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

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Abstract

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

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

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

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

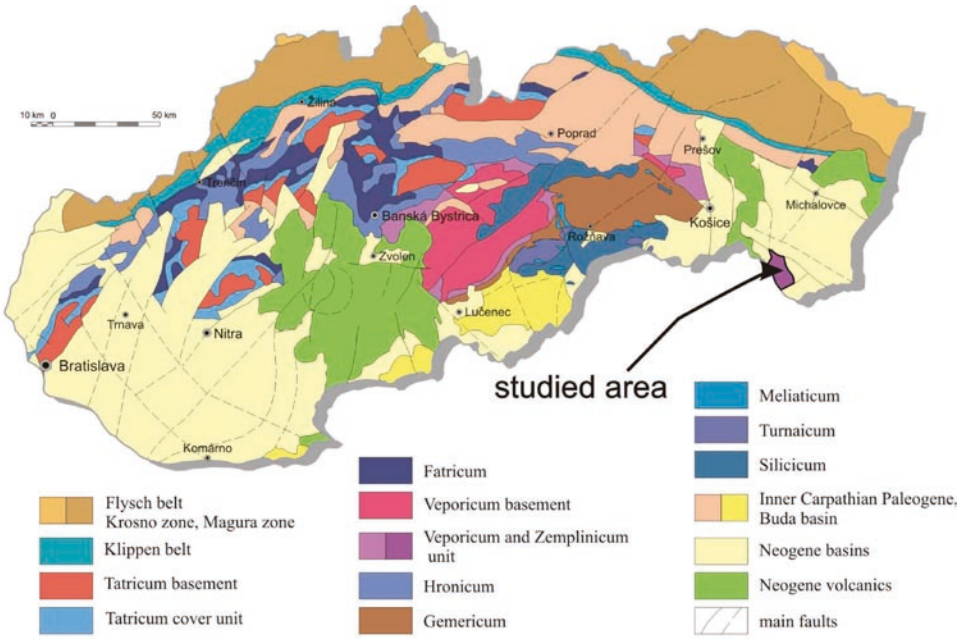

Fig. 1. Position of Zemplinicum in the general tectonic scheme of the Western Carpathians.

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

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

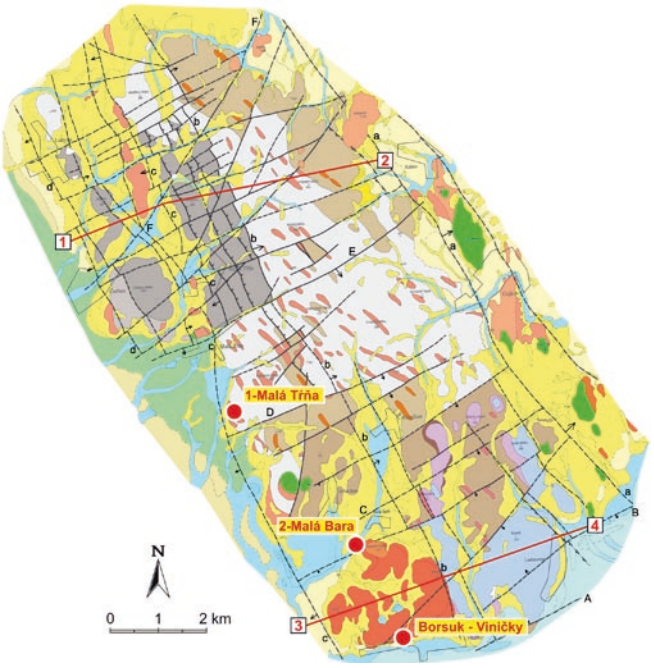

Fig. 2. Tectonic scheme of the Zemplínske vrchy Mts. (Kobulský and Gazdačko in Kobulský et al., 2011) with position of localities 1 and 2, as well as the position of volcanic body Borsuk. Tectonic scheme indicates the principal overthrusts and faults. Two dominating trends of faults were revealed: Faults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

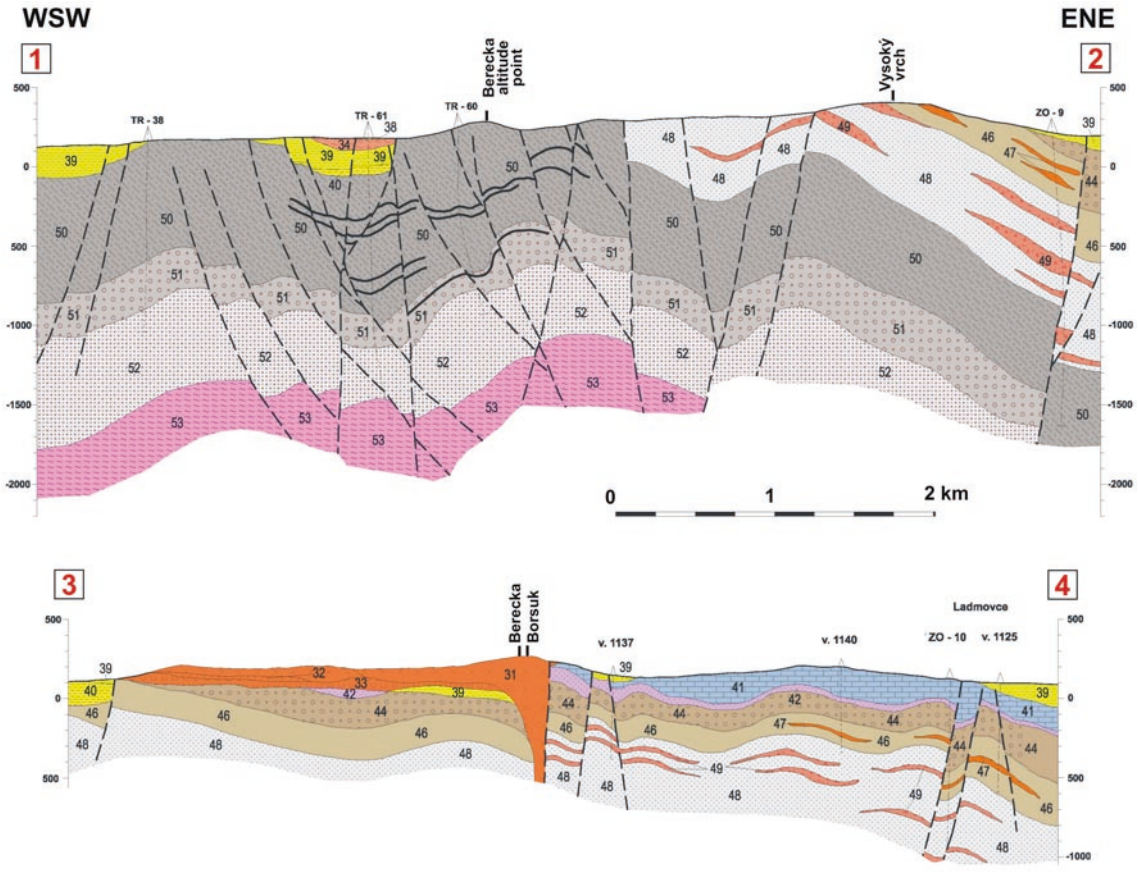

Fig. 3. The cross-sections trending WSW–ENE through the Zemplinicum in the Zemlínske vrchy Mts. (Kobulský and Gazdačko in Kobulský et al., 2011). The numbers of distinguished sequences in the cross-section corresponds with the description at the lithostratigraphic columns in Figs. 4 and 5.

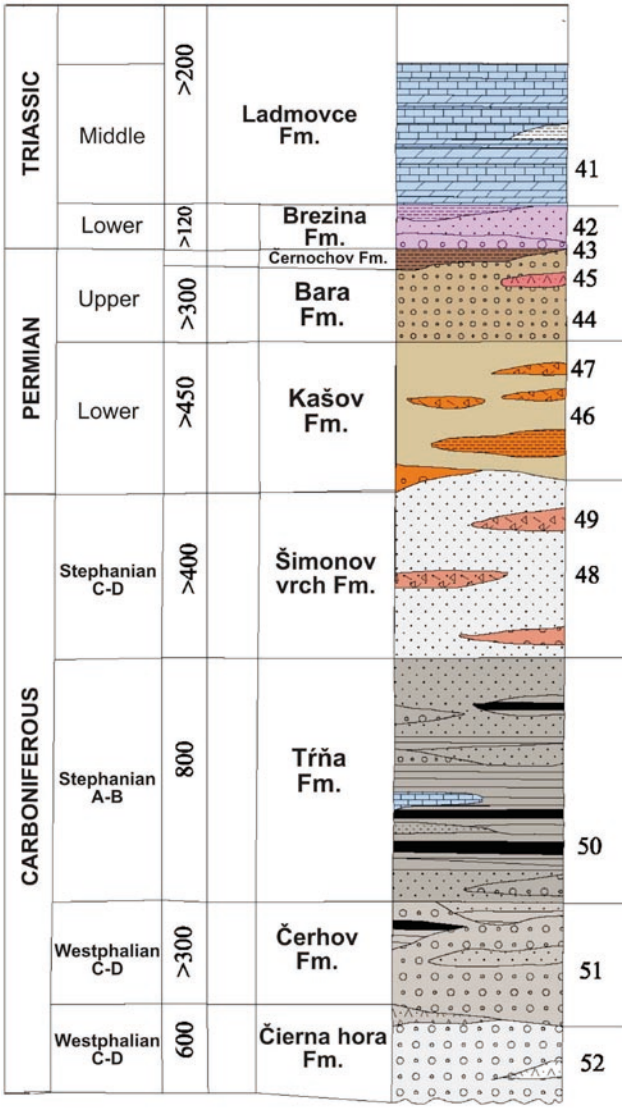

Fig. 4. Lithostratigraphic column of the Zemplinicum cover sequences in the area of the Zemplínske vrchy Mts. (Kobulský and Gazdačko in Kobulský et al., 2011). Lithology: **Ladmovce Fm.** (Anisian – Ladinian): 41 – dark-grey limestones, dark and light dolomites, locally with interbeds of clayey and marly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

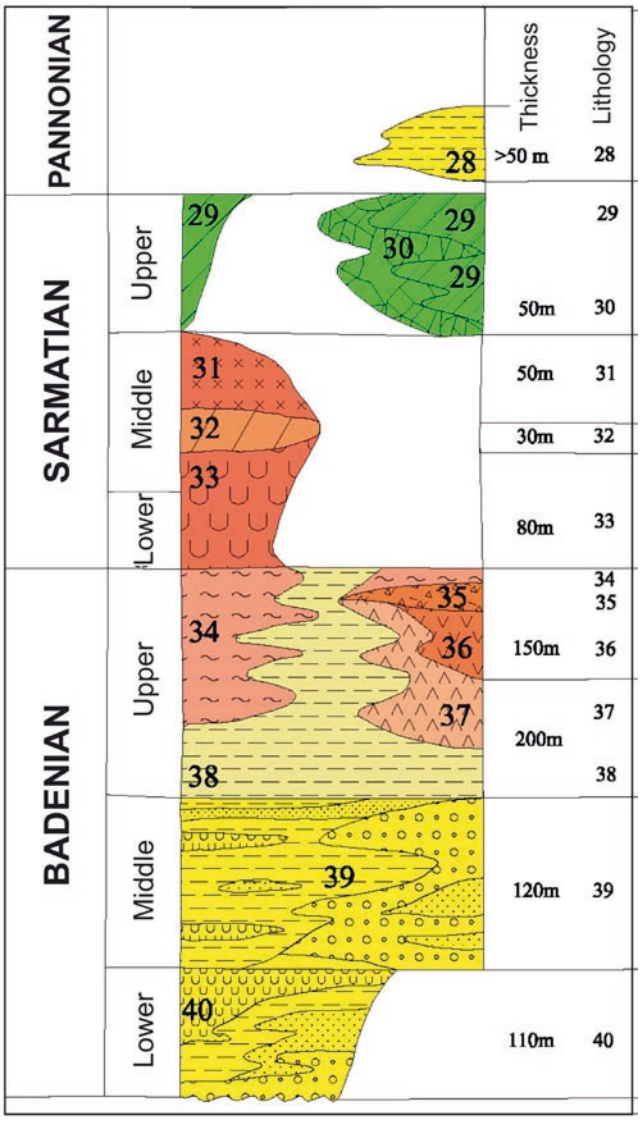

Fig. 5. Lithostratigraphic column of Neogene in the area of the Zemplínske vrchy Mts. (Kobulský and Gazdačko in Kobulský et al., 2011). Pannonian: 28 – **Sečovce Fm.** – grey, brown-grey and patchy clays, calcareous clays; Sarmatian: 29 – lava flows of basaltic pyroxene andesites; 30 – hyaloclastite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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

References

Baňacký, V., Elečko, M., Kaličiak, M., Lexa, J., Straka, P., Vass, D., Vozárová, A., & Vozár, J., 1988: Geological map of the southern part of the East Slovakian Lowland and the Zemplínske vrchy Mts. *Bratislava, SGÚ – GÚDŠ. (In Slovak.)*

Baňacký, V., Elečko, M., Kaličiak, M., Straka, P., Škvarka, L., Šucha, P., Vass, D., Vozárová, A., & Vozár, J., 1989: Explanations to Geological map of the southern part of the East Slovakian Lowland and the Zemplínske vrchy Mts. *Bratislava, GÚDŠ, 143 p. (In Slovak.)*

Együd, K., Gerhart, S., Bondarenková, A., & Varga, M., 1985: Veľká Tŕňa – anthracite, VP. Final report and computation of reserves. *Manuscript. Archive of ŠGÚDŠ, Spišská Nová Ves, 151 p. (In Slovak.)*

Felber, E., 1991: Zemplínske vrchy Mts. Fianal report about the results of the geological-exploration works. *Manuscript. Archive of Uranpres, š. p., Spišská Nová Ves, 111 p. (In Slovak.)*

Grecula, P., Együd, K., Bacsó, Z., Ďuďa, R., Fabián, M., Halečka, J., Hodermarský, J., Kobulský, J., Planderová, E., Vlasák, M. S., & Seliga, J., 1982: Zemplín island, base metal ore and coal, VP. Final report. *Manuscript. Archive ŠGÚDŠ, Spišská Nová Ves, 178 p. (In Slovak.)*

Kobulský, J., Gerhart, S., Dubéci, B., & Varga, M., 1989: Final report of the project Veľká Tŕňa – surrounding, anthracite and black coal, VP. *Manuscript. Archive of ŠGÚDŠ, Spišská Nová Ves, 134 p. (In Slovak.)*

Kobulský, J., Dubéci, B., Hrinko, V., Pacindová, N., Horská, A., Horský, S., Stupák, J., & Seliga, J., 1992: Final report of the project Veľká Tŕňa – II. subphase, anthracite, VP. *Manuscript. Archive of ŠGÚDŠ, Spišská Nová Ves, 149 p. (In Slovak.)*

Kobulský, J., Elečko, M., Gazdačko, Ľ., Maglay, J., Pramuka, S., Zlinská, A., & Žecová, K., 2011: Geological setting of the Zemplinicum in the Zemplínske vrchy Mts. Partial final report. *In: Hraško, Ľ., et al. (ed.): Actualization of the geological setting of the problem areas of the Slovak Republic. Manuscript. Archive of ŠGÚDŠ, Bratislava, 143 p. (In Slovak.)*