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Allochthonous position of the Meliaticum in the North-Gemeric zone (Inner Western Carpathians) as demonstrated by paleopiezometric data

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Abstract

Article presents new paleopiezometric data of calcite marbles, contributing to solution of principal geological and tectonic problem of autochthonous (cover) vs. allochthonous position of carbonatic suite north of the village of Jaklovce in the eastern part of the North-Gemeric zone (Inner Western Carpathians). The Triassic-Jurassic sequences in the Kurtová skala hill are from the 1970s linked with Meliaticum – so-called Jaklovce Meliaticum, but direct tectonic and structural evidences about its allochthonous position were still missing. Moreover, due to the corresponding appearance of both – autochthonous and allochthonous carbonates, the dividing boundary between both complexes is not clearly determined, or even both sequences were put together into autochthonous position with primary lithological transitions.

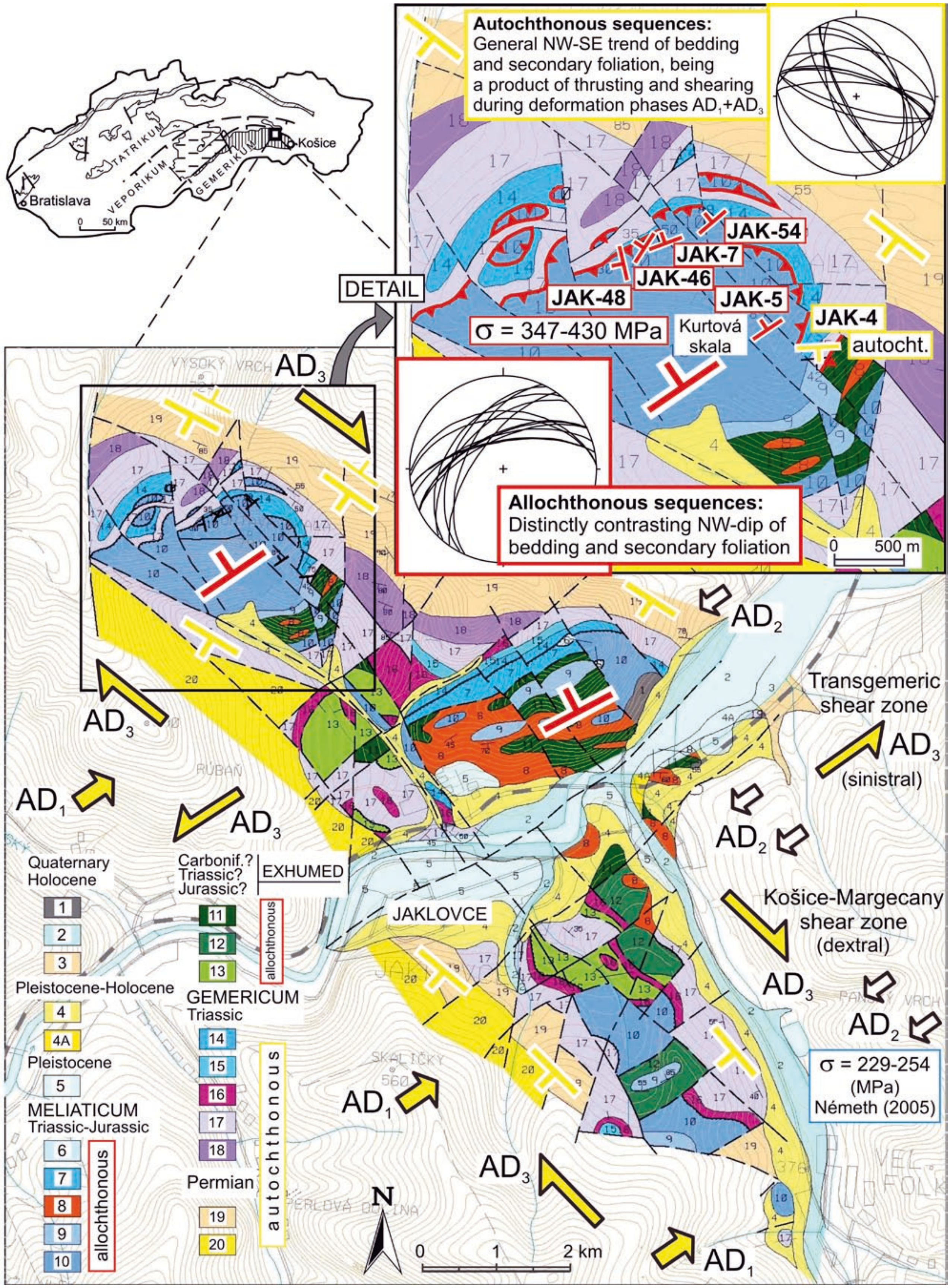
The dynamic recrystallization of the whole volume of allochthonous calcite marbles, being found by our recent research, caused the origin of deformation twins nearly in each calcite grain (Twinning incidence up to 100 %). The high number of deformation twins per 1 mm of perpendicular diameter of the grain (D = 173.05–646.25) at the very small size of grains (23.7 to 42.7 μm) was caused by their recrystallization at high differential stresses σ = 347.49–429.55 MPa. This differs the allochthonous bodies of Meliaticum from those of autochthonous Permo-Triassic cover of the Northern Gemericum, which do not exhibit deformation twins and ductile overprint. This difference simultaneously indicates that the total dynamic recrystallization of allochthonous marbles should occur in conditions of subduction zone, but their post-exhumation transport on autochthonous carbonates without their whole-volume plastic deformation should occur in “could conditions”, corresponding with the transport of the superficial nappe. The exhumed suite (besides carbonates also radiolarites, mafic and ultramafic rocks, etc.,) was overprinted by two principal Alpine deformation phases AD_1 and AD_3 of tectonic imbrication and horizontal shearing, causing the origin of brittle-ductile and brittle disjunctive structures. Despite the overprint, the primary bedding (gen. 330/55) of allochthonous carbonates remained preserved, and contrasts to general NW–SE trending bedding and secondary foliation of autochthonous sequences.

Key words: exhumed suite, tectonic setting, paleopiezometry, Twinning incidence, Twin density, differential stress, Meliaticum, Gemericum, Western Carpathians

Introduction

According to recent knowledge, the rocks of Meliata Unit, being defined in the type locality at the village Meliata in the Slovak Karst (Southern Gemericum; Rožňava suture zone), are represented by mélanges of ophiolites and sediments from the bottom and marginal parts of Triassic--Jurassic Meliata ocean. The rocks were overprinted by metamorphic processes and transported on Gemericum, being a part of the north-vergent Jurassic accretion prism (Mello et al., 1997, 1998, 2000; Németh, 1994, 1996; Ivan, 2002; Ivan et al., 2009; Putiš et al., 2011).

The occurrences of Meliaticum at Jaklovce after biostratigraphic proof of the presence of Jurassic sequences in this zone (Kozur and Mock, 1995), were firstly interpreted in autochthonous position as a part of so-called northern branch of the Meliata ocean (with Gemericum as an island between both branches). Later there prevailed the interpretations of the Meliatic tectonic outlier in the North-Gemeric zone, consisting of relatively thick Jurassic schistose formation with olistoliths and olistostromes of older, mainly Permian-Triassic formations, including metabasalts (Kamenický, 1957; Mock et al., 1998 – the Jaklovce Formation, Hovorka and Spišiak, 1998; Faryad et al., 2005), metasilicites and serpentinites. The ultramafic rocks located in this outlier at Jaklovce (Jacko in Polák, 1997) form isolated bodies either in the sandy-schistose sequence or at the contact with overlying Middle Triassic


Autochthonous sequences:
General NW-SE trend of bedding and secondary foliation, being a product of thrusting and shearing during deformation phases AD1+AD3
Allochthonous sequences:
Distinctly contrasting NW-dip of bedding and secondary foliation
σ = 347-430 MPa
JAK-54
JAK-7
JAK-46
JAK-48
JAK-5
JAK-4
autocht.
Kurtová skala
0 500 m
DETAIL
Košice
Bratislava
TATRIKUM
VEPORIKUM
GEMERIKUM
0 50 km
AD1
AD2
AD3
Transgemeric shear zone
(sinistral)
Košice-Margecany shear zone
(dextral)
σ = 229-254 (MPa) Németh (2005)
JAKLOVCE
Quaternary Holocene
Pleistocene-Holocene
Pleistocene
MELIATICUM Triassic-Jurassic
allochthonous
Carbonif.? Triassic? Jurassic?
EXHUMED
GEMERICUM Triassic
Permian
autochthonous
0 1 2 km
N

carbonates, as well as they are infolded or tectonically placed inside the carbonate sequence (cf. Radvanec, 2000). The petrological research (l. c.) revealed their complex exhumation trajectory and defined them as the ultra-high pressure metamorphosed peridotite. The higher--pressure metamorphism of exhumed blocks of Meliaticum in the Jaklovce zone is indicated also by the finding of magnesioriebeckite to riebeckite, resp. ferrowinchite in metabasalt veins and metasilicite by Ivan et al. (2009) and Putiš et al. (2011), but even by the finding of three occurrences of retrograde eclogite in association with metaperidotite and metagabbro by Radvanec et al. (2011).

Used methodology

Geological mapping and reambulation of existing maps

The compiling of a new geological map of the Meliaticum and underlying sequences north of the village Jaklovce was based on prior archive retrieval of old maps and the results of old drilling works (Kobulský and Gazdačko in Radvanec et al., 2011). New geological mapping allowed to compile a new map at a scale 1 : 25 000, reflecting new findings concerning lithology of distinguished rock sequences and their tectonometamorphic overprint.

Meso-scale structural analysis and lithotectonic observations

Outcrop-scale structural research consisted from registration of planar and linear structures and determining of overprinting relations of individual structures. Deformation gradient of rocks was investigated also among particular outcrops in in-situ samples of the debris. Computer processing of data led to construction of stereograms with separated structures attributed to particular tectonic events. Oriented representative samples were taken from outcrops, attempting to cover the complete range of lithological types of various deformation gradients.

When considering the Alpine deformation overpring in investigated area (and s.l. the whole eastern part of the North-Gemeric zone), the following earlier defined deformation phases were applied (cf. Németh, 2002 and following works):

AD_1 – Lower Cretaceous N-vergent (in our studied territory NE-vergent) thrusting and imbrication of pre-Cretacesous sequences related to collisional ovethrusting of Gemericum on Veporicum.

AD_2 – Upper Cretaceours post-collisional unroofing due to the metamorphic core complex dynamics and gradual uplift of superposed megaunits; in the eastern contact zone of Gemericum with Veporicum the unroofing is trending to SW.

AD_3 – Tertiary; conjugate system of regional shear zones trending NW–SE and NE–SW. In the eastern part of the contact zone the NW–SE trending shearing is dominant along the Košice–Margecany shear zone (cf. Grecula et al., 1990). The Jaklovce area is affected also by the ENE–WSW trending Transgemeric shear zone (l. c.). The very complicated tectonic puzzle originated by this way at the Jaklovce village (cf. Fig. 1).

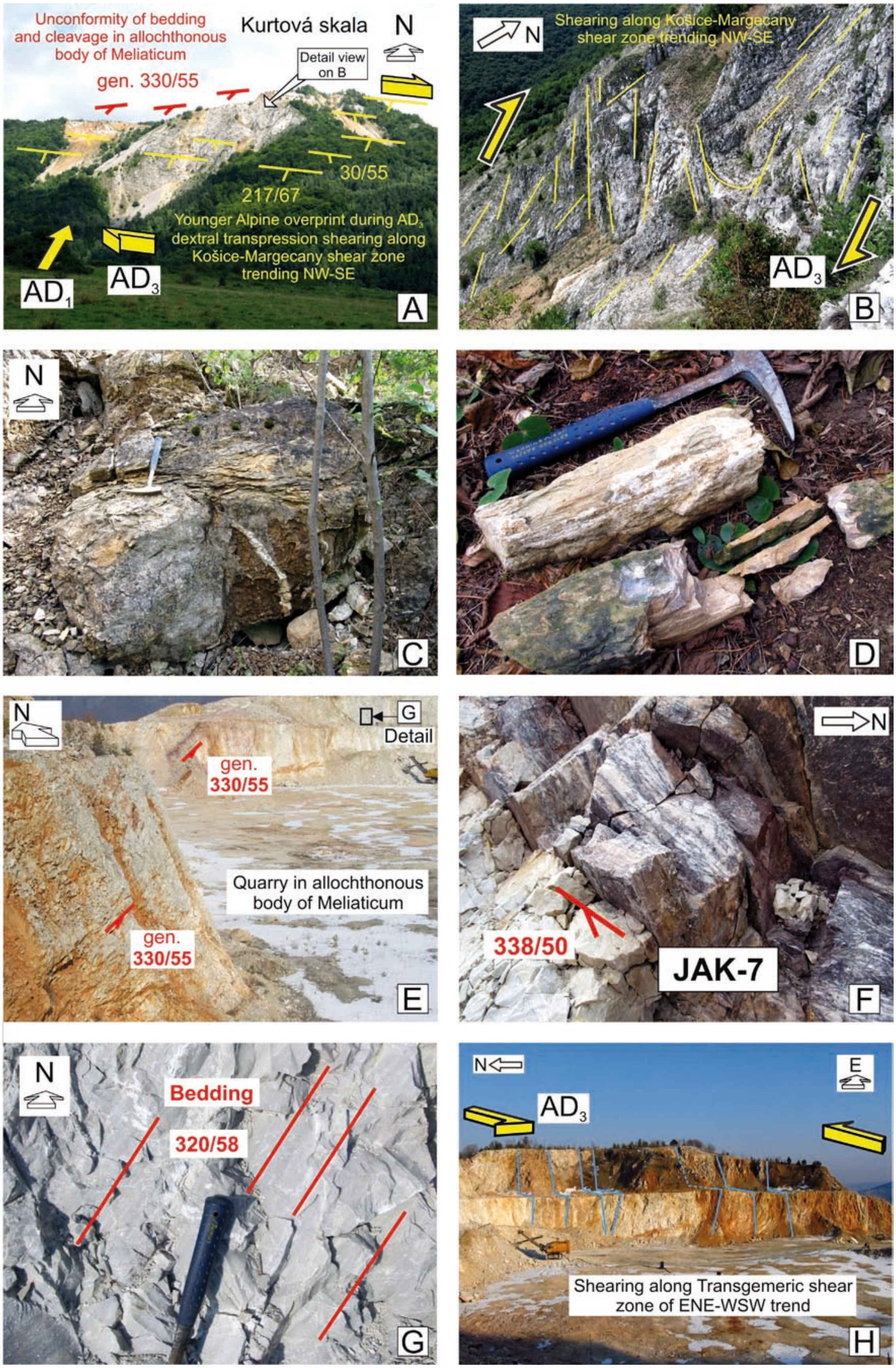
Paleopiezometry

Paleopiezometry applied on calcitic marbles represented the principal investigation method, attempting to find criterion for distinguishing of autochthonous and allochthonous carbonates. Its application was motivated by the earlier finding of a very high differential stress recrystallization in one sample from the Kurtová skala hill (396.66 MPa) by Németh (2005).

The numeric determining of differential stresses in MPa, based on calcite paleopiezometry, takes into account the size of dynamically recrystallized calcite grains, but also the number and character of deformation twins. We used two independent numeric procedures based on *Twinning incidence* and *Twin density* methods (Rowe and Rutter, 1990). Final processing followed the methodology by Németh (2005), by this way allowing to compare new results with previously found differential stresses from three principal shear zones in the Gemeric region.

Twinning incidence, I_t, is defined as the percentage of grains of the distinguished size interval that demonstrate

◀ **Fig. 1.** Position of Meliaticum in the North-Gemeric zone and direction of principal thrusting (AD_1, top-to-the NE), unroofing (top-to-the SW; more external – relates the contact of superunits Gemericum and Veporicum, AD_2; Németh, 2002), as well as conjugated NW–SE trending dextral shearing (AD_3, Košice–Margecany shear zone; Grecula et al., 1990) and NE–SW trending shearing (Transgemeric shear zone, l. c.). Geological map is taken after Kobulský and Gazdačko in Radvanec et al. (2011). The map, as well as detail of the Kurtová skala hill visualize the angular discordance of NW-dipping bedding in allochthonous bodies with the general Alpine structural plan of NW–SE trend, including NW–SE trending bedding of sequences in the North-Gemeric zone. The differences are shown in two stereograms (lower hemisphere; each plane represents one outcrop). Detail shows the position of the oriented samples of carbonates, being studied by calcite paleopiezometry. JAK-4 represents the autochthonous limestone in the tectonic window SE of the quarry and JAK-5, JAK-7, JAK-46, JAK-48 and JAK-54 the calcitic marbles of allochthonous body of Meliaticum. *Lithology: Quaternary – Holocene:* 1 – anthropogeneous deposits, dumps; 2 – fluvial loams, alluvial sandy and gravel loams; 3 – proluvial loams with gravels and rock fragments. *Pleistocene--Holocene:* 4 and 4A – undivided deluvial sediments and debrises. *Pleistocene:* 5 – fluvial sandy gravels of terrace accumulations and the Wurmian. *Meliaticum: Triassic – Jurassic:* 6 – claystones, siltstones, sandstones – radiolarites, locally with belemnites (Middle Jurassic); 7 – dark-grey nodular limestones, marly schists, grey limestones with schistose interbeds (Carnian – Upper Ladinian); 8 – red and green quartzy schists, silicites (with radiolarians), limestone interbeds (Upper Anisian – Middle Jurassic?); 9 – grey, dark-grey cherty limestones with interbeds of red limestones and schists (Upper Anisian – Lower Ladinian); 10 – light and light-grey bedded limestones (Anisian – Lower Ladinian). *Carboniferous?-Triassic?-Jurassic?:* 11 – coarse- to medium-grained gabbro, fine-grained amphibolite; 12 – retrograde eclogite; 13 – metaperidotite, metalamprophyre. *Gemericum – Triassic:* 14 – light-grey, grey and dark-grey dolomites (Lower Anisian); 15 – dark-grey and grey limestones (Lower Anisian); 16 – rauchwackes, rauchwacke dolomites and limestones (Lower Anisian); 17 – green and grey--green calcareous shales and sandstones with interbeds of grey marly limestones (Scythian); 18 – variegated shales and sandstones with rare interbeds of quartzites and limestones (Scythian), *Permian* (Krompachy Group of Gemeric cover): 19 – sandstones, shales, locally evaporites and conglomerates; 20 – sandstones, shales, conglomerates, rhyolites, dacites, andesites and their pyroclastics.


Unconformity of bedding and cleavage in allochthonous body of Meliaticum
Kurtová skala
N
Detail view on B
gen. 330/55
30/55
217/67
Younger Alpine overprint during AD3 dextral transpression shearing along Košice-Margecany shear zone trending NW-SE
AD1
AD3
A
N
Shearing along Košice-Margecany shear zone trending NW-SE
AD3
B
N
C
D
N
G
Detail
gen. 330/55
Quarry in allochthonous body of Meliaticum
gen. 330/55
E
N
338/50
JAK-7
F
N
Bedding
320/58
G
N
E
AD3
Shearing along Transgemeric shear zone of ENE-WSW trend
H

microscopically visible twins. In our case the very small grains required the high magnification (objective x25, eyepieces x12.5; total magnification x312.5). Altogether 240 grains were measured in each sample. The value of differential stress $\sigma(\sigma_1-\sigma_3$; MPa) was determined by following equation, where d represents the size of grains in μm:

$$\sigma = 523 + 2.13\ I_t - 204 \log d\ [\text{MPa}]$$

Twin density, D, is defined as the number of twins regarding the grain diameter, measured perpendicularly to the twins. Input data were restricted by the variation coefficient 0.25 (Ranalli, 1984). The relation of differential stress on twin density D is as follows:

$$\sigma = -52.0 + 171.1 \log D\ [\text{MPa}]$$

To guarantee the maximum representativeness of data, measurements were done systematically on profiles through oriented thin sections, taking into account each neighbouring grain.

Obtained data

Meso-scale structural analysis

New geological mapping and structural research confirmed the prevailing NW–SE trending outcrop-scale planar structures (bedding – the primary foliation, in schistose formations usually reactivated with the origin of the secondary foliation, cleavage and more extended dislocations; Fig. 1 – upper stereogram in the detail map). Prevailing dip of the primary and secondary foliation was to SW (generally 217/67°), with minor opposite dipping planes (gen. 30/55°; Figs. 2A, B). The succession of the meso-scale structures confirmed the previous extended regional structural research of this research team in eastern Gemericum (cf. Németh, 2002; Gazdačko, 1994; Grecula et al., 1990) and the Alpine dextral transpression shearing along the Košice–Margecany shear zone has attributed the crucial role in forming of the recent course of lithological units in the eastern part of the North-Gemeric zone. This shearing is attributed to AD_3 deformation phase (Tertiary, cf. division of Alpine deformation phases in Németh, 2005; Figs. 1 and 3 ibid.). The maximum shearing was localized along the boundary of Gemericum with underlying Veporicum app. 2 km to NE of studied area, so the horizontal stretching lineations trending NW–SE usually were not distinct in the studied area of the Kurtová skala hill. The NW–SE trending shearing preferably used the disjunctive structures of previous tectonic phase AD_1 (NE-vergent imbrication, Lower Cretaceous, cf. l. c.). The effects of the AD_2 phase (SW-trending Upper Cretaceous unroofing in the eastern contact zone of Gemericum with Veporicum) were not revealed in the studied area because of their location close to tectonic contact of both units 2 km to NE of the Kurtová skala hill.

The distinctly differing structural inventory was found in the quarry located in the apical parts of the Kurtová skala hill, where also oriented samples of calcitic marbles for the paleopiezometric investigation were taken (Fig. 1 detail and general map; Figs. 2E–G). The bedding (generally 330/55°) manifested a principal angular unconformity with the dominant NW–SE trending structural plan of the Jaklovce area. As revealed by microstructural research and paleopiezometry, this bedding concerned the calcitic marbles with strong dynamic recrystallization, representing allochthonous (nappe) outlier. This whole-volume bedding azimuth and dip parameters hardly can be attributed to shearing along the Transgemeric shear zone of ENE–WSW direction, which applies in the quarry with steeply dipping brittle faults (AD_3 conjugate system; Fig. 2H), penetrating marbles with earlier ductile recrystallization (and bedding).

Attempting to found the displacement plane between autochthonous and allochthonous rock sequences, we found large rounded blocks of silicitic rocks and carbonates (Fig. 2C), but also ultramafics, which indicate the prior exhumation kinematics. Strongly stretched limestones and silicitic rocks were found only in the debris along the basal parts of the Kurtová skala hill, so no spatial orientation of tectonic transport could be attributed by the impossibility to learn their in-situ (outcrop) orientation (Fig. 2D).

Paleopiezometry

Six studied fine-grained limestones from the apical part of Kurtová skala hill (Fig. 1 Detail) encompassed five calcitic marbles with strong recrystallization (JAK-5, JAK-7, JAK-46, JAK-48, JAK-54) and one sample, taken on the

◀ **Fig. 2.** Field-scale evidences of the allochthonous position of Meliaticum in the Jaklovce zone. **A** – The Kurtová skala hill consists of strongly recrystallized calcitic marbles (being recently exploited in the quarry), as well as the suite of mafic and silicitic rocks in eastern continuation of the hill. The allochthonous sequences were together with their underlier overprinted by the north-vergent Alpine thrusting (AD_1), but mainly by the AD_3 dextral shearing in the Košice–Margecany shear zone. General trend of planar structures (217/67, 30/55, visualized by the yellow signs) is tied with phases AD_1-AD_3, but reflects also the general trend of bedding in this zone. Contrary to this, the planar structures dipping to NW (330/55; bedding, often reactivated by secondary cleavage; red coloured), represent an unconformity with the AD_1–AD_3 tectonic plan and are remnants of the pre-AD_1 evolution. **B** – View on the unforested southern steep slope of the Kurtová skala hill from the upper edge of the quarry indicates numerous disjunctive structures related with AD_3 shearing. **C** – At the base of allochthonous body numerous rounded blocks were found, consisting mainly of silicites, radiolarites and mafic/ultramafic rocks. **D** – Shearing during displacement of allochthonous body is indicated also by stretching of rocks. **E** – The NNW side of the quarry demonstrates the bedding dipping to NW, being usually reactivated with the origin of secondary cleavage (gen. 330/55). The NNW side of the quarry is bearing several decimetres wide shear zone with fragmented calcitic marble, being penetrated by the Fe-bearing fluids. This shear zone is supposed to represent the pre-AD_1 structure (detail in F); **F** – detail of the shear zone being penetrated by the Fe-bearing fluids of pre pre-AD_1 phase. Note – the orientation of photo F is nearly opposite to that in photo E, the dip of the shear-zone is to NW and corresponds to that in photo E. **G** – Bedding of dynamically recrystallized marbles in the NNE side of the quarry. **H** – The allochthonous bodies of Meliaticum in Jaklovce zone were penetrated also by disjunctive structures related with the Transgemeric shear zone and trending ENE–WSW.

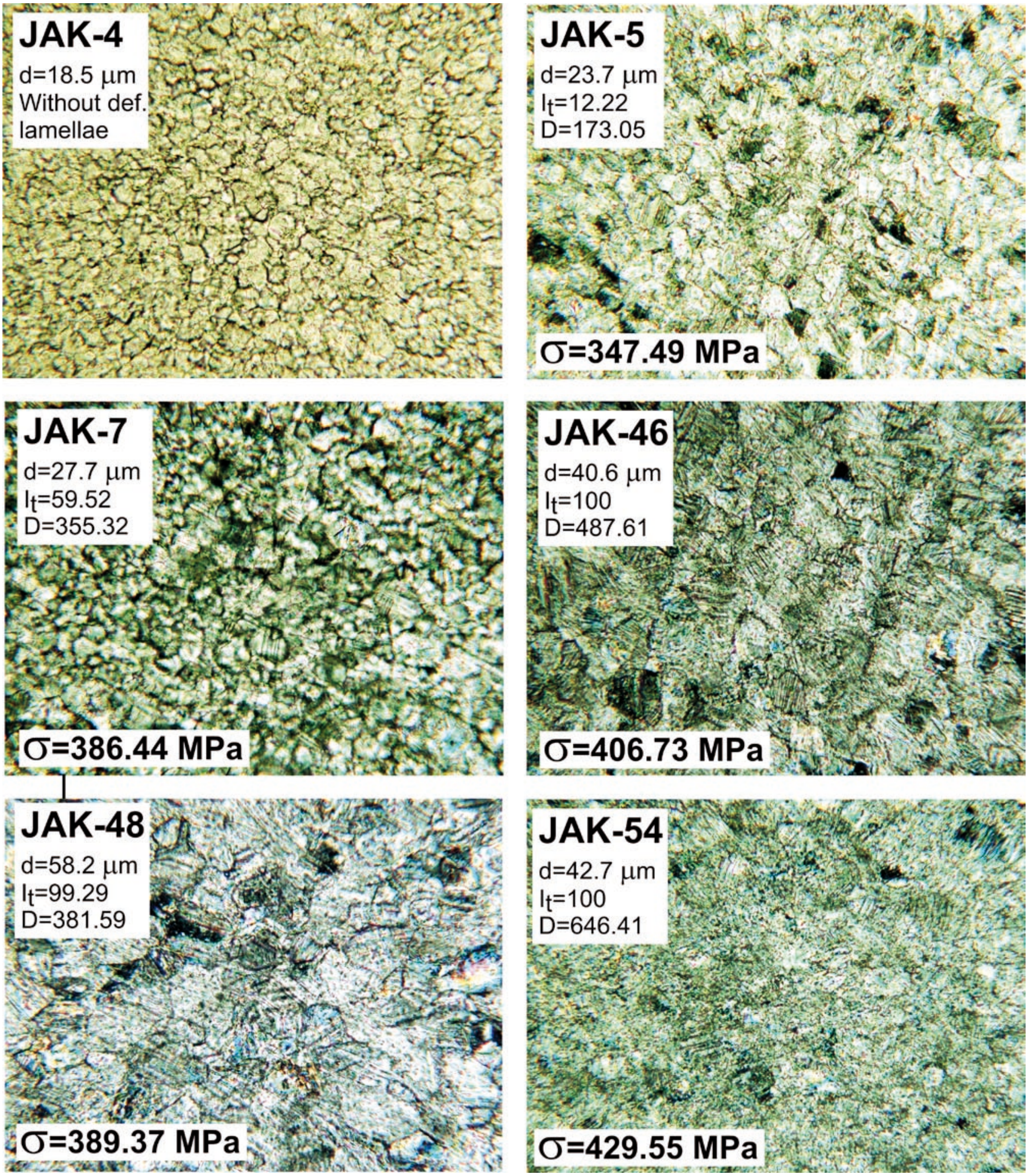


Fig. 3. Microphotographs of studied samples with principal parameters: d – average grain-size; I_t – Twinning incidence – the percentage of grains with deformation twins; D – Twin density – the average number of twins per 1 mm of perpendicular diameter of the grain; σ – differential stress ($\sigma_1 - \sigma_3$) causing recrystallization of grains. Sample JAK-4 represents autochthonous limestone without twins. The revealed differential stresses of allochthonous samples of Meliaticum in the Jaklovce zone represent the highest values until found in the Western Carpathians.

Tab. 1
Results of paleopiezometry applied on carbonates of the Kurtová skala hill. The laboratory paleopiezometric microscopy and computing done by Zákršmidová (2012)

		TWINNING INCIDENCE					TWIN DENSITY		
	Representative grain-size	Calcul. without variation coeffic. / Calculat. with weight. mean	It for interval determined by variation coefficient	Calculation with variation coefficient: Calculat. with the whole It	Calculation with variation coefficient: Arith. mean of σ for size classes	Calculation with variation coefficient: Weight. mean of σ for size classes	D – no. of twins per 1 mm of perpend. diameter	Calculat. without variation coeffic.	Calculat. with variation coeffic.
	µm	σ(MPa)	It	σ(MPa)	σ(MPa)	σ(MPa)	D	σ(MPa)	σ(MPa)
Autochthonous sequences of Jaklovce Meliaticum									
JAK-4	18.5	*No deformation lamellae are present in autochthonous limestone*							
Allochthonous sequences of Jaklovce Meliaticum									
JAK-5	23.7	269.40	12.22	268.72	272.07	269.40	173.05	330.95	**347.49**
JAK-7	27.7	356.45	59.52	355.62	353.29	281.27	355.32	384.41	**386.44**
JAK-46	40.6	411.63	100	407.79	405.79	408.52	487.61	407.93	**406.73**
JAK-48	58.2	208.46	99.29	374.42	373.43	375.30	381.59	389.71	**389.37**
JAK-54	42.7	407.15	100	403.40	403.73	404.25	646.41	428.88	**429.55**

eastern slope of the hill (JAK-4) and manifesting a weak tectonometamorphic overprint.

The stress field and recrystallization of the whole volume of calcite marbles of the first group caused the origin of deformation twins nearly in each calcite grain (Twinning incidence up to 100 %; Fig. 3, Tab. 1). The high number of deformation twins per 1 mm of perpendicular diameter of the grain (D = 173.05–646.25) at the very small size of grains (23.7–42.7 µm) was caused by their recrystallization at high differential stresses σ = 347.49–429.55 MPa.

This differs the allochthonous limestone bodies of Meliaticum from those of autochthonous Permo-Triassic cover of the Northern Gemericum, which do not exhibit deformation twins and ductile overprint.

Discussion and interpretation

The bedding planes (gen. 330/55°; Fig. 2E), manifesting the angular unconformity of the allochthonous block of the Kurtová skala hill with the contrasting structural plan of surrounding tectonized cover sequences of Gemericum in the North-Gemeric zone, correspond with that of further (exhumed) block of silicitic and mafic sequences in the zone of Jaklovce Meliaticum, located to SE closer to the Jaklovce village. Nearly perpendicular bedding to that present in this part of the North-Gemeric zone, resp. in the zone of so-called Jaklovce suture zone indicates the need of exhumation in other place of accretion prism and the N (NE)-trending nappe transport of the exhumed body. This “cold” transport is indicated also by preserved state of maximum dynamic recrystallization, without signs of static recrystallization, as discussed below. Meso-scale kinematics is consistent with that derived from the calcite textural patterns of marbles in the neighbouring Murovaná skala Meliatic fragment (Putiš et al., 1999).

Obtained values of the differential stresses are extremely high, reaching at least by 30 % higher values than those, found previously in other most important regional shear zones in Gemericum (cf. Németh, 2005; Tab. 1 ibid.): The recrystallized Lower Paleozoic carbonates manifested in previous research the σ values 168.06–230.98 MPa and in the ductile shear zone between Gemericum and Veporicum there were found differential stresses 228.82–253.71 MPa.

The previous research (Németh, 2005) of the calcitic marbles of the Bôrka nappe (the sequences of Meliaticum in allochthonous position on Gemericum) found notable relation: The frontal parts of the Bôrka nappe – among which also the Kurtová skala occurrences belong – revealed high differential stresses 244.79–396.66 MPa, but the rear parts of the nappe near the suture zone (Rožňava discontinuity zone) manifested the lower values (187.56–277.92 MPa). This paradox was explained (l. c.) by the evidences of onset static recrystallization in the warm rear zones of the exhumed body, causing the static growth (recrystallization) of calcite grains at gradually and moderately lowering values of the pressure and temperature, despite the calcite marbles in the frontal parts of transported sequence contain the “frozen” conditions closer to maximum affecting differential stress, the processes of the strain softening by diffusion and dynamic recrystallization like in the rear parts of exhuming body were restricted.

Conclusion

The main contribution of the research consists of (1) revealing the principal angular unconformity in the structural plan of allochthonous body vs. autochthonous sequences, and (2) paleopiezometric finding of the highest values of differential stresses until found in the Gemeric region, as well as the Western Carpathians, distinctly contrasting with undeformed limestone in the underlier of allochthonous body. This finding is important even in the particular case of the Kurtová skala hill, when both carbonate types were for many decades undistinguishable by the hand sample--scale observations, having the same appearance.

By this way the method of paleopiezometry appears to be a principal differing tool for distinguishing the deformation and stress gradients in monomineral lithologies.

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References

Aubrech, R., Gawlick, H., Missoni, S., Suzuki, H., Plašienka, D., Kronome, K., & Kronome, B., 2010: Middle Jurassic matrix radiolarians from the Meliata ophiolite mélange at the type Meliatic sites Meliata and Jaklovce (Western Carpathians): Paleogeographic evidence. *J. Alpine Geol., 52, PANGEO 2010, Abstracts, 82 – 83.*

Faryad, S. W., Spišiak, J., Horváth, P., Hovorka, D., Dianiška, I., & Józsa, S., 2005: Petrological and geochemical features of the Meliata mafic rocks from the sutured Triassic oceanic basin, Western Carpathians. *Ofioliti, 30, 27 – 35.*

Grecula, P., Návesňák, D., Bartalský, B., Gazdačko, Ľ., Németh, Z., Ištván, J., & Vrbatovič, P., 1990: Shear zones and arc structure of Gemericum, the Western Carpathians. *Bratislava, Miner. Slov., 22, 97 – 110.*

Hovorka, D., & Spišiak, J., 1998: Mesozoic Meliata ocean dismembered ophiolites. *In: Rakús, M. (ed.): Geodynamic development of the Western Carpathians. D. Štúr Publishers, Bratislava, 81 – 88.*

Kozur, H., & Mock, R., 1973: Zum Alter und zur tektonischen Stellung der Meliata-Serie der Slowakischen Karstes. *Geol. Zbor. Geol. carpath., 24, 365 – 374.*

Ivan, P., 2002: Relics of the Meliata Ocean crust: Geodynamic implications of mineralogical, petrological and geochemical proxies. *Geol. Carpath., 53, 245 – 256.*

Ivan, P., Méres, Š., & Sýkora, M., 2009: Magnesioriebeckite in red cherts and basalts (Jaklovce Fm. of the Meliatic Unit, Western Carpathians): An indicator of initial stage of the high-pressure subduction metamorphism. *Bratislava, Miner. Slov., 41, 419 – 432. (In Slovak with English resume.)*

Kamenický, J., 1957: Serpentines and diabase rocks of Triassic of the surrounding of Jaklovce village. *Geol. Práce, Zoš., 46, 3 – 71. (In Slovak.)*

Kozur, H., & Mock, R., 1995: First evidence of Jurassic in the Folkmár Suture Zone of the Meliaticum in Slovakia and its tectonic implications. *Bratislava, Miner. Slov., 27, 301 – 307.*

Mello, J., Elečko, M., Pristaš, J., Reichwalder, P., Snopko, L., Vass, D., Vozárová, A., Gaál, Ľ., Hanzel, V., Hók, J., Kováč, P., Slavkay, M., & Steiner, A., 1997: Explanations to geological map of the Slovak Karst 1 : 50 000. *Publishing house of Dionýz Štúr, Bratislava, 255 p. (In Slovak.)*

Mello, J., Reichwalder, P., & Vozárová, A., 1998: Bôrka nappe: High-pressure relic from the subduction-accretion prism of the Meliata ocean (Inner Western Carpathians, Slovakia). *Slovak Geol. Mag., 4, 261 – 273.*

Mello, J., Filo, I., Havrila, M., Ivan, P., Ivanička, J., Madarás, J., Németh, Z., Polák, M., Pristaš, J., Vozár, J., Vozárová, A., Liščák, P., Kubeš, P., Scherer, S., Siráňová, Z., Szalaiová, V., & Žáková, E., 2000: Explanations to geological map of the Slovak Paradise, Galmus and Hornád Basin 1 : 50 000. *Publishing house of Dionýz Štúr, Bratislava, 303 p. (In Slovak.)*

Mock, R., Sýkora, M., Aubrecht, R., Ožvoldová, L., Kronome, B., Reichwalder, P., & Jablonský, J., 1998: Petrology and petrography of the Meliaticum near the Meliata and Jaklovce villages, Slovakia. *Slovak Geol. Mag., 4, 223 – 260.*

Németh, Z., 1994: Alpine tectonics in the Nižná Slaná Depression. *Bratislava, Miner. Slov., 26, 399 – 410. (In Slovak with extended English resume.)*

Németh, Z., 1996: First discovery of the Bôrka nappe in the eastern part of the Spiš-Gemer Ore Mts. *Bratislava, Miner. Slov., 28, 175 – 184.*

Németh, Z., 2002: Variscan suture zone in Gemericum: Contribution to reconstruction of geodynamic evolution and metallogenetic events of Inner Western Carpathians. *Slovak Geol. Mag., 8, 3 – 4, 247 – 257.*

Németh, Z., 2005: Paleopiezometry: Tool for determination of differential stresses for principal ductile shear zones of Gemericum, Western Carpathians. *Slovak Geol. Mag., 11, 2 – 3, 185 – 193.*

Polák, M., Jacko, S., Vozárová, A., Vozár, J., Gross, P., Harčár, J., Zacharov, M., Baláž, B., Liščák, P., Malík, P., Zakovič, M., Karoli, S., Kaličiak, M., & Sasvári, T., 1997: Explanations to geological map of Branisko and Čierna hora Mts. 1 : 50 000. *Publishing house of Dionýz Štúr, Bratislava, 202 p. (In Slovak.)*

Putiš, M., Németh, Z., Unzog, W., & Wallbrecher, E., 1999: The quartz and calcite X-ray texture goniometer patterns from the Western Carpathians Cretaceous ductile shear zones used as kinematic indicators.. *Bratislava, Geol. Carpath., 50, sp. no., 165 – 169.*

Putiš, M., Radvanec, M., Sergeev, S., Koller, F., Michálek, M., Snárska, B., Koppa, M., Šarinová, K., & Németh, Z., 2011: Metamorphosed succession of cherty shales with basalt and diastrophic breccia in olistolith of the Meliatic Jurassic accretion wedge near Jaklovce (Slovakia), dated on zircon (U-Pb SIMS SHRIMP). *Bratislava, Miner. Slov., 43, 1 – 18. (In Slovak with English resume.)*

Radvanec, M., 2000: P-T path and exhumation of ultra-high pressure metamorphosed peridotite at Jaklovce on the north of Gemericum and on the locality Skalka at Sedlice northward of the zone Branisko – Čierna hora Mts. (Western Carpathians, Slovakia). *Bratislava, Miner. Slov., 32, 439 – 458. (In Slovak with extended English resume.)*

Radvanec, M., Kobulský, J., & Gazdačko, Ľ., 2011: Geological background of the origin of glaucophanic schists and peridotites in localities Danková, Jaklovce, Radzim and the Šugovský potok stream. Final report. *Manuscript, archive of ŠGÚDŠ, Bratislava, 1 – 73.*

Ranalli, G., 1984: Grain size distribution and flow stress in tectonites. *J. Struct. Geol., 6, 443 – 447.*

Rowe, K. J., & Rutter, E. H., 1990: Paleostress estimation using calcite twinning: Experimental calibration and application to nature. *J. Struct. Geol., 12, 1 – 17.*

Zákršmidová, B., 2012: Tectonic setting of the occurrences of Meliaticum at Jaklovce village: Application of mesostructural and microstructural research. Diploma thesis. *Technical Univ., Košice, 89 p.*

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