Mineralia Slovaca, Web ISSN 1338-3523, ISSN 0369-2086, https://doi.org/10.56623/ms.2024.56.1.2
56, 1 (2024), 51 – 70,

Structural evolution of the Selec Block in the Považský Inovec Mts (Western Carpathians) and the Infratatric issue

ONDREJ PELECH[1] and JOZEF HÓK[2]

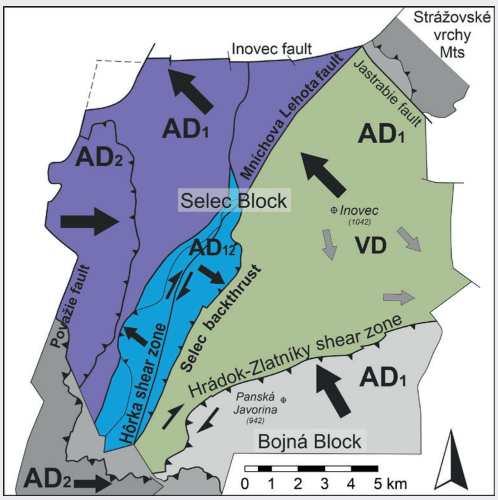
[1]State Geological Institute of Dionýz Štúr, Mlynská dolina 1, 817 04 Bratislava 1, Slovak Republic; ondrej.pelech@geology.sk
[2]Comenius University in Bratislava, Faculty of Natural Sciences, Department of Geology and Palaentology, Ilkovičova 6, 842 15 Bratislava, Slovak Republic; hok@fns.uniba.sk

Abstract: In west-east direction, the Selec Block of the Považský Inovec Mts consists of three geologically and tectonically distinct segments of Tatricum.

1) Eastern segment is characterized by dominance of the Tatric crystalline basement rocks (mica schists), subautochthonous position and internally imbricated structure with thrust sheets of Permian, Triassic and Upper Cretaceous (Horné Belice Group) rocks. Rocks of the Fatricum and Hronicum are rudimentarily preserved along the eastern margin of the block.
2) Central segment represents deformed – folded and sheared structure, composed of the Tatric crystalline basement (orthogneiss) and sedimentary rocks of Carboniferous to Triassic age. This segment largely corresponds to lithology surrounding the Hôrka shear zone and the Selec thrust.
3) The western segment is represented by internally imbricated structure, containing Variscan (Lower Carboniferous) crystalline basement rocks (diaphthorites of different types), Permian to Triassic rocks of the Tatricum and thin-skinned nappe complexes of Fatricum and Hronicum.

Key words: Tatricum, crystalline basement, Kálnica Group, Hôrka shear zone, Selec thrust

Graphical abstract



Highlights

The Selec Block in northern part of Považský Inovec Mts is divided into 3 distinct structural segments:

- Eastern segment (green in Graphical abstract) is composed mainly of Variscan (VD, Carboniferous) mica schists with Late Paleozoic to Mesozoic cover and locally preserved synclines filled by the Upper Cretaceous mélange. The whole sequence is imbricated by NW-vergent thrust sheets.
- Central segment (blue in GA) with thick Upper Paleozoic volcano-sedimentary sequence in dominant subvertical position, being strongly dextrally sheared due to the course of the Hôrka shear zone and Selec thrust.
- Western segment (violet in GA) consists of crystalline basement and its Upper Paleozoic to Mesozoic sedimentary cover, overlain by the Fatric and Hronic nappes. It shows signs of Paleogene to Early Miocene backthrusting and possible unroofing.

Introduction

The Považský Inovec Mts represents NNE-SSW trending elevated horst, belonging to the Western Carpathian Core mountains belt. It is composed dominantly of the subautochthonous Tatricum (Early Paleozoic crystalline basement and its Late Paleozoic / Mesozoic cover) and nappes of Fatricum and Hronicum (Late Paleozoic/ Mesozoic sequences). The geological structure of the Považský Inovec Mts is summarized in regional map at a scale 1 : 50 000 and accompanying explanatory notes (Ivanička et al., 2007, 2011). The Selec Block (Maheľ, 1986) represents the northern part of the mountain range, being separated from the south located Bojná Block by the Hrádok-Zlatníky dextral thrust shear zone (Pelech & Hók, 2017; Fig. 1). The substantial part of the Selec Block is represented by Tatricum, dominantly composed of Variscan mica schist to gneiss crystalline basement with locally occurring amphibolite bodies and sedimentary cover ranging from Late Carboniferous to Early Jurassic (Fig. 2;

Kamenický, 1956). These complexes are unevenly distributed. The crystalline basement prevails in the eastern side, while western and central part of the block is characterized by thicker Upper Paleozoic volcano-sedimentary rocks (Ivanička et al., 2007, 2011). The presence of thick Upper Paleozoic succession (Kálnica Group; see Štimmel et al., 1984; Miháľ, 2006; Olšavský, 2008) as well as Upper Cretaceous mélange (Horné Belice Group; Kullmanová & Gašpariková, 1982; Plašienka et al., 1994; Pelech et al., 2016, 2021) is unique within the Western Carpathian Core mountains and may be considered noticeable in the frame of other Tethyan regions, as well. The Hrádok-Zlatníky shear zone constitutes an important structure with respect to the structural position of investigated area. It is generally accepted that it represents the north-vergent Alpine (or Alpine rejuvenized) thrust of the Bojná Block on the Selec Block (Fig. 1; Putiš, 1980, 1991; Maheľ, 1986; Leško et al., 1988; Plašienka & Marko, 1993; Pelech & Hók, 2017).

The Bojná Block is generally considered as tectonic element of the Tatricum (e.g. Maheľ, 1986; Putiš, 1992; Plašienka & Marko, 1993; Plašienka, 1999) or so-called Carpathian Austroalpine (Leško et al., 1988). Due to tectonic position of the Selec Block in the footwall of the Tatric Bojná Block, Leško et al. (1988) considered the whole Selec Block as the Penninic Unit of the Western Carpathians. However, in this interpretation the sequences of Hronicum, Fatricum and both – Tatric crystalline basement and sedimentary cover (Inovec Unit) were also incorporated to this Western Carpathian Penninic Unit (l.c.). Later Putiš (1992) assigned the crystalline basement of the Selec Block as the Infratatricum, which seems to express the position below the Tatricum of the Bojná Block, and in the hanging wall of the Upper Cretaceous rocks which were called the "Perivahicum". However, the aforementioned reclassification was provided without any further comments or clear definitions (for further information see chapter *The question of Infratatricum*).

Plašienka et al. (1994) considered the rock complexes of the crystalline basement of the Selec Block (Inovec Unit) as the Tatricum, however emphasized its allochthonous position on the Upper Cretaceous sediments (Belice Succession), which are considered as equivalent of Penninic Unit of the Eastern Alps (in the W. Carpathians named the Vahic Unit). Later Plašienka (1995) designated the Inovec Unit as a nappe (Inovec nappe) of Tatric crystalline basement bearing autochthonous Upper Paleozoic (Kálnica Group) and rudimentary preserved Mesozoic sedimentary cover (Selec succession). Authors (Plašienka et al., 1994; Plašienka, 1995) in both cases underline that the Selec Block forms the northern – external part of the Tatricum. Such paleotectonic affiliation of the Selec Block (or Inovec nappe) resulted in new definition of Infratatricum (Plašienka et al., 1997; Plašienka, 1999), which was considered hierarchically as a sub-unit of Tatric superunit.

Ivanička et al. (2011) described the Selec Block of the Považský Inovec Mts as region composed of Hronicum, Fatricum and Tatricum or Infratatricum respectively, and included a separate Horné Belice Group. This study generally agrees with Ivanička et al. (2007, 2011) and considers rock complexes of Selec and Bojná blocks as integral part of Tatricum with complicated deformation history, including several smaller scale structures and superimposed Fatricum, Hronicum and the Horné Belice Group (Fig. 1).

One of the key points in the interpretation of the tectonic structure of the Selec Block is the position of the rock sequences of the Upper Cretaceous Horné Belice Group. The opinions on its structure and sedimentary sequence considerably vary and the discussion goes beyond the scope of this paper (Kullmanová & Gašpariková, 1982; Plašienka et al., 1994, 2017; Pelech et al., 2016, 2017a, b, c, 2021; Putiš et al., 2008, 2021). Some authors consider the Horné Belice Group as tectonic windows of the Váhicum (= Penninicum) or Infratatricum cropping out from beneath the Tatricum crystalline basement nappes. The stratigraphic range of the rocks of the Horné Belice Group is according to this interpretation Lower Jurassic to Upper Cretaceous (Plašienka et al., 1994; Putiš et al., 2008). However, the Horné Belice Group is a tectonic mélange formerly overlying the Tatric crystalline basement, now occurring in imbricated structure between the crystalline basement thrust sheets (Ivanička et al., 2007, 2011). It consists of the deep-water syn-orogenic sediments with olistoliths (block-in-matrix) of various rocks from the overlying Tatric crystalline basement as well as exotic blocks (Plašienka et al., 1994; Pelech et al., 2021).

Previous investigations have led to the definition of several tectonic structures. A brief characterization of them is necessary for the understanding of the following text. These are mainly:

The **Selec thrust** or **Selec backthrust** (Slovak: *selecký prešmyk*, defined formerly by Štimmel et al., 1984) represents NNE-SSW trending, WNW dipping brittle-ductile thrust and reverse fault zone along which Upper Paleozoic (mainly Permian) complexes are backthrust with top to ESE-vergence on to the Mesozoic and crystalline basement rocks in the east. It constitutes eastern margin of the Hôrka shear zone, located approx. between the Hôrčanská dolina valley and Klenkov vrch hill. The thrust is well marked by the borehole (Štimmel et al., 1984) and surface data. Most likely it represents reactivated normal fault which formerly played important role in the structure of the Late Paleozoic (Kálnica) rift basin, as the Upper Carboniferous complexes are not known east of this fault (Maheľ, 1986; Ivanička et al., 2007). However, Carboniferous

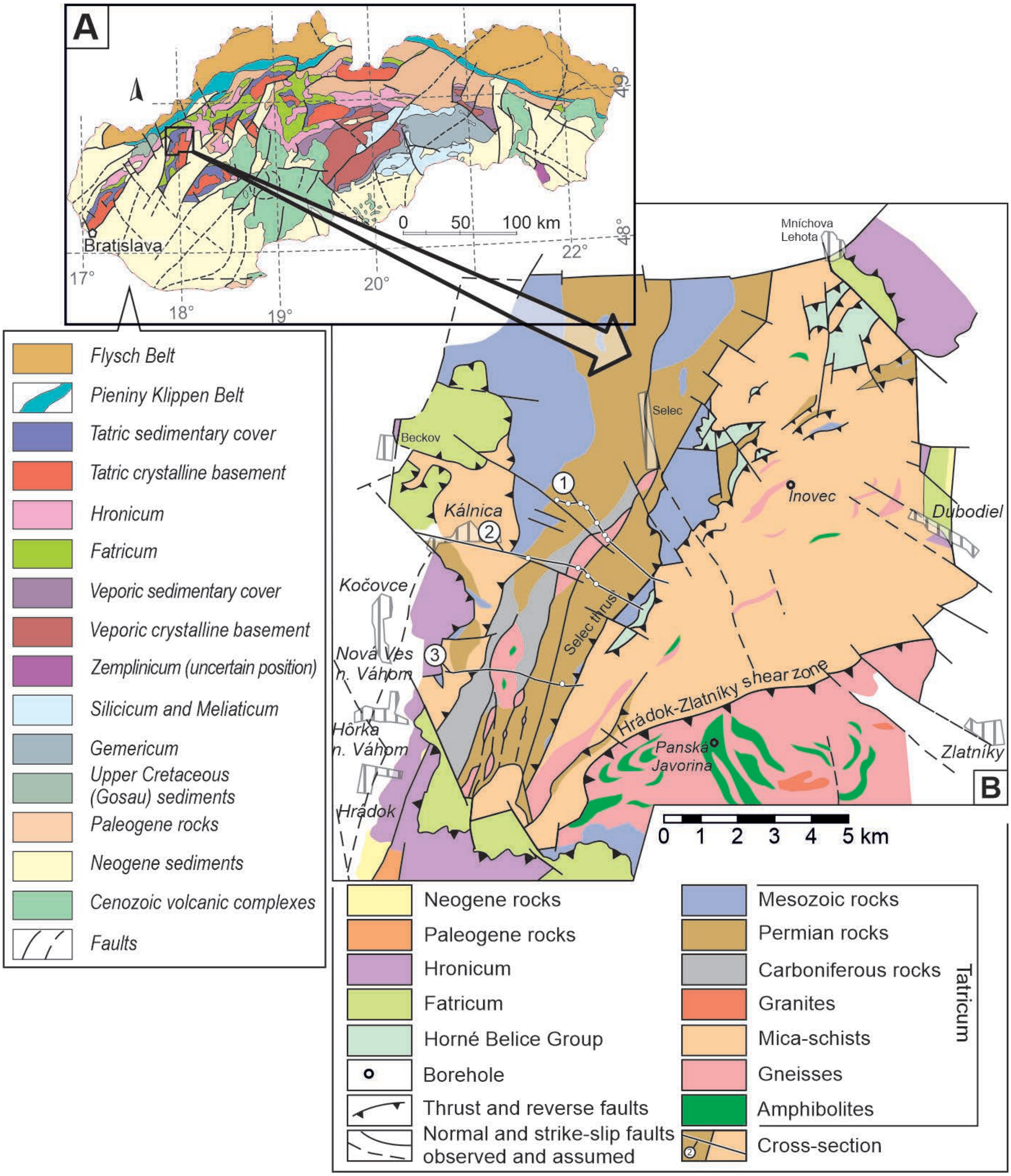


Fig. 1. A – Simplified tectonic map of Slovakia (based on Hók et al., 2019) with marked studied area. **B –** Simplified geological map of the northern Považský Inovec Mts (based on Elečko et al., 2008). E-W trending cross-sections in the map (1–3) show the relations among individual segments of the Selec Block in Fig. 11.

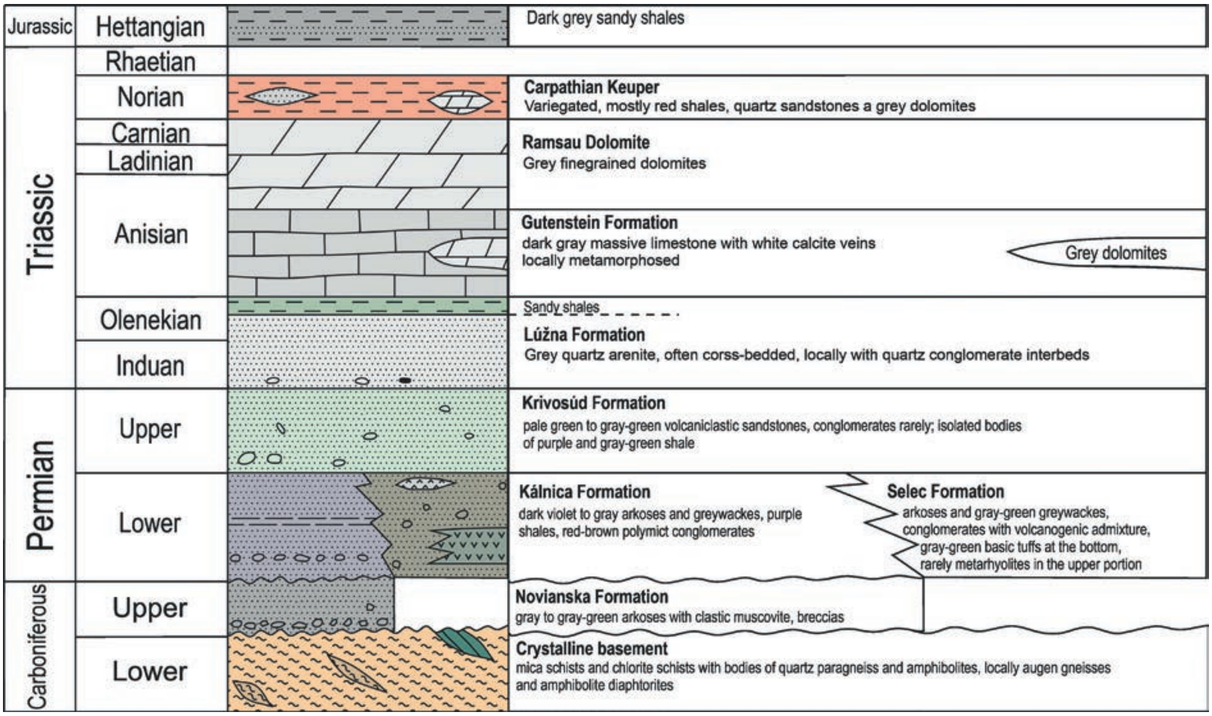


Fig. 2. Lithostratigraphic column of the Tatric cover sequence (Selec Unit) in the investigated area (based on Ivanička et al., 2011; Olšavský, 2008).

rocks are not exposed east of the Mníchova Lehota fault (described below), which is a younger structure bounding the Selec thrust from the west.

The **Hôrka shear zone** (Slovak: *hôrčanská strižná zóna*) was defined formerly by Maheľ (1986) as Hôrka [tectonic] slices belt (Slovak: *hôrčanské šupinové pásmo*) and later without further comments or clear definition renamed by Putiš (1991) as the Hrádok-Selec shear zone. However, we do not recommend using this term any longer due to the possibility of confusion with Hrádok-Zlatníky shear zone. The Hôrka shear zone represents N-S to NNE-SSW trending several 100 meters up to 2.5 km thick, dominantly dextral transpressional brittle-ductile shear zone marked by flower arrangement of strike-slip duplexes (Madarás et al., 2007). The shear zone is traceable in crystalline basement and Upper Paleozoic complexes between the Selec village and Hrádocká dolina valley, and is generally thickening to the south, where it is covered by thrust of the Hrádok-Zlatníky shear zone and Fatricum. The Hôrka shear zone is present west of Selec thrust and east of longitudinally irregular border, corresponding approximately to the westernmost occurrence of Upper Carboniferous Novianska Formation. It is characterized by the predominance of rocks of Kálnica Group and several isolated occurrences of crystalline basement rocks. Apart of typical Paleo-Alpine deformation also signs of older Albian (approx. 100 Ma) deformation are preserved (Štimmel et al., 1984; Putiš et al., 2008, 2009, 2019, 2021). However, it is not clear what particular events in terms of structural evolution have been dated by previous research. As detailed documentation and structural context of the dated samples are not available. Axial part of the shear zone is cut by the younger Mníchova Lehota fault zone.

The **Mníchova Lehota fault** (Slovak: *zlom Mníchovej Lehoty*), respectively the fault in direct continuation of the Strážov fault to the SW (*sensu* Elečko in Ivanička et al., 2011, Fig. 1) – this fault starts in the Mníchova Lehota and courses to the SW through the Selec village, where it deflects to the SSW and continues across the Prostredná and Krajná dolina valleys. In the area of Sevaldova kopanica it cuts the Hôrčanská dolina valley and is covered by the Fatricum south of Palkova kopanica settlement in the Hôrčanská dolina valley. This fault has not yet credited any important role. The NE segment of this fault was formerly interpreted as thrust of the mica schist basement of the eastern part of the block over the rocks of Kálnica Group (Ivanička et al., 2007). Despite the legitimacy of this interpretation, no signs of such contact are found in the area between the Selec and Mníchova Lehota villages (NE segment). This fault zone appears as an important structural boundary separating the crystalline basement and Carboniferous rocks from the Permian rocks of the Selec thrust (contact between the crystalline basement and so-called marginal succession of the Kálnica Group *sensu* Štimmel et al. (1984) in the region between Selec village and Hrádocká dolina valley. The fault is distinct as well in the DEM (Beták & Vojtko, 2009) and could be considered as relatively younger Neogene fault (AnD3-4).

Aims and methods

The main aim of this paper is to describe and define the kinematic character and timing of observed tectonic structures in the Selec Block of the Považský Inovec Mts. Study is based on the analysis and interpretation of the mesoscopic geological structures obtained during the fieldwork (Pelech, 2015). Classical methods of structural research were used to determine the kinematic character of deformation (e.g. Hanmer & Passchier, 1991; McClay, 1992; Pelech & Hók, 2017). Geological mapping was conducted at a scale 1 : 10 000, using standard GNSS instruments with an accuracy of +/– 5m. Location of important studied sites and boreholes is in the table 1. Most of the structural data were observed in the rocks of the Tatricum crystalline basement and autochthonous Upper Paleozoic and Mesozoic sedimentary cover as well as rocks of the Upper Cretaceous Horné Belice Group, Fatricum and Hronicum. Apart of the field data, the borehole data obtained by Uranium Exploration Comp. (Štimmel et al., 1984), the neotectonic analysis (Beták & Vojtko, 2009), and results of low temperature thermochronology (Kováč et al., 1994; Danišík et al., 2004; Králiková et al., 2016), as well as available geochronological data (Putiš et al., 2009, 2019, 2021; Kráľ et al., 2013) were integrated.

The deformation stages were designated according to their interpreted age and chronology as Variscan (VD) and Alpine (AD) as is standardly used in the Western Carpathians (eg., Plašienka & Marko, 1993; Madarás et al., 1994; Putiš et al., 2006, 2009; Vojtko & Kriváňová, 2024). XD labelling designation of orogenic cycles and their phases is based on method proposed by Németh (2021). This approach documents benefits from simultaneous use of both designation methodologies, allowing to reconstruct complicated multiphase orogenic & deformation evolution of studied regions.

The results and interpretation of structural research

The investigated area of the Selec Block could be divided into 3 main structural segments (Fig. 3) which differ in terms of quality and quantity of the structural record.

The **Eastern segment** (formerly the Železník unit *sensu* Maheľ, 1986); situated eastward of the Selec thrust and Mníchova Lehota fault) is characterized by dominance of the Tatric crystalline basement rocks and occurrence of the Upper Cretaceous flysch of the Horné Belice Group. The erosional remnants of Tatric sedimentary cover rocks, Fatricum and Hronicum complexes form only smaller part of the Eastern segment. The Eastern segment formerly represented the structurally higher unit relative to the Western and Central segment in the tectonic framework of the Selec Block.

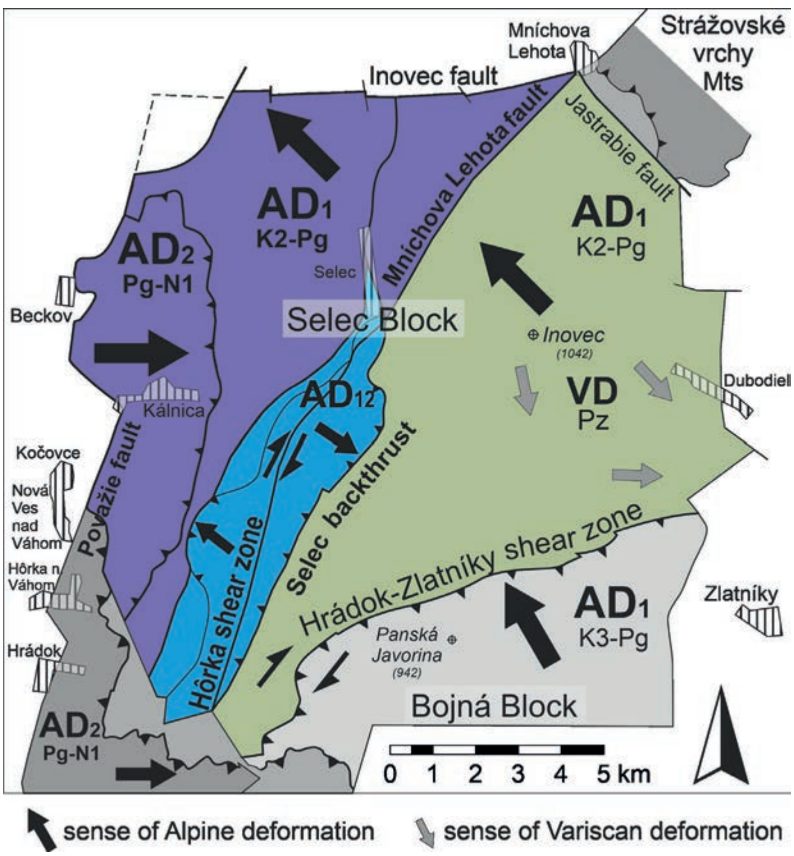


Fig. 3. Regional division of the Selec Block into 3 segments and naming of important regional tectonic features. Eastern segment is marked green, Central segment – blue and Western segment violet. The NW-vergent thrusts of Eastern and Western segments including their imbrication are interpreted to be Middle Cretaceous–Paleogene (in structural designation: AD_1 (or ApD1c sensu Németh, 2021). The dextral thrust of the Bojná Block (pale grey) along the Hrádok-Zlatníky shear zone on the Eastern segment is interpreted to be Late Cretaceous–Paleogene (AD1; ApD1c). East-vergent thrust (back-thrust) of westernmost zone within Western segment and units located more to the south (dark-grey colour), manifest relatively younger – Paleogene–Miocene thrusting and unroofing (AD_2; AnD1c, AnD2) are interpreted to be Neo-Alpine.

On contrary the **Western segment** (formerly the Drieňový vrch Monocline *sensu* Maheľ (1986); located west of the Selec thrust and Mníchova Lehota fault) is characterized by higher areal extent of Tatric sedimentary cover – the Upper Carboniferous and Permian rocks (Kálnica Group). The Tatric crystalline basement, Fatricum and Hronicum occur here as well, however are less frequent. So, the Western segment represents former Paleo-Alpine footwall structurally lower than Eastern segment.

The **Central segment** is represented by the Hôrka shear zone (formerly the Hôrka [tectonic] slices belt *sensu* Maheľ, 1986); located west of Selec thrust and east of longitudinaly irregular boundary approximately equivalent to westernmost occurrences of the Upper Carboniferous Novianska Formation. The zone is characterized by the predominance of Upper Paleozoic rocks of the Kálnica Group and several occurrences of crystalline basement, having similar structural record as the Western segment.

Bedding and metamorphic foliation

Eastern segment

The rock complexes of diaphtorites, mainly mica schists and gneisses, present in the eastern part of the Selec Block, show relatively uniform orientation of foliation, generally trending NE–SW, with dispersion between ENE–WSW to NNE–SSW, dipping generally to SE (Fig. 4). The diapthtoritic foliation generally copies the original bedding or schistosity of protolith. Current orientation of schistosity is a result of the Paleo-Alpine (Eoalpine) deformation (AD_1; ApD1c) which modified in various degrees the pre-existing Variscan diaphtoritic foliation.

Tab. 1

Location of important outcrops. Coordinates in S-JTSK system

Name	SJTSK X	SJTSK Y	Rocks	Structure or important notes	Figure
P40	–499580.5	–1213174.2	Sandstone, Krivosúd Fm.	Folded sandstone layer	Fig. 6E
P44	–501799.3	–1220204.4	Gneiss	Kink folds	Fig. 10A
P45	–502269.7	–1219604	Sandstones, Selec Fm.	Cleavage	Fig. 7A
P49	–507933.3	–1215981.7	Mica schist	Alpine folds in crystalline basement	Fig. 6D
P65	–500405.2	–1216243.5	Grey flysch, Rázová Fm.	Folded sandstone	Fig. 6G
P68	–499197.2	–1215900.4	Siliceous shales „Lazy Fm.“	Cleavage	Fig. 6F
P69	–497478.8	–1215464	Mica schists	Relics of separated hinges of folded quartz veins (Variscan)	Fig. 6C
P83	–508106	–1223528.6	Conglomerate, Novianska Fm.	Cleavage	Fig. 7D
P111	–499025.9	–1216822.1	Mica schists, gneiss	Alpine recumbent fold in the crystalline basement, Extensional kink bands, Character of mica schist and gneiss protolith	Fig. 6H, Fig. 10D
P124	–496388.1	–1218211.9	Mica schists, gneiss	Folded secretion quartz layers (Variscan)	
P133	–498421.9	–1222749.8	Mica schists	Folded secretion quartz layers (Variscan)	Fig. 6B
P143	–506843.1	–1224160.3	Sandstone, Selec Fm.	Compressional kink bands	Fig. 10C
P148	–504576.7	–1219262.6	Augen gneiss	Dextral sence of shear based on feldspar porphyroclasts, Hôrka shear zone	Fig. 7E
P310	–505487.6	–1218981.3	Conglomerates, Selec Fm.	Deformed conglomerate (dextral shear)	Fig. 7B
P313	–503012.1	–1220253.7	Sandstones, Selec Fm.	Folded quartz vein, mesocopic faults (slickensides)	Fig. 7C
P315	–502712.1	–1219927.1	Shales, Selec Fm.	Compressional kink bands	Fig. 10B
P403	–507716.9	–1224901.8	Augen gneiss	Dextral sence of shear based on feldspar porphyroclasts	Fig. 7F
P404	–507315.5	–1225012.6	Shales, Selec Fm.	Subvertical dip in the centre of the Hôrka shear zone	Fig. 7G
P406	–502040.7	–1216872.6	Mica schists	S/C structure	Fig. 7H

The Mesozoic and Upper Paleozoic rock complexes of the Tatric sedimentary cover unit located east of the block rest conformably with the strike of imbricated structures of crystalline basement and the Horné Belice Unit. Dip direction of olistholiths situated in the Horné Belice Group is conformal as well, whereby the dip to the SE dominates in all rock complexes (Fig. 4).

Western segment

The occurrences of crystalline basement rocks are less abundant in the western part of the Selec Block. They are composed mainly by augen gneisses, quartz paragneisses and lesser amount of mica schists. Here the trend of foliation is dominantly N–S to NW–SE, hence consistently with direction of the rock stripes (Fig. 5). Sedimentary and volcanic rocks of the Late Carboniferous and Permian age (Kálnica Group) are more abundant. The bedding planes are trending NNE–SSW and lesser in NNW–SSE direction. The bedding planes and metamorphic foliations are dipping to the west (Fig. 5). Important structural phenomenon is the flower-like arrangement with crystalline basement and Kálnica Group rocks located in the centre of the fan structure with nearly subvertical dip.

Western segment of the Selec Block is characterized with higher occurrence of Tatric Mesozoic rocks as well as the Mesozoic complexes of Fatricum and Hronicum. The Tatric sedimentary cover rocks are usually monoclinally dipping to the west. The Mesozoic rock sequence in the area between Beckov and Krivosúd-Bodovka villages is in overturned position (c.f. Ivanička et al., 2007). Overturned position is observed also in the Hronicum complexes of the Beckov castle rock (probably erosional remnant of larger overturned fold limb)

Folds and cleavage

The dispersion of the fold B-axis in the Selec Block is a result of polyphase deformation and interaction of Variscan and Alpine structures (Figs. 4 and 5). There is striking difference between the Eastern and Western segments.

The crystalline basement of the Eastern segment is dominated by E–W strike of B-axis and cleavage (Figs. 4 and 5A) which was pointed out as well by the previous studies (Putiš, 1983, 1986; Marko et al., 1990). E–W direction generally represents a result of Variscan deformation which was dominantly south-vergent (VD_1, Figs. 6A and C). Several localities (e.g. west of Inovec

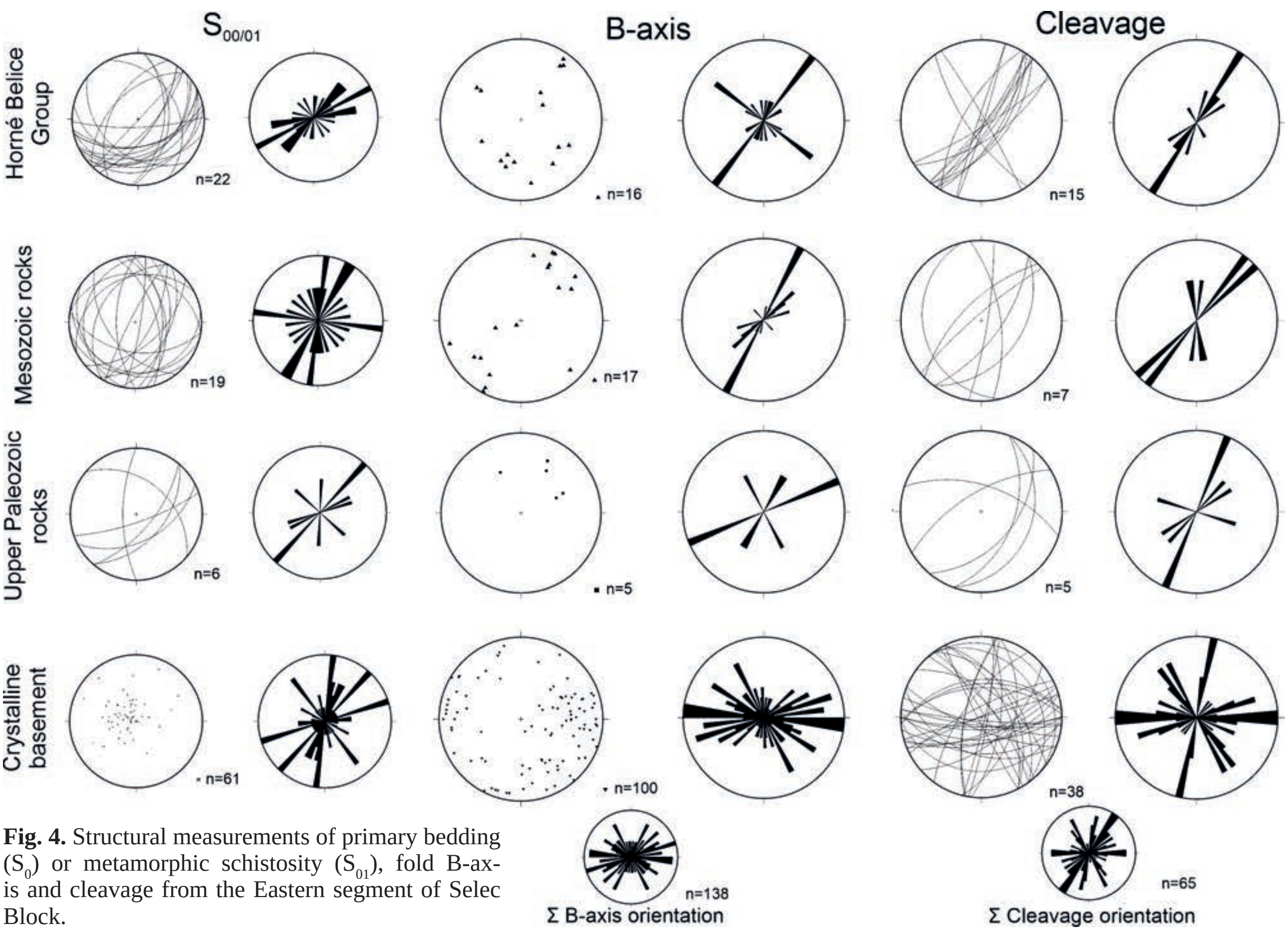


Fig. 4. Structural measurements of primary bedding (S_0) or metamorphic schistosity (S_{01}), fold B-axis and cleavage from the Eastern segment of Selec Block.

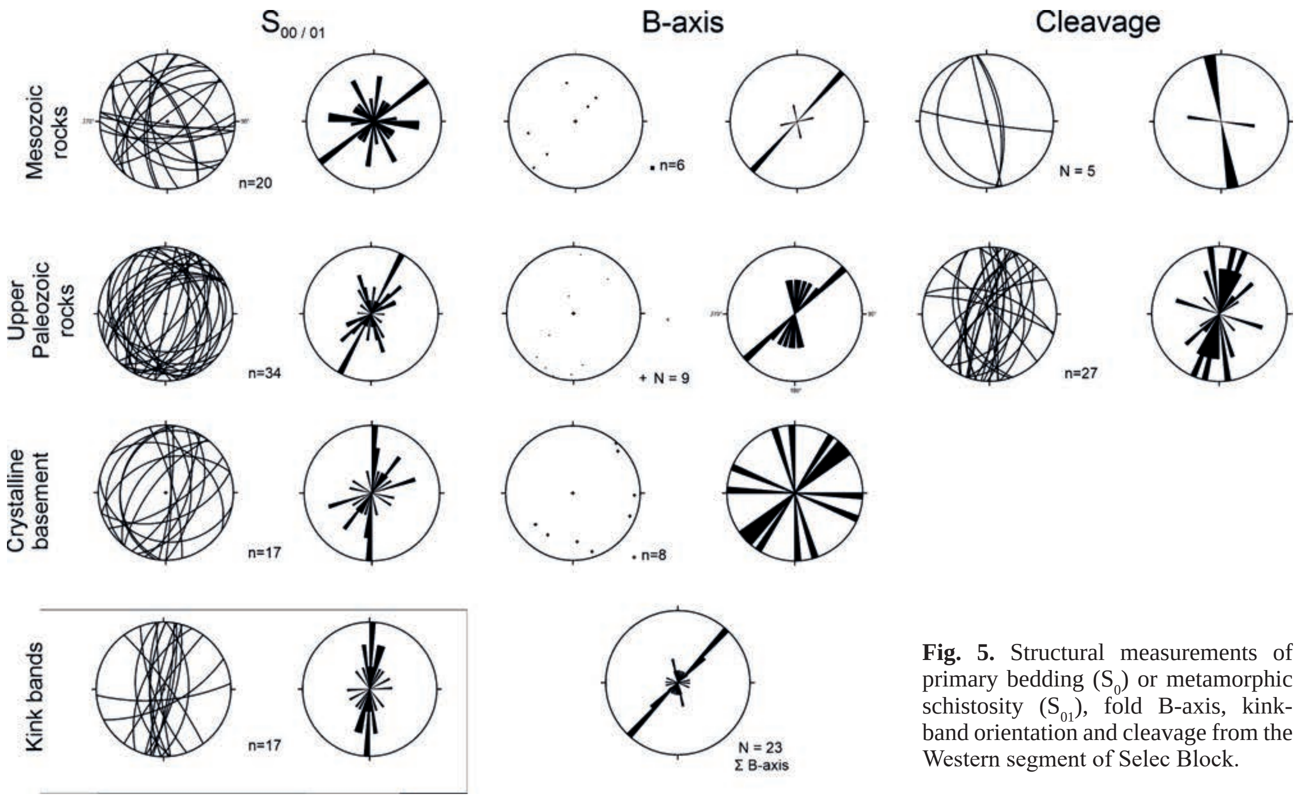


Fig. 5. Structural measurements of primary bedding (S_0) or metamorphic schistosity (S_{01}), fold B-axis, kink-band orientation and cleavage from the Western segment of Selec Block.

hill) within the crystalline basement outcrops show that E–W striking folds are affected by another deformation phase with E–W compression which resulted in restraining and formation of second generation of folds with N–S orientation of fold axis and vergence to the E (Fig. 6B). Such structures were not revealed in the Upper Paleozoic or Mesozoic complexes; and therefore, it is possible to regard them as Variscan. The N–S oriented structures related to E–W trending deformation, are missing in the other Western Carpathian areas, and therefore could be related to the VD_2 retrograde metamorphism dated to the period approx. 310.0 Ma (Kráľ et al., 2013).

The structural dataset from the Central and Western segment of the Selec Block is relatively small due to worse exposure conditions. It is especially true for the crystalline basement complexes where only few deformation structures were observed. The present observations so far show that the crystalline basement rocks were affected by Variscan deformation VD_1 responsible for E–W trending folds.

The whole Selec Block is characterized by the presence of the Alpine folds with NW-vergence and NE-SW orientation of fold axes (Figs. 4, 5, 6D-F and H). The fold B-axis in the Tatric sedimentary cover in the Eastern segment are oriented in NE–SW direction (Fig. 4).

The N-S trending folds axes and cleavage are dominating in the Central segment, present especially in the rocks of the Kálnica Group (Figs. 4, 7A, G, H). The N–S striking folds and cleavage are generally parallel to the elongated Kálnica Group occurrences and the N–S to NNE–SSW oriented branches of the Hôrka shear zone (Putiš, 1991; Madarás et al., 2007; Fig. 5). The region of the Hôrka shear zone is characterized for NNE–SSW orientation of metamorphic schistosity and primary sedimentary bedding (Fig. 8B). Orientation of the stretching lineation (Fig. 8A) as well as ductile kinematic indicators, primarily the sigmoidal deformed porphyroclasts, S-C structures and cleavage (Figs. 7B, D–H) indicate dextral (transpressional-transtensional) character of the shear zone. Prevailing structural record of Central and Western segment indicate presence of NW-vergent thrusting during the oldest deformation phase AD_1, occurring probably before the sedimentation of the Horné Belice Group (approx. 100 Ma, see Putiš et al., 2008, 2009, 2019, 2021), which is, however, missing in this region. Bivergent transpressional structures associated with the Hôrka shear zone probably occurred during this period as well.

The Selec thrust, as one of the most prominent tectonic structures in the Central segment, represents a brittle-ductile thrust with top to ESE-vergence which is very well marked by the borehole and surface data (Figs. 9 and 11; Štimmel et al., 1984). The thrust is located in the eastern margin of the shear zone, approx. between Hôrčanská dolina valley and Klenkov vrch hill, and represents the boundary between Eastern and Western segments of the Selec Block.

Fig. 6. A – South vergent (Variscan) parasitic folds within the limb of larger recumbent fold in the mica schists, NW of Inovec hill. **B** – Folded secretion quartz layers in mica schists with E vergence, Chotina valley. **C** – Relics of SE vergent secretion quartz veins in the mica schists, locality Vaškova chata (P124). **D** – NW-vergent folds in mica schists, brook SE of Beckov (P49). **E** – NW-vergent buckle fold in Permian sandstones of the Krivosúd Formation, Sedličiansky potok valley (P40). **F** – SE-dipping cleavage in the cherty shales (“Lazy Formation”) olistolith in the Upper Cretaceous rocks of the Horné Belice Group, locality Lazy (P68). **G** – Non-cylindrical buckle fold in the Upper Cretaceous Rázová Formation of the Belice Unit, NNW of Hradisko hill (P65). **H** – NW vergent recumbent fold of crystalline basement in the hanging wall of the Upper Cretaceous Belice Unit, at the locality Hranty (P111).

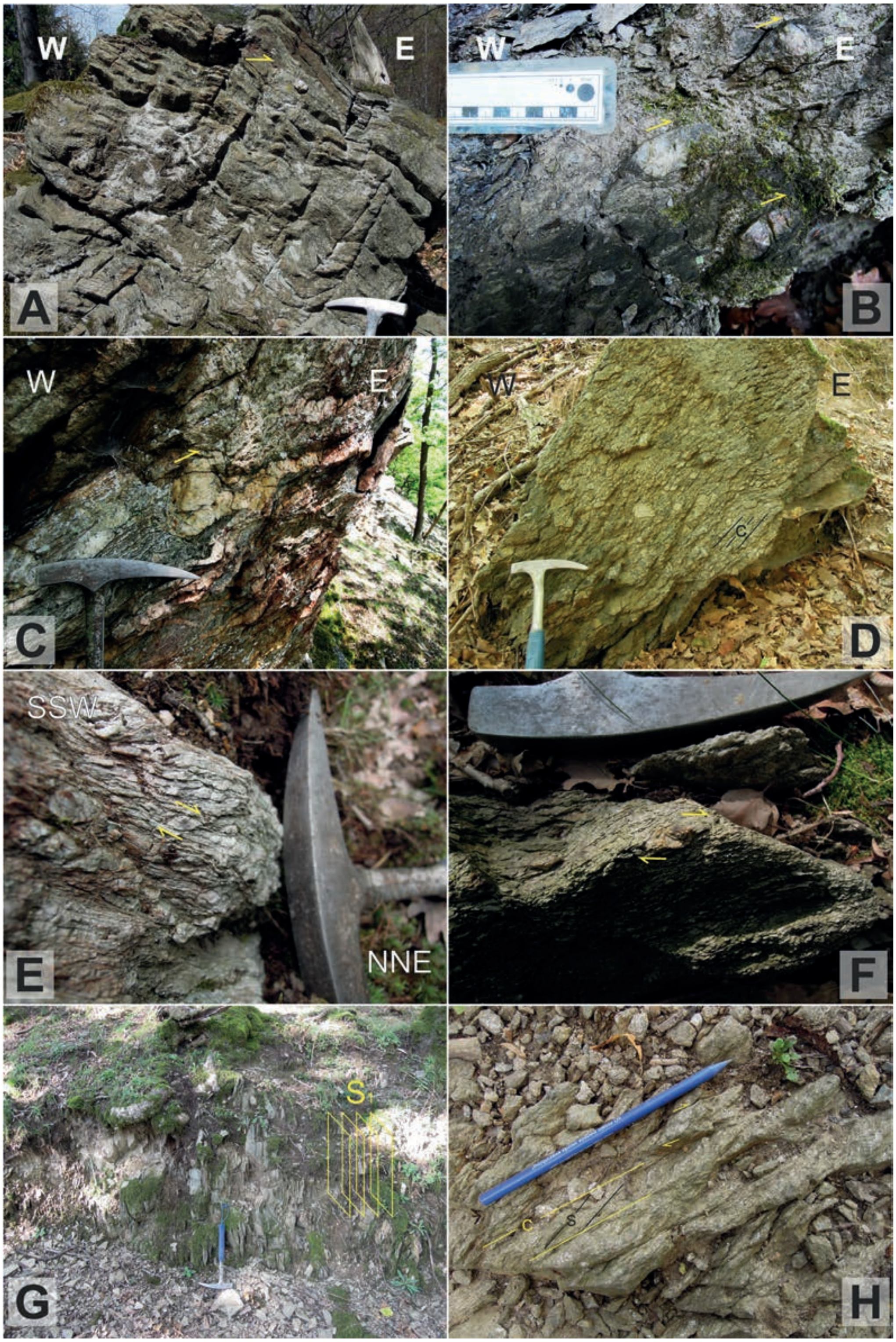


Fig. 7. A – W-dipping cleavage in Permian sandstones of Selec Formation, locality Nad Klenkovým vrchom (P45). **B** – Deformed quartz pebbles in sheared Permian conglomerate. Prostredná dolina valley (P310). **C** – Folded quartz vein with SE-vergence in the rocks of Permian Selec Formation, Prostredná dolina valley (P313). **D** – Cleavage in the conglomerates of the Novianska Fm., Hôrka valley (P83). **E** – Dextral shear in the pale augen paragneisses, Prostredná dolina valley (P148). **F** – Dextral shear in the pale augen paragneisses, locality Kopúnova kopanica, Hôrčanská dolina valley (P403). **G** – Subvertically dipping shales of Permian Selec Formation in the Hôrka shear zone, Holubací vrch hill (P404). **H** – S/C structures with apparent dextral shear sense in the mica schists, S of Selec (P406).

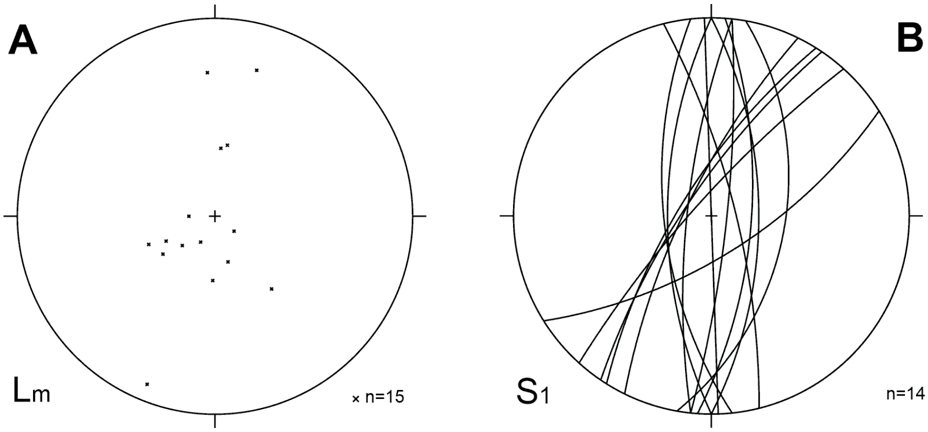


Fig. 8. Structural characteristics measured in the Hôrka shear zone. **A** – Orientation of mineral lineations collected in rocks of the Hôrka shear zone. **B** – Orientation of metamorphic foliation in the crystalline basement complexes and bedding of the Kálnica Group.

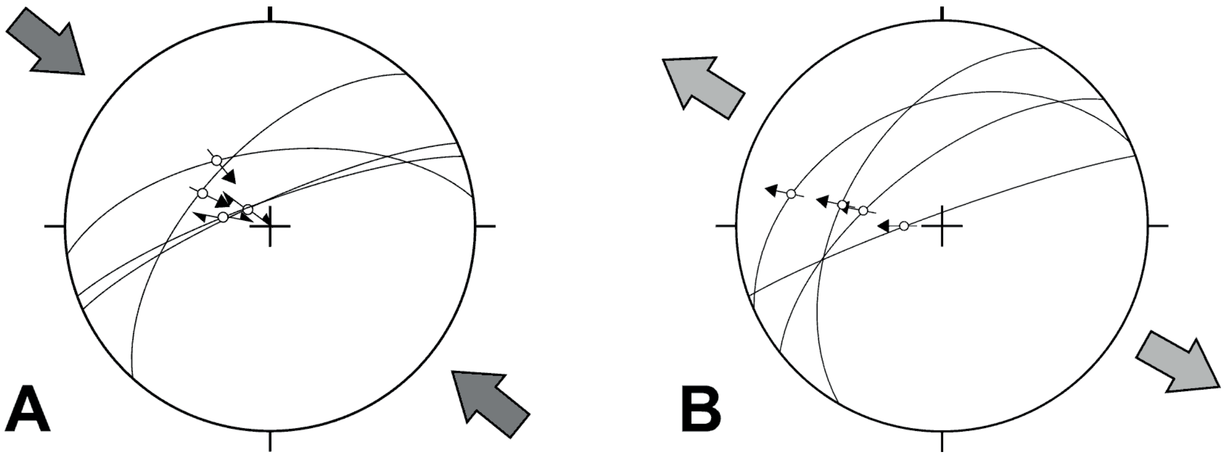


Fig. 9. A – Reverse faults of the Selec thrust related to AD_2 phase. **B** – Normal faults measured in the same area indicate unroofing. Measured at the Babia hora locality (P313).

Fig. 10. A – Kink folds in the gneisses at the locality Pod Jakubovou (P44); **B** – Kink bands in the sandstones of the Selec Fm. (Lower Permian), Babia hora (P315); **C** – Kink bands in the sandstones and shales of the Selec Fm., Hôrčanská dolina valley (P143); **D** – Extensional kink bands related to Horné Belice Group exhumation, Hranty (P111).

Kink bands

Kink bands and kink folds, usually trending N–S or NNE–SSW, are very common in studied region (Fig. 5). Most of the previous studies (e.g. Putiš, 1986; Plašienka, 1995) associate them with the youngest deformation phases. The kink folds are found mainly in the strongly anisotropic Upper Paleozoic formations (Fig. 10) as well as foliated crystalline basement. Occurrences are scattered throughout the investigated area however strongly dominate in the Western segment.

Structural cross-sections

Cross-sections were constructed perpendicular to the observed structures in NW–SE or E–W directions applying our own structural data (Pelech, 2015), using issued official map (Ivanička et al., 2007) and with an important contribution of borehole data (summarized by Štimmel et al., 1984), to understand the complicated geological conditions west of the Selec thrust. Deformation is particularly expressive in the central part of the Selec Block affected by the Hôrka shear zone. Its manifestation in is the intense Paleo-Alpine ductile and brittle deformation of the crystalline rocks and the Kálnica Group, causing their subvertical to vertical arrangement (Figs. 7A and G). Evidence of the dextral shearing is provided mainly by the occurrences of crystalline basement rocks in the Hrádocká dolina valley (Kopúnova kopanica, Fig. 7E), Prostredná dolina valley (Pod Bielou hlinou, Fig. 7B) and in Selec village (Fig. 7H). The Paleo-Alpine structure is modified by younger Mníchova Lehota Fault.

Cross-section 1 follows the boreholes 814 (Kňažia Valley), 816, 812, 810, 806, enters the highest parts of Prostredná dolina Valley and ends at the locality Pod Jakubovou. The boreholes 816 and 812 demonstrate the structural position of the Novianska Formation and the adjacent crystalline basement complexes forming the recumbent overturned fold with northwestern vergence. Crystalline basement drilled by the borehole No. 810 represents core of the anticline, being dissected by the Mníchova Lehota fault and separated from the structurally higher complexes of the Selec thrust with eastern vergence (Fig. 7C). This segment of the Selec Thrust is built by 200 m thick body of Permian Selec and Krivosúd formations overlying the Triassic carbonates of Hradisko hill. Tectonic slice of the Upper Cretaceous Horné Belice Group cropping out from bellow the crystalline basement rocks is overlying the Triassic carbonates of the Hradisko hill in the upper part of the Prostredná dolina valley (Pelech et al., 2016).

Cross-section 2 starting in Kálnica, continuing parallel to the Prostredná dolina valley across the boreholes 811, 802, 724,742, 884, Kamenný krám ridge to the vicinity of Horné vápenice locality. The structure is dominated by the lower limb of an overturned north-vergent fold with rocks of the Novianska Formation and crystalline basement in its core, following the anticline documented in the cross-section 1. It is overlain from the west by two thick thrust sheets formed by carbonates of the Fatricum and, in particular, by a large body of diaphthorites exposed in the area south of Kálnica. The presence of east-vergent structures and the deformation of the hinge part of the anticline in the area of the mouth of the Prostredná dolina valley are documented by deformed conglomerate clasts and cleavage, visible in the rocks of the Selec Formation (Fig. 7B). The block of the Kálnica Group rocks in the hanging wall of the Selec thrust is thicker in the cross-section area and, according to borehole and surface information, deformed by west-vergent thrust faults that were formed during contraction after the backthrusts.

The southernmost **cross-section 3** passes through Novianska dolina valley, borehole No. 1110 to the Polámaný vrch hill. It demonstrates an imbricated structure with backthrust of crystalline basement rocks with rudimentarily preserved sedimentary cover over the Mesozoic, Permian and Carboniferous rocks of the Tatric sedimentary cover between the Babušina kopanica and Novianske kopanice localities. The central part of the section is dominated by an anticlinal fold structure of the Novianska Formation with crystalline basement rocks in its core, cut from the East by the Mníchova Lehota fault, which separates it from the body of Permian rocks in the hanging wall of the Selec thrust. The hanging wall of the Selec thrust is present in the borehole 1110 and is considerably thicker than in corss-sections 1 and 2. Surface and subsurface data do not confirm the presence of Mesozoic rocks of the Hradisko hill in the area.

Discussion

Transpression or two-phase deformation of Horné Belice Group

There are two views on the mode of formation of NW–SE trending "perpendicular" folds within the rocks of the Horné Belice Group (Fig. 3). Plašienka (1995) originally considered the perpendicular folds as kink folds and interpreted them as a result of the final stage of the closure of the former Belice Unit basin accompanied by transpression (AD_3 stage sensu Plašienka, l. c.). Later, Pešková (2011) considered folds of both directions as a single event resulting from inclined transpression (sensu Jones et al., 2004). According to the current knowledge, it cannot be clearly decided whether the transpression was ongoing throughout the AD_1 deformation event or represented only its final stage.

With respect to aforementioned, it is possible to distinguish 2 or 3 Alpine contractional tectonic events

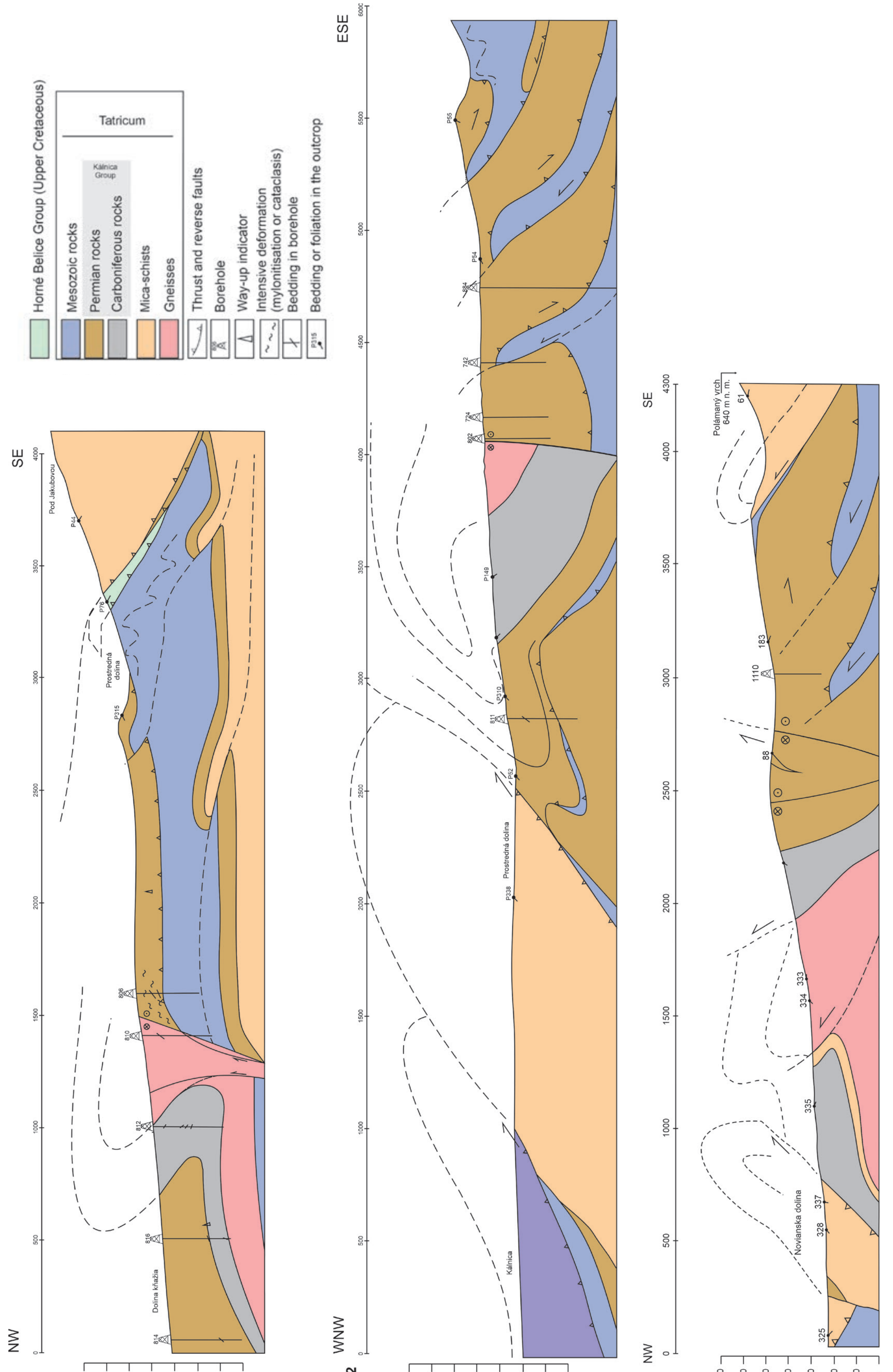


Fig. 11. Cross-sections 1, 2 and 3. For location see Fig. 1.

(ApD1c, AnD1c, AnD3) in the Selec Block. The presence of Cenomanian–Turonian Paleo-Alpine deformation (Hron phase *sensu* Plašienka, 2005), associated with the nappe emplacement of the Fatricum and Hronicum in this region, is not clear. Due to presence of Upper Cretaceous sequences of the Horné Belice Group as well as the occurrence of the Upper Cretaceous Hubina Formation in the Bojná Block (Pelech et al., 2017c), the nappe emplacement of the Fatricum and Hronicum occurred probably after Cretaceous/Paleocene boundary in the Považský Inovec Mts.

Kink folds

The kink folds are usually considered as generally low temperature deformation products (Anderson, 1964). Therefore, we consider their formation to be relatively younger and in shallower structural position within the Alpine deformation. Due to the increased presence of complexes with penetrative foliation within the rocks of the Selec Block, it is likely that the kink bands were formed in multiple stages of deformation. The compressional kink bads have predominantly N–S trend (Fig. 4) and are probably the result of the strong expression of second Alpine deformation AD_2 in the western part of the block and also the reorientation due to the activity of the Hôrka shear zone. At the same time, the similar orientation of the cleavage and kink bands indicates similar PT conditions and possible genetic relationship. The monoclinal and conjugate kink bands occurring in the rocks of the Kálnica Group represent an evidence of both – oblique and subhorizontal shortening. However, the genesis of kink folds within the basement rocks is apparently not uniform. Local kink bands are also associated with extensional structures in the overlying bodies of the Belice Unit showing signs of SE-vergent extension (ApD2) or possibly also Variscan.

The question of Infratatricum

The term *Infratatricum* was introduced by Putiš (1992) for the outer (northern in today's coordinates) margin of the Tatricum. However, it is important to remark, that no definition was provided in this paper. Only from the context and the Fig. 2 (ibid) one may get the message that the *Infratatricum* is represented by the crystalline basement of the Selec Block of the Považský Inovec Mts. The aim was to express the position of the Selec Block in the footwall of the typical Tatric Bojná Block; as well as the position above the Upper Cretaceous rock complexes (Horné Belice Group), which was designated as *Perivahicum* (no definition of this term was provided either). The definition or more precise spatial distribution of the aforementioned new terms was neither clearly expressed in the later works (cf. Korikovsky et al., 1995; Putiš et al., 2006, 2008, 2016 and 2021). The definition, however, appeared in the work of Plašienka et al. (1997, p. 141–145) as follows: "*The Infratatric units occur in the most external core mountains and include units as the Borinka and Orešany units in the Malé Karpaty Mts., Inovec nappe (Selec block) and*

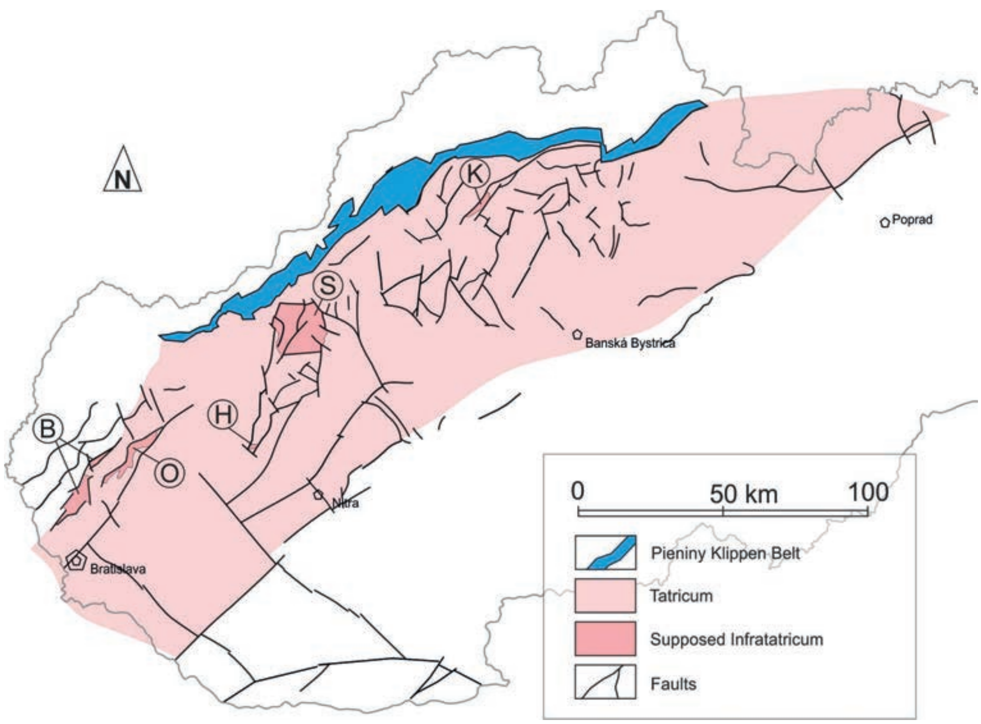


Fig. 12. Location of the Infratatricum occurrences within the Tatricum in the Western part of Slovakia: B – Borinka Unit, O – Orešany Unit, H – Hlohovec Unit, S – Selec Unit, K – Kozol Unit.

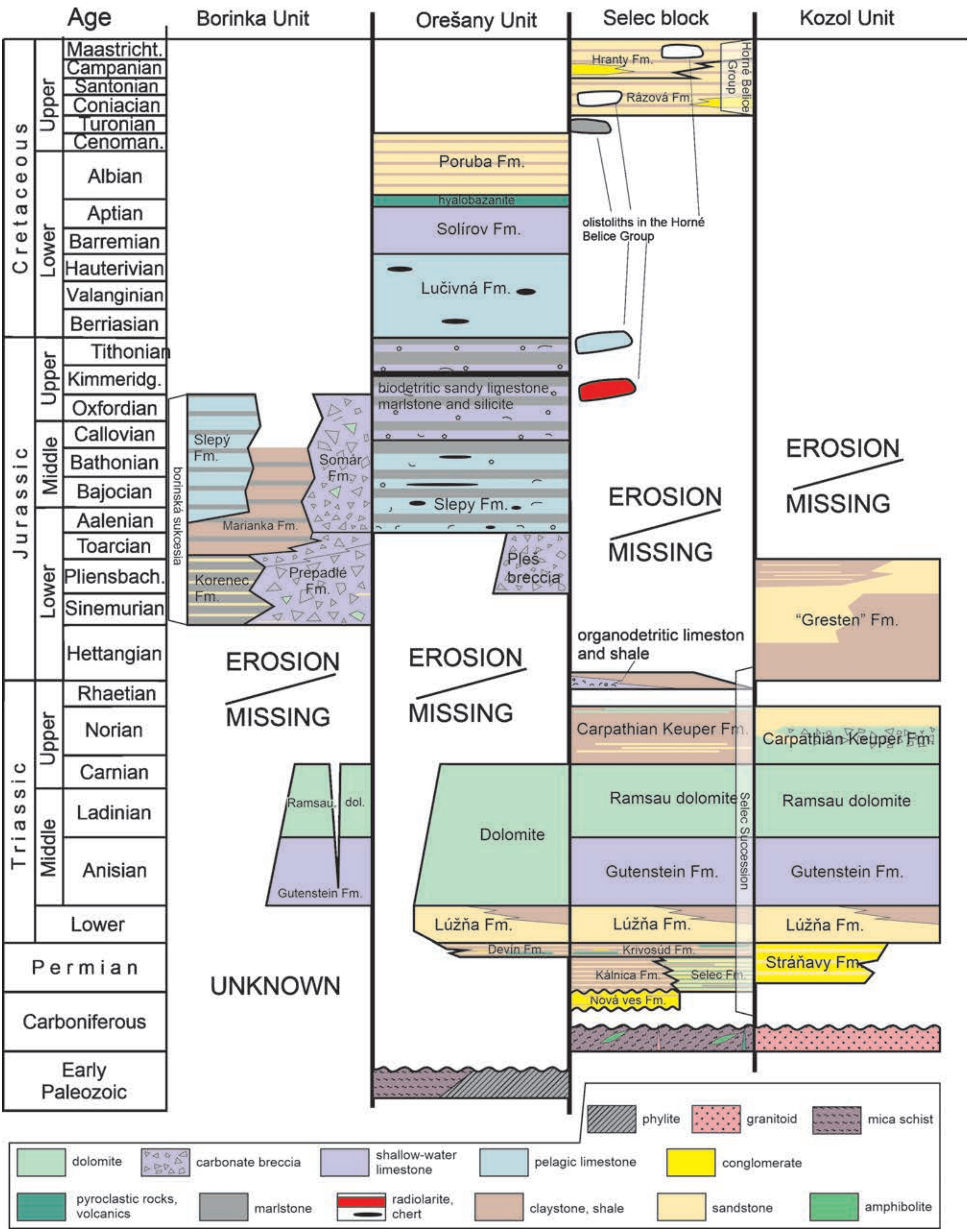


Fig. 13. Lithostratigraphic correlation scheme of supposed Infratatric units (based on Plašienka, 1987; Ivanička et al., 2011; Polák et al., 2012; Olšavský, 2007; Havrila & Olšavský, 2015).

Hlohovec nappe in the Považský Inovec Mts. and the Kozol unit in the Malá Fatra Mts." The characteristic features were: "*1) Pre-Alpine basement composed of low- to medium-grade metamorphics, less granitoids; 2) locally (Selec block, Kozol antiform) very thick Upper Paleozoic volcanosedimentary complexes are present; 3) deep erosion of the Triassic substratum during the two-phase Lower Jurassic rifting (Hettangian and Toarcian); 4) presence of syn-rift scarp breccias throughout the Jurassic, up to Lower Cretaceous (Borinka, Orešany and Inovec units); 5) the deepest structural position within the Tatric stack, below important regional thrust fault (Prepadlé shear zone between the Borinka unit and the Tatric Bratislava nappe, the Hrádok–Zlatniky thrust fault separating the Selec and Bojná blocks in the Považský Inovec Mts.); 6) regional low-grade metamorphism of cover sequences (Borinka unit, Selec block), complex internal structure either with dominating flattening and noncoaxial shearing (Borinka and Orešany units), or folding and imbrication (Selec block, Kozol unit); 7) partial resetting of K-Ar isotopic ages of pre-Alpine basement rocks within ductile-brittle shear zones (Malé Karpaty Mts.), which constrain the time of thrusting to the Late Cretaceous, confirmed by involvement of Senonian sediments and Krížna nappe rocks into the imbricated structure of the Selec block."* Later Plašienka (1999) excluded the Hlohovec block from the Infratatricum.

Recently, however, various authors have questioned the validity of the term Infratatricum for different regions (Pelech, 2015; Havrila & Olšavský, 2015; Hók et al., 2022). The common feature of Infratatricum is mainly the occurrence in the external Tatricum, intensive folding and presence in the footwall of the Tatric thrust sheets.

According to the latest study based on geological mapping in the Lúčanská zone of Malá Fatra Mts, the structure of so-called Kozol anticline was reinterpreted as an intensely imbricated Tatric monocline with overlying Fatricum and Hronicum (Havrila & Olšavský, 2015). There are no signs of overthrusting of Tatricum over the Kozol Unit. The Orešany Unit in the Malé Karpaty Mts is overthrust by Fatricum. The contact with the Modra Massif is usually interpreted as thrust of the crystalline basement of Tatric Modra Massif (Polák et al., 2011). However, the structural evidence is missing and contact could be interpreted alternatively as normal fault or backthrust.

Considering lithostratigraphic correlation of the studied sequences, the supposed Infratatricum does not show any material continuity (Figs. 12 and 13). The Jurassic olistostrome of the Borinka Unit (Plašienka, 1987; Polák et al., 2012) is not comparable with any other Tatric unit. Likewise, the correlation of the Orešany Unit (Michalík et al., 1991; Polák et al., 2012) with the the Selec or Kozol units is very difficult to impossible. There is also considerable difference between the Selec or Kozol units. Despite both contain the Upper Palaeozoic rocks, the thickness, stratigraphic range and lithologic variability is much higher in the Selec Unit (the Kálnica Group; Olšavský, 2008; Havrila & Olšavský, 2015). The presence of the Upper Cretaceous sequence is unique only for the Považský Inovec Mts. However, the occurrence was documented in all 3 blocks including supposed Infratatricum (Selec and Hlohovec blocks, Ivanička et al., 2007) as well in the Bojná Block (Pelech et al., 2017c), which is uniformly considered as Tatric (e.g. Plašienka, 1999; Ivanička et al., 2011). The unification of the all-aforementioned units into one tectonic unit, or sub-unit cannot be considered appropriate or necessary. The unique structure of the Selec Block points to fact that it undoubtedly represents the most external part of the Tatricum.

Conclusions

The paper gives a new insight into the structural evolution of the Selec Block of the Považský Inovec region, being documented by numerous structural measurements.

The Variscan deformation of the Selec Block was south-vergent and probably had several phases, the final one (ca. 310 Ma) of which was accompanied by extensive retrograde metamorphism (Kráľ et al., 2013). N–S compression VD_1 was dominant, generating numerous fold structures in the basement rocks (Figs. 6A and C). The Alpine deformation of the Selec Block occurred in 2 or 3 phases and was obviously bivergent in kinematics. The first was the Paleo-Alpine phase AD_1 (ApD1), when the Tatric basement complexes and their sedimentary cover, together with the rocks of the Horné Belice Group, were displaced towards the NW. Observations suggest that the NW-SE convergence was not perpendicular but also had elements of transpression. The nature of the deformation can be traced throughout the whole Selec Block area. However, on the basis of the present knowledge, it cannot be entirely excluded that the deformation during AD_1 was already of a bivergent character, and resulted in the formation of the Hôrka shear zone (in orogenic phase ApD3). Based on geochronological and stratigraphic evidence, especially the wedge-top provenance of the Horné Belice Group, the age of the AD_1 deformation phase is post Late Cretaceous, probably Paleogene (Maheľ & Kullmanová, 1975; Štimmel at al., 1984; Kováč et al., 1994; Putiš et al., 2009; Ivanička et al., 2007; Pelech et al., 2016, 2017b, c).

The second phase of deformation (AD_2) is represented by the km-scale E and SE-vergent backthrusts of the Tatric crystalline basement and sedimentary cover rocks as well as of the Hronic and Fatric rocks. Their presence is confirmed only in the western part of the mountain range, both within the Selec Block and in more southern areas (Pešková, 2011). The reverse thrusts, especially the Selec thrust, are documented by both drilling (Štimmel et al., 1984, Fig. 13 ibid) and structural research (Figs. 7A–C). Their origin is probably related to the oblique collision of the Internal West Carpathian Block with the Bohemian Massif during the Oligocene to the Lower Miocene (Jiříček, 1979). The presence of the backthrusts is related to a broader zone extending from the Vienna Basin to Malá Fatra Mts (Sentpetery, 2011; Pešková et al., 2012; Pelech et al., 2018; Pelech & Olšavský, 2018; Olšavský & Pelech, 2021).

Significant exhumation that took place in the Selec Block in the area of the backtrust crystalline sheets and on the Mníchova Lehota Fault is documented by young AFT ages of 13–14 Ma (Danišík et al., 2004; Králiková et al., 2016). It indicates Neo-Alpine exhumation process (AnD2 to AnD4 *sensu* Németh, 2021).

Acknowledgements

Authors express their thanks to Ministry of Environment of the Slovak Republic for funding regional geological research projects, and simultaneously to Slovak Research and Development Agency (APVV) funding grant No. APVV-21-281 (*Alpine geodynamic evolution of the inner zones of the Western Carpathians*). Valuable comments of the reviewer Ľ. Gazdačko (ŠGÚDŠ) and another anonymous reviewer have improved the quality of the original manuscript. This paper is also a contribution of the State Geological Institute of Dionýz Štúr (ŠGÚDŠ), Slovakia, for the EC – CINEA HORIZON-CL5-2021-D3-D2 project 101075609 Geological Service for Europe (GSEU) within WP6 – Geological framework for the European geological data & information system.

References

Anderson, T. B., 1964: Kink-bands and related geological structures. *Nature, 202, 272–274.*

Beták, J. & Vojtko, R., 2009: Implementácia nástrojov tektonickej geomorfológie a v neotektonickom výskume (na príklade pohoria Považský Inovec). *Geografický časopis, 61, 29–47.*

Danišík, M., Dunkl, I., Putiš, M., Frisch, W. & Kráľ, J., 2004: Tertiary burial and exhumation history of basement highs along the NW margin of the Pannonian basin – an apatite fission track study. *Austrian Journal of Earth Sciences, 95/96, 60–70.*

Elečko, M. (ed.), Polák, M., Fordinál, K., Bezák, V., Ivanička, J., Mello, J., Konečný, V., Šimon, L., Nagy, A., Potfaj, M., Maglay, J., Broska, I., Buček, S., Gross, P., Havrila, M., Hók, J., Kohút, M., Kováčik, M., Madarás, J., Olšavský, M., Pristaš, J., Salaj, J. & Vozárová, A., 2008: Prehľadná geologická mapa Slovenskej republiky. List 35 Trnava 1 : 200 000. *Bratislava, ŠGÚDŠ.*

Hanmer, S. & Passchier, C., 1991: Shear-sence indicators. A review. *Geological Survey of Canada Paper, 90-17, 1–72.*

Havrila, M. & Olšavský, M., 2015: Správa o geologickom mapovaní vrstvového sledu Kozla medzi Turskou dolinou a údolím Porubského potoka. *Geologické práce, Správy, 127, 7–79.*

Hók, J., Pelech, O., Teťák, F., Németh, Z. & Nagy, A., 2019: Outline of the geology of Slovakia (W. Carpathians). *Mineralia Slovaca, 51, 1, 31–60.*

Hók, J., Schuster, R., Pelech, O., Vojtko, R. & Šamajová, L., 2022: Geological significance of Upper Cretaceous sediments in deciphering of the Alpine tectonic evolution at the contact of the Eastern Alps, Bohemian Massif and Western Carpathians. *International Journal of Earth Sciences (Geol. Rundschau), 111, 6, 1805–1822.* https://doi.org/10.1007/s00531-022-02201-5.

Ivanička, J., Havrila, M., Kohút, M. (eds.), Olšavský, M., Hók, J., Kováčik, M., Madarás, J., Polák, M., Rakús, M., Filo, I., Elečko, M., Fordinál, K., Maglay, J., Pristaš, J., Buček, S., Šimon, L., Kubeš, P., Scherer, S. & Zuberec, J., 2007: Geologická mapa Považského Inovca a jv. časti Trenčianskej kotliny, M = 1 : 50 000. *Bratislava, ŠGÚDŠ.*

Ivanička, J., Kohút, M. (eds.), Olšavský, M., Havrila, M., Hók, J., Kováčik, M., Madarás, J., Polák, M., Rakús, M., Filo, I., Elečko, M., Fordinál, K., Maglay, J., Pristaš, J., Buček, S., Šimon, L., Kubeš, P., Scherer, S. & Zuberec, J., 2011: Vysvetlivky ku Geologickej mape regiónu Považský Inovec a jv. časť Trenčianskej kotliny, M = 1 : 50 000. *Bratislava, ŠGÚDŠ, 389 p.*

Jiříček, R., 1979: Tektogenetický vývoj karpatského oblouku během oligocénu a neogénu. In: Maheľ, M.: Tektonické profily Západných Karpát. *Bratislava, GÚDŠ, 203–213.*

Jones, R. R., Holdsworth, R. E., Clegg, P., McCaffrey, K. & Tavarnelli, E., 2004: Inclined transpression. *Journal of Structural Geology, 26, 1531–1548.* https://doi.org/10.1016/j.jsg.2004.01.004.

Kamenický, J., 1956: Zpráva o geologickom výskume a mapovaní severnej časti kryštalinika Považského Inovca. *Geologické práce, Zprávy, 8, 110–124.*

Korikovsky, S. P., Putiš, M., Plašienka, D., Jacko, S. & Ďurovič, V., 1997: Cretaceous very low-grade metamorphism of the InfraTatricum and SupraTatricum domains: an indicator of thin-skinned tectonics in the central Western Carpathians. In: Grecula, P., Hovorka, D. & Putiš, M. (eds.): Geological evolution of the Western Carpathians. *Bratislava, Mineralia Slovaca – Monograph., 89–106.*

Kováč, M., Kráľ, J., Márton, E., Plašienka, D. & Uher, P., 1994: Alpine uplift history of the Central Western Carpathians: geochronological, paleomagnetic, sedimentary and structural data. *Geologica Carpathica, 45, 2, 83–96.*

Kráľ, J., Hók, J., Bachliński, R. & Ivanička, J., 2013: Rb/Sr a $^{40}Ar/^{39}Ar$ údaje z kryštalinika Považského Inovca (Západné Karpaty). *Acta Geologica Slovaca, 5, 2, 195–210.*

Králiková, S., Vojtko, R., Hók, J., Fügenschuh, B. & Kováč, M., 2016: Low-temperature constraints on the Alpine thermal evolution of the Western Carpathian basement rock complexes. *Journal of Structural Geology, 91, 144–160.* https://doi.org/10.1016/j.jsg.2016.09.006.

Kullmanová, A. & Gašpariková, V., 1982: Vrchnokriedové sedimenty v severnej časti pohoria Považský Inovec. *Geologické práce, Správy, 78, 85–95.*

Leško, B., Šutora, A. & Putiš, M., 1988: Geology of the Považský Inovec Horst based on geophysical investigation. *Geologický zborník – Geologica Carpathica, 39, 2, 195–216.*

Madarás, J., Putiš, M. & Dubík, B., 1994: Štruktúrna charakteristika stredného úseku pohorelskej tektonickej zóny. *Mineralia Slovaca, 26, 177–191.*

Madarás, J., Olšavský, M., Siman, P. & Hók, J., 2007: Imbrikovaná stavba kryštalinika a sedimentárneho obalu sz. časti seleckého bloku Považského Inovca. In: Plašienka, D., Németh, Z., Šimon, L., Iglárová, Ľ. a Magálová, D. (eds.): 5. výročný predvianočný seminár Slovenskej geologickej spoločnosti. *Mineralia Slovaca, Geovestník, 14.*

Maheľ, M., 1986: Geológia Československých Karpát 1. Paleoalpínske jednotky. *Bratislava, Veda, 510 p.*

Marko, F., Hacura, A., Janták, V. & Plašienka, D., 1990: Geologická stavba a štruktúrne vzťahy v strednej časti Považského Inovca. Čiastková záverečná správa za úlohu II-4-5/01 ŠPZV Geologická stavba Malých Karpát, Považského Inovca a priľahlých území. *Manuscript. Bratislava, archive of Geological Inst. Slovak Acad. Sci., 85 p.*

McClay, K. R., 1992: The Mapping of Geological Structures. *Chichester, John Wiley, 161 p.*

Miháľ, F., 2003: Geologická stavba severnej časti Považského Inovca na základe výsledkov vyhľadávacieho prieskumu na rádioaktívne suroviny v rokoch 1972 – 1983. *Manuscript. Bratislava, archive of SGIDŠ (arch. n. 86922), 48 p.*

Michalík, J., Reháková, D. & Soták, J., 1994: Environments and setting of the Jurassic/Lower Cretaceous succession in the Tatri area, Malé Karpaty Mts. *Geologica Carpathica, 45, 1, 45–56.*

Németh, Z., 2021: Lithotectonic units of the Western Carpathians: Suggestion of simple methodology for lithotectonic units defining, applicable for orogenic belts world-wide. *Mineralia Slovaca, 53, 2, 81–90.*

Olšavský, M., 2008: Litostratigrafia a sedimentogenéza vrchnopaleozoických súvrství v severnej časti Považského Inovca. *Mineralia Slovaca, 40, 1–16.*

Olšavský, M. & Pelech, O., 2021: Nový výskyt brekcií a zlepencov asociujúcich so spätnými prešmykmi v oblasti Nitrických vrchov (juhovýchodná časť Strážovských vrchov). *Geologické práce, Sprá*vy*, 137, 13–30.*

Pelech, O., 2015: Kinematická analýza tektonických jednotiek Považského Inovca. Dizertačná práca. *Manuscript. Bratislava, archive of Department of geology and paleontology, 166 p.* http://opac.crzp.sk/?fn=detailBiblioForm&sid=C2BA1884BE5254848992F6495C76

Pelech, O., Hók, J., Pešková, I. & Havrila, M., 2016: Structural position of the Upper Cretaceous sediments in the Považský Inovec Mts. (Western Carpathians). *Acta Geologica Slovaca, 8, 1, 43–58.*

Pelech, O. & Hók, J., 2017: Metodika mezoskopického štúdia strižných zón a jej aplikácia pri kinematickej analýze hrádocko-zlatníckej strižnej zóny v Považskom Inovci. *Geologické práce, Sprá*vy*, 130, 47 – 67.*

Pelech, O., Hók, J., Havrila, M. & Pešková, I., 2017a: Reply to Comment on "Structural position of the Upper Cretaceous sediments in the Považský Inovec Mts. (Western Carpathians)". *Acta Geologica Slovaca, 9, 1, 39–43.*

Pelech, O., Kušnirák, D., Bošanský, M., Dostál, I., Putiška, R. & Hók, J., 2017b: The resistivity image of Upper Cretaceous Horné Belice Group, a case study from the Hranty area (Považský Inovec Mts., Western Carpahians). *Contributions Geophys. and Geodesy, 47, 1, 21–36.*

Pelech, O., Hók, J. & Józsa, Š., 2017c: Turonian-Santonian sediments in the Tatricum of the Považský Inovec Mts. (Internal Western Carpathians, Slovakia). *Austrian Journal of Earth Sciences, 110, 1, 19–33.*

Pelech, O. & Olšavský, M., 2018: Post-early Eocene backthrusting in the northeastern Strážovské vrchy Mts. (Western Carpathians). *Mineralia Slovaca, 50, 2, 147–156.*

Pelech, O., Józsa, Š. & Fajdek, P., 2018: Fold deformation of Fatricum – a case study from Banka section (Považský Inovec Mts., Slovakia). *Mineralia Slovaca, 50, 1, 25–36.*

Pelech, O., Boorová, D., Hók, J. & Rakús, M., 2021: Upper Cretaceous limestone olistoliths in the Rázová Formation (Horné Belice Group), Považský Inovec Mts (Slovakia). *Mineralia Slovaca, 53, 1, 39–48.*

Pešková, I., 2011: Tektonická interpretácia západného úseku kontaktnej zóny externíd a interníd Západných Karpát. Dizertačná práca. *Manuscript. Bratislava, Archive of Department of geology and paleontology, 94 p.*

Pešková, I., Hók, J., Potfaj, M. & Vojtko, R., 2012: Štruktúrna interpretácia varínskeho a oravského úseku bradlového pásma. *Geologické práce, Sprá*vy*, 120, 51–64.*

Plašienka, D., 1987: Litologicko-sedimentologický a paleotektonický charakter borinskej jednotky v Malých Karpatoch. *Mineralia Slovaca, 19, 3, 217–230.*

Plašienka, D., 1995: Pôvod a štruktúrna pozícia vrchnokriedových sedimentov v severnej časti Považského Inovca. Druhá časť: Štruktúrna geológia a paleotektonická rekonštrukcia. *Mineralia Slovaca, 27, 179–192.*

Plašienka, D., 1999: Tektochronológia a paleotektonický model jursko-kriedového vývoja centrálnych Západných Karpát. *Bratislava, Veda, 125 p.*

Plašienka, D., 2005: Tektonický vývoj Západných Karpát počas mezozoika. *Mineralia Slovaca, 37, 3, 179–184.*

Plašienka, D. & Marko, F., 1993: Geologická stavba strednej časti Považského Inovca. *Mineralia Slovaca, 25, 1, 11–25.*

Plašienka, D., Marschalko, R., Soták, J., Peterčáková, M. & Uher, P., 1994: Pôvod a štruktúrna pozícia vrchnokriedových sedimentov v severnej časti Považského Inovca. Prvá časť: Litostratigrafia a sedimentológia. *Mineralia Slovaca, 26, 311–334.*

Plašienka, D., Havrila, M., Michalík, J., Putiš, M. & Reháková, D., 1997: Nappe structure of the western part of the Central Carpathians. In: Plašienka, D., Hók, J., Vozár, J. & Elečko, M. (eds.): Alpine evolution of the Western Carpathians and related areas. Abstracts & Introductory Articles to the Excursion, Bratislava, Slovakia, September 11 – 14th. *Bratislava, Dionyz Stur Publishers, 139–161.*

Plašienka, D., Putiš, M., Soták, J. & Méres, Š., 2017: Are we still far from a reliable solution? *Acta Geologica Slovaca, 9, 1, 35–38.*

Polák, M. (ed.), Plašienka, D., Kohút, M., Putiš, M., Bezák, V., Filo, I., Olšavský, M., Havrila, M., Buček, S., Maglay, J., Elečko, M., Fordinál, K., Nagy, A., Hraško, Ľ., Németh, Z., Ivanička, J. & Broska, I., 2011: Geolologická mapa Malých Karpát 1 : 50 000. *Bratislava, MŽP SR – ŠGÚDŠ.*

Polák, M. (ed.), Plašienka, D., Kohút, M., Putiš, M., Bezák, V., Maglay, J., Olšavský, M., Havrila, M., Buček, S., Elečko, M., Fordinál, K., Nagy, A., Hraško, Ľ., Németh Z., Malík, P., Liščák, P., Madarás, J., Slavkay, M., Kubeš, P., Kucharič, Ľ., Boorová, D., Zlinská, A., Siráňová, Z. & Žecová, K., 2012: Vysvetlivky ku geologickej mape regiónu Malé Karpaty 1 : 50 000. *Bratislava, ŠGÚDŠ, 287 p.*

Putiš, M., 1980: Succesion of tectonic structures in crystalline and envelope Paleozoic of the Považský Inovec Mts. *Geologický zborník – Geologica Carpathica, 31, 4, 619–625.*

Putiš, M., 1983: Outline of geological-structural development of the crystalline complex and envelope Paleozoic of the Považský Inovec Mts. *Geologický zborník – Geologica Carpathica, 34, 4, 457–482.*

Putiš, M., 1986: Príspevok k poznaniu mladšieho paleozoika Považského Inovca. *Geologické práce, Správy, 84, 65–83.*

Putiš, M., 1991: Geology and petrotectonics of some shear zones in the Western Carpathian crystalline complexes. *Mineralia Slovaca, 23, 459–473.*

Putiš, M., 1992: Variscan and Alpidic nappe structures of the Western Carpathians crystalline complexes. *Geologica Carpathica, 43, 6, 369–380.*

Putiš, M., Gawlick, H. J., Frisch, W. & Sulák, M., 2008: Cretaceous transformation from passive to active continental margin in the Western Carpathians as indicated by the sedimentary record in the InfraTatricum unit. *Int. Journal of Earth Sciences (Geol. Rundsch.), 97, 4, 799–819.*

Putiš, M., Frank, W., Plašienka, D., Siman, D., Sulák, M. & Biroň, A., 2009: Progradation of the Alpidic Central Western Carpathians orogenic wedge related to two subduction: constrained by $^{40}Ar/^{39}Ar$ ages of white micas. *Geodyn. Acta, 22, 1–3, 31–56.*

Putiš, M., Danišík, M., Siman, P., Nemec, O., Tomek, Č. & Ružička, P., 2019: Cretaceous and Eocene tectono-thermal events determined in the Inner Western Carpathians orogenic front Infratatricum. *Geol. Quarterly, 63, 2, 1–47.*

Putiš, M., Nemec, O., Danišík, M., Jourdan, F., Soták, J., Tomek, Č., Ružička, P. & Molnárová, A., 2021: Formation of a Composite Albian-Eocene Orogenic Wedge in the Inner Western Carpathians: P-T Estimates and $^{40}Ar/^{39}Ar$ Geochronology from Structural Units. *Minerals, 11, 988.* https://doi.org/10.3390/min11090988.

Sentpetery, M., 2011: South-vergent structures observed in the western part of the Krivánska Fatra Mts. (Central Western Carpathians). *Acta Geologica Slovaca, 3, 2, 123–129.*

Štimmel, I., Máťuš, J., Novotný, L., Miháľ, F., Gluch, A., Gregorovič, J., Daniel, J., Cicmanová, S., Šimko, A. & Mlynarčík, L., 1984: Záverečná správa o geologicko-prieskumných prácach v oblasti Považského Inovca v rokoch 1965 – 1983. *Manuscript. Bratislava, archive of SGIDŠ (arch. no. 58751), 220 p.*

Vojtko, R. & Kriváňová, K., 2024: Cretaceous collision and thrusting of the Veporic Unit onto Tatric Unit in the Nízke Tatry Mts. revealed from structural analysis. *Acta Geologica Slovaca, 16, 1, 19–31.*

Štruktúrny vývoj seleckého bloku v Považskom Inovci a problematika infratatrika v Západných Karpatoch

Jadrové pohorie Považský Inovec je tradične rozdelené na tri bloky (Maheľ, 1986) líšiace sa nerovnomerným výskytom litotektonických jednotiek Vnútorných Západných Karpát. Objektom podrobného štruktúrneho výskumu bol selecký blok (obr. 1) situovaný na severe pohoria, ktorý sa vyznačuje najkomplexnejšou geologickou stavbou vrátane sedimentov mladšieho paleozoika (kálnická skupina *sensu* Štimmel et al., 1984; Miháľ, 2006; Olšavský, 2008) a vrchnej kriedy (hornobelická skupina *sensu* Rakús in Ivanička et al., 2011; Kullmanová a Gašpariková, 1982; Plašienka et al., 1994; Pelech et al., 2016, 2021), výnimočných v stavbe jadrových pohorí.

V rámci seleckého bloku boli definované variské a alpínske deformačné štruktúry. Variská deformácia (VD_1) sa vyznačuje kompresiou v smere S – J a vznikom juhovergentných štruktúr (obr. 6A a C). Štruktúrne pretvorenie bolo sprevádzané retrográdnou metamorfózou hornín kryštalinika (Kráľ et al., 2013).

Prvá fáza alpínskej deformácie (AD_1) postihla horninové komplexy tatrika vrátane sedimentov hornobelickej skupiny, ktoré boli presunuté smerom na SZ. Prvú fázu (AD_1) alpínskej deformácie je možné datovať do obdobia mástrichtu až paleocénu. Poukazujú na to biostratigrafické údaje vrchnokampánskeho veku z blokov (olistolitov) pelagických vápencov v sedimentoch tektonickej melanže hornobelickej skupiny (Pelech et al., 2021).

Druhú fázu alpínskej deformácie (AD_2) reprezentujú rozsiahle vrásy horninových súborov tatrika, fatrika a hronika s vergenciou na východ až severovýchod. Spätné presuny (najmä selecký spätný prešmyk) sú zdokumentované výsledkami vrtných prác (Štimmel et al., 1984, obr. 13 ibid.), ako aj štruktúrnym výskumom (obr. 7A – C). Ich vznik pravdepodobne súvisí so šikmou kolíziou bloku Vnútorných Západných Karpát s Českým masívom počas oligocénu až spodného miocénu. Zároveň treba poznamenať, že spätné presuny mohli lokálne vznikať aj v transpresnom režime (AD_1), ako je to v prípade hôrčanskej strižnej zóny (obr. 3).

Posledná alpínska deformácia je spätá s neoalpínskou fázou, ktorá súvisí s výraznou exhumáciou seleckého bloku. Dokumentujú to AFT údaje o veku 13 – 14 mil. r. (Danišík et al., 2004; Králiková et al., 2016).

Na základe získaných údajov selecký blok v Považskom Inovci nie je možné považovať za súčasť infratatrika (*sensu* Putiš, 1992; Plašienka, 1997), podobne, ako je to v ostatných diskutovaných územiach (obr. 12 a 13).

Doručené / Received: 10. 5. 2024
Prijaté na publikovanie / Accepted: 28. 6. 2024