

# NEW GEOLOGICAL, PALAEOBOTANICAL AND PALYNOLOGICAL EVIDENCE OF THE CARBONIFEROUS FROM BRANDOV (KRUŠNÉ HORY MTS., CZECH REPUBLIC)

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**Abstract:** Gas-pipeline construction around Brandov (Czech Republic) exposed pre Quaternary strata allowing more precise understanding of the regional geology. The crystalline rocks in the basement, near the Brandov Carboniferous Relict, belong to Sayda Dome rather than to the Hora Svaté Kateřiny (Katharinaberg) Dome. The lower Carboniferous unit (Westphalian – Moscovian) is of greater extent than previously estimated. In contrast, the upper unit, which is correlated with Stephanian (Kasimovian or Gzhelian) strata, is areally less extensive than previously estimated and is devoid of fossil remains. An anthracite seam, in the lower unit, was discovered in the "North depth" some 1–1.3 km to the North from old mining activity of the "South depth". The seam was accompanied by a flora dominated by cordaitaleans and sphenopsids (calamitaleans), and common lycopsids and ferns. Palynomorphs were isolated from mudstones for the first time and 36 genera and 51 species of miospores could be determined. A humic clayey layer was discovered in the Quaternary deposits whose palynological age is 500 – 100 years old.

**Key words:** Westphalian, Brandov Carboniferous relict, flora, palynoflora, geology

## INTRODUCTION

Interest in the "Brandov Basin" renewed during the construction of the gas-pipeline "Gazela" in 2010-2012. Fossiliferous Carboniferous rocks and an anthracite coal seam were discovered in the "North depth", which occurs in the northern part of the "Brandov Basin" separated by submerged crystalline ridge from the "South depth". Plant fossils and palynological samples were obtained for the first time. Though palynological assemblages have been obtained from both the pipeline trench in the "North depth" and from the tailings of the "Glück auf" mine in the "South depth"; they are impoverished. This study is the first palynological study conducted on samples from the "Brandov Basin".

In this study we use "Brandov Carboniferous" for a small remnant block of sediment that remained from a much larger sedimentary basin, which is now tectonically separated from other crystalline rocks. The Brandov Carboniferous were deposited unconformably on Precambrian - lower Paleozoic (?) crystalline rock. In older literature the "Brandov Carboniferous" has had several names: Brandov (Anthracite) Basin (Němcejc,

1930, 1953), Krušné hory (Erzgebirge) Carboniferous, Brandov Relict (Havlena, 1964), Upper Palaeozoic occurrences in Krušné hory, Occurrence near Brandov (Pešek *et al.*, 2001), and Brandov-Olbernhau Basin (Hofman *et al.*, 2012). It is clear that "basin" is not an appropriate term for this small relict, and suggested is the name Brandov Carboniferous Relict ("Brandov C.R." used herein), or Brandov Carboniferous Occurrence.

## MATERIAL AND METHODS

Palaeobotanical samples were collected in the three localities along the trench for gas the pipeline "Gazela": Br 1 (N: 50° 38.1'; E: 13° 23.687'), Br 2 (N: 50° 38.213'; E: 13° 23.593') and Br 3 (N: 50° 38.26'; E: 13° 23.53'), and they are stored in the Czech Geological Survey, Prague. The figured samples have numbers ZŠ 392, 393, 394 and ZŠ 551 through ZŠ 558. The unfigured samples, mostly *Cordaites* sp. and *Calamites* sp. have numbers ZŠ 559 through 584.

Br 1 locality was the only locality in which it was possible to study the section and collect fos-

sils from individual layers *in situ*. The rest of the flora was obtained from the berm material that has since been put back in the trench to cover the pipeline and is no longer accessible.

Seven samples from carbonaceous claystones, siltstones and bright coal were processed to obtain palynomorphs. Two Br 1 samples are from beneath the coal (Plate 1, Figs 4, 5). Five samples (coal, dark grey claystones and siltstones) were collected at an old spoil pile of the "Glück auf" mine. Palynomorphs were isolated from the rocks using standard technique (Batten in Jones and Rowe, 1999). Ten palynological glycerine-jelly slides were made from each sample. Slides, digital images and samples are stored in the Czech Geological Survey, Prague. Spores were compared according to the system of classification suggested by Potonié and Kremp (1954, 1955a, b), Dettmann (1963) and Smith and Butterworth (1967). Percentage proportion of palynomorphs was not stated due to poor preservation.

## MINING HISTORY, STRATIGRAPHY AND GEOLOGY

The Brandov C.R. is a small basin (3.5 km long and 1.5 km wide), situated on the northern slope of the Krušné hory (Erzgebirge) Mountains, near Hora Svaté Kateřiny (Katharinaberg) in Bohemia. This basin is well-known for its anthracite seams that have been mined for nearly 100 years (Čílek, 1964). The coal discovery was made in 1825, mining began a year later. In 1924 the mines were abandoned after 700,000 t anthracite had been removed from the ground. Mining stopped due to inflation in Germany. The documents that held the history of this mining district have subsequently been lost in a fire. A geological overview and coal history was published by Purkyně (1926, 1930), who elaborated on the results of earlier research by various authors (Ernst von Warnsdorf, 1853; Cotta, 1854; Feismantel, 1873; Pošepný, 1926; Zelenka, 1926). Later papers deal with basin stratigraphy (Havlena, 1964; Pešek, *et al.*, 2001; Spudil, 1998). Mlčoch *et al.*, (1991) placed crystalline basement rocks into the Precambrian Sayda Dome complex.

Although mining activity started in the Brandov C.R. in the 1<sup>st</sup> half of the 19<sup>th</sup> century, plant fossils were not reported until Cotta (1854) reported

many finds of *Sigillaria* homotaxially demonstrating the Carboniferous age of the sediment. Geinitz (1856) classified "Brandov Carboniferous" to his "*Sigillaria* coal zone" and so did Jokély (1857). Feistmantel, O. (1873) grouped the upper Brandov coals seams with the red deposits (Permian) immediately overlying the coal, while his father Feistmantel, K. (1883) correlated the Brandov coals with the Upper Radnice coal (Carboniferous). Thuma (1920) published Sterzel's floral list and indicated that the flora was Westphalian in age. Němejč (1930) undertook a comprehensive revision of Brandov flora and correlated it with the Moscovian (Westphalian C) Radnice flora. Němejč (1953) revised the *Sigillaria* from the Brandov coal seams. Using this revision Němejč correlated the Brandov material with the Bashkirian (Upper Westphalian A) Žaclěř coal seams. There are other taxa in the flora which must be considered when correlating a flora to any time scale. When these taxa are taken into account, Pešek *et al.*, (2001) correlated the Brandov coal seams as Bolsovian (Westphalian C).

The aim of borehole and geophysical prospecting in 1957 was to verify total anthracite reserves and determine mining feasibility Čílek (1965). Slánský & Valín (1962) focussed on clay-mineral layers in rhyolitic tuffs. Pipeline construction in 1992 and 2010–2012 added significantly to the geology of the area most notably increasing greatly the extent Carboniferous units (Malík J. *et al.*, 2011).

## Crystalline basement

A gas pump station was built on the muscovite gneiss of the Sayda Dome complex (Mlčoch *et al.*, 1991) and are exposed below the Carboniferous strata along the northern and western margin. The basement complex here was formerly thought to be part of the Hora Svaté Kateřiny (Reitzenheim-Catharinaberg) Dome (Zelenka, 1926).

An altered serpentinite complex was exposed, in the pipeline trench at the unconformity between the basement and the Brandov C.R. at its SE. margin (Figure 1). The serpentinites were previously unknown as the area is overlain by Quaternary coluvial deposits. This body lies in continuation of serpentinite body near Zöblitz and is connected with smaller serpentinite bodies on the German side of the Svídnice valley.

## Carboniferous (Westphalian)

The Carboniferous (Westphalian) sequence (Lower unit of Pešek *et al.*, 2001; Brandov Formation of Hofman *et al.*, 2012), of the Brandov C.R. is formed of conglomerates, sandstones, mudstones clays and coal (anthracite) seams. Conglomerates dominate with mudstones making up the remainder of the sediments in the lower part of the section. Upward from the conglomerate the proportion of mudstone layers increases and four coal cycles are preserved (Pešek *et al.*, 2001). The maximum thickness of the Carboniferous is estimated to be 250 m. Coal seams heretofore known and mined only in the southern part of the Brandov C.R. in the "South depth", are now know to be present in the pipeline trench in the "North depth".

During the winter months 2011–2012, 2.2 km. open pipeline trench ran from the pump station bisecting a line between Brandov village and state boundary (Figure 1), and through the whole northeastern part of the Brandov C.R. The Carboniferous rocks exposed in the trench included 0.8 km of Westphalian and 0.95 km of Stephanian rocks. The remainder of the trench exposed circa 0.45 km of Quaternary colluvial deposits.

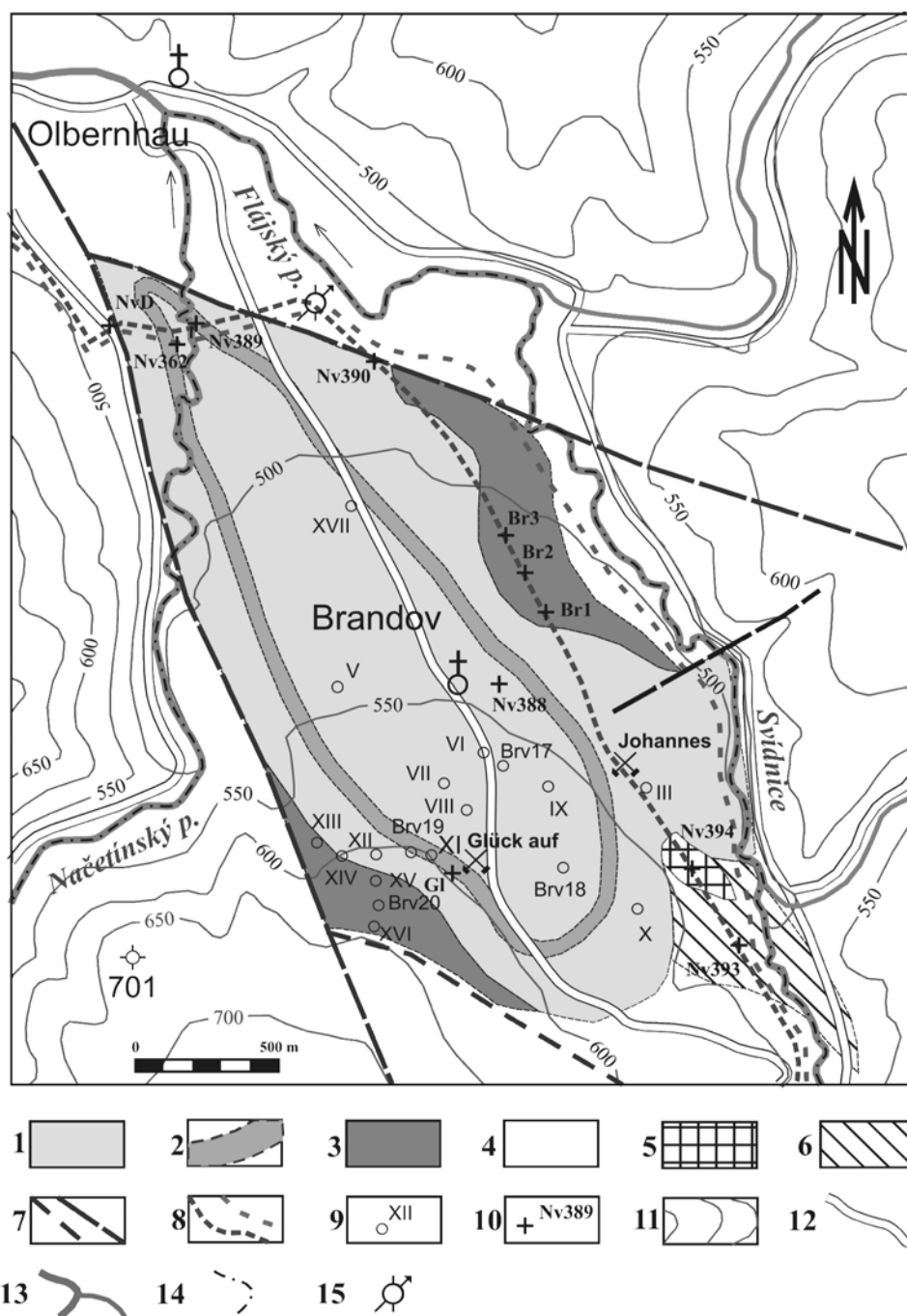


Figure 1. Geological chart of the Brandov Basin. 1 – Stephanian; 2 – Horizon of rhyolite tuff intercalations; 3 – Westphalian; 4 – Muscovite ± garnet gneisses; 5 – Altered serpentinite; 6 – Fine-grained paragneiss (4, 5, 6 – Sayda Dome); 7 – Faults; 8 – Trench for gas-pipeline Gazela in 2012 and 2000; 9 – Boreholes; 10 – Documentation point; 11 – Contour lines (25 m); 12 – Road; 13 – Creek; 14 – State border; 15 – Gas-pipe-station.

The naturally exposed Carboniferous strata in the study area are all Westphalian sandstones, coaly sandstones, mudstones, claystones and a 1 m thick coal (anthracite) seam. It is now possible to

project the existence of Carboniferous strata under the Quaternary deposits along the northeastern margin of the basin with a greater areal extent than previously known. Carboniferous strata extends from the pipeline to Svídnice Creek but is not exposed at the surface due to the thick Quaternary deposits unconformably overlaying them.

### Carboniferous (Stephanian)

The upper sequence (Upper unit of Pešek *et al.*, 2001; Olbernhau Formation of Hofman *et al.*, 2012) has an erosional contact with the Westphalian strata, itself up to 100 m thick (Purkyně, 1930; Čílek, 1965). This Upper unit is formed by conglomerates, sandstones and mudstones.

The Carboniferous conglomerates are composed primarily of cobbles of the basement rock, however there are much less common clasts of rhyolite (Čílek, 1965). Čílek (1965) subdivided the strata into three units: pre-tuffite, tuffite and post-tuffite. The "tuffite horizon" consists mainly of grey or pinkish fine-grained tuffaceous sandstones with sporadic layers of limestones. The sandstones contain a large component of clay. The sand-sized components contain bi-pyramidal quartz crystals, orthoclase grains and hexagonal laminas of biotite among others. The thin layers of illite-montmorillonite claystones (Slánský & Valín, 1962) represent reworked weathered rhyolite tuffs. Valín (1970) mentioned 18 m of rhyolite tuffs and tuffites. Zelenka (1926) indicated that the tuffite extended to the northwest, based on small surface outcrops and manmade exposures. He described argillaceous and arkose tuffite and glass porphyry in this unit.

A sequence of reworked rhyolite tuffs and lapilli tuffs, were documented in the northern margin of the basin by the excavation for pipeline excavation in the years 1992 (location point NV 362) and 2010 (NV 389) (Figure 1). These occurrences of acid volcanic tuffs are further North than earlier supposed in the "north depth" (Purkyně, 1929). Acid volcanic tuffs were not recognized in the "North depth" by Zelenka (1926). Laminated tuff beds several cm to tens cm thick (Figure 2) dip 10–15° west were observed, below the Quaternary gravels, in the 4m deep trench on the right side (east) of the Načetín Creek. Total thickness of the rhyolite tuffs is not known. As exposed in the bottom of the trench it is more than 1 m.



Figure 2. Trench for pipeline near the Czech side of the Svídnice creek. Fine-grained bedded tuffs lie beneath the altered Stephanian clays and Holocene fluvial gravels (NV 389). Photo B. Mlčoch.

Microscopically, a sample from NV 389, is very fine-grained tuff and contains rare fragments of quartz and biotite. Finely laminated tuff, a sample from NV 388, consists of quartz fragments (up to 0.5 mm), flakes of biotite (up to 0.7 mm), muscovite and small lithic fragments of crystalline rocks, (up to 0.5 mm) enclosed in a fine-grained matrix (Figure 3). The quartz fragments are angular to subangular (explosive fragmentation, excluding transport by water) with great variability in size. The poor sorting supports deposition near the source vent. Platy fragments and crystals have a strongly preferred orientation that suggests pyroclastic surge deposition. Field and laboratory measurements of this tuff are given in the Table 1.



Table 1. Value of natural radioactive elements and magnetic susceptibility

			field measurement				laboratory measurement						
lokality	rock	point	K %	eU ppm	eTh ppm	kappa	Th	U	eU	K	Do	Dm	por.
Brandov near cemetery	tuff	NV388	3.2	7.18	23.52	1.48; 2.17; 0.06; 2.26; 2.28; 0.07	19.8	3.7	3.7	1.78	2.35	2.628	10.59
Brandov near cemetery	tuff	NV388	3.4	4.65	25.63								
Brandov near cemetery	tuff	NV388B	2.93	4.94	16.25	0.03;0.15;0.07							
Brandov Načetín creek	bedded tuff	NV389									2.427	2.567	V.42

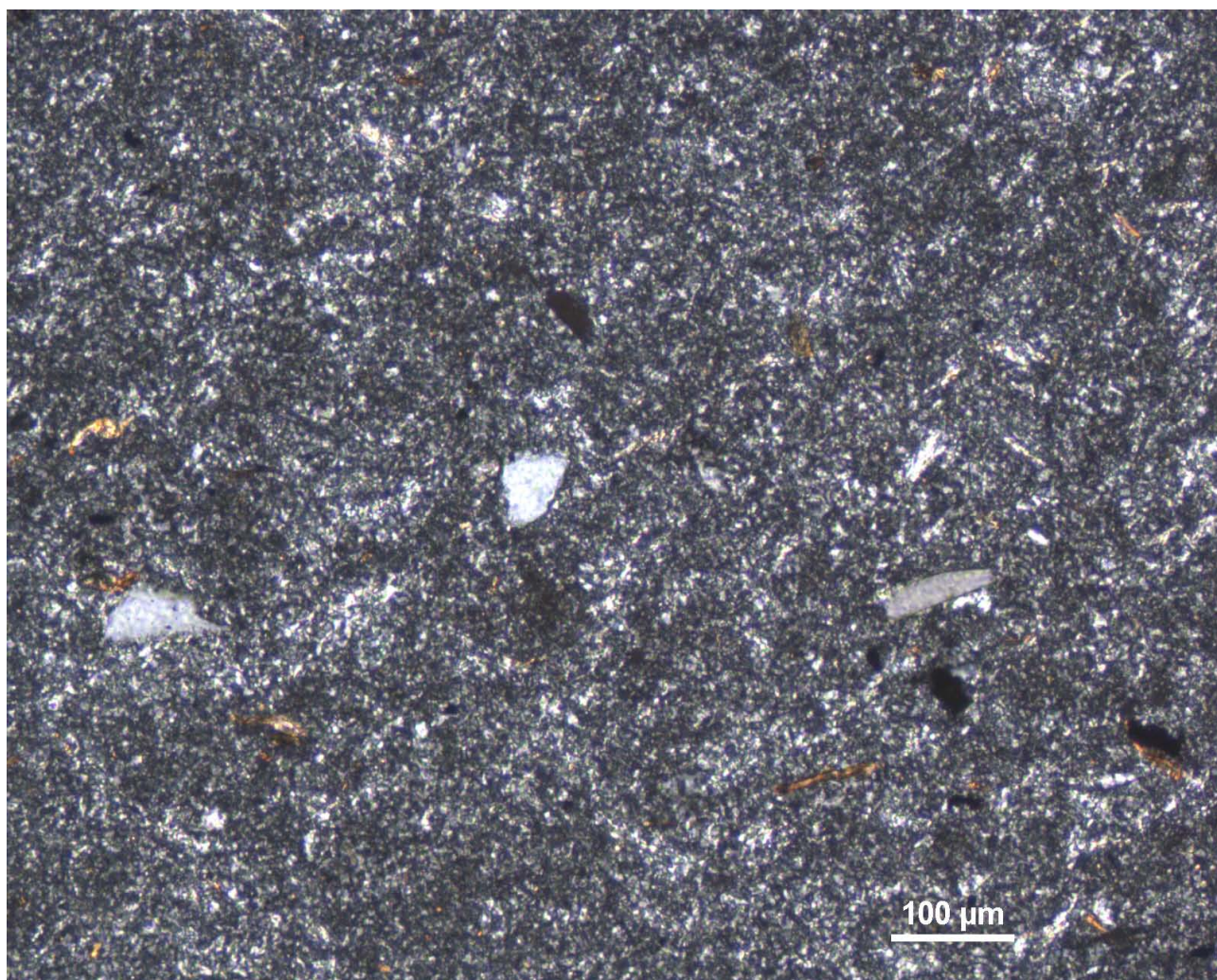


Figure 3. Microphotograph showing finely-bedded tuff that consists of fragments of quartz (up to 0.5 mm), flakes of biotite (up to 0.7 mm), muscovite and small lithic fragments (crystalline rocks, up to 0.5 mm) enclosed in fine-grained matrix. Photo B. Mlčoch.

The recently recognized extent of rhyolite pyroclastics is shown on the geological map "Erzgebirge/Vogtland" 1:100,000 (Hoth *et al.*, 1995), which covers both Czech and German sides of the basin. (here Figure 1).

The biostratigraphic age of these deposits is not known as they are unfossiliferous. Feistmantel, O. (1873) suggested a Permian (Saxonian) age. Hofman *et al.* (2012) dated zircons from the pyroclastic rocks in the Olbernhau Formation ("Olbernhau Basin") in Germany (Schneider & Romer, 2010), which are equivalents of the "Permian" rocks of the Brandov C.R. They stated the age as  $302.6 \pm 2.8$  Ma and came to the conclusion that these rocks are younger than the Teplice Rhyolite body. Note that taking the standard deviation of  $\pm 2.8$  Ma into account the strata could be Stephanian (upper part of the Kasimovian) or be wholly Gzhelian.

### Quaternary

A one meter thick layer of grey clays probably of limnic origin (Holocene) was found below the colluvial deposits (locality NV D, see Figure 1), at the foot of crystalline elevation on the German side between the villages Rothenthal and Grünthal. Twelve spaced 5cm thick bulk samples were collected from the 60 cm thick humic clayey layer at 2.5 – 3.1m below the surface. The sediment ranges from 500 – 100 years old was determined palynologically by Břízová in Malík *et al.* (2011).

## PALAEOBOTANY

**Systematics** (According to Cleal & Thomas, 1995)

Class Lycopsidea (club-mosses)

Order LEPIDOCARPALES Thomas et Brack-Hanes, 1984

**Cyperites** sp. (Plate II, Fig. 5) (specimen ZŠ 553, locality Br 1, name Brandov)

1930 *Sigillaria* sp. – Leaves. Němejč. pl. 5, fig. 11. Fragments of 15 leaves found on two slabs, one of which is just similar to Němejč (1930, pl. 5, fig. 11). The biggest leaf fragment is 75 mm long. All leaves are only 2–3 mm wide with a prominent central vein. A specimen bears strongly marked lines along the midrib (stomatal grooves?).

Remark: This provisional genus reserved for the sterile, long (grass-like), pointed apex, enlarged and thickened at the base leaves of arborescent lycopsids. They belong predominantly to *Sigillaria*, but also to *Lepidodendron*, *Asolanus* and possibly to other stems.

Cf. **Lepidostrobus** sp. (Plate II, Fig. 1) (specimen ZŠ 551 locality Br 1, name Brandov)

S fragment 35 mm long and 10 mm wide has been found. The sharp distal parts of sporophylls are visible. Maybe this cone is of the *Flemingites*-type.

Class EQUISETOPSIDA (horsetails)

Order EQUISETALES Trevisan, 1876

Family CALAMOSTACHYACEAE Meyen, 1978

**Calamites** cf. **carinatus** Sternberg, 1823. (Plate II, Fig. 3) (specimen ZŠ 392 locality Br 1, name Brandov)

1823 *Calamites carinatus* Sternberg. pp. 36, 39, pl. 32, fig. 1.

1825 *Calamites carinatus* Sternberg. Tentamen, p. XXVII.

1930 *Calamites carinatus* Sternberg. Němejč p. 48, 92, pl. 4, figs 6, 7.

1966 *Calamites carinatus* Sternberg. Crookall, p. 682-686. pl. 129, figs 2, 3, pl. 131, figs 1–3, pl. 132, fig. 5, text-figs 200, 201.

Description: The fragment is 140 mm long and >60 mm wide (at the node), as the specimen is damaged and full width is not known. The single twig scar (hole) is elliptical and large – 12 mm in diameter. The ribs are deformed around this hole in the circle of 40 mm, and are relatively wide – 1.5–2.5 mm.

**Calamites** cf. **cistii** Brongniart, 1828. (Plate II, Fig. 4) (specimen ZŠ 393 locality Br 3, name Brandov)

1828 *Calamites Cistii* Brongniart, p. 129, pl. 20, figs 1–5.

1930 *Calamites Cisti* Brongniart. Němejč, p. 48, 93, pl. 4, fig. 9.

1966 *Calamites Cistii* Brongniart. Crookall, p. 639-641. pl. 123 fig. 1, text-fig. 183.

Description: The imprint of axis fragment is 170 mm long and 40 mm wide. The ribs are fine and separated by shallow furrows, and together (a rib and furrow) are commonly 1 mm wide, or a little less. The nodes are not very prominent (three of

them are preserved on the sample). The internode lengths are about 45 mm.

Remark: This species differs from other *Calamites* species by very narrow ribs. The described specimen resembles the specimen figured by Němejc (1930) on pl. 4, fig. 9. However, Němejc's specimens have internodes 68 mm long.

***Calamites* cf. *suckowii*** Brongniart, 1828. (Plate II, Fig. 2) (specimen ZŠ 552 locality Br 1, name Brandov)

1828 *Calamites Suckowi* Brongniart, p. 124, pl. 15, figs 5, 6, pl. 16, fig. 2, (non pl. 14, fig. 6, pl. 15, fig. 1 and pl. 16, fig. 1).

1930 *Calamites* aff. *C. suckowi* Brongniart. Němejc, p. 47, 92, pl. 3, fig. 4.

1966 *Calamites suckowi* Brongniart. Crookall, p. 632–639, pl. 119, figs 1–4, pl. 120, figs 1–3, pl. 121, fig. 1, pl. 123, fig. 2, text-figs 181, 182.

Description: Only a small axis fragment with one node has been found. The ribs wide – around 2 mm, rounded at top and bottom, separated by narrow furrows. Tubercles at upper ends of ribs are oval or circular. The fragment is 70 mm long and >30 mm wide (damaged specimen).

Remark: The rounded ends of ribs are typical for this species.

***Calamites schuetzeiformis*** Kidston et Jongmans, 1917. (Plate III, Fig. 1) (specimen ZŠ 394 locality dump of the Glück auf coal mine, name Brandov)

1917 *Calamites Schützeiformis* Kidston et Jongmans, pp. 90, 92

1930 *Calamites* sp. Němejc, p. 91, pl. 4, fig. 10.

1966 *Calamites schützeiformis* Kidston and Jongmans. Crookall, p. 660, Text-fig. 194.

Description: This specimen was found on a dump of the coal mine in Brandov. It represents a calamite axis fragment 27 cm long and 45–47 mm wide. Internode lengths vary between 10–22 mm. Ribs are straight, generally prominent, in many cases not alternating in the nodes. Nodes are usually contracted. Tubercles at top of ribs are obscure. The ribs are 1–1.3 mm wide.

Remark: Němejc's (1930 pl. 4, fig. 10) specimen probably belongs to this species. It has also contracted nodes and short internodes, 5–10 mm long, shorter than in our sample, but it fits to the 4–90 mm range given by Crookall (1966).

Undeterminable *Calamites* remains (specimens: ZŠ 559, 562 through 564; 579 through 581; 583, locality Br. 1, Br 2, Br 3, name Brandov)

***Asterophyllites* cf. *longifolius*** (Sternberg, 1825) Brongniart, 1828. (Plate II, Fig. 2) (specimen ZŠ 554, locality Br 1, name Brandov)

1825 *Bruckmania longifolia* Sternberg, Tentamen, p. XXIX, pl. 57, fig. 1.

1828a *Asterophyllites longifolia* Sternberg.

Brongniart 'Prodrome', pp. 159, 176.

1930 *Asterophyllites longifolius* Sternberg. Němejc, 49, 94, pl. 4, figs 1 and 2.

1966 *Asterophyllites longifolius* Sternberg sp. forma *typica* Crookall, p. 704–707, pl. 150, fig. 2, pl. 140, fig. 2 (forma *rigida* Weiss pro sp.), text-fig. 205.

Description: Only one twig fragment with several nodes was found. Internodes are clear, but leaves are obscure. The internodes are 20–22 mm long and about 9 mm wide. 10–12 low relief ribs are present at the internode.

Remark: Němejc (1930) described this species from the Brandov C.R. with comparable dimensions. Though leafless and thus problematic, we are comfortable with the assignment of this specimen to *Asterophyllites longifolius*.

Class FILICOPSIDA (ferns)

Order BOTRYOPTERIDALES Meyen, 1987

Family TEDELEACEAE Eggert et Taylor, 1966

***Senftenbergia plumosa*** (Artis, 1825) Stur 1885. (Plate III, Figs 3, 4) (specimen ZŠ 555, locality Br 3, name Brandov)

1825 *Filicites plumosus* Artis, p. 17, pl. 17.

1832 *Pecopteris plumosa* Artis. Brongniart, p. 348, pl. 121, figs 1–2, pl. 122, figs 1–4.

1885 *Senftenbergia plumosa* (Artis). Stur, p. 92–96, pl. 51, figs 1–3.

2003 *Senftenbergia plumosa* (Artis) Stur. Bek et Pšenička, p. 301–306, pl. 1–4.

Description: A sterile penultimate pinna fragment is 80 mm long and 35 mm at its widest. Preserved ultimate pinnae are 18–22 mm long and 6–7 mm wide. The pinnules are triangular, attached to the ultimate rachis by the whole basis. They are 4–6 mm long and 1.5 to 2 mm wide with entire, sinuoid or slightly lobed pinnule margins. The mid-vein extends to the apex; single veins terminate to the margin teeth or lobes.

Remarks: *Senftenbergia plumosa* is easily recognisable by its short triangular pinnules. Sterzel's floral list for Brandov C.R. includes this taxa (Thuma, 1920). However, Němejc (1930) was unable to locate the specimen either in the collections at the National Museum in Prague, nor in the Museum in Chemnitz. Lacking additional material of this taxa he thought that it was a misidentified. New material assignable to *Senftenbergia plumosa* has been recovered from the pipeline trench in the "North depth".

In the artificial system of fern-like foliage "Pteridophylla", the name *Pecopteris plumosa* is often used. Bek and Pšenička (2003) prefer using the name *Senftenbergia plumosa* based on its fructification. Additionally, the genus *Pecopteris* Brongniart usually contains genera and species of the family Marattiaceae, whereas *Senftenbergia* belongs only to the family Tedeaceae.

#### Class PINOPSIDA

Order CORDAITANTHALES (cordaitaleans)

Family CORDAITANTHACEAE Meyen, 1984

***Cordaite*** sp. (Plate III, Fig 5, 6; Plate IV, Figs 1, 3) (specimen ZŠ 560, 561; 566 through 571; 573 through 578; 582, localities Br 1, Br 2 and Br 3, name Brandov)

Němejc (1930) found only incomplete leaves in the collections of Chemnitz Museum and the National Museum in Prague. Based on the venation with two "sclerenchymatous strips" alternating with a true vein, assigned the Brandov specimens to the most common species *Cordaite principalis* (Germar) Geinitz. However, as with the new material, lack of the base and apex of the leaf it is impossible to make specific determinations. Therefore, none of the cordaitalean specimens can be classified beyond *Cordaite* sp.

***Artisia*** cf. ***approximata*** Lindley et Hutton, 1837. (Plate II, Fig. 2) (specimen ZŠ 558, locality Br 1, name Brandov)

1828 *Sternbergia approximata* Brongniart 'Prodrome', p. 137 (nomen nudum)

1837 *Sternbergia approximata* Brongniart. Lindley et Hutton pl. 224, pl. 225

1838 *Artisia approximata* Brongniart. Corda in Sternberg, p. 22, pl. 53, figs 1–6.

1970 *Artisia approximata* Lindley and Hutton. Crookall, p. 819–820, pl. 155, fig. 11, text-fig. 234A.

Description: Pith casts 90 mm long and 25 mm wide. Alternating horizontal constrictions and ridges are visible on the surface. The constrictions are very narrow and shallow; the ridges are usually 1.5–2.5 mm wide.

## EVALUATION

### Brandov 1 (Br 1)

Plant fossils were collected from several layers. Most of floral remains were obtained from friable claystones below the coal seam. A nearly monotypic cordaitalean assemblage was preserved here (Plate I, Fig. 5). Although the claystones were full of cordaitalean leaves only fragments could be obtained. Below this layer, is a four cm thick layer of silty sandstones (Plate I, Fig. 4). Plant axes, twigs and small stems occur in the base of this layer, they are usually poorly preserved, decorticated, and difficult to identify. They contain pith casts (and axis fragments) – *Calamites* sp. and *Artisia* cf. *A. approximata*. From the debris removed from the trench specimens of cordaitalean leaves and calamitaleans (*Calamites* sp. and *Calamites* cf. *C. suckowii* Brongniart) have been recovered. A specimen of indeterminate lycopsid remains (?*Lepidostrobus* sp. and ?*Cyperites* sp.) probably comes from the roof of the coal.

### Brandov 2 (Br 2)

Only cordaitalean leaves (*Cordaite* sp.) in mudstones and a sphenopsid pith cast *Calamites* sp. in sandy siltstone were obtained.

### Brandov 3 (Br 3)

This locality represents an approximately 50 m long section of trench. The material from the trench was a pile of black and grey sand and clay debris (Plate I, Fig. 1). Pith casts and axis fragments of sphenopsids (*Calamites* sp. and *Calamites* cf. *C. cistii* Brongniart) have been obtained from sandy rocks. Grey claystones and siltstones were poorly fossiliferous. Cordaitalean leaf were dominant, rare sphenopsid axis [*Asterophyllites* cf. *A. longifolius* (Sternberg) Brongniart] and the fern *Senftenbergia plumosa* (Artis) Stur have also been recovered. Questionable fragments of arborescent lycopsids (*Cyperites* sp.) have been obtained. Roots penetrating mudstones are seen penetrating the bedding. Charcoal is present on some bedding surfaces.



Table 2. Distribution of palynomorphs in the Brandov C. R.

TAXA	Locality	
	Br 1	Gl
<i>Leiotriletes adnatoides</i> Potonié et Kremp, 1955	o	o
<i>Leiotriletes</i> cf. <i>convexus</i> (Kosanke) Potonié et Kremp, 1955		o
<i>Leiotriletes minutus</i> (Knox) Potonié et Kremp, 1955	o	o
<i>Leiotriletes subadnatoides</i> Bhardwaj, 1957		o
<i>Leiotriletes sphaerotriangulus</i> (Loose) Potonié et Kremp, 1954	o	o
<i>Leiotriletes gulaferus</i> Potonié et Kremp, 1955	o	o
<i>Leiotriletes tumidus</i> Butterworth et Williams, 1958		o
<i>Leiotriletes</i> sp.	•	
<i>Punctatisporites minutus</i> Kosanke, 1950		o
<i>Punctatisporites punctatus</i> Ibrahim, 1932 (in Potonié, Ibrahim et Loose, 1932)		o
<i>Calamospora mutabilis</i> (Loose) Schopf, Wilson et Bentall, 1944		•
<i>Calamospora</i> sp.	o	o
<i>Granulatisporites minutus</i> Potonié et Kremp, 1955		o
<i>Granulatisporites granulatus</i> Ibrahim, 1933		o
<i>Verrucosisporites</i> sp.	o	o
<i>Cyclogranisporites</i> sp.		o
<i>Lophotriletes pseudaculeatus</i> Potonié et Kremp, 1955		o
<i>Lophotriletes</i> sp.	o	o
<i>Anapiculatisporites minor</i> (Butterworth et Williams) Smith et Butterworth, 1967	o	•
<i>Apiculatisporites</i> cf. <i>setulosus</i> (Kosanke) Potonié et Kremp, 1955		o
<i>Apiculatisporites</i> sp.	o	o
<i>Apiculatisporites spinulistratus</i> (Loose) Ibrahim, 1933		o
<i>Acanthotriletes</i> cf. <i>echinatus</i> (Knox) Potonié et Kremp, 1955	o	
<i>Acanthotriletes</i> sp.	o	
<i>Raistrickia</i> cf. <i>superba</i> (Ibrahim) Schopf, Wilson et Bentall, 1944		o
<i>Raistrickia major</i> Bhardwaj, 1957		o
<i>Raistrickia</i> sp.		o
<i>Convolutispora</i> sp.		o
<i>Microreticulatisporites</i> cf. <i>fistulosus</i> (Ibrahim) Knox, 1950		o
<i>Dictyotriletes densoreticulatus</i> Potonié et Kremp, 1955		•
<i>Dictyotriletes</i> cf. <i>falsus</i> Potonié et Kremp, 1955		o
<i>Dictyotriletes reticulocingulum</i> (Loose) Smith et Butterworth, 1967		o
<i>Dictyotriletes bireticulatus</i> (Ibrahim) Smith et Butterworth, 1967	o	
<i>Reticulatisporites alveolatus</i> Knox, 1950		o
<i>Triquitrites sculptilis</i> (Balme) Smith et Butterworth, 1967	o	
<i>Triquitrites</i> cf. <i>tricuspis</i> (Horst) Potonié et Kremp, 1956	o	
<i>Triquitrites</i> sp.	•	

TAXA	Locality	
	Br 1	Gl
<i>Tripartites vetustus</i> Schemel, 1950	o	
<i>Mooreisporites inusitatus</i> (Kosanke) Neves, 1961	o	o
<i>Reinschospora triangularis</i> (Kosanke) Ravn, 1979		o
<i>Savitrisporites concavus</i> Marshall and Smith, 1965		•
<i>Savitrisporites nux</i> (Butterworth et Williams) Smith et Butterworth, 1967		••
<i>Savitrisporites</i> sp.	•	o
<i>Crassispora kosankei</i> (Potonié et Kremp) Bharadwaj, 1957		o
<i>Crassispora</i> sp.	o	o
<i>Gorgonispora convoluta</i> (Butterworth et Spinner) Playford, 1976		•
<i>Densosporites</i> sp.	o	
cf. <i>Lycospora</i> sp.	o	
<i>Lundbladispota</i> cf. <i>gigantea</i> Alpern, 1959		•
<i>Alatisporites pustulatus</i> (Ibrahim) Ibrahim, 1933		o
<i>Cirratriradites</i> cf. <i>saturni</i> (Ibrahim) Schopf, Wilson et Bentall, 1944		o
<i>Cirratriradites</i> sp.	o	o
<i>Microspinosporites orbiculus</i> (Potonié et Kremp) Bek, 2013		o
<i>Spencerisporites</i> cf. <i>radiatus</i> (Ibrahim) Drábková, Bek et Opluštil, 2004	o	
<i>Endosporites zonalis</i> (Loose) Knox, 1950	•	o
<i>Endosporites globiformis</i> (Ibrahim) Schopf, Wilson et Bentall, 1944	o	
<i>Endosporites</i> cf. <i>zonalis</i> sp.	o	
<i>Laevigatosporites desmoinesensis</i> (Wilson et Coe) Schopf, Wilson et Bentall, 1944	o	•••
<i>Laevigatosporites medius</i> Kosanke, 1950		•
<i>Laevigatosporites minimus</i> (Wilson et Coe) Schopf, Wilson & Bentall, 1944		•
<i>Latosporites latus</i> (Kosanke) Potonié et Kremp, 1956		•
<i>Vestispora magna</i> (Butterworth et Williams) Smith et Butterworth, 1967		o
<i>Vestispora</i> sp.	o	•
<i>Florinites mediapudens</i> (Loose) Potonié et Kremp, 1956		o
<i>Florinites visendus</i> (Ibrahim) Schopf, Wilson et Bentall, 1944	o	
<i>Florinites</i> sp.	••	
<i>Wilsonites</i> sp.	••	
<i>Guthörlisporites volans</i> (Loose) Loboziak	o	
<i>Guthörlisporites</i> sp.	•	
<i>Potonieisporites</i> sp.	•	
<i>Pityosporites westphalensis</i> Williams, 1955	o	

Occurrence: ••• Abundant, •• Common, • Frequent, o Rare

#### Plate I.

1. Landscape near Brandov with heap near Br 3 locality (arrows). Heidersdorf village on the background.
2. View to the coal (anthracite) seam with a small fault (dashed line) (Br 1).
- 3.–4. Outcrop Br 1, where fossil flora has been collected.
5. Detail of the layer from Fig. 4 with many cordaitalean remains (Br 1).

Plate I.

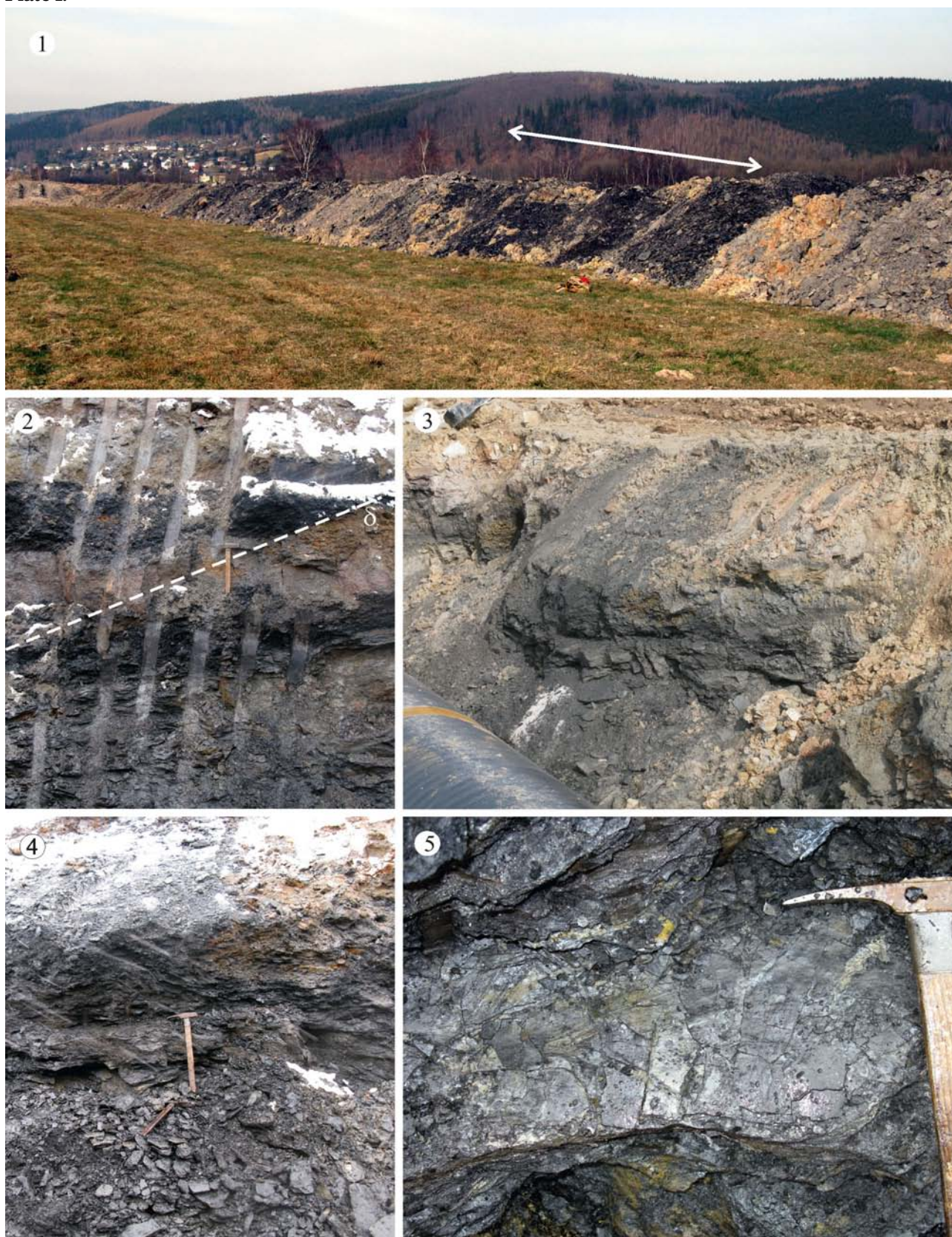




Plate II.

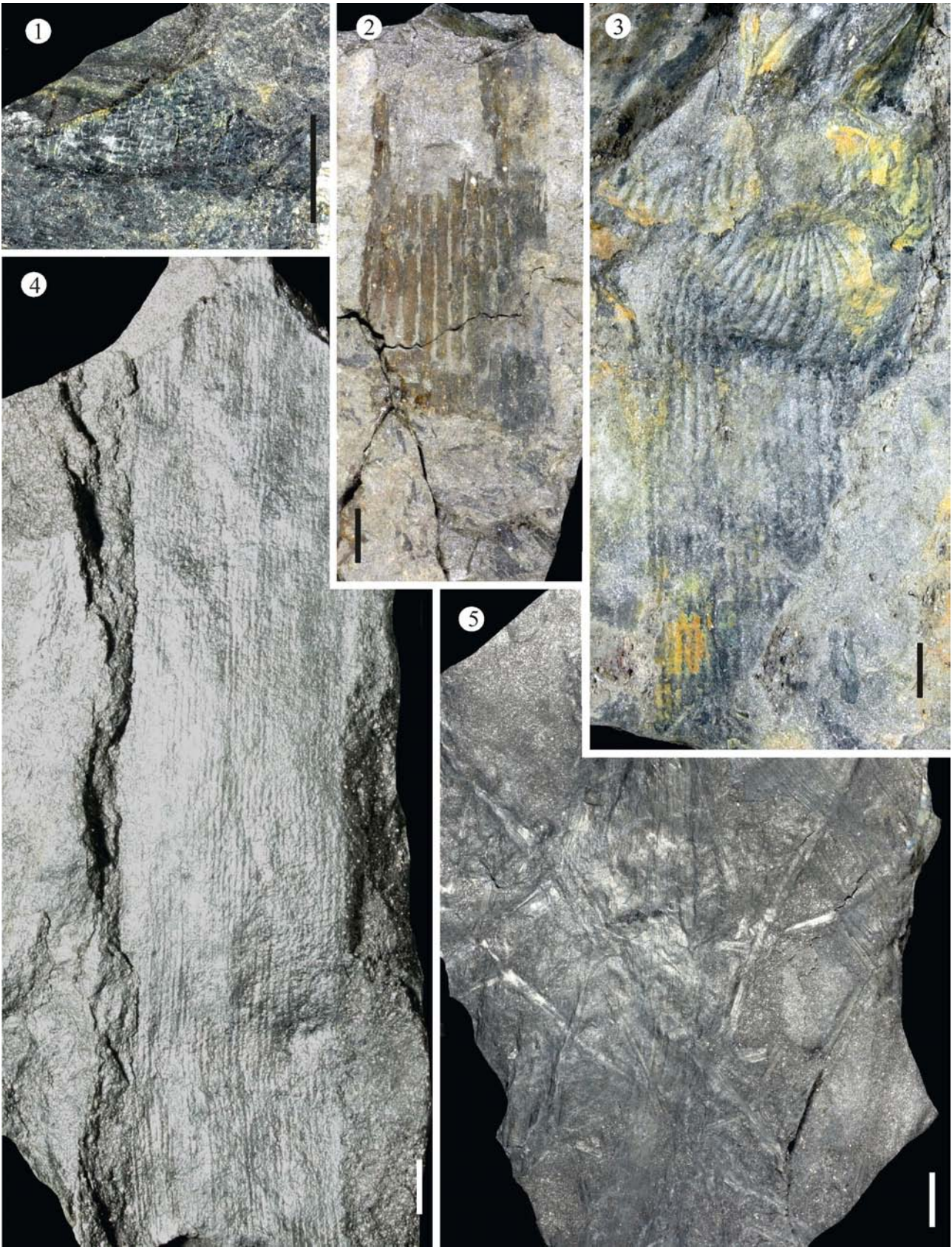




Plate III.

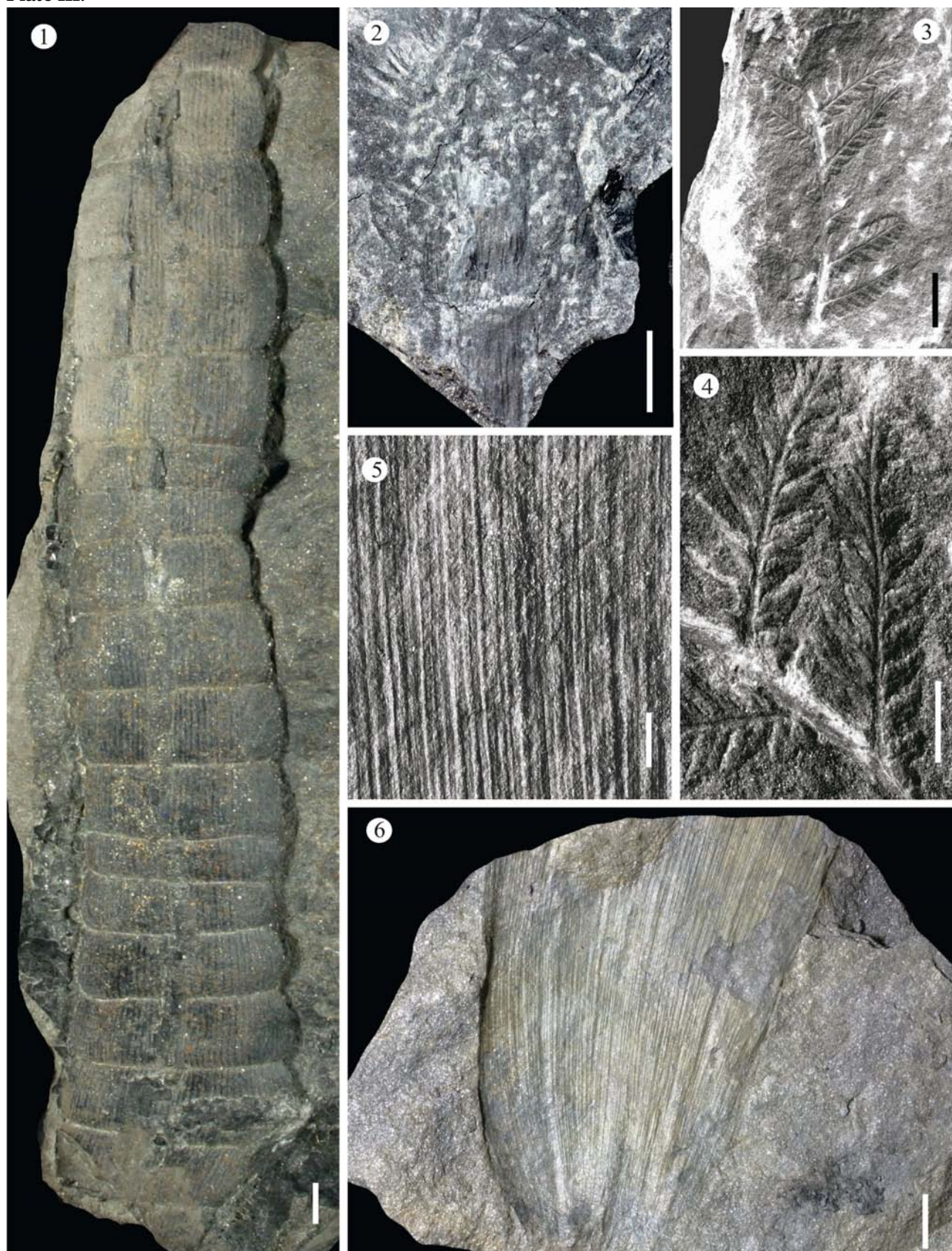




Plate IV.

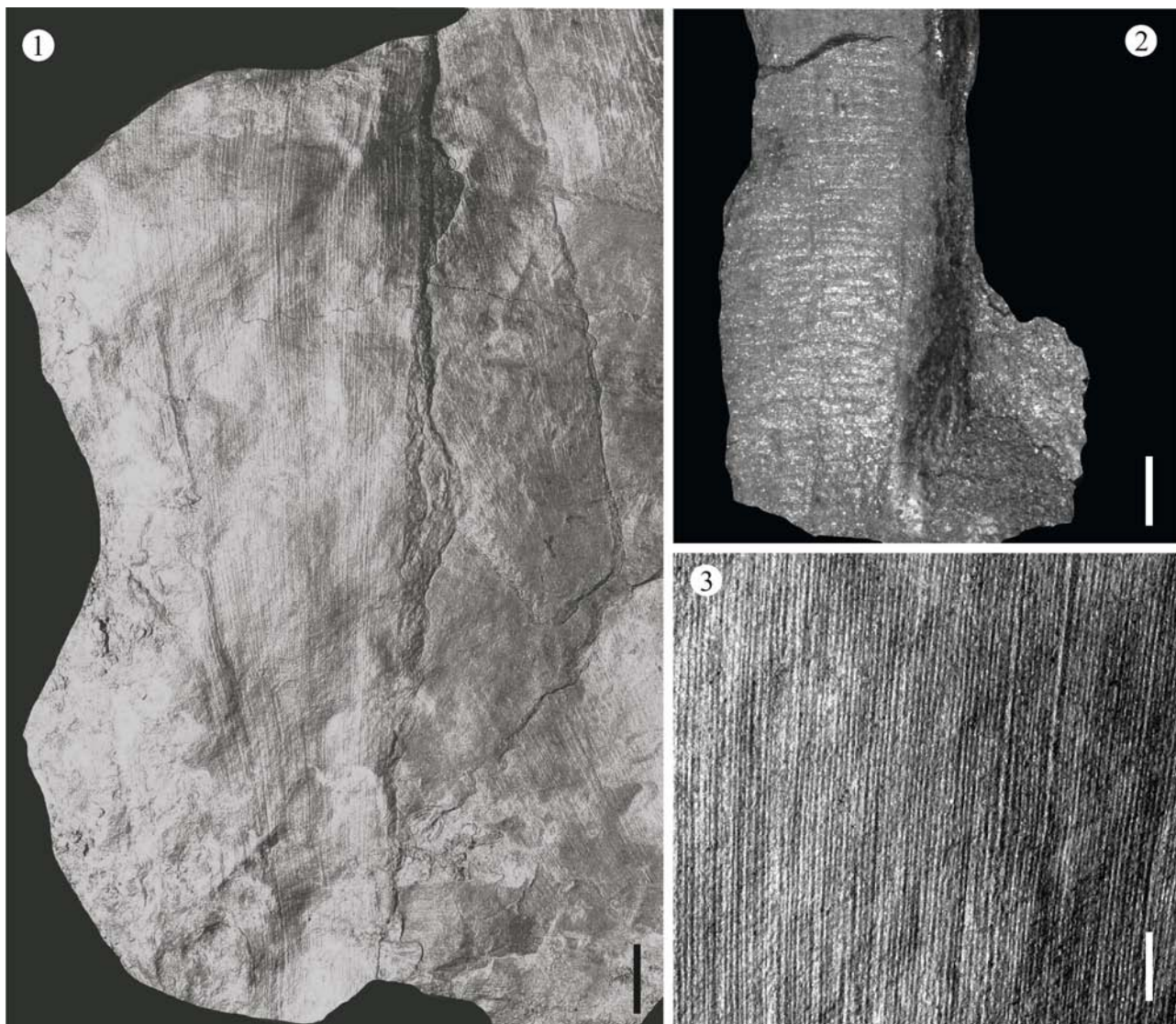


Plate IV.

1. *Cordaites* sp., Br 3. Coll. ZŠ 557, Scale bar = 1 cm.
2. *Artisia* cf. *approximata*, Br 1. Coll. ZŠ 558, Scale bar = 1 cm.
3. Detail of venation of *Cordaites* sp. Venation type *Cordaites palmaeformis*. Br 3. Scale bar = 2 mm.

Plate II. (page 13)

1. *Lepidostrobus* sp., loc. Br 1. Coll. ZŠ 551, scale bar = 1 cm.
2. *Calamites suckowii*, loc. Br 1. Coll. ZŠ 552, scale bar = 1 cm.
3. *Calamites carinatus*, loc. Br 1. Coll. ZŠ 392, scale bar = 1 cm.
4. *Calamites cistii*, loc. Br 3. Coll. ZŠ 393, scale bar = 1 cm.
5. *Cyperites* sp. loc. Br 3. Coll. ZŠ 553, scale bar = 1 cm.

Plate III. (page 13)

1. *Calamites schuetzeiformis*, loc. Brandov, dump of the "Glück auf" coal mine. Coll. ZŠ 394, scale bar = 1 cm.
2. *Asterophyllites* cf. *longifolius*, Br 1. Coll. ZŠ 554, Scale bar = 1 cm.
3. *Senftenbergia plumosa*. Br 3. Coll. ZŠ 555, Scale bar = 1 cm.
4. Detail of 2 ultimate pinnae of *Senftenbergia plumosa*. Br 3. Scale bar = 5 mm.
5. Detail of venation of *Cordaites* sp. Venation type *Cordaites principalis*. Br 2. Scale bar = 2 mm.
6. *Cordaites* sp., Br 2. Coll. ZŠ 556, scale bar = 1 cm.

Plate V.

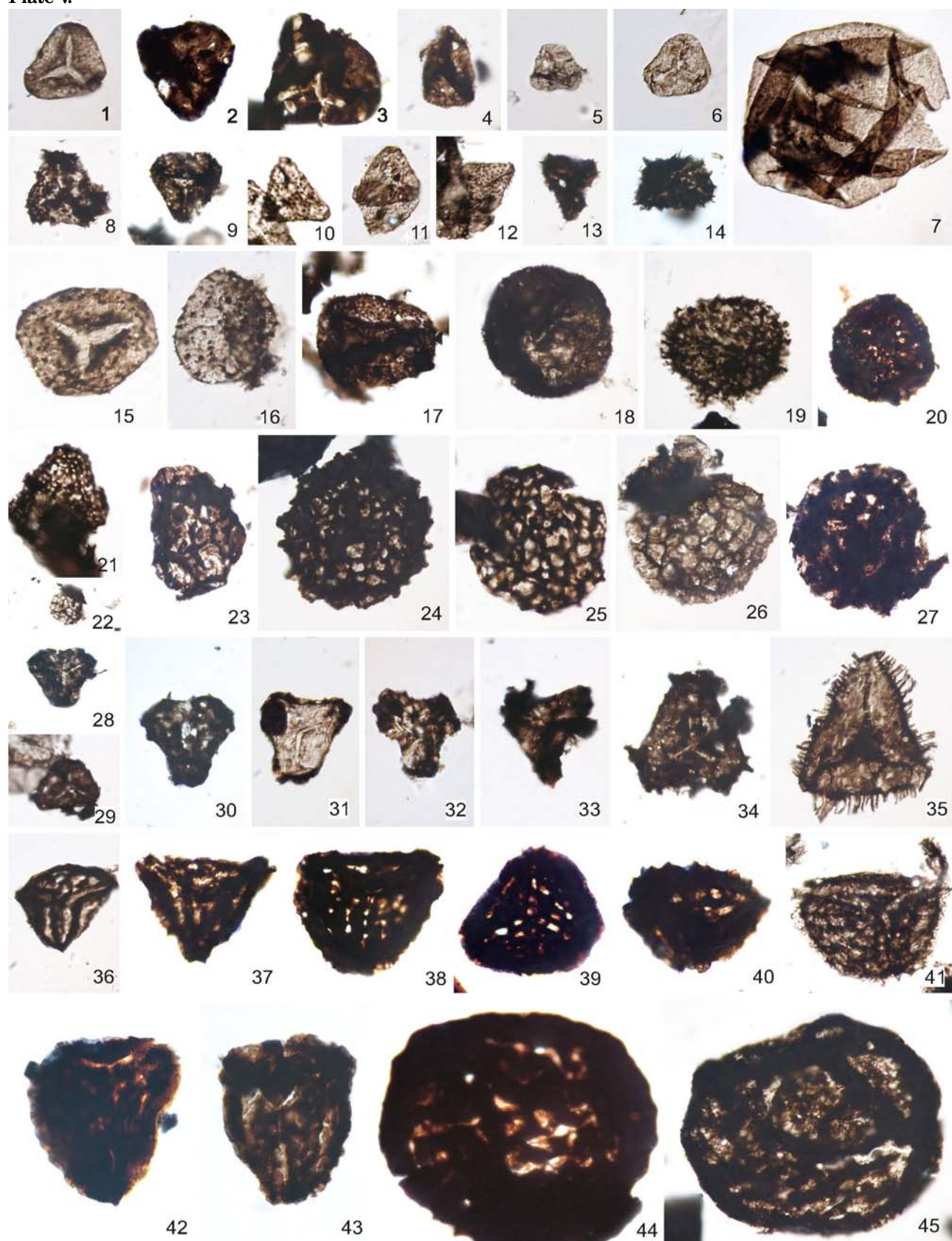
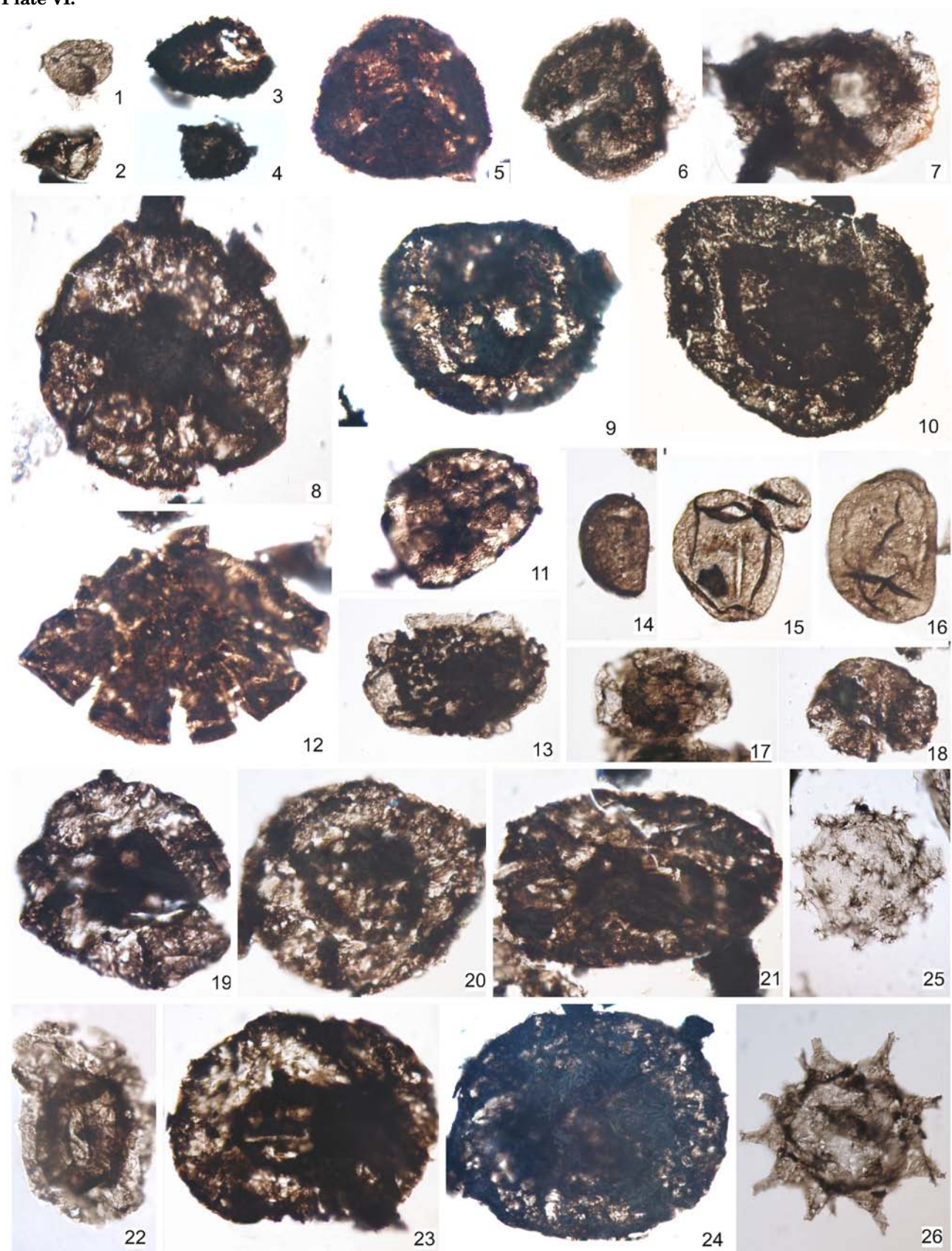




Plate VI.





**Plate V.** (page 15)

All figures of miospores are  $\times 500$  enlarged, unless stated else.

Brandov 1 locality (loc. Br 1), dump of the "Glück auf" mine (loc. Gl),

1. *Leiotriletes adnatoides*, loc. Brandov 1 (Br 1).
2. *Leiotriletes* cf. *convexus*, loc. Gl.
3. *Leiotriletes sphaerotriangulus*, loc. Gl.
4. *Leiotriletes tumidus*, loc. Br 1.
5. *Granulatisporites minutus*, loc. Gl.
6. *Granulatisporites granulatus*, loc. Gl.
7. *Calamospora mutabilis*, loc. Gl.
8. *Lophotriletes* sp., loc. Br 1.
9. *Lophotriletes* sp., loc. Br 1.
- 10.–12. *Anapiculatisporites minor*, loc. Gl.
13. *Acanthotriletes* sp., loc. Br 1.
14. *Acanthotriletes* cf. *echinatus*, loc. Br 1.
15. *Lophotriletes pseudaculeatus*, loc. Gl.
16. *Apiculatisporites* cf. *setulosus*, loc. Gl.
17. *Apiculatisporites* sp., loc. Br 1.
18. *Apiculatisporites spinulistratus*, loc. Gl.
19. *Raistrickia* cf. *superba*, loc. Gl.
20. *Convolutispora* sp., loc. Gl.
21. *Microreticulatisporites* cf. *fistulosus*, loc. Gl.
22. *Reticulatisporites alveolatus*, loc. Gl.
23. *Dictyotriletes bireticulatus*, loc. Br 1.
- 24.–25. *Dictyotriletes densoreticulatus*, loc. Gl.
26. *Dictyotriletes reticulocingulum*, loc. Gl.
27. *Dictyotriletes* sp., loc. Gl.
28. *Triquitrites sculptilis*, loc. Br 1.
29. *Triquitrites* sp., loc. Br 1.
30. *Triquitrites* cf. *sculptilis*, loc. Br 1.
31. *Triquitrites* cf. *tricuspis*, loc. Br 1.
32. *Tripartites vetustus*, loc. Br 1.
33. *Mooreisporites inusitatus*, loc. Br 1.
34. *Mooreisporites inusitatus*, loc. Gl.
35. *Reinschospora triangulata*, loc. Gl.
36. *Savitrissporites concavus*, loc. Gl.
37. *Savitrissporites* sp., loc. Gl.
38. *Savitrissporites nux*, loc. Gl.
39. *Savitrissporites nux*, loc. Gl.
40. *Savitrissporites* sp., loc. Gl.
41. *Savitrissporites* sp., loc. Gl.
- 42.–43. *Savitrissporites* sp., loc. Br 1.
44. *Gorgonispora convoluta*, loc. Gl, ?400.
45. *Gorgonispora convoluta*, loc. Gl, ?400.

**Plate VI.** (page 16)

All figures of miospores and acritarchs are  $\times 500$  enlarged, unless stated else.

Locality Brandov 1 (loc. Br 1), dump of the "Glück auf" mine (loc. Gl),

1. *Microspinosporites orbiculus*, loc. Gl.
2. *Lycospora*? sp., loc. Br 1.
- 3.–4. *Densosporites* sp., loc. Br 1.
5. *Lundbladispora* sp., loc. Gl.
6. *Crassispora* sp., loc. Gl.
7. *Cirratriradites* cf. *saturni*, loc. Gl.
8. *Endosporites globiformis*, loc. Br 1.
9. *Endosporites zonalis*, loc. Br 1.
10. *Spencerisporites* cf. *radiatus*, loc. Br 1. ?200.
11. *Endosporites* sp., loc. Br 1.
12. *Vestispora magna*, loc. Gl.
13. *Alatisporites pustulatus*, loc. Gl.
14. *Laevigatosporites medius*, loc. Gl.
15. *Laevigatosporites desmoinesensis* and *L. minimus*, loc. Gl.
16. *Laevigatosporites desmoinesensis*, loc. Gl.
17. *Florinites mediapudens*, loc. Gl.
18. *Pityosporites westphalensis*, loc. Br 1.
19. *Wilsonites* sp., loc. Br 1.
20. *Wilsonites* sp., loc. Br 1.
21. *Guthörlisporites volans*, loc. Br 1.
22. *Potonieisporites* sp., loc. Br 1.
23. *Potonieisporites* sp. loc. Br 1.
24. Monosaccate pollen grain,  $\times 400$
- 25.–26. *Acritarcha*, loc. Gl.

## PALYNOLOGY

The palynomorphs from the Brandov Basin are here reported on for the first time, 36 genera and 51 species of miospores are present. Miospore assemblage is poorly preserved. Spores are strongly degraded due to transport and are usually dark brown to brown-black due to coalification. Identified miospore taxa are given in the Table 2, and some are figured in Plates V and VI.

Brandov (Br 1) has the following pollen and spore assemblage. Monosaccate pollen *Florinites* and *Guthörlisporites* are abundant. *Potonieisporites* and bisaccate pollen grains *Pityosporites westphalensis* are present. However, most monosaccate pollen grains are indeterminate due to poor preservation. Spores are represented by, most to least common, *Leiotriletes*, *Savitrissporites* and *Endosporites*. Other more spars taxa are *Triquitrites*, *Laevigatosporites*, *Lycospora* and *Spencerisporites* among others. In some samples, pollen of cordaitaleans, pteridosperms and possibly conifers, dominate over fern spores. Spores produced by subarborescent lycopsids of the genera *Polysporia* and *Spencerites* are very rare.

The laevigate monolet spores *Laevigatosporites* (*L. desmoinesensis*, *L. medius* Kosanke, 1950) and *Latosporites* (*L. latus*) is dominate the dark grey mudstones ("Glück auf" mine). The common taxa in order of decreasing dominance in the sample are, spores of *Savitrissporites* (*S. nux*, *S. concavus* and *Savitrissporites* sp.) and *Dictyotriletes densoreticulatus*, *Anapiculatisporites minor*, *Vestispora magna*, *Calamospora*, *Apiculatisporites* and *Crasispora*. Those less common are *Gorgonispora*, *Lundbladispore*, *Cirratiradites* and *Microspinosporites*, *Florinites*.

The spore assemblage of the "Glück auf" mine is characterized by the dominance of spores of sphenophylls and subdominance of spores produced by ferns, calamitaleans, selaginellas and sigillarians. Spores other plant groups (e.g. *Flemingites*, *Cordaites*) are rare.

## STRATIGRAPHY

Němejc (1930) updated the floral lists found in Jokély (1857), Geinitz (1856) and Feistmantel, O. (1873), which were based on the collections housed in the museum in Chemnitz and the National Museum in Prague. Němejc (1930) ascertained that

most of the plant fossils came from the roof of the coal seam no. III in the Brandov coal measure. Šimůnek in Pešek *et al.* (2001) for the most part adopted Němejc's (1930) floral list.

Němejc (1930) regarded sigillarian, ferns and pteridosperms as stratigraphically important plants and compared the Brandov flora with the Central Bohemian flora and floras from the small basins in Saxony. Based on the presence of *Saccopteris angustissima* (later synonym *Alloiopteris angustissima*) (Sternberg) Potonié, *Sphenopteris stipulata* Gutbier et Geinitz, *Eusphenopteris nummularia* (Brongniart) Novik, *Pecopteris* (*Senftenbergia*) *pennaeformis* Brongniart and *Pecopteris miltonii* Artis, Němejc thought that the peat-forming sequence of the Brandov C.R. was Moscovian (Upper Westphalian) and compared it with the Radnice Member. This correlation was strongly influenced by the co-occurrence of *Saccopteris angustissima* and *Sphenopteris stipulata* in both regions. Němejc (1953) later re-evaluated this correlation strongly relying on the presence of *Sigillaria schlotheimiana* (Namurian B to Westphalian A) in the Brandov flora correlated it with the Langsettian (upper Westphalian A). Havlena (1964) preferred Němejc's (1930) original determination of the age of the Brandov C.R. – Duckmantian or Bolsovian (Westphalian B or C).

Most of the species from the Brandov C.R. show a stratigraphic range from Bashkirian (upper Namurian) to Moscovian (lower Bolsovian). For more reliable stratigraphy, *Sphenophyllum myriophyllum* Crépin (upper Duckmantian – lower Bolsovian) and *Annularia spinulosa* Sternberg (formerly *A. stellata* Schlotheim) (middle Bolsovian – Permian) could be important. Unfortunately the Němejc's (1930) specimens relied on for his determinations and correlations have not been adequately preserved. Němejc's (1930) published a list of 38 taxa from the Brandov C.R. Šimůnek in Pešek *et al.* (2001) mention only 30 species (not including taxa identified with "sp." or other decorated forms).

The fern *Senftenbergia plumosa* (Artis) Stur was found in the outcrop Br 3 and thus confirmed the presence of this species in the Brandov C.R. *Artisia* cf. *approximata* Lindley et Hutton from locality Br 1 is a newly identified taxon for this region. Another new species for the Brandov C.R. comes from the "Glück auf" mine dump in Brandov village

and was found by B. Mlčoch. It probably represents a pith cast of the sphenopsid *Calamites* cf. *schuetzeiformis* Kidston. Němejc (1930, pl. 4, fig. 10) figured a specimen, but was not secure in a more precise identification than *Calamites* sp.

The species *Dictyotriletes bireticulatus*, *D. densoreticulatus*, *D. reticulocingulum*, *Anapiculatisporites minor*, *Reinschospora*, *Mooreisporites inusitatus*, *Alatisporites pustulatus*, *Cirratriradites saturni*, *Endosporites zonalis*, *Savitrissporites nux*, *Savitrissporites concavus*, and *Vestispora magna* are stratigraphically significant taxa. These taxa can precisely correlated with assemblages of the Prkenný Důl-Žďárky Member from the Intrasedimentary Basin and the Radnice coal seams of the Central Bohemian Upper Palaeozoic. However, some taxa typically present in these units have not been identified in the Brandov Basin, most notably *Lycospora* sp., *Punctatisporites obesus*, *Reticulatisporites muricatus* and *Knoxisporites polygonalis*. Nevertheless, a latest Duckmantian or early Bolsovian for the Brandov C.R. is well supported.

## PALAEOECOLOGICAL EVALUATION

The most common plant remains in the study localities are cordaitalean leaves and calamitalean pith casts. Their position in the section could be studied only at locality Brandov 1 (Br 1), where trench walls were accessible for collecting. Sphenopsids – calamitaleans grew predominantly on river banks (Behrensmeyer *et al.*, 1992), but they apparently were tolerant to dynamic environmental conditions, they also grew in sandy deposits. It is not unusual in other location to find upright but in Brandov only short fallen stem fragments that suggest some transport were recovered. Sporadically, a cordaitalean stem with *Artisia*-type pith cast was found among calamitalean remains. In the lower part of the sandstone layer, indeterminate stems with smooth surfaces dominated – first fossiliferous layer.

The second fossiliferous layer (above the sandstone) is represented by grey and black claystones (Plate 1, Fig. 5). Only cordaitalean leaf accumulations were found here. The "assemblage" beneath the coal seam is difficult to evaluate, because different cordaitalean species grew on different substrates from dry, well drained, to wet, partly inundated (Behrensmeyer *et al.*, 1992). We do not know the ecological demands of these plants, but they

must have been transported a short distance (parautochthonous) because they are well preserved. Their fragmentary nature of the specimens is due to the friable claystone, they were more complete in the sediment but could not be recovered. Most probably these plants represent wet conditions, because they are preserved in fine clastic deposits immediately below the coal seam. Here conditions started to change from seasonal to ever wet, but cuticles are not preserved to prove our hypothesis.

The differences among palynological assemblages of the localities evidently reveal palaeoecologic and taphonomic biases. In contrast to miospore assemblages of the Radnice and Prkenný Důl-Žďárky members, the Brandov assemblages are impoverished for many taxa. The most important difference is the absence of the spore *Lycospora* in the Brandov C.R.

## DISCUSSION

The slight metamorphism is manifested only on coal and claystones. The coal is coalified to anthracite stage. It is evident that coal is not appropriate for cuticular and palynological studies according to the following characteristics:  $R_r = 3.8\text{--}4.3\%$  and  $V_{daf} = 3.8\%$  (Sýkorová in Pešek *et al.*, 2001). The palynomorphs were obtained from claystones and mudstones exhibiting little if any metamorphism. The poor preservation of palynomorphs is due to combination of high coalification, which caused changes during the fossilisation process; and primarily, because palynomorphs are transported to the site of deposits from different habitats, often after long water transport. They are corroded and differently destroyed before sedimentation and fossilization. It is not surprising that the obtained spore assemblages are poor in comparison with assemblages from Radnice and Prkenný Důl-Žďárky members (Kladno-Rakovník and Intrasedimentary basins). The important thing is that palynomorphs from the Brandov localities were obtained only from mudstones and claystones, whereas those from Kladno-Rakovník and Intrasedimentary basins they are predominantly from coal.

The fossilized leaf fragments of cordaitaleans found on claystones are bright and cuticles are not preserved. The upper unit is a red bed and similarly to the rhyolitic tuff are unfossiliferous.

## CONCLUSION

The crystalline basement belongs to Sayda Dome and not to Hora Svaté Kateřiny (Katharinaberg) Dome as formerly interpreted. An older Carboniferous unit [Moscovian, (Bolsovian)] is present in the "Northern depth" of the basin, including an anthracite coal seam previously unknown. The areal extent of the younger Carboniferous unit (Stephanian – Kasimovian or Gzhelian) is significantly less than previously mapped (see Figure 1). The Quaternary is represented by colluvial and fluvial deposits, and the Holocene grey clayey layer is palynologically dated as 500 – 100 years old.

During the construction of gas-pipeline "Gazela" near Brandov a heretofore unknown flora was discovered in the "Northern depth". However, it is not diverse nor well preserved. It differs from the "ordinary" assemblage collected during the mining activity in the "Southern depth" of the Brandov C.R. (Němejc, 1930). The assemblages from the "Northern depth" contain many cordaitalean and calamitalean remains, whereas assemblages studied by Němejc (1930) are typically dominated by lycopsids, namely *Sigillaria* that are considered peat-forming plants. This difference could maybe explained by the fact that the newly studied assemblage is from the edge of the basin as well as from strata below the coal seam, whereas the assemblage studied by Němejc (1930) comes from the centre of the basin and therefore different palaeoecologic and sedimentologic conditions.

The species formerly unknown from the Brandov C.R. include: *Artisia* cf. *approximata* Lindley et Hutton, and *Calamites schuetzeiformis* Kidston. *Senftenbergia plumosa* was newly discovered during the gas-pipeline construction.

Palynomorphs are identified from the Brandov Basin for the first time. Pollen grains of cordaitaleans, pteridosperms and possibly conifers prevail over fern spores in the pipeline excavation, whereas, sphenophyll spores dominate in the samples from the "Glück auf" mine dump; spores produced by ferns, calamitaleans and sigillarians are subordinate.

## ACKNOWLEDGMENTS

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