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# Neo-Alpine fault controlled crustal blocks dynamics recorded by distribution of the Internal Western Carpathian Neogene basins and core mountains

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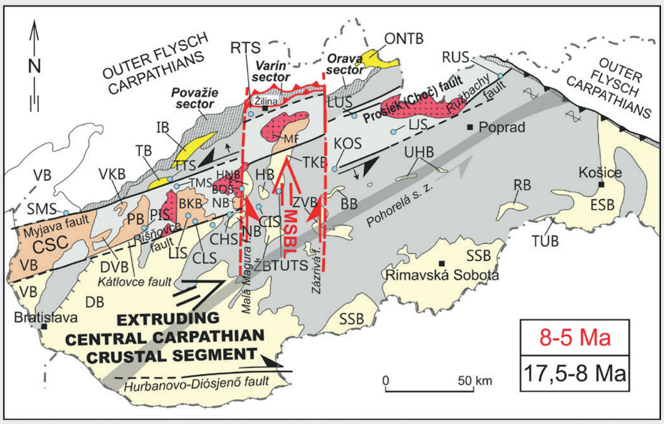
**Abstract:** In the Miocene epoch, the crust of eastward escaping Carpathian units was segmented by faults to independently moving tectonic blocks. Contemporaneously with invasion of the Carpathian units to the subducting oceanic embayment situated in the North European platform, syntectonic sedimentation took place on these moving tectonic blocks. The Neogene basins of the Internal Western Carpathians (IWC) reflect basin basement movement activity and can be from the point of view of their position in the orogen, basement dynamics and tectonic style divided to three geodynamic types: i) Large Middle Miocene-Pliocene back-arc, thermal-subsidence basins related to the mantle upwelling, ii) Early-Middle Miocene inter-arc fault-controlled basins, or their rotated and tilted remnants situated inside the Carpathian Shear Corridor (CSC) – a boundary strike-slip shear zone of extruded IWC crustal segment; iii) tectonically separated parts of disintegrated Internal Western Carpathian Early Miocene-Pliocene molasse basin, situated within strongly deformed peri-Klippen and Klippen zone, representing strike-slip tectonic interface between mutually rotated Internal and External Western Carpathian domains. The crustal block dynamics is reflected simultaneously in the core mountains distribution. The youngest core mountains (AFT age 9–22 Ma) are geneticaly related to and situated inside the CSC, which was interrupted by northward shifted tectonic block, explaining the outstanding position of the Malá Fatra Mts.

**Key words:** faults, block dynamics, Neogene basins, core mountains, Internal Western Carpathians

**Graphical abstract**




**Highlights**

- Paper deals with the Internal Western Carpathians blocks Miocene dynamics recorded in distribution of Neogene sedimentary basins and core mountains.
- As the prominent tectonic block boundary is regarded herein the Carpathian Shear Corridor (CSC), representing the northern sinistral tectonic interface of extruding Internal Carpathian crustal block.
- The division of Neogene basins to three geodynamic types is discussed, based on basement activity and indication of the Late Miocene interruption of the Carpathian Shear Corridor by Mid-Slovakian block shift towards the north.

## Introduction

The Western Carpathian branch of Tethyan Alpides (Schmid et al., 2008; Minár et al., 2011) is composed of two tectonically juxtaposed prominent tectonic superunits of the Internal and External Western Carpathians (sensu Biely et al., 1996; Bezák et al., 2004). This principal tectonic division of the Western Carpathians is derived from the youngest Neo-Alpine (mostly Miocene) tectonic processes, when the flysch accretionary prism of the External Western Carpathians and the Pieniny Klippen Belt (PKB) structure were created due to the collision of the Internal Western Carpathians (IWC) block with the European platform. Internal Western Carpathians consist of the crustal basement thrust sheets with their sedimentary cover and superimposed detached superficial Mesozoic nappe units formed during the Paleo- and Meso-Alpine (Middle / Late Cretaceous up to the Early Paleogene) period. The crustal basement nappe units are composed of Variscan crystalline complexes and Upper Paleozoic and Mesozoic cover formations. The sedimentary basins with Upper Cretaceous and Paleogene flysch sequences represent the Meso-Alpine formations and Neogene sedimentary basins and neovolcanic complexes represent the Neo-Alpine formations superimposed on the Paleo- and Meso-Alpine nappe system.

Faulting had an important role during the Neo-Alpine tectonic evolution of Carpatho-Pannonian area (e.g. Grecula et al., 1990; Csontos et al., 1992; Csontos & Nagymarosy, 1998). Especially, in the process of individual detached blocks invasion into the future Carpathian realm controlled by strike-slip faults (Golonka et al., 2006). The shape of the Carpathian orogenic belt was constrained by the pre-collision shape of thin crust embayment – flysch basin inside the stable North European Platform (NEP). In the area of Eastern Alps, the progress of the orogenic front advancement stopped due to collision and Alpine units were pushed-up and juxtaposed to the southern margin of the Bohemian massif by Apulia microplate propagation to the north. Meanwhile, after frontal collision of Alpine orogenic belt with the European foreland, the Carpatho-Pannonian units escaped eastward to the bay of subducting thin quasioceanic crust (Ratschbacher et al., 1991; Nemčok, 1993; Fodor, 1995; Nemčok et al., 1998; Sperner et al., 2002; Kováč et al., 2018). Oceanic embayment in the North European platform was the depositional area for the Paleogene Magura basin flysch sediments (Oszczypko et al., 2015). In the Carpathian loop the active collisional front progressively moved from the west to the east (e.g. Jiříček, 1979; Matenco & Bertotti, 2000) due to oblique collision. During subduction of underlying thin crust beneath progressing Internal Western Carpathians, sediments of the Magura basin were scraped off and transformed to the structure of diachronous External Carpathian accretionary prism, consisting of rootless compressional flysch nappes and duplexes. These were arranged in a thin-skinned thrust system transfered to high-angle thrusts along the Pieniny Klippen Belt (PKB) boundary. The western segment of the PKB structure in between the External and Internal Carpathians was finally formed as the transpressional flower structure (e.g. Plašienka et al., 2020). In front of the flysch accretionary prism, fore-arc fore-land basin was created due to loading of pile of flysch nappes. Contemporaneously, the Internal Carpathian micro-plate, broken to several decoupled fragments that underwent large translations, rotations and smaller blocks also uplifts and subsidences due to tilting (e.g. Grecula & Roth, 1977; Jurewicz, 2005; Németh et al., 2023). It resulted in development of specific morpho-tectonic features as alternating intramontane basins (halfgrabens) and asymmetric horsts (core mountains), structural bendings due to strike-slip movements, fan-shaped tectonic structures and robust Miocene volcanic activity (Lexa & Konečný; 1998), which are all representing peculiarities of the Western Carpathians.

Dynamic evolution of the Western Carpathians resulted in a genetical variability of the Neogene sedimentary basins. Depending upon their geodynamic position in the orogen they were already described as fore-arc, inter-arc and back-arc basins and were recognized as basins formed by lithospheric extension – thermal subsidence, flexure and strike-slip related basins (Vass, 1979, 1998; Fodor et al., 1999; Kováč et al., 1997, 2017; Kováč, 2000). In the following, we focus to description and geodynamic evaluation of the Internal Western Carpathian basins in respect to IWC blocks movement activity.

## The nature and tectonic zonation of the Internal Western Carpathian Neogene basins and young core mountains distribution related to crustal blocks dynamics

The process of Neo-Alpine tectonic evolution is reflected in the character of sedimentary depositions. The Western Carpathian Neogene basins are syn-orogenic and except of the foredeep basin, they are piggy-back in nature, because they were created on fluently moving Internal Carpathian crustal segments. The basins evolved, and some or part of them were subsequently deformed, even destroyed due to the basin inversion and erosion. This evolution is reflected in distribution, tectonic and age diversity of the Neogene sedimentary complexes.

Miall (1984) specifies the following principal criteria used in plate-tectonics related basin classification: (1) basin position relative to the plate margin; (2) character of the plate margin dynamics related to convergece, divergence and strike-slip, and (3) geotectonic type of crust (continetal, ocean, thick, thin,…). Depending upon basins geotectonic position there are in the Western Carpathians fore-arc basins in front of the orogenic belt because of roll-over down-warping of the over-riding External Carpathians flysch nappe units, large back-arc basins in the Internal Western Carpathians formed by lithospheric extension, and there are also many smaller intra-mountain (intramontane), intra-arc fault-controlled basins (Vass, 1979, 1998; Royden et al., 1982; Čech, 1988; Kováč et al., 1989, 1997, 1998, 2017, 2018; Kováč, 2000; Janočko et al., 2003). Some recent occurrences of Neogene sediments are only relics of inverted and eroded basins. The Western Carpathian Neo-Alpine orogenic belt has no classic volcanic arc, and volcanites, except of Vihorlat and Popriečny Mts., which occur inside the escaped micro-plate of Internal Western Carpathians. This is why the further major classification is based upon basin position relative to the progressing margin of the Internal Western Carpathians, what is the contact zone inbetween the Internal and External Carpathians – the Pieniny Klippen Belt. All basins south of the PKB, situated inside the moving Internal Western Carpathians are in back-arc or inter-arc position and basins north of the PKB are in fore-arc position.

The Vienna basin has an outstanding tectonic position among the Western Carpathians basins. It covers Alpine-Carpathian junction structure / area as well as contact zone of External and Internal Western Carpathians (PKB).

The Vienna basin is long-living depocentre of Neogene sedimentation with a complex history and it comprisizes both back-arc as well as fore-arc parts. The Vienna basin is genetically related to tectonic separation of the Eastern Alpine and Western Carpathian branches of Alpine orogenic belt (Tari et al., 2021). Basin as a whole was defined as a pull-apart basin (Royden, 1985) controlled by NW-SE sinistral strike-slip faults and N-S normal faults, creating depocenters of sedimentation. Sediments of the Slovakian part of the Vienna basin, situated on relatively thick crust (Čech, 1984, 1988; Royden, 1985; Wessely, 1988; Jiříček & Tomek, 1981; Tomek & Thon, 1988), cover the contact zone of Internal and External Western Carpathians, and the basin was classified as inter-mountain and inter-block, repectively (Čech, 1988), inter-arc sensu Miall (1984). The basin portion south of the PKB is in back-arc position and its basement is formed by IWC or Austro-Alpine units. The part of the Vienna basin situated north of the PKB is in fore-arc position and its basement is formed by flysch units of External Carpathians accretionary wedge. The middle part of the Vienna basin is affected by the strike-slips within the Carpahian Shear Corridor (Marko et al., 2017). The Early-Middle Miocene sequences of the Vienna basin, situated south of PKB, are strongly affected by escape of Central Carpathian Crustal Segment (CCCS; see Fig. 1) to the east. This model clarifies the origin of the Vienna basin isostatic imbalance (Tomek, pers. com.), caused by continued Central Carpathian Crustal Segment (CCCS) rapid escape during the Neo-Alpine period. Eastward motion of CCCS caused E-W extension at the back of escaping segment accommodated by N-S normal faulting and fast subsidence in the Vienna basin, as well N-S normal faulting in the Malé Karpaty Mts.

The Neogene basins of the Western Carpathians have been geodynamically classified to four types (Bezák et al., 2004); thermal extensional, shear (related to strike-slip faulting), post-collisional and piggy-back ones. Below we moderately moddify this division and we specify distribution of defined basin types in respect to prominent fault block boundaries.

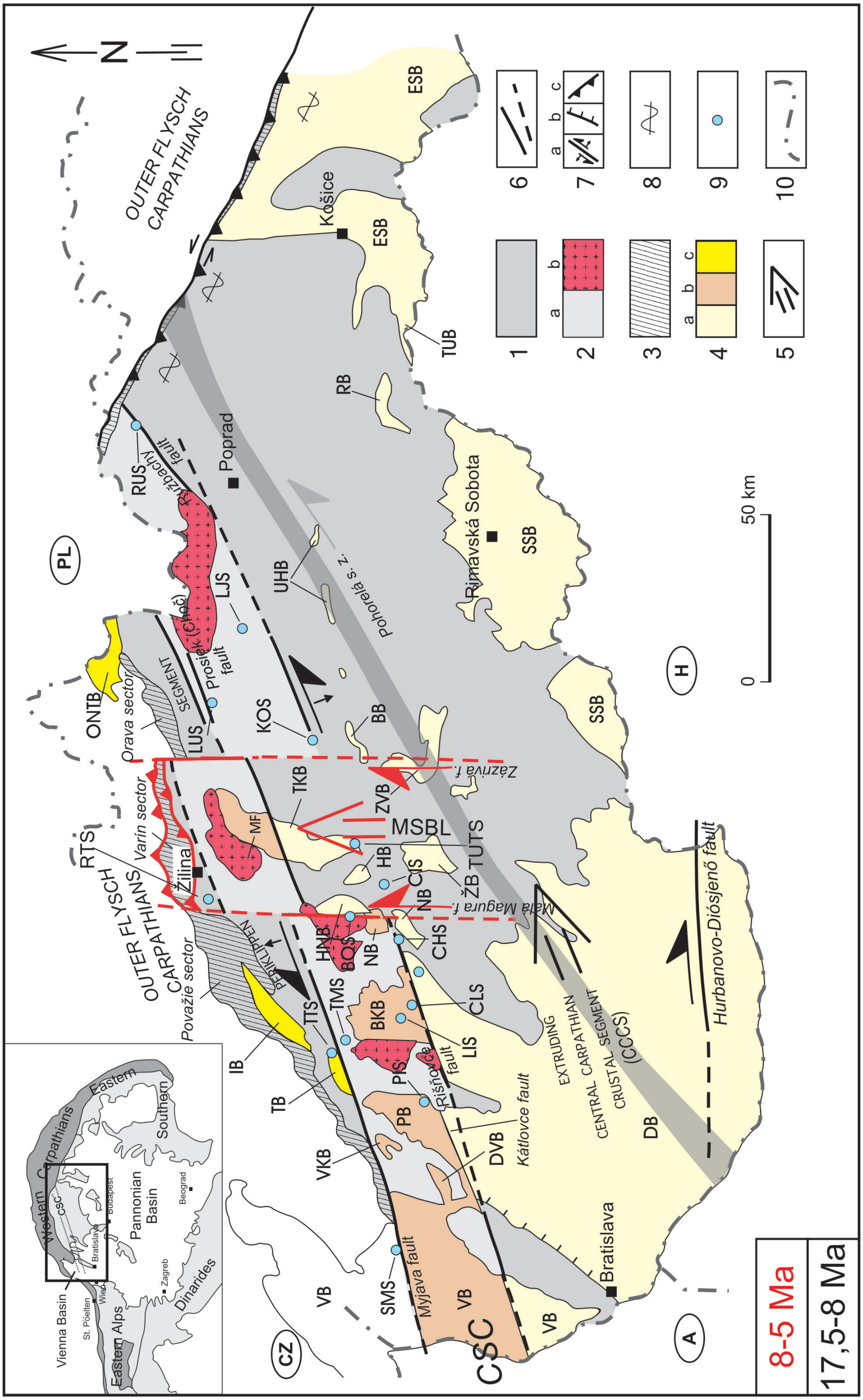
The **Internal Western Carpathian Neogene basins** can be from the viewpoint of tectonic style, position in orogenic belt and the basin substratum block dynamics divided into three geodynamic types (Fig. 1). These are listed from south to north and numbered (1), (2) and (3) below:

**(1)** Large **Middle Miocene-Pliocene back-arc basins** related to the great Pannonian basin (thermal extensional basins sensu Bezák et al., 2004), which occupy territories of thin crust (Bielik et al., 2010; Tomek, 1993), characterized by high density gravity field (Pašteka et al., 2017) and high heat flow (Majcin et al., 2017). These include the southern part of the Vienna basin and Danube basin (e.g. Šujan et al., 2023), South Slovakian and East Slovakian basins (including Turňa basin), which represent peripheral depressions of the great Pannonian basin, situated south of the Carpathian Shear Corridor. The formation of the Neogene back-arc basins in the Carpathian orogenic system was driven by subduction of quasi-oceanic thin crust beneath the moving Internal Carpathian continental plate (as expressed in Stegena et al., 1975; Horváth & Royden, 1981; Jiříček & Tomek, 1981; Doglioni et al., 1991). This geodynamic process led to oblique continental collision (CC type) of the Carpathians with foreland, gradually progressing from the west to the east. The origin and subsidence of the great Pannonian basin (Bergerat, 1989; Tari et al., 1992; Horváth, 1993) and its peripheral depressions are related to the Pannonian mantle diapir activity (Van Bemmelen, 1972; Stegena et al., 1975; Mc Kenzie, 1978; Vass, 1979; Horváth & Royden, 1981; Royden et al., 1982) and also to its marginal satellite diapirs (Vass, 1979; Čech, 1988; Pospíšil, 1980). In addition to the thermal-controlled slow subsidence concept, Horváth and Royden (1981) and Royden (1985) submitted the fault-controlled pull-apart model of rapid subsidence of some local depocentres of sedimentation of the Pannonian depositional system. The NE-SW trending sinistral strike-slip master faults were here considered as the dominant responsible structures. These works inspired also some followers to describe strike-slip tectonics in the Western Carpathians Neogene basins (as in Pospíšil, 1990; Fodor, 1995; Decker & Pereson, 1996; Hrušecký et al., 1996; Kováč et al., 1989; Marko et al., 1991, 2012, 2017).

The southern part of the Vienna basin and the Danube basin are situated at the periphery of the great Pannonian basin. Subsidence of the Pannonian basin, situated on thinner crust in comparison to the Vienna basin, is connected with **Pannonian mantle diapir collapse accompanied by extensive Pliocene volcanic activity**.

The Horná Nitra, Handlová, southern part of Turiec, Žiar, Zvolen, Banská Bystrica, Upper Hron valley and Rožňava intra-mountain basins are isolated and related to the Danube and South Slovakian basins. These are the remnants of peripheral embayments-spurs of large basins into IWC shore preserved by the fault-controlled subsidence of individual blocks and some of them represent local depressions filled by volcano-sedimentary and lacustrine depositions (Konečný et al., 2003).

**(2)** The second geodynamic type of basins encompasses the isolated **Early-Middle Miocene intra-mountain fault-controlled basins including the strike-slip basins** (wrench furrows sensu Montenat et al., 1987), shear basins respectively (sensu Bezák et al., 2004), or their remnants situated in the Carpathian Shear Corridor (CSC). This emphasises the role of ENE-WSW strike-slip faults in the north-western part of the Western Carpathians during Neo-Alpine tectonic evolution, and it led to definition of ENE-WSW Carpathian Shear Corridor as the strike-slip


OUTER FLYSCH CARPATHIANS
Košice
ESB
TUB
RB
Poprad
Rimavská Sobota
SSB
PL
H
CZ
A
UHB
LJS
RUS
Prosiek (Choč) fault
pohorelá s. z.
KOS
BB
LUS
ONTB
Orava sector
Varín sector
Považie sector
Žilina
RTS
MF
TKB
ZVB
MSBL
TUTS
HB
ČIS
ŽB
NB
CHS
Malá Magura f.
Zázriva f.
HNB
BOS
TMS
TTS
IB
TB
BKB
CLS
LIS
PS
PB
Rišňovce fault
VKB
DVB
Kátlovce fault
EXTRUDING CENTRAL CARPATHIAN CRUSTAL SEGMENT (CCCS)
DB
Hurbanovo-Diósjenő fault
Bratislava
VB
SMS
Myjava fault
CSC
8-5 Ma
17,5-8 Ma
0
50 km
Vienna Basin
Eastern Alps
Western Carpathians
Eastern
Southern
Pannonian Basin
Dinarides
Budapest
Beograd
Zagreb
Wien
St. Pöelten
Bratislava
1
2
3
4
5
6
7
8
9
10
a
b
c

boundary of an extruded Central Carpathian Crustal Segment of Internal Western Carpathians (Marko et al., 2017). Within this ca 50 km wide shear zone there are situated the middle part of the Vienna basin, the depocenters of sedimentation of the northern spurs of the Danube basin (Piešťany bay depression, Bánovce depression, e.g. Marko, 2012; Hók et al., 2016) and the majority of intra-mountain basins (Dobrá voda, Vaďovce, northern part of Nováky, Horná Nitra and northern part of Turiec basins). Intense strike-slip shearing, block rotation and tilting occurred inside the CSC during the Lower-Middle Miocene evolution. This is reflected in the tectonic style of the Neogene half-grabens, alternating with tilted and rotated horsts of the outer core mountain belt – a basin and range-like structure. The CSC was a very dynamic environment for sedimentation and / or disintegration of existing basins, and there is an evidence that the CSC operated as a dextral shear zone and strike-slip basins (Kingston et al., 1983), developed inside the shear zone (CSC) in the Early Miocene stages (Kováč et al., 1989). After en-bloc counter clock wise (CCW) rotation of the Western Carpathians Internides (Balla, 1984), the CSC was re-oriented to ENE-WSW course and commenced operation as a sinistral strike-slip boundary of the eastwardly escaping Central Carpathian Crustal Segment. The Early Miocene deposits within the CSC were disintegrated by CCW block rotations and tilting during the long lasting and intense sinistral shearing, and contemporary the new, Middle-Late Miocene tecto-sedimentary cycle continued in localy developed depressions.

From the distribution of young core mountains (pushed-up and exhumed at ca 20–9 Ma ago (Kráľ, 1977; Danišík et al., 2010; Králiková et al., 2014a, b; Marko et al., 2017), which are geneticaly and spatialy related to CSC, it can be considered, that the Carpathian Shear Corridor was after its Upper Miocene sinistral strike-slip activity cut and interrupted by the N-S oriented Malá Magura and Zázrivá tear faults, rimming Mid-Slovakian upper crustal block (MSBL). This segment of CSC, rimmed by mentioned boundary strike-slip faults (Kováč & Hók, 1993), was ca 20 km shifted to the north approximately 8–5 Ma ago (Fig. 1, highlighted in red). This event resulted in push-out of the exhumed Malá Fatra Mts. core with Turiec basin to the north. This shift is a reason of contrasting compressional tectonic style in frontal part of displaced Mid-Slovakian Block (Haško & Polák, 1979; Marko et al., 2005; Plašienka et al., 2016) and E-W orientation of the Varín sector of PKB in contrast with the strike-slip style and NE-SW orientation of neighbouring Považie and Orava sectors of PKB. The geodynamic reason / drive of such extreme northward shift of the Mid-Slovakian block is going to be discussed in currently prepared paper (Marko, in prep.). dealing with Neo-Alpine tectonic evolution of the Western Carpathians internides. It seems to be gravitational structure – slide of the upper crustal packet due to robust volcanic activity in the Central Slovakian area related to a mantle plume.

**(3)** The third geodynamic type encompass the Trenčín, Ilava and Orava-Nowy Targ **basins situated north of CSC inside the intensively deformed Pieniny Klippen Belt and peri-Klippen zone and affected by its dynamics**. The Klippen zone represents strike-slip tectonic zone – suture dividing converging and mutually rotating / shifting External and Internal Western Carpathian terranes (Marschalko, 1979; Birkenmajer, 1986; Plašienka, 2018).

The largest Orava-Nowy Targ basin was interpreted as the fresh water molasse intramontane (Żytko et al., 1989; Zuchiewicz, 2002; Ludwiniak et al., 2019). fault controlled pull-apart basin (Nemčok & Lexa, 1990; Baumgart-Kotarba, 2001; Pomianowski, 2003; Zuchiewicz, 2010) with maximum thickness of Karpatian-

**Fig. 1.** Distribution and tectonic zonation of the Internal Western Carpathian Neogene sedimentary basins and young core mountains related to Middle (in black) and Late Miocene (in red) dynamics of crustal segments and blocks propagation. 1 – Internal Western Carpathians (in the frame of general map located upper left); 2 – a) Pre-Neogene units in Carpathian Shear Corridor (CSC), b) crystalline mountain cores uplifted and exhumed (22–9 Ma AFT ages) due to CSC activity; 3 – Pieniny Klippen Belt; 4 – Inner Western Carpathian Neogene sedimentary basins: a) Middle-Late Miocene to Pliocene back-arc basins related to the great Pannonian basin (thermal basins) and small fault controlled intramountain basins, b) Early-Middle Miocene basins genetically and spatially related to the Carpathian Shear Corridor (shear basins), c) fragmented Early Miocene basins situated within the Pieniny Klippen Belt zone and peri-Klippen zone; 5 – Movement tendencies of Internal Western Carpathians crustal segments and blocks; 6 – Main block-boundary faults, existing and supposed; 7 – Fault kinematics: a) strike-slip, b) normal, c) reverse; 8 – Neo-Alpine folds; 9 – Prominent thermal mineral water resources related to boundary-faults and structure of the Carpathian Shear Corridor; 10 – Slovak Republic state border, Numbers in frames in left down corner indicate the dominant periods of activity on faults in scheme coloured red and black. Abreviations: BB – Banská Bystrica basin, BKB – Bánovská kotlina basin, DB – Danube basin, DVB – Dobrá voda basin, ESB – East Slovakian basin, HB – Handlová basin, HNB – Hornonitrianska kotlina basin, IB – Ilava basin, MF – Malá Fatra Mts., MSBL – Mid-Slovakian block, NB – Nováky basin, ONTB – Orava-Nowy Targ basin, PB – Piešťanský záliv basin, RB – Rožňava basin, SSB – South Slovakian basin, TB – Trenčín basin, TKB – Turčianska kotlina basin, TUB – Turňa basin, UHB – Upper Hron valley basin, VB – Vienna basin, VKB – Vaďovská kotlina basin, ŽB – Žiar basin, ZVB – Zvolen basin; Thermal mineral water spa and springs / wells: CIS – Cigeľ, BOS – Bojnice, CHS – Chalmová, CLS – Chudá Lehota, KOS – Korytnica, LIS – Libichava, LJS – Liptovský Ján, LUS – Lúčky-kúpele, PIS – Piešťany, RTS – Rajecké Teplice, RUS – Ružbachy, SMS – Smrdáky, TMS – Trenčianske Mitice, TTS – Trenčianske Teplice, TUS – Turčianske Teplice.

Badenian-Sarmathian-Pliocene formations reaching 950 m (Watycha, 1976; Nagy et al., 1996; Potfaj, 2003; Łój et al., 2009).

The Trenčín and Ilava basins are filled with Eggenburgian to Pliocene sediments. The upper parts of the Trenčín, Ilava and the Orava-Nowy Targ basins have facially and lithologically identical sedimentary fill of the same latest Pannonian age – lacustrine clays with lignite intercalations overlain by fluvial sands and gravels (Biely et al., 1996).

## Discussion

It is not excluded that formerly at least the Trenčín and Ilava, but maybe also Orava-Nowy Targ basins created one depocentre of molasse sedimentation in the early stages of the Carpathian Neo-Alpine evolution prior to the CCW en-bloc rotation of the Internal Western Carpathians, which are part of ALCAPA micro-plate (Balla, 1984). This basin could be in the process of ALCAPA CCW rotation disintegrated into the Trenčín, Ilava and perhaps also Orava-Nowy Targ parts, which were separated and dextrally displaced to the recent position, because ALCAPA CCW rotation should be in the Klippen and peri-Klippen zone accommodated by intensive dextral shearing inbetween the External and Internal Western Carpathians domains. If the Orava-Nowy Targ basin was a part of former unite molasses basin, we have to calculate with extreme ca 140 km dextral displacement along PKB zone, what represents the recent distance between Orava-Nowy Targ and Ilava basins.

In herein presented tectonic concept, the Carpathian Shear Corridor (CSC) operated as a prominent strike-slip boundary of the extruding Central Carpathian Crustal Segment (CCCS; Fig. 1). Boundary dislocations of CSC could be indicated also by occurences of thermal mineral water sources (Smrdáky, Piešťany, Trenčianske Teplice, Libichava, Chalmová, Chudá Lehota, Bojnice, Cigeľ, Turčianske Teplice, Korytnica, Lúčky-spa, Liptovský Ján, Ružbachy), which are apparently spatialy and geneticaly related to the structure of the Carpathian Shear Corridor. Deep reach of dynamic boundary faults of the Carpathian Shear Corridor could have been utilized as pathways for migration of water coming from deep thermal sources.

The Carpathian Shear Corridor, which represents the principal topic of this paper, is a conspicuous structure in morpho-tectonic surface architecture. Nevertheless, the most prominent crustal discontinuity named Pohorelá shear zone was interpreted by Bezák et al. (2023) in the new Bouger gravity anomaly map south of CSC. This tectonic interface is indicated also by magnetotelluric data (Bezák et al., 2020) and roughly corresponds the Vepor deep range fault formerly delineated by geophysicists and represents the strike-slip tectonic contact of gravitationally contrasting crustal segments (Bezák et al., 2023, and citations mentioned there). Pohorelá shear zone and CSC seems to be geneticaly related, they have similar course and strike-slip kinematics. This is why the Pohorelá shear zone, fault respectively, is drawn in Fig. 1 as well. While CSC accomodated significant Neo-Alpine progress of Carpathians crustal segments, the noticeable coeval activity of the Pohorelá shear zone has not been proven, it seems to be older structure.

## Conclusions

The geodynamic approach to the Internal Western Carpathian Neogene basins, outlined in this paper of conceptual discussion character, could contribute to understanding of the nature and distribution of Neogene sediments and core mountains (Fig. 1). The extrusion concept of the Internal Western Carpathians (IWC) Neo-Alpine Miocene tectonic evolution emphasizes the role of faults during the step-wise extrusion of the Carpathian crustal segments. The rigid upper crust of progressing IWC was broken to independently moving blocks which filled the complex shaped oceanic embayment in the foreland plate. The prominent strike-slip faults, combined with thrusts and extensional faults controlled the occupation of the NEP embayment by individual Internal Carpathian and Pannonian blocks.

Character and distribution of Neogene sedimentary basins reflects tectonic processes realized during the formation of Western Carpathian structure. Contemporaneously with the progress in Carpathian orogenesis, the Neogene sedimentary basins were formed on the moving basement. In this light, the Miocene sedimentary sequences of the Internal Western Carpathian Neogene basins represent the syn-orogenic products of syn-tectonic sedimentation. Internal Carpathian Neogene sedimentary basins belong into the following three geodynamic types based on basin position relative to the progressing crustal segments margins:

1. Large back-arc basins related to the Pannonian basin system genetically connected with the activity of the Pannonian mantle diapir and its satellites and remnants of their intramontane embayments – spurs being fingered into IWC shore.
2. Strike-slip fault-controlled basins situated inside boundary shear zone (Carpathian Shear Corridor) of extruded IWC crustal segment, arranged in basin-and-range like structure, due to rotation and tilting of blocks in this dynamic strike-slip shear zone.
3. Isolated basins situated within the Klippen and peri-Klippen zone, which represent the separated parts of tectonicaly disintegrated molasse basin of Internal Western Carpathians due to Early-Middle Miocene extensive strike-slip shearing in highly strained zone between Inner and Outer Western Carpathian domains.

Young core mountains (uplifted and exhumed ca 20–9 Ma ago) are evidently spatialy related to CSC. They emerged due to strike-slip dynamics of this shear zone. It can be considered, that the Carpathian Shear Corridor was after its Upper Miocene sinistral strike-slip activity cut and interrupted by N-S trending Malá Magura and Zázrivá tear faults, rimming the Mid-Slovakian upper crustal block (MSBL). This segment of CSC was shifted ca 20 km to the North approximately 8–5 Ma ago. This event resulted in push-out of the already exhumed Malá Fatra core Mts. with the Turiec basin to the north and is the reason of contrasting compressional tectonic style of the PKB Varín sector in contrast with the strike-slip style and NE-SW orientation of neighbouring Považie and Orava sectors of PKB.

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# Neoalpínska geodynamika kôrových segmentov ohraničených zlomami, dokumentovaná na príklade západokarpatských neogénnych bazénov a distribúcie jadrových pohorí

V neoalpínskej fáze orogenézy Západných Karpát dôležitú úlohu zohrali zlomy. Kontinentálna kôra kriedovo konsolidovaných vnútrokarpatských jednotiek bola zlomami vyšších rádov segmentovaná na samostatne sa pohybujúce bloky, ktoré extrudovali do zálivu subdukujúcej oceánskej kôry, situovaného v severoeurópskej platni (Ratschbacher et al., 1991; Doglioni et al., 1991). Po kolízii vnútrokarpatských jednotiek/blokov s predpolím (Český masív) v zóne pieninského bradlového pásma a kolmatovaní pribradlového segmentu Vnútorných Karpát sa aktívnym severným smernoposunovým rozhraním bloku pohybujúceho sa na VSV (CCCS) stal karpatský strižný koridor (CSC; Marko et al., 2017). Je dominantným dynamickým tektonickým rozhraním v miocéne (obr. 1).

V práci diskusného charakteru je navrhnutá tektonická kategorizácia neogénnych sedimentárnych bazénov vzhľadom na špecifickú dynamiku neoalpínskych blokov tvoriacich ich podložie. Podľa tohto kritéria už definované geodynamické typy vnútrokarpatských bazénov (Čech, 1984, 1989; Vass, 1979, 1998; Kováč, 2000; Janočko, 2003; Bezák et al., 2004) klasifikovaných na základe kritérií teórie platňovej tektoniky (pozícia bazénu vzhľadom na okraj platní/mikroplatní, tektonický režim platňových okrajov a geotektonický typ kôry/litosféry; napr. Mial, 1984) môžeme zaradiť do troch kategórií vymenovaných z juhu na sever: **1.** rozsiahle strednomiocénne až pliocénne zaoblúkové extenzné bazény vznikajúce termálnou subsidenciou vzťahujúce sa na veľký panónsky bazén. Sú vyvinuté na tenkej kôre (Pašteka et al., 2017) s vysokým tepelným tokom (Majcin et al., 2017) vlyvom aktivity plášťového diapíru a jeho satelitov (Vass, 1979; Čech, 1988; Pospíšil, 1990); **2.** izolované rotované a tiltované spodno- až strednomiocénne vnútrohorské bazény situované v zóne karpatského strižného koridoru (CSC) spojené so zlomovou smernoposunovou tektonikou – bazény strižných zón (napr. Montenat et al., 1987); **3.** bazény situované v zóne bradlového pásma a pribradlovej zóne, ktoré sú pravdepodobne smernými posunmi, pravostranne separovanými segmentmi molasového bazénu čela vnútrokarpatského bloku. To podporuje predpokladanú významnú rotáciu vnútrokarpatského bloku, ktorý je súčasťou bloku ALCAPA (Balla, 1984) vzhľadom na jednotky Vonkajších Karpát (napr. Marschalko, 1979).

Špecifikom Západných Karpát sú mladé jadrové pohoria (FT veky 22 – 9 mil. rokov) s exhumovaným kryštalinikom (Kráľ, 1977; Danišík et al., 2010; Králiková et al., 2014a, b; Marko et al., 2017) striedajúce sa s „halfgrabenmi“ neogénnych bazénov (štruktúra *basin and range*; napr. Nemčok a Lexa, 1990). Tento štýl stavby je vyvinutý v karpatskom strižnom koridore. Považujeme ho za dôsledok smernoposunovej dynamiky tejto strižnej zóny. Z konfigurácie mladých jadrových pohorí sa dá usúdiť, že CSC bol po jeho strednomiocénnej aktivite prerušený vysunutím stredoslovenského bloku (MSBL) ohraničeného zázrivským a malomagurským zlomom na sever (obr. 1). V tomto bloku sa nachádza aj jadrové pohorie Malá Fatra, ktoré bolo spolu s priľahlou Turčianskou kotlinou vysunuté na sever. Tento koncept vysvetľuje umiestnenie tohto mladého jadrového pohoria mimo kurzu miocénnej strižnej zóny CSC a zároveň vysvetľuje kontrastný kompresný tektonický štýl varínskeho segmentu bradlového pásma v porovnaní so susednými segmentmi, ktoré majú smernoposunový štýl. Príčinu vysunutia stredoslovenského bloku na sever nepoznáme, ale predpokladáme, že mohlo ísť o gravitačný fenomén spôsobený vyklenutím kôry v dôsledku subvulkanických intrúzií v kremnicko-štiavnickej vulkanickej oblasti a následného skĺznutia bloku na sever pozdĺž zlomov laterálnych rámp.

Dominantné stredno- až vrchnomiocénne rozhranie blokov CSC je ohraničené severnou a južnou okrajovou zlomovou zónou. Predpokladáme, že tieto rozhrania sú strmé, majú hlboký dosah a umožňujú migráciu podzemnej vody a fluíd s. l. do veľkej hĺbky, ich mineralizáciu a ohrev. Distribúcia významných minerálnych prameňov a studní termálnej minerálnej vody západnej časti Západných Karpát ukazuje, že sa priestorovo viažu na okrajové zlomy karpatského strižného koridoru. To zároveň indikuje existenciu týchto okrajových zlomov.

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