Neogene sediments between Podbranč and Hradište pod Vrátnom, Vienna Basin

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Abstract: The geological mapping and research during the year 2008 was carried out in the eastern part of the Vienna Basin in the area between Podbranč and Hradište pod Vrátnom. Sedimentological profiles, interpretation of geological structure and geological evolution during the Neogene (Eggenburgian – Karpatian) are the main results of the research. The purpose of this article is to present the geological structure of this area as well as new findings from the geological research not included in previous work. Sedimentation in this region took place during the Neogene in two cycles. Both cycles started by deposition of conglomerates. Transgressive deposits represent monomict carbonate breccias, conglomerates and sandstones lacking in fauna of the Brezová Mb. Fine- to medium-grained sandstones with shells of Chropov Mb. overlie Flysch units. Polymict conglomerates and sandstones occur on the places where they overlie the Pieniny Klippen Belt. They are overlain by the younger sandstone facies with polymict conglomeratic sandstone. The first cycle terminated with basinal sandstone-silty facies. Sedimentation of the second cycle developed in conglomerate facies, sandstone facies and thin-bedded facies. Presence of all the three facies with abundant polymict conglomerates is typical in the lower part of the second cycle (Jablonica Fm.). Subsequently deposited sandstones intercalated with thin-bedded facies without conglomerates. They represent the Prietrž Mb. Seven paleocurrent measurements of Jablonica Fm. sandstones confirm paleocurrent transport of deposits from the SW.

Key words: Neogene, Vienna Basin, sedimentology, conglomerates, delta, littoral

1. INTRODUCTION

Sedimentological research in the area between Podbranč and Hradište pod Vrátnom was realized with detailed geological research and mapping of the region Biele Karpaty Mts. (southern part) and Myjavská pahorkatina Upland (Potfaj & Teťák et al., 2014; Teťák & Potfaj et al., 2015). Geological research brought more information exceeding the standard content of the geological map and map explanations (Figs. 1 and 2). The results of geological research involve also sedimentological profiles (Figs. 3 and 4) and interpretation of geological evolution of the eastern part of the Vienna Basin during the Early Neogene, which are the extension of cited works.

The attached geological map and lithostratigraphic characteristics with the interpretation of the geological structure of this area (Figs. 1 and 2) slightly differs in details compared to the interpretation of Potfaj & Teťák et al. (2014). Slight differences are within geological boundaries. The authors (l.c.) suggest several faults in the Neogene sediments. They suggest also that polymict conglomerates of the Jablonica Fm. partially overlap with the Prietrž Mb. The purpose of this article is to present the geological structure of this area with small differences as well as new findings from the geological research not included in the cited work.

Hanáček (1954) lithofacially described the basal coarse clastic sediments as well as their overburden in the Nedzov Mountains. Buday (1955) defined the Unín Mb. as the basal conglomerates and marls. Marginal conglomerates of the Chropov Mb. and the Jablonica Fm. appear within the Unín Mb. Buday & Cicha (1956) divided the basal conglomerates in this area into the carbonate type and the Chropov type.

Geological map of Myjavská pahorkatina Upland, including Neogene sediments, has been compiled by Began et al. (1984).

Kováč (1985) interpreted the origin of conglomerates and sandstones of the Jablonica Fm. through their pebble analysis and sedimentological studies in Prievaly – Brezová pod Bradlom and Trstín – Dechtice area. Kováč (1986) later interpreted the sedimentation in the river alluvium, alluvial fan-delta and sea channels environments. He considers Jablonica Depression formed a part of longitudinal intramountain depression in the background of the lifted Flysch Belt. Longitudinal and transverse faults influenced the sedimentation. The author assumed the direction of sediment supply from SW, while coastline gradually shifted to the south (transgression). Kováč (2000) interpreted geodynamic, paleogeographic and structural development of the Carpathian-Pannonian region during the Miocene.

Mišík (1986) elaborated a detailed petrographic and microfacies analysis with the interpretation of the source area of conglomerate pebbles of the Jablonica Fm.

Salaj et al. (1987) published in the area of Myjavská pahorkatina Upland, Brezovské and Čachtické Karpaty Mts. a geological map in scale 1:50,000. The authors mostly covered geological structure and geological boundaries on the map by loams.

2. LITHOSTRATIGRAPHY OF THE NEOGENE SEDIMENTS

The Vienna Basin is situated at a junction of the Outer Western Carpathian Flysch Belt, Pieniny Klippen Belt (PKB) and the Central Western Carpathians (Fig. 1). Sediments deposited in

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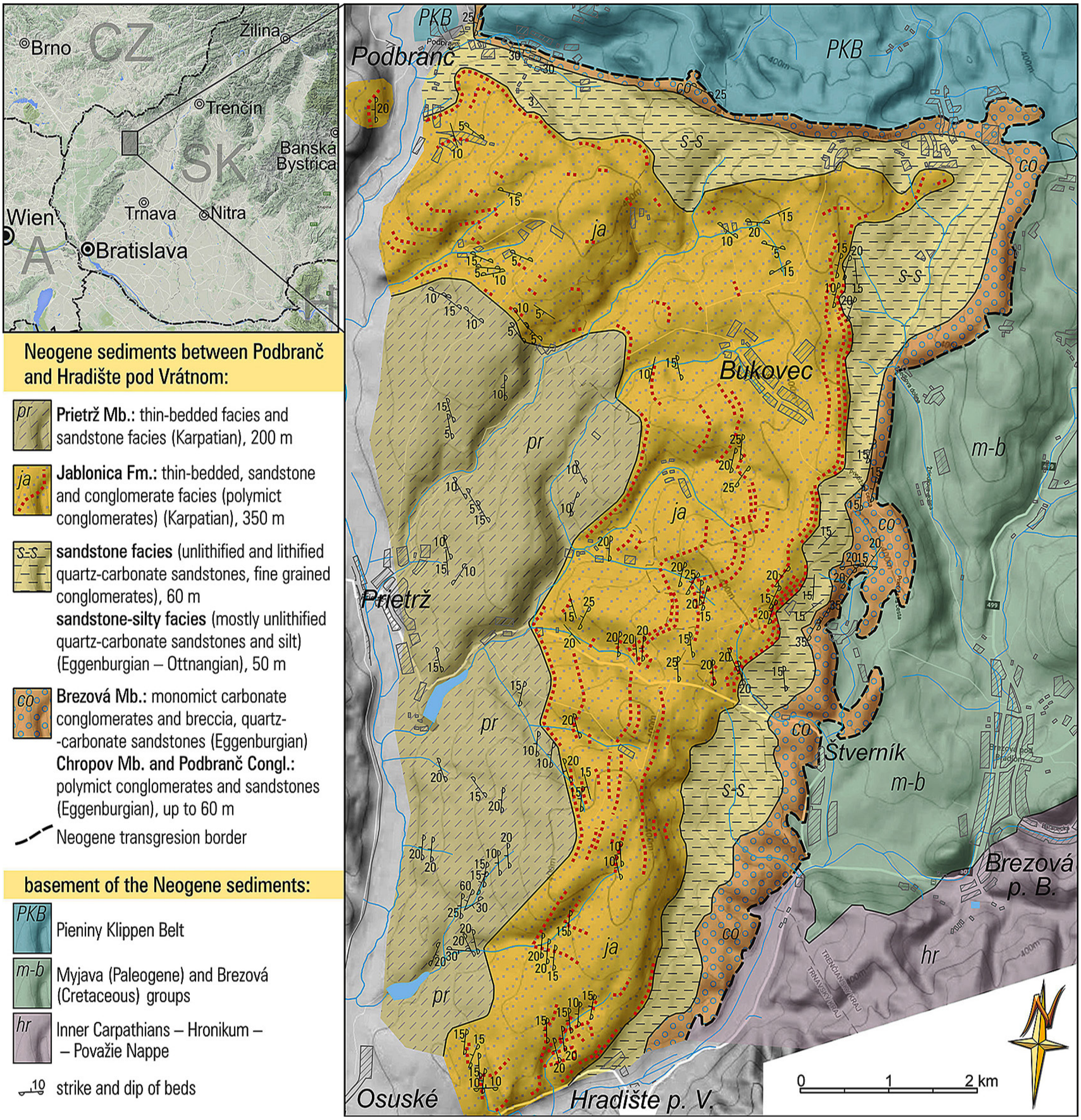

Fig. 1. Geological map of the Neogene sediments between Podbranč and Hradište pod Vrátnom villages (modified after Potfaj and Teťák et al., 2014).

the area between Podbranč and Hradište pod Vrátnom space during the Neogene in two cycles (Fig. 2). Both cycles started by deposition of the conglomerates. The clasts size in the cycles diminished gradually. Kováč et al. (2004) documented two stages of basin development in this region. The Early Miocene compressional tectonic regime during the Eggenburgian and Ottnangian was characterized by deposition concentrated in piggy-back basins on the folding accretionary wedge of the Outer Carpathians in wrench-fault furrows on the colliding margin of the Inner Western Carpathians. The Karpatian subsidence of the Vienna Basin allowed a rapid accumulation of thick marine and deltaic sediments. The transtensional tectonic regime in the Vienna Basin originated by pull-apart mechanism.

2.1. First sedimentation cycle – Chropov Mb., Podbranč Conglomerate and Brezová Mb. (transgressive conglomerates, breccias and sandstones), sandstone facies and sandstone-silty facies

Transgressive sediments contain clasts of the rocks of their pre-Neogene basement, respectively from their vicinity. Several types of the 1st sedimentation cycle transgressive deposits can be defined according to their composition and clasts lithology. The

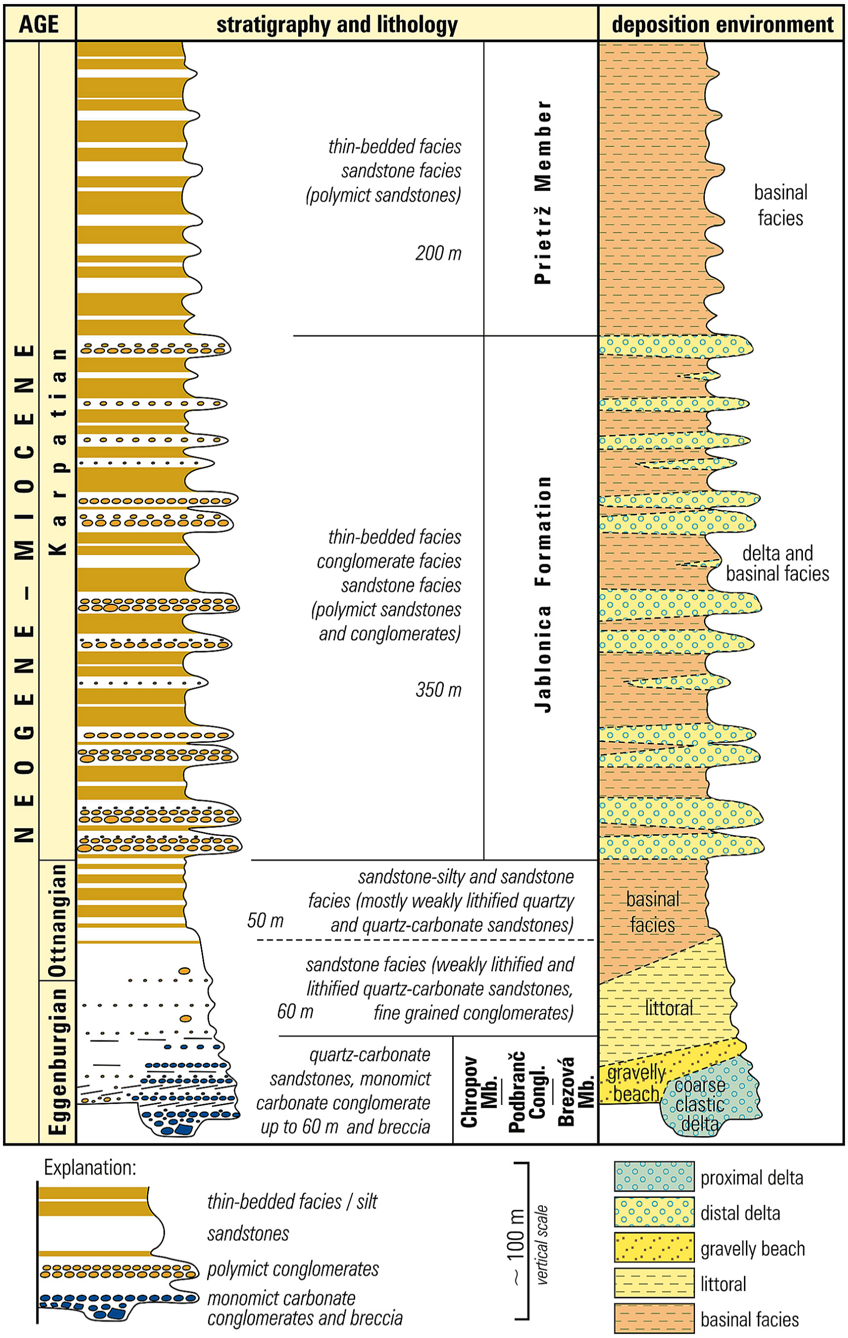

Fig. 2. Lithostratigraphic scheme of the Neogene sediments in the area between Branč and Hradište pod Vrátnom.

nappes of the Biele Karpaty Unit are overlain by the conglomerates of the Chropov Mb. with pebbles of quartz-carbonate sandstones from the Biele Karpaty Unit and abundant macrofauna represented by pectens and oysters. PKB basement overlaid the transgressive conglomerates and sandstones with macrofauna and the pebbles of the quartz porphyries and various carbonates (Buday & Cicha, 1956). The Myjava and Brezová Groups are overlain by monomict carbonate breccias, conglomerates and sandstones with pebbles from the Mesozoic carbonates but without macrofauna (Fig. 5A-B).

The thickness of the transgressive conglomerates and sandstones is highly variable. Only few meters thick erosional remnants are preserved near Chropov. They are 25 m thick in Podbranč and over 50 m near Štverník. At least 25 m thick sequences of breccias and conglomerates overlain by at least 50 m thick sandstones occur near Hradište pod Vrátnom. Outcrops of transgressive deposits occurring above the Biele Karpaty Unit are accompanied by red loams. Only slightly red coloured loams were observed below the transgressive deposits overlying the sediments of the Myjava and Brezová Groups.

The transgressive deposits are overlain by polymict sandstone facies, sporadically with pebble sandstone (Fig. 5C). Subsequent sandstone-silty facies terminate the first sedimentation cycle (Fig. 2).

Chropov Mb. and Podbranč Conglomerate *(polymict conglomerates and sandstones overlying the Biele Karpaty Unit and PKB)*

Transgressive conglomerates and sandstones overlying the Biele Karpaty Unit are designated as the Chropov Mb. (Buday, 1955). Conglomerates overlying the PKB around Podbranč were designated also as the Podbranč Conglomerate (Kodym & Matějka, 1923). The authors associated the Podbranč Conglomerate rather with carbonate conglomerates of the Brezová Mb. (Buday, 1955). In both cases, it represents similar sediments of the same genetic type and age. They differ in the lithological composition of clasts. The conglomerates and sandstones of the Chropov Mb. contain pebbles of fine to medium-grained quartz-carbonate sandstones from the Biele Karpaty Unit and abundant macrofauna represented by pectens and oysters (Chropov vicinity).

In transgressive deposits of the Podbranč Conglomerate overlying the PKB units predominate pebbles of rocks from the PKB sequences and Neogene macrofauna (e.g. “Biancone” limestones, black cherts, quartz, porphyry; quarry near Podbranč; Buday & Cicha, 1956). The conglomerates gradually pass into coarse-grained sandstones sporadically with conglomerate intercalations (Figs. 5D-F, 6A).

The size of clasts in the conglomerates of the Chropov Mb. varies between 4 and 18 cm. The size of pebbles and cobbles in conglomerates and sandstones reaches 1-6 cm near Podbranč and 5-15 cm at Starý hrad. Sedimentation generated gradational cycles (layers) 20-30 cm thick (quarry in Podbranč; Fig. 6A) or 20-60 cm thick (Starý hrad). Clasts are semi-angular. Both sandstones and conglomerates contain carbonate cement.

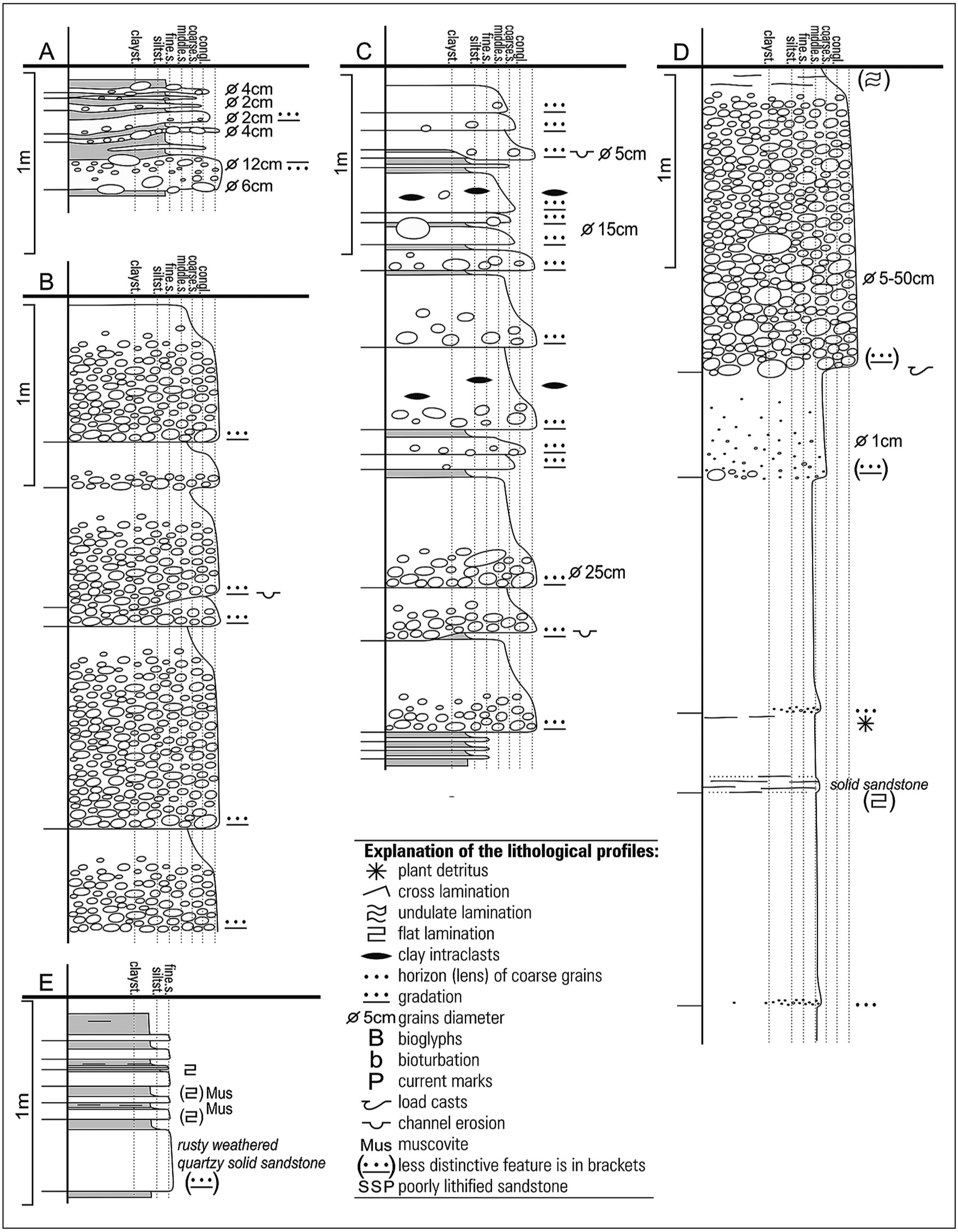

Fig. 3. A) Jablonica Fm. – thinner layers of conglomerates – pebble lines: pebbles formed mostly by carbonates, less quartzite, granite, dark siliceous rocks, metamorphosed rocks interbedded with thin layers of soft calcareous silty claystone (right tributary between Hradište pod Vrátnom and Osuské); B) Jablonica Fm. – thick layers of conglomerates (right tributary NW from Hradište pod Vrátnom); C) Jablonica Fm. – thinner layers of conglomerates (right tributary NW of Hradište pod Vrátnom); D) Jablonica Fm. – poorly lithified sandstones and conglomerate (Prietrž – valley N of Pri Kachlíkoch); E) Sandstone-silty facies – gradational poorly lithified laminated sandstones pass into the silty claystones (creek 500 m south of Bukovec farm).

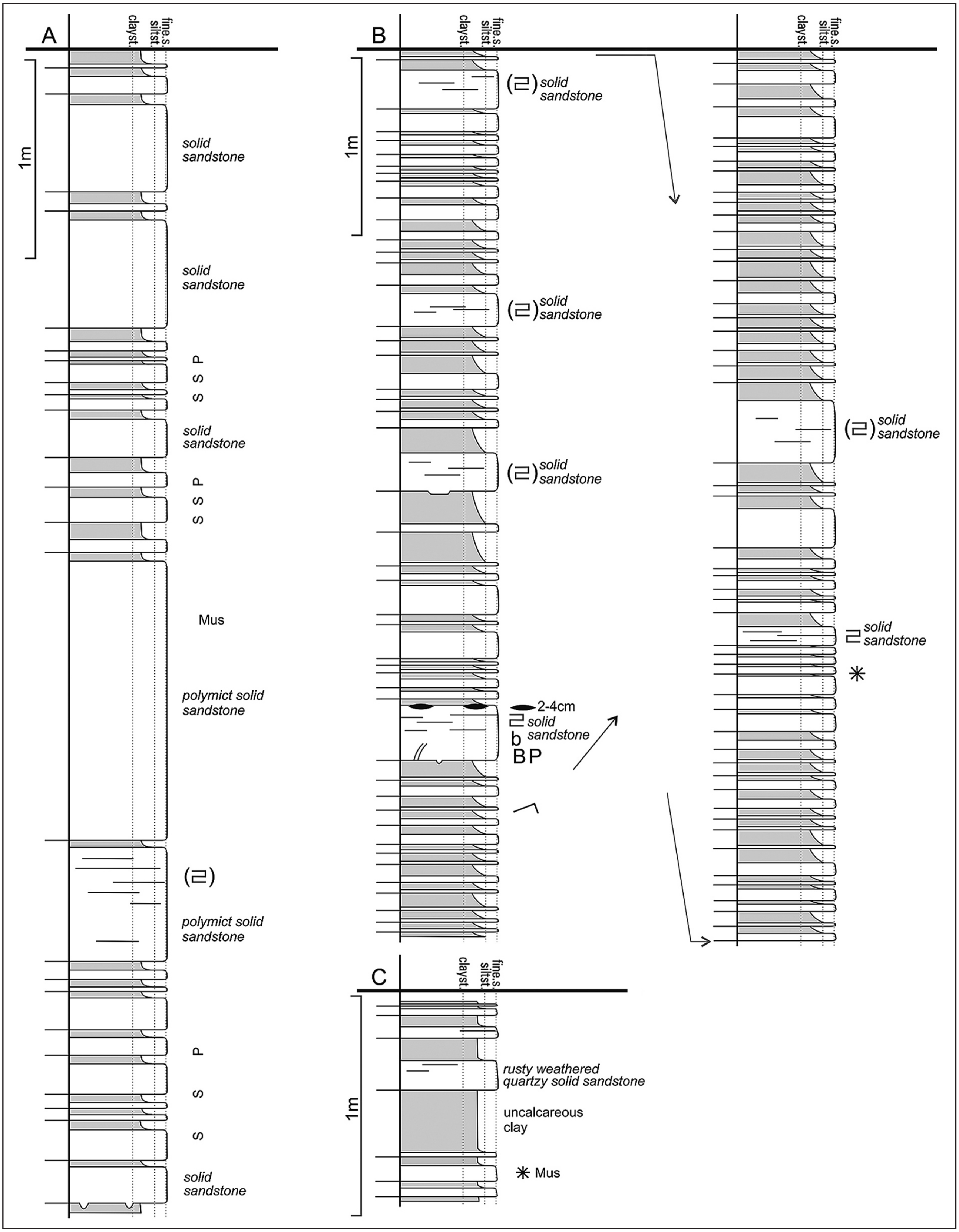

Fig. 4. A) Prietrž Mb. – poorly lithified fine- and middle-grained sandstones alternating with the silty claystones (Prietrž – right tributary between the upper and lower Deberník); B) Prietrž Mb. – thin-bedded facies – weakly lithified fine- and middle-grained crossbedded sandstones with the silty claystones (Prietrž – Podhorie, south of Dolné Podhorie); C) Sandstone-silty lithofacies – partly laminated weakly lithified sandstones pass into the silty claystones (creek 500 m south of the Bukovec farm).

Up to 4 cm thick layer of clay with pebbles and abundant up to 13 cm long thick-walled oysters occur on the transgression surface above the PKB basement (e.g. in the Podbranč quarry). The conglomerates overlay this horizon.

Boulders with a diameter over 30 cm were found above the transgression surface southeast of Branč on the Starý hrad Hill. The boulders comprise "Biancone" limestone (65 %), black cherts (30 %) and rarely quartzite, granite, red radiolarite, paleobasalt, paleorhyolite and others. The 5 m large block of the grey limestone occurs here as well. It could be interpreted as sediment of the several tens of meters deep feeder channel cutting into the bedrocks (the PKB sequences).

The age of the transgressive deposits is Eggenburgian (Vass, 2002). The Eggenburgian fauna (*Pecten hornensis*, *P.* cf. *pseudobeudanti*, *Macrochlamis gigas*, *Aequipecten scabrellus*, *Acantocardia* aff. *moeschanum* – Kováč et al., 2004) confirms the sublittoral environment, good communication among the sedimentation areas, subtropical to tropical climate and normal water salinity on the northern edge of the shallow water basin (Fig. 5E-F).

Brezová Mb. *(monomict carbonate conglomerates and sandstones overlying the Myjava and Brezová Groups and the Inner Carpathians)*

Coarse to medium-grained sandstones prevail. Conglomerates are less abundant and they are related to the surface of transgression or the base of gradational layers. Sandstones form 20 to 120 cm thick gradational cycles (layers) near Štverník and in Dolinka quarry (Fig. 5C). Thicker sandstone layers are present at some places as well (amalgamation can't be excluded). The sandstone of the upper part of the layer is generally planar- or cross-laminated.

The maximum size of grains is variable by location. Fine-grained conglomerates and sandstones near Štverník contain up to 1–4 (max. 10) cm large pebbles and cobbles. Breccias, conglomerates and sandstones near Hradište pod Vrátnom contain over 1 m large boulders. The Mesozoic limestones and dolomites of the Inner Carpathian provenance represent over 99 % of clasts in the Brezová Mb. The grains of quartz, glauconite, Cretaceous and Paleogene sandstones and granite are rare (Buday & Cicha, 1956). The pebbles and cobbles are mostly well-rounded. The exception is the quarry in Hradište pod Vrátnom (Fig. 5A), where the transgressive deposits are mostly angular (especially larger boulders). Thick and distinct transgressive breccia and eroded troughs covered foresets prograding from SE to NW. Roundness of the overlying sediments improves rapidly in the upper part of the sequence. Macrofauna was not observed in the Brezová Mb. Sandstones and conglomerates are cemented by carbonatic cement. Weakly lithified sandstones are light yellowish-grey, lithified fresh sandstones are blue-grey. The carbonate cement and clasts of the transgressive sandstones and conglomerates are locally dissolved and washed out by the rainwater (Štverník; Fig. 5B).

Sandstone facies *(polymict, sporadically pebble sandstones)*

Smooth transition from the transgressive conglomerates and sandstones into the overlying sandstone-silty facies is exposed in the outcrops near Štverník. The grain-size of sandstone facies gradually reduces and amount of pebbles transported from the distant sources increases upward the sequence. For instance, amount of dolomite clasts from the Biele Karpaty Unit and amount of rocks of the Inner Carpathian provenance increases southwards (mainly quartzite and quartz clasts, in smaller amount also dark red sandstones with muscovite, granites and sandstones from the Myjava and Brezová Groups). This suggests that the supply of clasts from local sources substituted the supply of material from the more distant southern sources in the whole area.

Sandstones are variously lithified. They are usually gradational, bright white, light grey, carbonatic, with less quartz clasts and cemented with carbonate cement. Quartz grains gradually prevail over carbonates to the top of the sequence. The clasts reach up to 3 (max. 20) mm. Well-rounded pebbles to boulders of the commonly laminated, white, yellow and pink coloured quartzite and quartz conglomerates, reaching 5–40 (max. 70) cm in size are found in the upper part of the sequence (near Štverník). Pebbles with a specific composition occur near the Štverník in the highest part of this facies – 75 % carbonates, 20 % quartzite and quartz, 5 % dark red fine- to coarse-grained sandstone with muscovite and feldspar, granites, porphyritic volcanic rocks and black fine-grained sandstone. Silts intercalations were not observed in this facies.

Sandstone-silty facies

The sandstone facies gradually passes into the sandstone-silty facies. This part of the sequence can be observed near Štverník. Thick grey calcareous silty clays and silts accompanied with thinner layers of weakly lithified sandstones represent the sandstone-silty facies (Figs. 3E, 4C and 8D). The silts typically occur with 5-30 cm thick layers of rusty coloured sandstones. The abundance of sandstones gradually increases. Sandstones locally significantly prevail over silts. The thickness of the sandstone-silty facies reaches about 50 m. It represents a period when neritic basinal Lužice Fm. gradually expanded to the Senica Depression. The sandstone-silty facies overlay the polymict conglomerates of the Jablonica Fm.

2.2. Second sedimentation cycle – Jablonica Fm. and Prietrž Mb. (polymict conglomerate facies, sandstone facies and thin-bedded facies)

Variable clastic sedimentation is characteristic of the second sedimentation cycle. It is possible to divide it stratigraphically into the lower part (Jablonica Fm.) with the occurrence of conglomerates and the upper part (Prietrž Mb.) without conglomerates and pebbles (Fig. 2). The sedimentation of the Jablonica Fm. developed in three facies: conglomerate facies, sandstone facies and thin-bedded facies. The Prietrž Mb. lacks of conglomerate facies. Facies alternate in couple of meters thick intervals (rarely only few decimetres). The transition among facies is usually smooth. Conglomerate layers wedge out laterally.

Sediments of the second sedimentation cycle occur in brachysynclinal position. The grain size continuously increases from the sandstones to conglomerates on the lower border of the second cycle. The first occurrence of conglomerates or pebbles is determined as the lower boundary of the second cycle as well as the lower boundary of the Jablonica Fm. The upper boundary is erosive. Younger sediments are preserved westward in the Vienna Basin (Kováč et al., 2004). The thickness of the second

Fig. 5. A) Contact of the basal breccia and conglomerate of Brezová Mb. (Eggenburgian) with the Hauptdolomite of the Považie Nappe (right part of the quarry Hradište pod Vrátnom – sand quarry Dolinka); B) Brezová Mb. – karstic alterations of basal carbonate conglomerates (Horný Štverník); C) Sandstone with erosion and bioturbation filled by coarse clastic material of younger event (the left part of the quarry Hradište pod Vrátnom – sand quarry Dolinka); D) Transgressive Eggenburgian sandstones overlying the Neocomian limestones of the Pieniny Klippen Belt (lower quarry in Podbranč); E) Pecteniid bivalve (lower quarry in Podbranč); F) Oyster (lower quarry in Podbranč).

cycle sediments in the study area reaches approximately 600 m. The thickness of the lower part of the cycle with conglomerates (Jablonica Fm.) is about 300-450 meters. The overlying sediments without conglomerates (Prietrž Mb.) are observed in the study area reaching a thickness of approximately 200 m (Fig. 2).

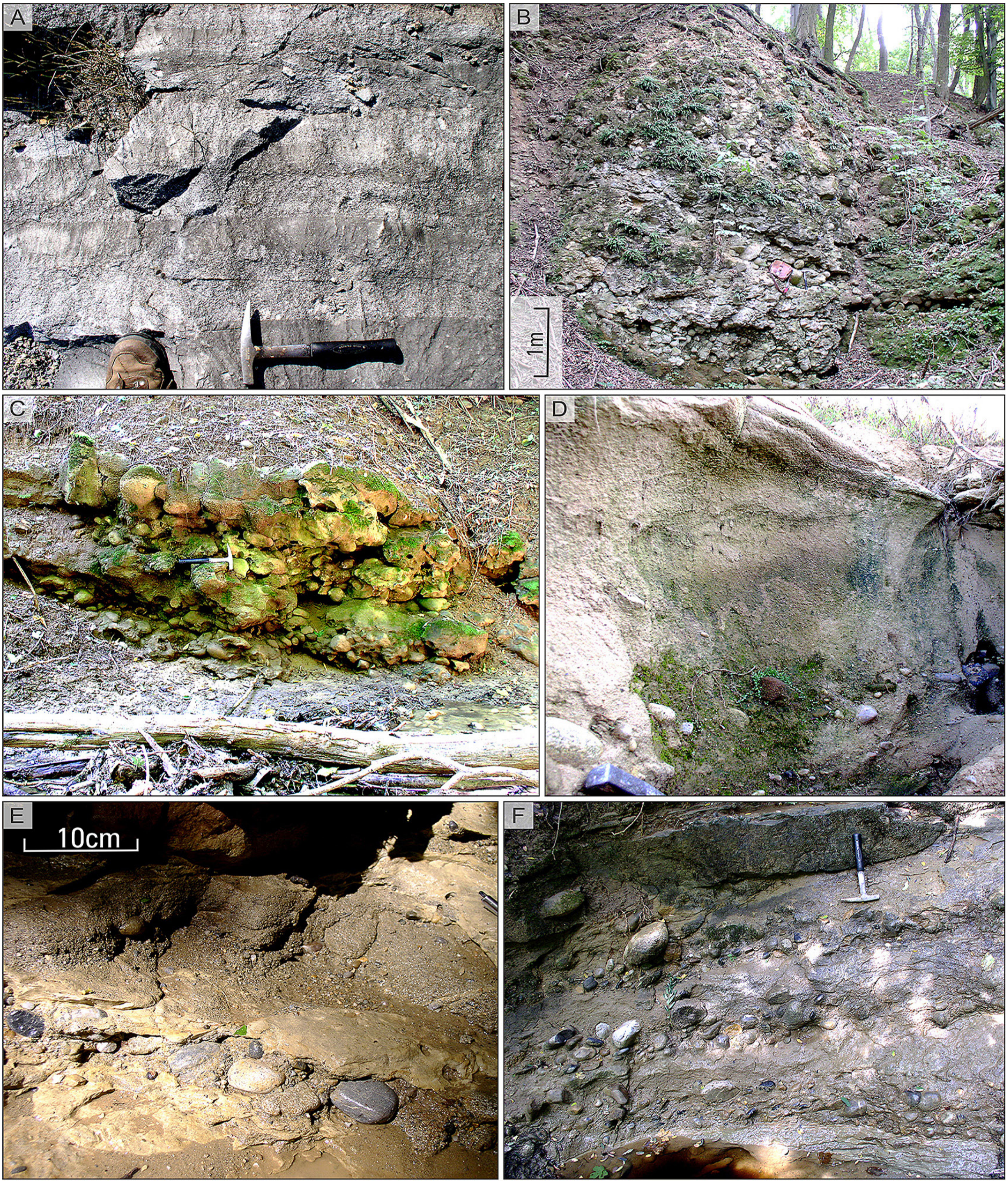

Fig. 6. A) Detail of gradational sandstone layers (lower quarry in Podbranč); B) Jablonica Fm. – at least 8 m thick conglomerate layer (SW of settlement Cabíci); C) Jablonica Fm. – conglomerate layer (right tributary NW of Hradište pod Vrátnom); D) Jablonica Fm. – sandstones with pebbles (SE of Podbranč); E-F) Jablonica Fm. – thin layers of the sandstones with pebbles – „pebble lines" (right tributary NW of Hradište pod Vrátnom).

Polymict orthoconglomerates form the morphological elevations in a flat shaped upland. The conglomerates represent about 10 % of the Jablonica Fm. Thicker layers of sandstones represent up to 20 % of formation volume. Thin-bedded facies represents remaining 70 %. The facies has low resistance to weathering. Therefore it is rarely exposed in outcrops, but it could be identified by the nature of terrain morphology, debris and loams. Grain size and occurrence of conglomerates reduces only slightly upwards the cycle/formation. Termination of the conglomerate sedimentation is the most significant

Fig. 7. A) Jablonica Fm. – limestone pebble drilled by mollusks (right tributary NW of Hradište pod Vrátnom); B) Jablonica Fm. – pebbles broken by Neogene faults (west of Štverník); C) Jablonica Fm. – bioturbation in the silty clays filled with sand (right tributary NW of Hradište pod Vrátnom); D) Prietrž Mb. – thin-bedded facies with thick sandstone bed (Prietrž – Podhorie); E) Prietrž Mb. – detail of the thin-bedded facies (Prietrž – Podhorie); F) Prietrž Mb. – anticline in the thin-bedded facies (NE of Osuské).

sign, which divides the second cycle into the Jablonica Fm. and Prietrž Mb. Thin-bedded facies and sandstone facies have the same character in both Jablonica Fm. and Prietrž Mb.

Conglomerate facies

The polymict conglomerates are characteristic for the lower part of the second sedimentation cycle (Jablonica Fm.). Buday (1955) named this sequence as the Jablonica Conglomerate.

Fig. 8. A-C) Bukovec landslide in the thin-bedded facies of the Jablonica Fm. and details of those sediments (NW of Bukovec); D) Detail of the sandstone-silty facies, 20 m below the first Jablonica conglomerate (NE of Bukovec); E) Prietrž Mb. – lime nodules „cicváre" in claystone; F) Jablonica Fm. – small seashells in the clayey sediment (SW of Podbranč).

The conglomerates represent only about 10 % of the Jablonica Fm. The conglomerates in the northern part of the territory between Prietrž and Podbranč were not observed directly in outcrops, but pebbles were found in large amount in debris. The pebbles and cobbles reach only up to 10 cm in diameter. They occur as scattered grains in weakly lithified sandstones (paraconglomerates), rarely as thinner layers of conglomerates.

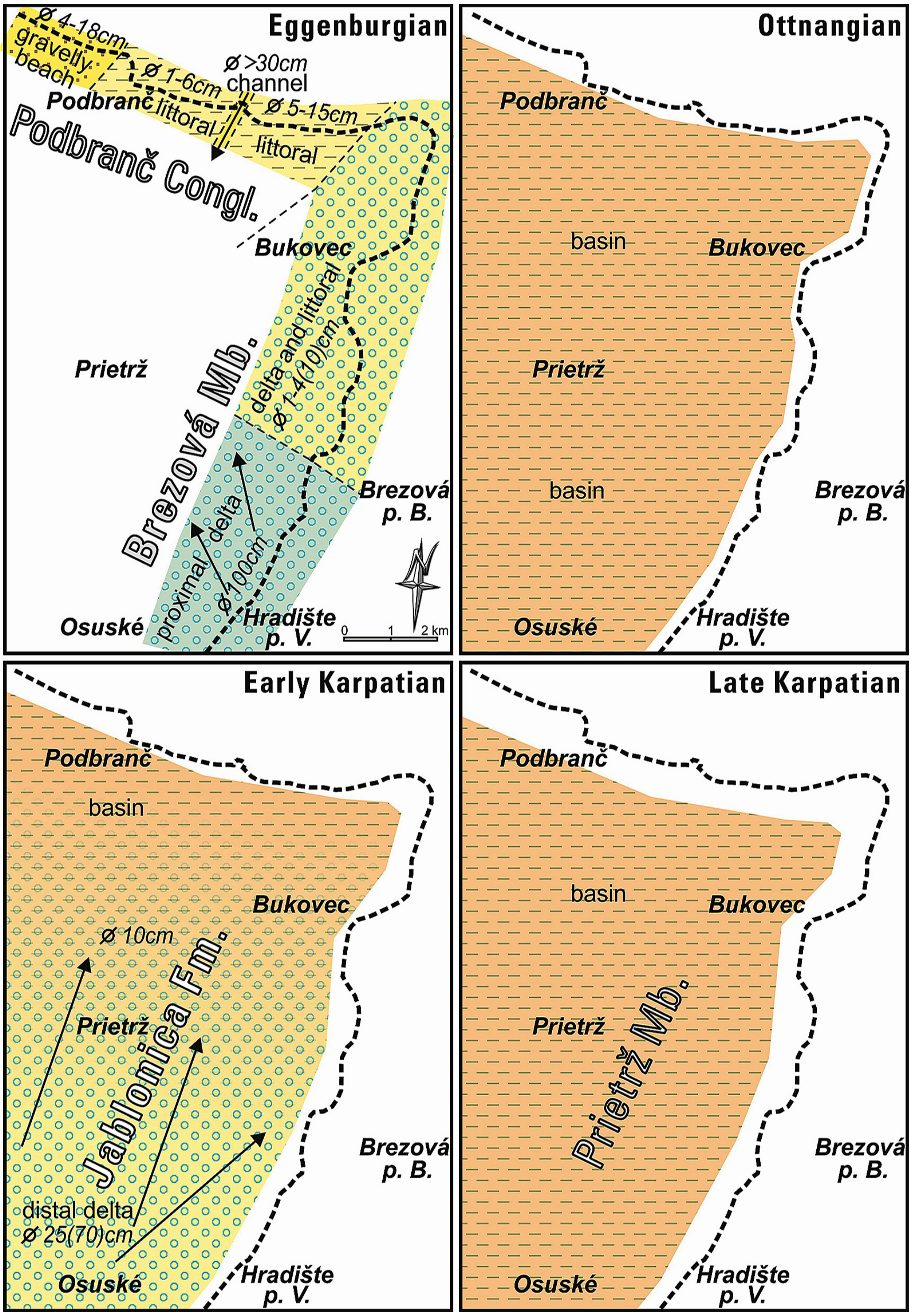

Fig. 9. Distribution of the 1st (Eggenburgian and Ottnangian) and the 2nd (Karpatian) sedimentation cycle facies and environments.

The outcrops with fairly well lithified conglomerates are common to the east and south of Prietrž (orthoconglomerates). The cobbles reach about 25 cm (max. 70 cm) in size. Smaller pebbles with diameter below 4 cm are less frequent. Thick amalgamated layers of conglomerates are common in the lower part of the formation. The conglomerate layers are interbedded with horizons of sandstone facies and thin-bedded facies. Medium- to coarse-grained sandstone fills the space between the pebbles and cobbles in orthoconglomerates. Up to 25 cm large pebbles and cobbles floating in the sandstone or siltstone are common (paraconglomerates). The orthoconglomerates pass into the sandstone in the upper 5-25 cm thick interval of the beds. Such graded beds reach a thickness of 20-150 cm (Fig. 3B). The thicker layers are result of amalgamation. Erosional channels are commonly observed. Conglomerate beds usually overlie each other and they form up to 8 m thick sequence (Fig. 6B-C). The thickness of the conglomerate layer may locally reduce to 2 cm. Pebbles and cobbles larger than the thickness of the layer form "pebble lines". These layers alternate with bright plastic calcareous claystones or siltstones (Figs. 3A, 6D-F).

Composition of pebbles across the study area is stable. The basic and acid volcanites are more abundant in the north. Quartzites are more abundant in the south. Carbonates (Triassic dolomites and limestones) form more than half of the clasts. The carbonates are accompanied by the abundant quartz, Lower Triassic quartzites, granites and black cherts. Fine-grained sandstones and polymict conglomerates, limestone with remarkable black cherts, organodetrital limestones with *Nummulites*, *Alveolina* and *Discocyclina*, and *Lithophaga* drilled carbonate cobbles (Figs. 3C, 7A) are less common. Pebbles and cobbles are very well-rounded to spherical. Large angular dolomite blocks were observed in few places. The cobbles are tectonically fractured (Fig. 7B).

Mišík (1986) elaborated detailed petrographic and microfacies analysis with the interpretation of the source area of conglomerate pebbles of the Jablonica Fm. He identified broad-spectrum of the rock types. The absence of the Eggenburgian transgressive breccias and conglomerates within pebbles demonstrate a broader range of the transgression in the Karpatian.

Sandstone facies

The sediments of sandstone facies are medium- to thick-bedded with an index of bedding from 0.5 to 6 beds per meter (Fig. 4A). This facies occurs in up to 8 m thick sequences. Clays form only up to 4 cm thin layers between thicker beds of sandstones. The individual beds of sandstones have a thickness of 5 to 100 cm, but amalgamated layers are over 3 m thick. The sandstones are mostly poorly lithified, massive and with rare water escape structures or planar lamination. Lithified sandstones show spheroidal weathering. Lithification of sandstone is related to the circulation of the fluids in the sediment as well as to degree of sediment sorting. The lithified sandstones are better assorted and indistinctively laminated in whole thickness. Ophiomorpha type bioturbation was observed in the sandstones (Fig. 7C). Clay intraclasts are commonly present at the top of the sandstone layers. It suggests significant erosion by mighty gravity currents and their density comparable to debrisflow. Flute casts and load casts were observed on the lower surfaces of the beds. They indicate material supply from the SW.

Thin-bedded facies

The sediments of thin-bedded facies form up to few tens of meters thick sequences (Figs. 4B, 7D-F; landslide Bukovec – Fig. 8A-C). They are formed by interbedded sandstones and silty claystones, approximately 8-14 layers per meter. Particular layers may be composed of a number of thin sand laminas in the claystone. The ratio of the thickness of sandstones and silty claystones is generally 1:1. Sandstones or claystones can prevail locally.

The sandstones are mostly less lithified, brown, poorly sorted and fine-grained. However, medium- to coarse-grained sandstones are common in the southern part of the investigated region. Graded bedding is common. Planar lamination sometimes occurs at the sandstone-claystone transition. Deposits are polymict, with abundant carbonates and with less abundant muscovite and glauconite. The thickness of sandstone layers is variable. It ranges between 0.5 and 20 cm. The base of the beds is clearly erosive, often with small current traces. This sediment is commonly bioturbated. Burrows in the claystones are filled with sand (Fig. 7C). Thin sandstone beds are also gradationally layered. Rusty coloured horizon rich in plant detritus terminates sedimentation of the sandstone beds. About 10 % of the sandstone beds are well lithified and better assorted, but the petrology of clasts is the same as in the weakly lithified sandstones.

The sandstone beds are of gravity flow origin. Common small current traces indicate bottom erosion by currents. Graded bedding of sandstones (T_a interval) indicates a potential turbulent nature of the depositional current. Cross-bedding and alternated clay and sand laminas (T_b and T_c intervals) suggest laminar character of currents. Character of the deposits indicate basin environment of sedimentation. Occurrence of conglomerates together with thin-bedded facies indicates the deposition from delta penetrating into the shallow basin.

The claystones at lower stratigraphic position (co-occurring with conglomerates) are soft, mostly light, brown to ochreous, rarely pinkish. The upper claystones are dark grey or brown-grey, solid, with conchoidal fracturing. They usually have silty or sandy admixture with muscovite. Claystones are calcareous. Migrating fluids precipitated in claystones secondary lime nodules up to 5 cm in diameter (Fig. 8E).

Claystones thicker than 12 cm without interruption by sandstone were observed only on three sites. They exceed 1 m there. In all three cases claystones included fragments or whole seashells. Shells are 1 cm large white with concentric ribs (Fig. 8F). Similar external mould of the shell core was found in the sandstone NE from Prietrž. The stratigraphic position of all these claystones is only a few 10 m below the last occurrence of conglomerate of the Jablonica Fm. It is possible to treat them as one horizon since the shells were not observed beside these three claystone layers.

3. TECTONICS

The study area has brachysynclinal structure in the map view. Its axis dips to the SW. North of Prietrž the beds dip to the SW or south. Southeast of Prietrž they are dipping with inclination of 5° to 25° mostly to the west. Two small-size folds were observed NE from Osuské. These folds have parallel axes in the direction of 80°-260° (Fig. 7F).

Fault displacement observed in outcrops is only a few centimetres and is rare. Distinct postdepositional fracturing of the Jablonica Conglomerate cobbles reaches offset on the particular fractures up to 2 cm (Fig. 7B).

4. DISCUSSION ABOUT PALEOGEOGRAPHY

The study area of the Senica Depression includes the easternmost part of the Vienna Basin (Kováč et al., 2004). During the Neogene, sedimentation began with the Eggenburgian transgression on geologically and tectonically dismembered basement formed by the flysch of the Biele Karpaty Unit, PKB, Senonian and Paleogene rocks of the Myjava and Brezová Groups and by the Mesozoic of Inner Carpathians (Kováč et al., 1988; Baráth, 1993). Sedimentation started with deposition of transgressive breccias, boulders and conglomerates associated with significant erosion and erosional channels (Hradište pod Vrátnom, Podbranč – Starý hrad). Sedimentation laterally continued with deposition of layered conglomerates and sandstones, and gradually prevailing sandstones (Fig. 9). Sandstones with interbedded silt deposited later. The Brezová and Chropov mbs represent coastal (sublittoral) transgression facies developed in the Senica Depression (Buday, 1955; Kováč et al., 2004). The basinal Lužice Fm. deposited deeper in the basin at the same time.

Previous interpretations of paleogeographic and geological evolution interpreted the origin of the conglomerates of the Jablonica Fm. based on their pebble analysis and sedimentological study in different way. E.g. Kováč (1985, 1986) interpreted these sediments as fluvial deposits. Thin sandstone interlayers in conglomerates were considered as a reworking due to wave motion. Expressively imbricated pebbles were observed. Orientation of their a-axis is SW-NE. Kováč (1985, 1986) assumes river transport from SW in the south area, but the transport took place from the NW in the north area (Hradište pod Vrátnom). Similar results he interpreted from grain size changes.

The evolution of the sedimentation in the basin we interpret in the sense of Kováč et al. (2004). Transgressive sediments represent clastic channel facies (Starý hrad), deltas and rocky beaches (quarries in Hradište pod Vrátnom and in Podbranč). They occur along the entire edge of the Neogene basin across the whole investigated territory from Jablonica to Sobotište up to Chropov. Advancing transgression on the rugged rocky relief created sandy-gravelly beach. Several deltas transported sediments into the basin. The deposits were transported only for a short distance from the coastal area and the nearby surrounding region. During the Ottnangian, the subsidence of the basin continued. Deepening of the basin resulted in sedimentation of thinner sandstone layers alternating with silty claystones which terminated the first sedimentation cycle.

The subsidence in the Vienna Basin and the erosion of the surrounding areas occurred subsequently in the Early Karpatian. The deposition of conglomerates was renewed in the next sedimentation cycle (Kováč et al., 2004). The clastic material was far more variegated and more reworked. This reflected the progress of transgression to distant and geologically more complex areas, as well as the longer transport. The conglomerates are interbedded with sandstone facies and thin-bedded facies. Nature of deposits indicates distal delta to basin environment (Jablonica Fm.). The sedimentation continued by deposition of the basinal Prietrž Mb. with sandstone facies and thin-bedded facies which lack in conglomerates. The Early Miocene evolution of the Senica Depression resulted in two thinning-up cycles.

The upper Karpatian and younger sediments are not preserved in the studied area. The marine sedimentation retreated further into the Vienna Basin. Littoral zone in the Badenian and Sarmatian was situated west of Borský Mikuláš (Kováč et al., 2004).

Seven current directions measured on the bedding planes of sandstones of the Jablonica Fm. tend from the SW to NE. Namely they tend 1x20°, 2x30°, 2x40° and 2x50°. The grain size changes as well as wedging out of the conglomerate bodies also suggest the southern source of clastic material and transport from the south to north.

5. CONCLUSION

The results of this study complement the earlier knowledge and interpretation from the past. The geological field study and mapping in the area between Podbranč and Hradište pod Vrátnom provided information about lithofacial nature of the investigated sediments.

Sedimentation in this region took place in two cycles during the Neogene. Both cycles started by deposition of conglomerates. Transgressive deposits represent monomict carbonate breccias, conglomerates and sandstones without fauna of the Brezová Mb. Fine- to medium-grained sandstones with shells of the Chropov Mb. overlie the Flysch units. They are overlain by the younger sandstone facies with polymict conglomeratic sandstone. The first cycle terminated with basinal sandstone-silty facies. Sedimentation of the second cycle developed in conglomerate facies, sandstone facies and thin-bedded facies. Presence of all the three facies with abundant polymict conglomerates is typical at the lower part of the second cycle (Jablonica Fm.). Subsequently deposited thin-bedded facies are intercalated with sandstones without conglomerates. They represent the Prietrž Mb.

Seven paleocurrent measurements of Jablonica Fm. sandstones confirm paleocurrent transport of deposits from the SW. The identification of facial composition of the Neogene (Eggenburgian – Karpatian) sediments, relationship and evolution of the facies and character of lithostratigraphic units is the main result of this article.

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