

Geology of fossil sites with the oldest Bohemian fauna (Lower Cambrian, Barrandian area)

Geologie nalezišť nejstarší české fauny
(spodní kambrium, Barrandien)
(Czech summary)



(13 text-figs.)

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The oldest and unique arthropod fauna with *Kodymirus* derives from the Paseky Shale Member in the Brdy Mts. area. The Paseky Shale is a rather thin but persistent unit within the thick Lower Cambrian siliciclastic sequence of inferred continental origin, deep below the strata with Middle Cambrian marine faunas. The sharp lower limit of the Paseky Shale indicates a regional event marked by interruption of coarse siliciclastic input and temporal dominance of silty-clayey sedimentation under probable restricted marine influence (brackish lagoon). The return to coarse clastic continental sedimentation is indicated by gradual vertical transition into clastics of the Holšiny-Hořice Formation.

Key words: Lower Cambrian, Paseky Shale, fossiliferous localities, stratigraphy, lagoonal environment

The unique Lower Cambrian fauna with *Kodymirus vagans* and other special arthropods is contained in the Paseky Shale Member embedded within the thick coarse siliciclastic sequence generally regarded by Barrande (1852) and subsequent authors as unfossiliferous ("étages azoiques"). Stratigraphically, the Paseky Shale is deposited deep below (800 to more than 1 500 m) the richly fossiliferous strata of the Middle Cambrian Jince Formation, world famous by finds of trilobites and other fossils.

The up to several thousand meters thick sequence of coarse siliciclastic rocks (mostly conglomerates and sandstones) with the embedded thin (around 10 m) Paseky Shale Member crops out in the Brdy Mts. in the SW part of the Barrandian area, Central Bohemia.

The stratigraphic assignment of this sequence depended formerly on evaluation of the Middle Cambrian Jince Formation: Whilst the older concept shared the late Middle Cambrian age of the overlying Jince Formation (Havlíček - Šnajdr 1951), and, consequently inferred even for the thick underlying clastics the Middle Cambrian age (e.g. Havlíček in Svoboda et al. 1966), new finds of early Middle Cambrian faunas in the lower part of the Jince Formation (Fatka et al. 1992) corroborated the Lower Cambrian age of the underlying siliciclastic sequence with the Paseky Shale Member, being thus in accordance with the former concept of Kettner (1918), Kettner and Kodým (1918) and reevaluation of Havlíček (1971).

The Paseky Shale, introduced for the first time as a separate stratigraphic member by Havlíček (1950), represents a constituent of the Holšiny-Hořice Formation (Havlíček 1971) of the Brdy Cambrian (cp. Figs. 1,

2). The Lower Cambrian age is now evidenced indirectly by superposition (deep below beds with early Middle Cambrian faunas) and directly by micropalaeontological data (see report by Konzalová - Fatka 1995, Fatka - Konzalová 1993 and in this volume).

The present report contains results of detailed investigation of individual fossil localities as was carried out in 1992-1994 under the kind sponsorship of the Ministry of Environment of the Czech Republic and with help of the District Office of the town of Příbram and the District Museum of Dr. B. Horák at Rokycany.

The results of palaeontological studies (arthropods, ichnofossils, microfossils) and sedimentology are contained in separate papers of this volume (see I. Chlupáč, R. Mikuláš, O. Fatka - M. Konzalová, Z. Kukul).

1. Mount Kočka

The mount Kočka in the western part of the Brdy Mts. is the principal palaeontological locality in the Paseky Shale. It is the first place of discovery of the *Kodymirus*-fauna and the only site which yielded the material for the first description of the fauna by Chlupáč and Havlíček (1965).

During the recent investigation in 1992, a 30 m long trench of NW-SE strike and another 5 m long transversal trench with maximum depth 2.5 m was excavated, being situated 150 to 200 m SE from the top of the Mount Kočka (elev. 788.7 m) in close eastern proximity of the road (see Fig. 3).

The trench exposed the richly fossiliferous middle part of the Paseky Shale sequence and its transition into overlying upper part with dominant siltstones. The

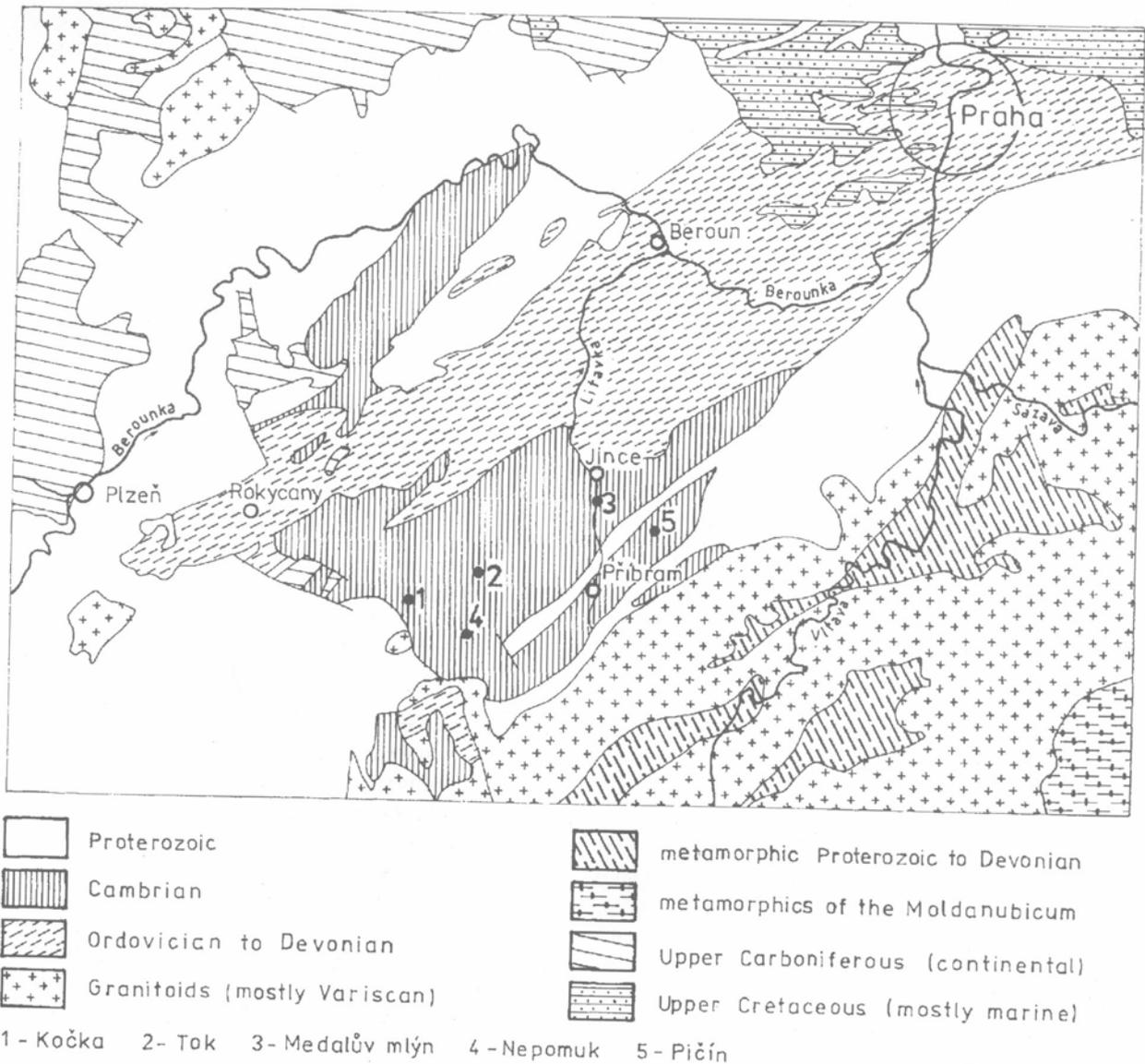


Fig. 1. Location of the described fossil sites in central Bohemia

upper limit was affected by tectonics. The sharp lower limit was encountered by a boring in the depth of 6 m (realized in 1994).

The detailed stratigraphy of the Paseky Shale may be summarized as follows: The shale member is underlain by hard yellow and light grey Hořice Sandstone, enriched with Fe-oxides in the uppermost part. After the sharp lower contact, the shale sequence starts with dark violet silty shales (1.5 m thick, only in boring). After a rather quick transition (yellow-grey silty and clayey shales), typical light green, olive-green and grey-green typical Paseky Shale with well expressed lamination prevail. These layers, exposed in the trench as 180 to 200 cm thick lowermost interval (1 in Fig. 4), represent the most productive fossiliferous beds. The fossils with strongly dominant *Kodymirus vagans* are concentrated in clayey laminae, where they are frequently found crowded in clusters. Intercalations of

hard greenish siltstones are sporadic, not exceeding the thickness of few centimetres.

The overlying part of the sequence exhibits a marked and gradual increase of grey-green, higher also reddish siltstones, clayey intercalations with only sporadic remains of fauna being strongly subordinate (intervals 2 to 4 in Fig. 4, beds 9 and 10 in Fig. 5, thickness around 200 cm). The uppermost layer of the Paseky Shale exposed in the trench consisted almost exclusively of brown-green and reddish siltstones with only rare clayey laminae (incomplete thickness around 50 cm, interval 5 in Fig. 4). These beds are bounded tectonically being in contact with dark violet and brown-violet sandstones with slump structures and clayey clasts (13 in Fig. 5).

The excavations at Kočka evidenced the sharp lower boundary of the Paseky Shale, the concentration of fossils in the soft shales below the increase of coars-

er silty layers, and the vertical transition of soft and laminated shales into unfossiliferous siltstones in the upper part.

2. Mount Tok

This site was first reported as a fossil locality by Havlíček (1968). It is situated in the southern part of the flat top plain of the Mt. Tok, around 500 m of the elev. point 865 m, about 30 m SW from the road (Fig. 6). Two trenches of the depth 2.5 and 4 m exposed the lower part of the Paseky Shale sequence, the deeper one reached even the base of the shale member (Fig. 7).

The lower limit of the Paseky Shale Member is expressively sharp: light grey claystones (weathered Paseky Shale) conformably but sharply overlie light Hořice Sandstones rich in feldspars. The exposed 3 m thick lower part of the Paseky Shale consists of light grey-green (due to weathering also light brown and light grey) clayey and silty shales with distinct fine lamination. The position is subhorizontal, the dip of strata does not exceed 10 degrees towards the NW.

Most fossils were found in the lowest 80 cm of the shale sequence, finds in higher layers were sporadic. *Kodymirus vagans* is the markedly dominant species, being accompanied by rather rare *Kockurus grandis* and very sporadic *Vladicaris subtilis*. *Kodymirus vagans* is represented not only as disarticulated exoskeletal parts but also as articulated major parts of specimens of different size.

3. Medalův mlýn near Čenkov

This site is the stratotype of the Paseky Shale Member and was reported as example of lithology and stratigraphic position even in excursion guidebooks (Havlíček et al. 1958, Chlupáč 1993). However, the former finds of two fragments of *Kodymirus* were negligible.

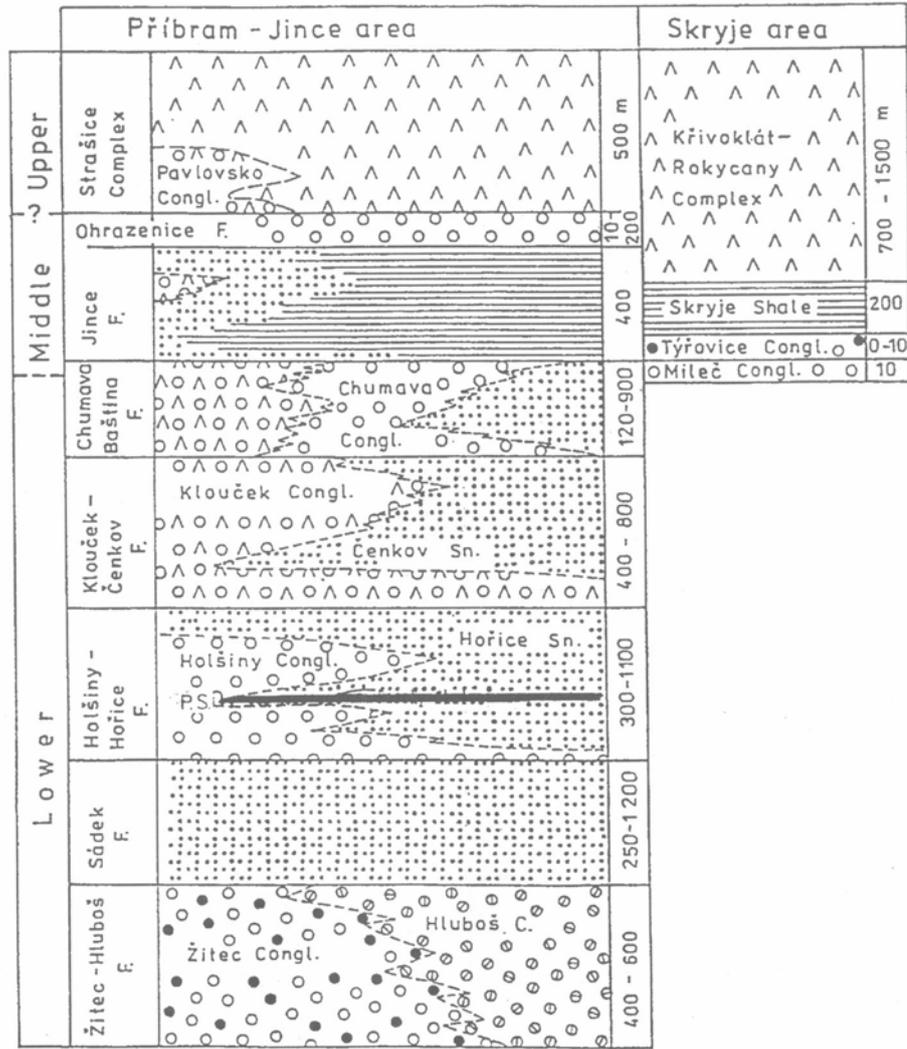


Fig. 2. Position of the Paseky Shale within the sequence of the Cambrian in central Bohemia (stratigraphy according to Havlíček 1971, simplified), P. S. - the Paseky Shale

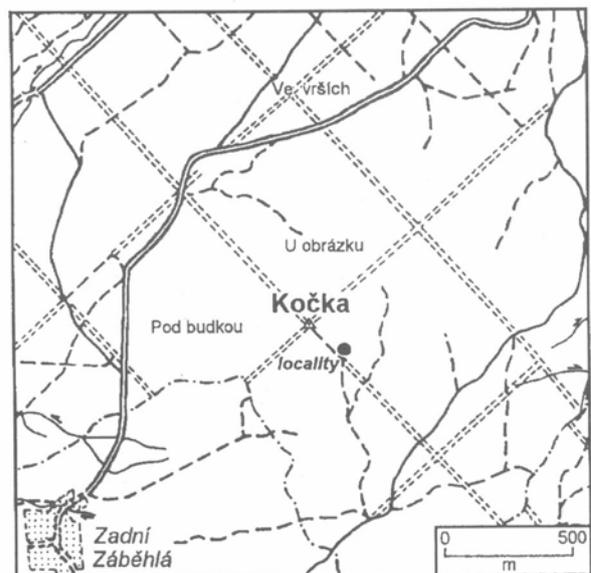


Fig. 3. Topographic location of the fossil site Mt. Kočka in the Brdy Mts. area (N at the upper margin)

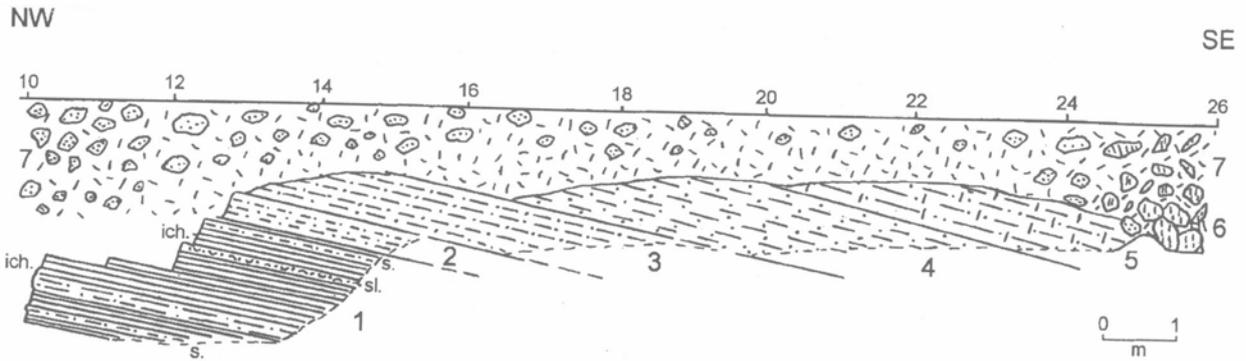


Fig. 4. Position of fossiliferous Paseky Shale exposed in the trench at Mt. Kočka

1-5 - the Paseky Shale: 1 - the main fossiliferous interval - grey-green clayey and silty shales with thin siltstone laminae (*s* - siltstone interbeds thicker than 3 cm, *sl.* - siltstone layer with slump structures, *ich.* - siltstone laminae with common ichnofossils), thickness 190-200 cm; 2 - grey-green siltstones dominate (40 cm); 3 - light green and reddish spotted siltstones with common laminae of green and red clayey shales (60-70 cm), fauna rare; 4 - green and red siltstones with subordinate laminae of clayey shales (90-100 cm), affected by weathering; 5 - red and greenish siltstones with rare clayey laminae (50-70 cm), affected by weathering; 6 - blocks of violet siltstones and sandstones with flat clasts of clayey shales and slump structures; 7 - debris and soil with large blocks of the Holšiny Conglomerate

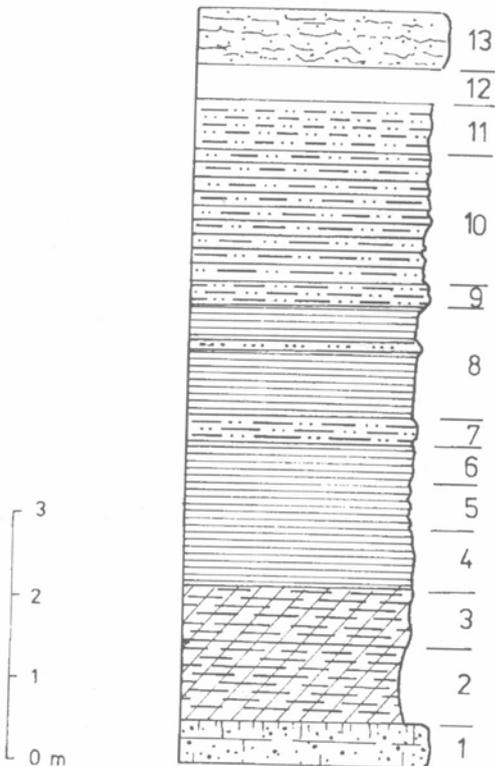


Fig. 5. Sequence of the Paseky Shale at Mt. Kočka. Reconstructed from the boring and trench outcrops

1 - light grey Hořice Sandstone enriched in Fe-oxides in the uppermost layer; 2 - dark violet shales, damaged by boring (around 1 m); 3 - dark violet clayey and silty shale (70 cm); 4 - greenish shales with red spots (70 cm); 5 - greenish shales strongly damaged by boring (50-100 cm); 6 - grey-green clayey shales rich in *Kodymirus* (lowest beds encountered in the trench, 37 cm); 7 - harder silty shales with red spots (20 cm); 8 - fossiliferous layers: green and grey-green clayey shales with siltstone laminae and a single layer of hard siltstone, total thickness 120-130 cm; 9 - grey-green siltstones dominate (30 cm); 10 - light green and reddish spotted siltstones and subordinate claystones with sporadic remains of fauna (170 cm); 11 - harder siltstones with subordinate red claystone laminae (50 cm); 12 - missing interval (fault zone); 13 - violet and brown siltstones and sandstones with strongly recrystallized clayey matrix, slump structures and clayey clasts

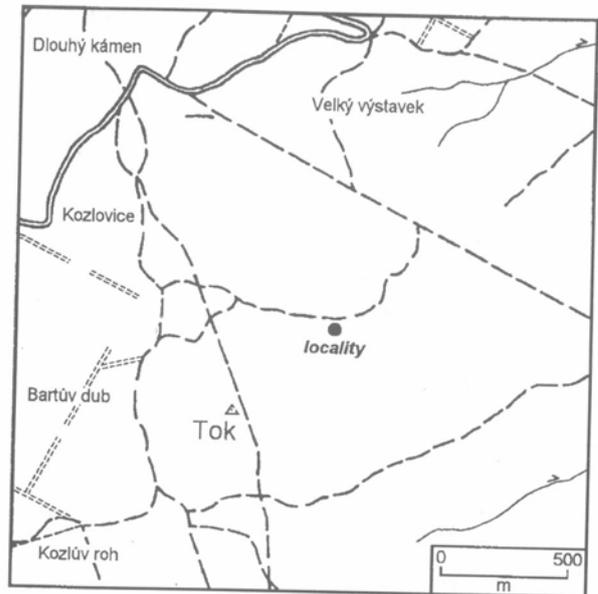


Fig. 6. Topographic location of the fossil site at Mt. Tok, Brdy Mts. (N at the upper margin)

This locality is situated on the eastern slope of the Litavka valley, around 400 m N of Medalův mlýn (former mill) on the right side of the highway leading from Hluboš to Čenkov (Fig. 8). The geological situation is depicted on the geological map 1:25 000, Sheet 12-433 Rosovice, Mašek et al. 1986).

The complete sequence of the Paseky Shale Member was exposed in a 13 m long trench and in the northwards situated small quarry close to the highway (Fig. 9).

The lower limit of the Paseky Shale is also here expressively sharp and weathered brown-green shales directly but conformably overlie the light brown Hořice Sandstone with ripplemarks on their uppermost bedding plane. Most fossils were concentrated in the 50 to 60 cm thick lowest part of the shale sequence and only

few (but better preserved) specimens of *Kodymirus* were found in soft and light brown clayey shales 140 to 150 cm above the shale base. Last very sporadic fragments of *Kodymirus* derive from greenish shales of the interval 6 in Fig. 9, around 1 m above the thicker greenish siltstone bed with small ripplemarks (bed 5 in Fig. 9) in the small quarry.

The higher part of the Paseky Shale sequence is distinguished by increasing number and thickness of brown and greenish siltstones indicating a gradual increase of coarser clastic input (some layers show slump structures). The vertical facies transition of the Paseky Shale into the overlying light quartzose Hořice Sandstone, marked by alternation of sandstone and siltstone layers, is well exposed in the roadside outcrop N of the quarry.

The locality near Medalův mlýn best exposes the whole sequence of the Paseky Shale with its sharp lower boundary and gradual upper transition into coarser siliciclastics. A marked analogy with the localities Kočka and Tok indicates not only the stratigraphic identity of fossiliferous layers but also the close similarity in sedimentary development.

Nepomuk near Rožmitál pod Třemšínem

The occurrence of the Paseky Shale in the southern part of the Brdy Mts. between the mounts Praha (elev. 862.6 m) and Malý Tok (elev. 863.9 m) was verified by a trench. This was situated N of the village of Nepomuk on the southern slope at the forest around 650 m NNW from the Nepomuk foresters (i.e. around 280 m south of the ruins of the forest cottage called U svatého Jana, comp. Fig. 10).

The trench (Fig. 11) exposed the lower limit of the Paseky Shale Member: reddish and varicoloured spotted clayey and silty shales (35 cm) sharply overlie the light Hořice Sandstone, being vertically replaced by light grey and leached clayey shales with weathering products (20 cm). The overlying typical grey-green clayey and silty Paseky Shale with distinct fine lamination and siltstone layers were strongly affected by slope movements and shifted downwards from their original position higher on the slope. They yielded a single isolated segment of *Kodymirus vagans* and a trunk of *Vladicaris subtilis*, both preserved in clayey laminae (interval 6 in Fig. 11).

The lower part of the Paseky Shale Member demonstrates at Nepomuk a clear analogy with other localities, expressed in the sharp lower boundary, soft nature of lowest shale layers and lithologic analogy of fossiliferous rocks.

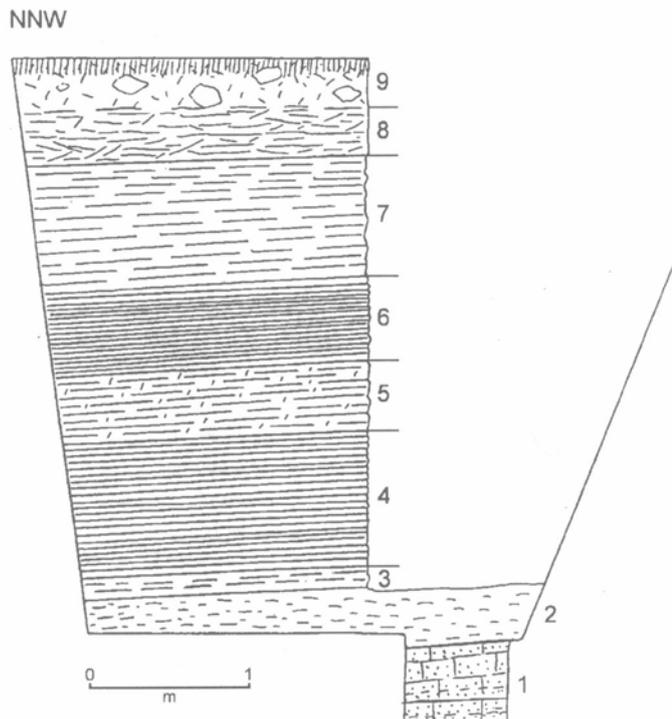


Fig. 7. Sequence exposed in the trench at the Mt. Tok

1 - light grey and yellow arcose Hořice Sandstone; 2 - light grey claystones - strongly weathered base of the Paseky Shale (30 cm); 3 - grey-green and secondary red-coloured silty shales (15 cm); 4 - the main fossiliferous interval: grey-green clayey and silty shales with expressive thin lamination (80 cm); 5 - grey-green clayey and silty shales affected by cleavage (40 cm); 6 - grey-green spotted and clayey shales with less frequent fauna (50 cm); 7 - light brown and greenish clayey and silty shales with rare remains of *Kodymirus* (affected by weathering, 70 cm); 8 - strongly weathered shales affected by solifluction (30 cm); 9 - soil with large blocks of sandstones and conglomerates of the Hořiny-Hořice Formation

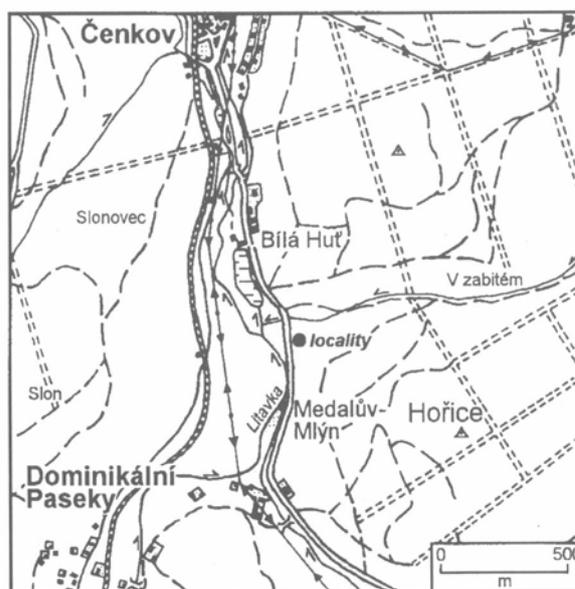
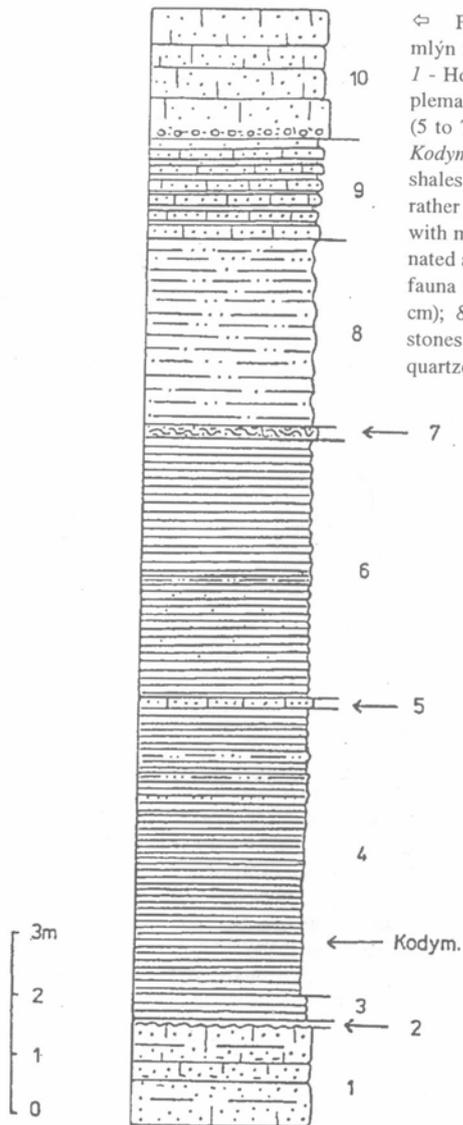


Fig. 8. Location of the trench near Medalův mlýn S of Čenkov (N at the upper margin)



⇐ Fig. 9. Complete sequence of the Paseky Shale Member as exposed at Medalův mlýn near Čenkov

1 - Hořice Sandstone: light grey-brown lithic greywackes with large clayey clasts, ripplemarks on the uppermost bedding surface; 2 - light grey and rusty weathering products (5 to 7 cm); 3 - green-brown silty and spotted shales with rather common remains of *Kodymirus* (40-52 cm); 4 - light brown, higher also greenish soft clayey and spotted shales with siltstone laminae and thin siltstone intercalations in upper part (450-470 cm, rather rare remains of fauna found 90-100 cm from the base); 5 - green solid siltstone with mini-ripplemarks and other sedimentary structures (8-10 cm); 6 - grey-green laminated and spotted clayey and silty shales with siltstone laminae and very rare remains of fauna in the lower part (400-420 cm); 7 - brown siltstone with slump structures (20-30 cm); 8 - brown micaceous siltstones (around 300 cm); 9 - light grey quartzose sandstones alternating with subordinate green-brown siltstones (170 cm); 10 - light-grey quartzose sandstones and conglomerates of the Hořšiny-Hořice Formation

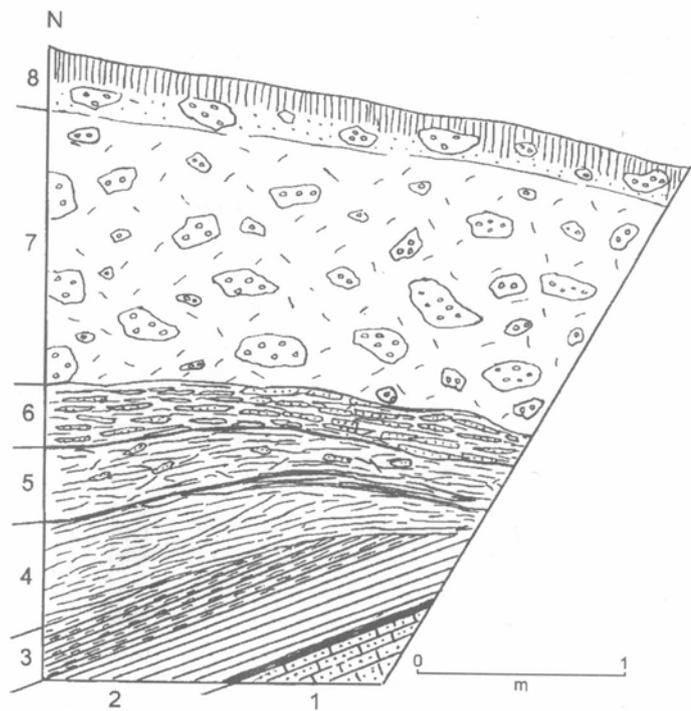


Fig. 11. Section exposed in the trench N of Nepomuk

1 - light grey-green Hořice Sandstone, secondarily enriched in Fe-oxides; 2 - reddish and spotted clayey shales with weathering products near the base (35 cm); 3 - grey clayey and spotted shales with weathering products (20 cm); 4 - grey-green clayey and silty shales affected by slope movements (20-45 cm); 5 - fragments of grey and greenish shales and weathering products affected by solifluction; 6 - fragments of grey-green siltstones and clayey shales (with very rare remains of the Paseky Shale fauna); 7 - weathering products with large blocks of the Hořšiny Conglomerate; 8 - soil with debris

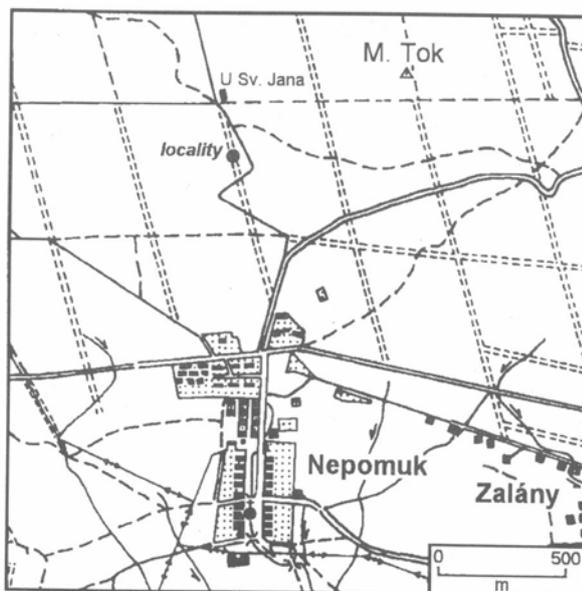


Fig. 10. Location of the trench N of Nepomuk near Rožmítal pod Třemšínem (N at the upper margin)

Pičín

The sequence of the Paseky Shale in the eastern limb of the Příbram syncline was studied in a 26 m long trench (maximum depth 2.5 m) excavated around 500 m NW of the pond Pilský rybník, E of the village of Pičín. (E of the elev. 471, comp. Fig. 12).

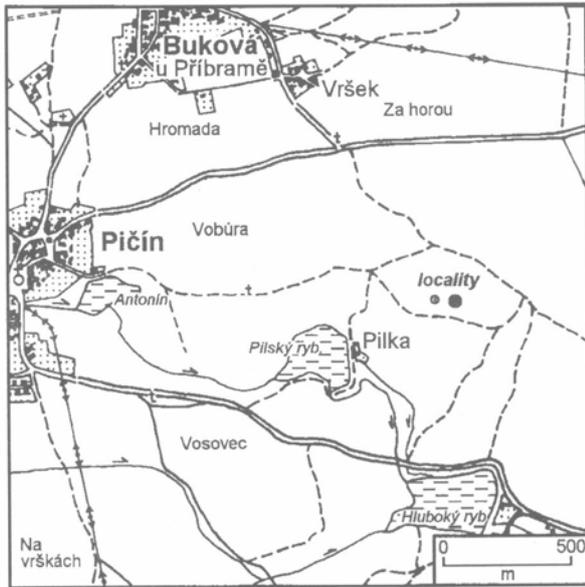


Fig. 12. Location of the trench near Pičín (N at the upper margin)

The lower limit of the Paseky Shale is here also sharp and the grey-green laminated Paseky Shale conformably overlies the light Hořice Sandstone with thin violet claystone interbeds. Though the development of the Paseky Shale is analogous to other fossil localities (only hard siltstone layers seem to be more common), no demonstrable remains of fauna were found.

The shale sequence is disturbed by several faults and also the upper contact with light sandstones and conglomerates of the Hořiny-Hořice Formation is of tectonic nature. The total thickness of the Paseky Shale is unknown and only roughly estimated to 10-15 m.

However, the Paseky Shale encountered in the trench does not represent the single belt as depicted on the geological map 1:25 000 sheet 12-433 Rosovice (Mašek, ed. 1986). The belt of the Paseky Shales repeats westwards from the trench close to the elev. 471, where also no remnants of fauna were found.

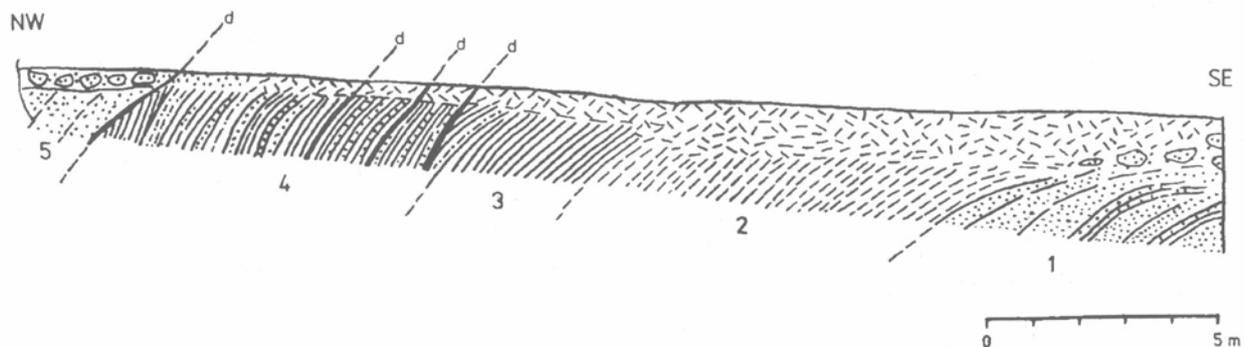


Fig. 13. Incomplete sequence of the Paseky Shale in the trench near Pičín

1 - light grey and brown sandstones and conglomerates with several intercalations of violet silty shales; 2 - weathered grey-green and brownish Paseky Shale; 3 - harder brown-green silty shales; 4 - brown-green and brown silty shales with intercalations of hard siltstones; 5 - yellow and brown sandstones and conglomerates of the Hořiny-Hořice Formation; d - thrusts or faults

Conclusions

The study of the Paseky Shale localities in the Brdy Mts. area allows the following conclusions to be made:

1. The fossiliferous Paseky Shale with the oldest Bohemian fauna constitute in the central Brdy area a single, rather thin (6-10 m) member of remarkable lateral persistence. This member is embedded (as already stated by Havlíček, 1968, 1971) within the lower part of the Hořiny-Hořice Formation, deep below (800 to more than 1 500 m) the fossiliferous Middle Cambrian Jince Formation.
2. The lower limit of the fossiliferous Paseky Shale is conformable but expressively sharp at all localities studied. It demonstrates an abrupt and profound change in facies - an interruption of the coarse siliciclastic input and onset of soft clayey and silty sediments. This change may be interpreted as a regional event which might result in temporal and restricted marine influence and communication.
3. The fossiliferous layers with *Kodymirus vagans* and other arthropods are concentrated in the lower part of the Paseky Shale sequence, where thinly laminated clayey and subordinate silty shales dominate.
4. The upper part of the Paseky Shale sequence is marked by gradual increase of coarser silty and later even sandy material. The arthropod fauna disappears in these layers and the development indicates a gradual return to coarser siliciclastic sedimentation, analogous to beds underlying the Paseky Shale Member.
5. The occurrence of the oldest Bohemian fauna within the Paseky Shale is not merely a very local phenomenon. Diverse localities in the Brdy area show marked similarity in lithology and fossil content, and discoveries of new localities depend on new outcrops only. The present localities should be protected as sites of a special scientific interest.
6. Though the fossiliferous Paseky Shale with the oldest Bohemian fauna represent a single and rather persistent member within the coarse siliciclastic sequence, similar shale layers may repeat as local lenses (comp. Havlíček 1971). These lenses, however, did not yield any fauna.

Submitted, January 12, 1995 Translated by the authors

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Geologie nalezišť nejstarší české fauny (spodní kambrium, Barrandien)

Nejstarší česká fauna pochází z paseckých břidlic brdského spodního kambria. Tyto břidlice tvoří v centrálních Brdech laterálně perzistentní člen uvnitř sledu holšínsko-hořického souvrství, v hlubokém podloží jineckého souvrství se známými faunami středního kambria.

Spodní hranice fosiliferních paseckých břidlic je nápadně ostrá. Je spojena s náhlým přerušením hrubě klastického přínosu a s dočasným nástupem sedimentace jílovitých a prachových břidlic. Tuto změnu lze hodnotit jako projev regionálního eventu, který mohl být spjat s omezenou a dočasnou komunikací s mořským prostředím. Návrat k režimu hrubě siliciklastické sedimentace byl relativně pozvolný.

Lokality s výskyty nejstarší české fauny s vůdčím eurypteridním členovcem *Kodymirus vagans* Chl. et Havl. a dalšími arthropody vykazují v centrálních Brdech nápadnou podobnost ve stratigrafickém vývoji i způsobu výskytu fosilií. Dovolují závěr, že fauna různých lokalit (hora Kočka, Tok, Medalův mlýn, Nepomuk) patří jedinému stratigrafickému horizontu uprostřed sledu hrubě klastických uloženin brdského spodního kambria.