8 – Cl9. Photo P. Bačo.

Fig. 10. Polymict fragments and boulders in the slope sediments of the primary cone developed on eroded underlier of the older, mainly ashy, rhyolite tuffs. Location – Viničky, cellar, III.-SL-9B. Photo P. Bačo.

Fig. 11. The gravitation flow of the original autoclastic breccia dragged away the block of the former pyroclastic sediments with the distinct thermic effect of the blazing surrounding environment. Location – Viničky, cellar, I.-P-2 – Cl-2. Photo P. Bačo.

Fig. 12. Detail of the autoclastic breccia with angular shape of fragments to boulders from the various levels of individual bodies, manifesting the gravitation displacement. Location – Viničky, cellar, I.-P-1B, right side, B, 6.4 m. Photo P. Bačo.