STRUCTURAL DEVELOPMENT OF DUCTILE AND BRITTLE DOMAIN IN THE VEPORICUM UNIT (THE CENTRAL WESTERN CARPATHIANS)

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Abstract: The contribution summarized structural and tectonic development of the Veporic basement and its (meta)sedimentary cover sequences during main phases of the Hercynian and Alpine orogenesis. During this time the exchange of compression, transpression, transtension and extension processes forming today structural pattern of the study area.

Key words: structural and tectonic development, Hercynian orogene, Alpine orogene, succession of deformation, Veporicum Unit, Western Carpathians.

Introduction to the Veporic structure`s pattern

The Veporicum Unit represent the Alpine structural unit, which is situated in central part of the Inner Carpathian belt (Fig.1). Composed of Hercynian crystalline basement and its cover, the Veporicum Unit has been thrusted over the Tatricum Unit, the Čertovica line being the trace of the thrust. The unit in question has been overthrusted by the Gemericum Unit along the Lubeník line (Biely et al., 1996). Complicated internal structure of the Veporicum unit comprises several litho – tectonic units (complexes). The results of latest researches (c.f. Putiš, 1992; 1994; Madarás et al., 1994; Bezák et al., 1997) have shown that tectonic superposition of the crystalline rock complexes has already been fixed during the Hercynian tectonic events, although a great deal of rejuvenisation, or destruction has taken place during the Alpine processes.

The Hercynian structural pattern

The Veporic crystalline complexes in the central part of the Western Carpathian mountain range represents the domain of intensive alpine overprinting.

The Hercynian structural elements are conserved only in relicts and incorporated into the Alpine structural pattern, with locally preserved older relicts blocks "swimming" in Alpine structures in "tectonic shadows" of the Alpine overprinting.

Characteristic for pre – Alpine structures are foliation planes generally dipping at medium to steep angle to N, NW and S, SE with construction megafold axis in NE-SW direction (Ph.I – 2). They represent the oldest preserved foliation planar elements (partly also magmatic foliation stressed by banded structure) defined by the fundamental mineral associations: Qz, Pl, Kf, Ms, Bt, ± Amph, ±Grt. These planar elements and ductile folds structures, which were formatted in deeply seated shear zones, are often fixing by penetration of the Late Hercynian granitic rocks (Ph.I – 1). To these planes stretching lineation (generally with NW – SE direction) of elongated Bt, Qz and feldspars is bound. Kinematic indicators in mesoscale point in general to sinistral and dextral shears - thrusts to SE (top-to-the SE), however, also opposite directions (top-to-the NW) are found (Ph.I – 3-4). The direction NW-SE is, however, in good agreement with the kinematic sense of high - temperature deformation (top-to-the SE) determined in crystalline complexes of the Tatricum and Veporicum Units, which is considered as Hercynian as well as with generally southern vergencies of Hercynian overthrusts in the Western Carpathians (Janák et al., 1993; Jacko et al., 1997; Madarás et al., 1999).

The Alpine structural pattern

The paleo – Alpine deformation had two main stages: thrusting in transpression regime (top to the NW, respectively top to the N). The result of stress relaxation was an extension, resp. transtension stage, generally in NE – SW direction.

The Alpine compression and transpression

The compression stage (Ph.I – 5) is connected with closing of the Meliata oceanic domain and successive displacement of the Gemericum, Meliaticum, Turnaicum and Silicicum nappes. The stacking of the nappes has wedge shaped form with thickness decreasing northward. The compression and overthrusting, generally from SE to NW, took place during the Late Kimerian stage of the Alpine orogeny (Late Jurassic - Early Cretaceous). The duplex structures are presented mainly at the contact zone of the Southern Veporicum and the Gemericum (Plašienka, 1993; Hók et al., 1993; Vojtko et al., 2000).

The uniform Alpine tectonic style is evident from comparison of many structural data from metamorphic complexes, granitoids and sedimentary cover – the Foederata Unit and the Veľký bok Unit. The youngest data of paleo – Alpine compression are recorded in the Neocomian carbonates of the Veľký bok Unit, in the northern part of the Veporicum. The vergence and direction of structural elements are identical with data obtained from all crystalline complexes of the Veporicum (Madarás et al., 1994; 1996). Thrusting stage in the Veporicum can be dated as Late Jurassic to Early Cretaceous – i.e. within the Late Kimmerian orogenic phase. It is result of comparison of structural, petrological, sedimentological and geochronological data from internal zones of the Western Carpathians. Alpine reactivation of the southern Veporicum basement on the base of Ar/Ar dates prove Kováčik et al., 1997. Alpine planar fabrics are mostly SE dipping (opposite to Hercynian) and NE – SW trending. Alpine recrystalization mineral assemblages comprise Ms/Phe, greenish Bt_2, Kfs_2, Ab, Chl, Ep-Czo, Act, Ttn_2, Rt-Sag, Grs-Grt, ±Cal, Tur, indicating NE-SW trending lineations (Putiš et al., 1997) .

The Alpine extensional unroofing

After the compression stage and the crustal thickening, an inversion tectonic regime took place and exhumation of the crystalline basement followed (Madarás et al., 1996). An uplift of the crystalline basement occurred which resulted to an extensional unroofing of the overlying tectonic units (Foederata, Markuška, Gemericum, Meliaticum etc.) and emplacement of the hidden Rochovce granitic body. The Late Cretaceous age of the extension was evidenced by Ar - Ar, K - Ar and FT dating (Kráľ, 1977; Maluski et al., 1993; Kováč et al., 1994; Hraško et al., 1995; Kráľ et al., 1996; Michalko et al., 1998; Poller et al., 2001).

The Alpine transtension

Second paleo – Alpine tectonic phase – transtension and extension is defined by mineral and stretching lineations and striations with NE – SW direction, numerous kinematic indicators in macro -, meso - , and microscale, extension veins, normal (listric) faults and gravitational slides in crystalline complexes and sedimentary cover (Ph.I – 6-8). These processes can be dated from the mid (Late) – Cretaceous (numerous geochronological data) to Paleogene, when are combined with strike – slips on reactivating discontinuities. Steeply dipping and in places fan-like mylonitic foliations reflect Cretaceous sinistral-transpression movements along NE – SW oriented thrust-faults (Fig.1) dividing the crystalline complexes (Hók & Hraško, 1990; Madarás et al., 1994).

During the Late Cretaceous period in higher structural levels, a dextral movement along the NW-SE oriented dislocations started. The N-S compression during the Late Cretaceous and the Paleogene caused deformation within the sinistral SW-NE (Muráň fault) and dextral SE-NW (Mýto-Tisovec fault zone) brittle fault zones (Marko, 1993).

The Neoalpine tectonics

The Neoalpine fault systems in the Veporicum, connecting with brittle deformation structures are mostly steeply dipping and striking NE – SW; NNE-SSW, NW - SE oriented faults. The Neoalpine phase continues in transtensional regime. Strike – slip movements in the Neogene were combined with normal faults. Final phase is presented by vertical movements of blocks mainly on NW – SE oriented normal faults. The faults controlled distribution of the Neogene volcanic rocks. Probable Badenian - Sarmathian age of volcanic rocks and normal character of the NNE-SSW faults correspond with the WNW - ESE orientation of principal extension (Kováč & Hók, 1993). The faults are also accompanied by Neogene basins origination.

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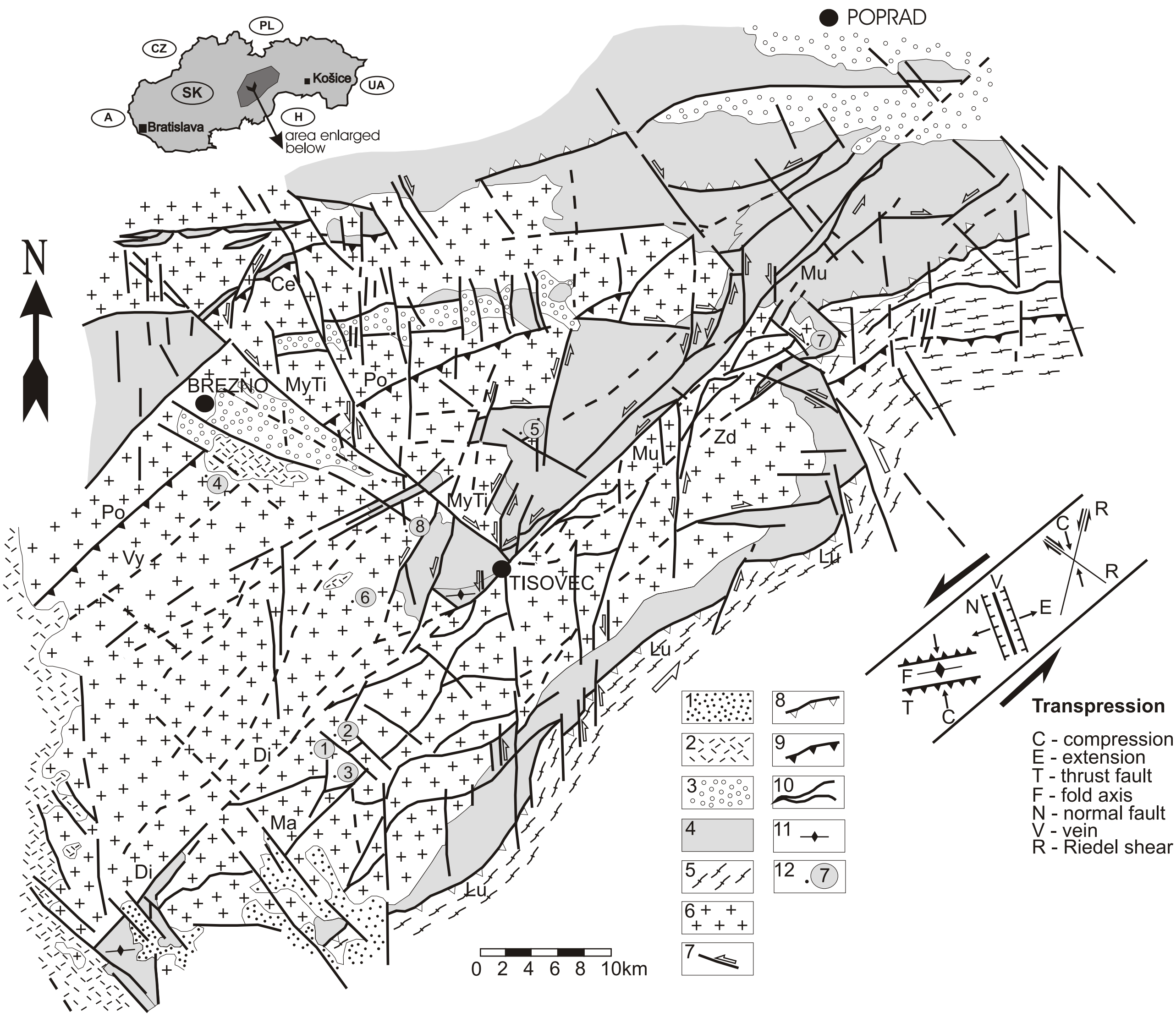
Fig. 1. Today fault pattern in the Veporicum Unit (According to Marko, 1993; modify by Madarás, 2002) 1 – Neogene sediments; 2 – Neogene volcanics; 3 – Paleogene sediments; 4 – Mesozoic and Upper Paleozoic units; 5 – Lower Paleozoic complexes of the Gemericum Unit; 6 – Hercynian crystalline complexes; 7 – strike – slip; 8 – overthrust; 9 – reverse fault; 10 – disjunctive contacts; 11 – mesoscale fold axis; 12 – rock sampling sites in photoplate I. Explanation to main Alpine fault and shear zones names: **Ce** – Čertovica; **Di** – Divín; **Lu** – Lubeník; **Ma** – Málinec; **Mu** – Muráň; **MyTi** – Mýto – Tisovec; **Po** – Pohorelá; **Vy** – Vydrovo; **Zd** – Zdychava.

Photo I. Mesoscale Hercynian (1-4) and Alpine (5-8) structures: 1 - Kokava n. Rimavicou – Lipové (Stolické vrchy Mts.). Intrusion of porphyritic granodiorite to magmatic / metamorphic foliation (12/30) in migmatite; 2 – Rimavica valley near Utekáč (Stolické vrchy Mts.). High ductile deformation and partial melting in migmatite. B-axis fold is parallel with mineral lineations (NW – SE trend); 3 – Liešnica valley near Kokava n. Rimavicou (Stolické vrchy Mts.). South Veporic hybrid complex – migmatites, orthogneisses. High temperature dextral shear zone (NW – SE sense of shear); 4 – Čierny Balog (Veporské vrchy Mts.). North Veporic crystalline basement. Brittle – ductile deformation of aplitic vein conform to metamorphic schistosity in retrograde orthogneiss. Contraction reverse folds demonstrate sense of Hercynian thrust (top–to-the SE); 5 – Hrdzavá valley (Muránska planina plateau). Horizontal isoclinal fold (B-axis = 45/15) in Middle Triassic marble. AD_1 compressive stage; 6 – Klenovec – Skorušina (Veporské vrchy Mts.). S-C mylonite of Late Hercynian porphyritic granodiorite. S-planes are subhorizontal, extension C-planes dipping to SE. Intersection mineral lineations has general E-W trend; 7 – Rejdová (Stolické vrchy Mts.). Mylonitized porphyritic granodiorite. Brittle segmentation of K – feldspar porphyroblast (book – shelf sliding) indicate extensional sinistral shear (top-to-the SE) in mylonitic foliation planes; 8 – Bánovo valley near Tisovec (Veporské vrchy Mts.). Subhorizontal mylonite zone in porphyritic granodiorite in central part of Veporicum Unit demonstrate latest Alpine extensional (unroofing) processes in brittle conditions. Photo: J. Madarás, 1992 – 2001.



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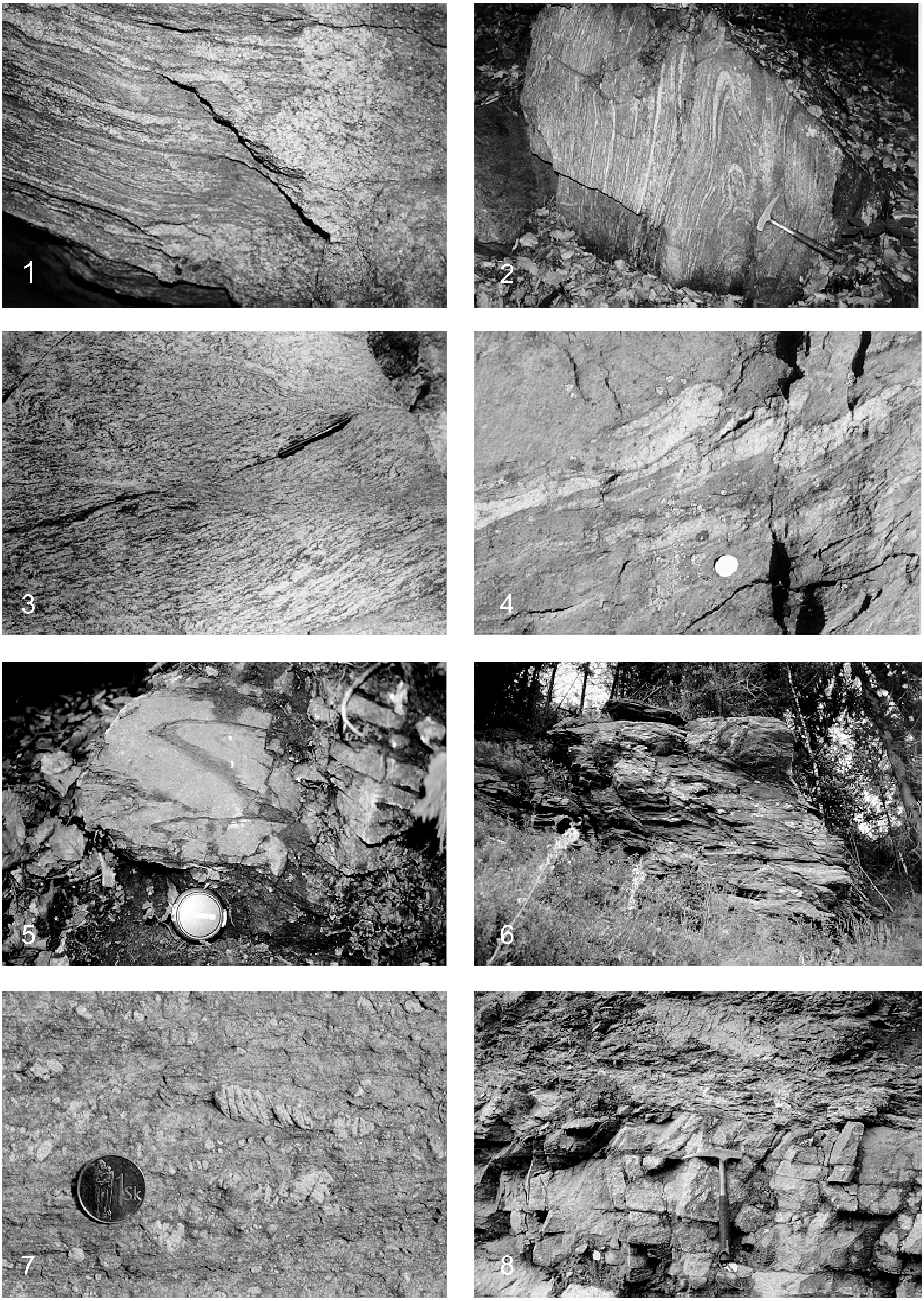
E - extension
T - thrust fault
F - fold axis
N - normal fault
V - vein
R - Riedel shear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