SBORNÍK NÁRODNÍHO MUZEA V PRAZE
Řada B – Přírodní vědy • sv. 63 • 2007 • čís. 2–4 • s. 195–205

ACTA MUSEI NATIONALIS PRAGAE
Series B – Historia Naturalis • vol. 63 • 2007 • no. 2–4 • pp. 195–205

SILICEOUS MICROFOSSILS FROM THE OLIGOCENE TRIPOLI-DEPOSIT OF SEIFHENNERSDORF

WOLFGANG SCHILLER
Institut für Geowissenschaften (IfG), Johann Wolfgang Goethe-Universität, Altenhöferallee 1, D-60438 Frankfurt am Main; Germany

Schiller, W. (2007): Siliceous microfossils from the Oligocene tripoli-deposit of Seifhennersdorf – Acta Mus. Nat. Pragae, Ser. B, Hist. Nat. 63(2–4): 195–205, Praha. ISSN 0036-5343.

Abstract: The limnic tripoli-deposit of Seifhennersdorf is of large interest concerning Northern Bohemian Paleogene sediments and their stratigraphic correlation. During two periods of underground mining in the last two centuries the deposit has been explored and at least five seams of organic rich sediments like brown coal and bituminous tripoli have been detected. Siliceous microfossils of which diatoms and cysts of chrysophytes are dominant had formed massive beds with thickness of several decimetres up to some metres. These tripoli-sediments show strong effects of diagenesis, especially compaction. The originally deposited kieselgur-sediments have been transformed by geological processes to a kind of polishing slate, called tripoli. The compaction and compression of these diatom-bearing sediments caused the shattering and shearing of its components and impedes scientific investigations of the siliceous microfossils and their taxonomic classification. With the help of SEM-techniques it is possible to study bedding-planes of sample material, where fragments of microfossils could be determined. The siliceous microfossil association shows similarity to the deposit of Varnsdorf. The absence of the pennate diatom *Gomphopleura nobilis* Reichelt ex Tempère 1894, a characteristical leading fossil for Upper Oligocene to Lower Miocene sediments in Northern Bohemia might give evidence that the deposit of Seifhennersdorf is of Lower Oligocene age.

■ Tripoli, limnic siliceous microfossils, Oligocene, underground mining

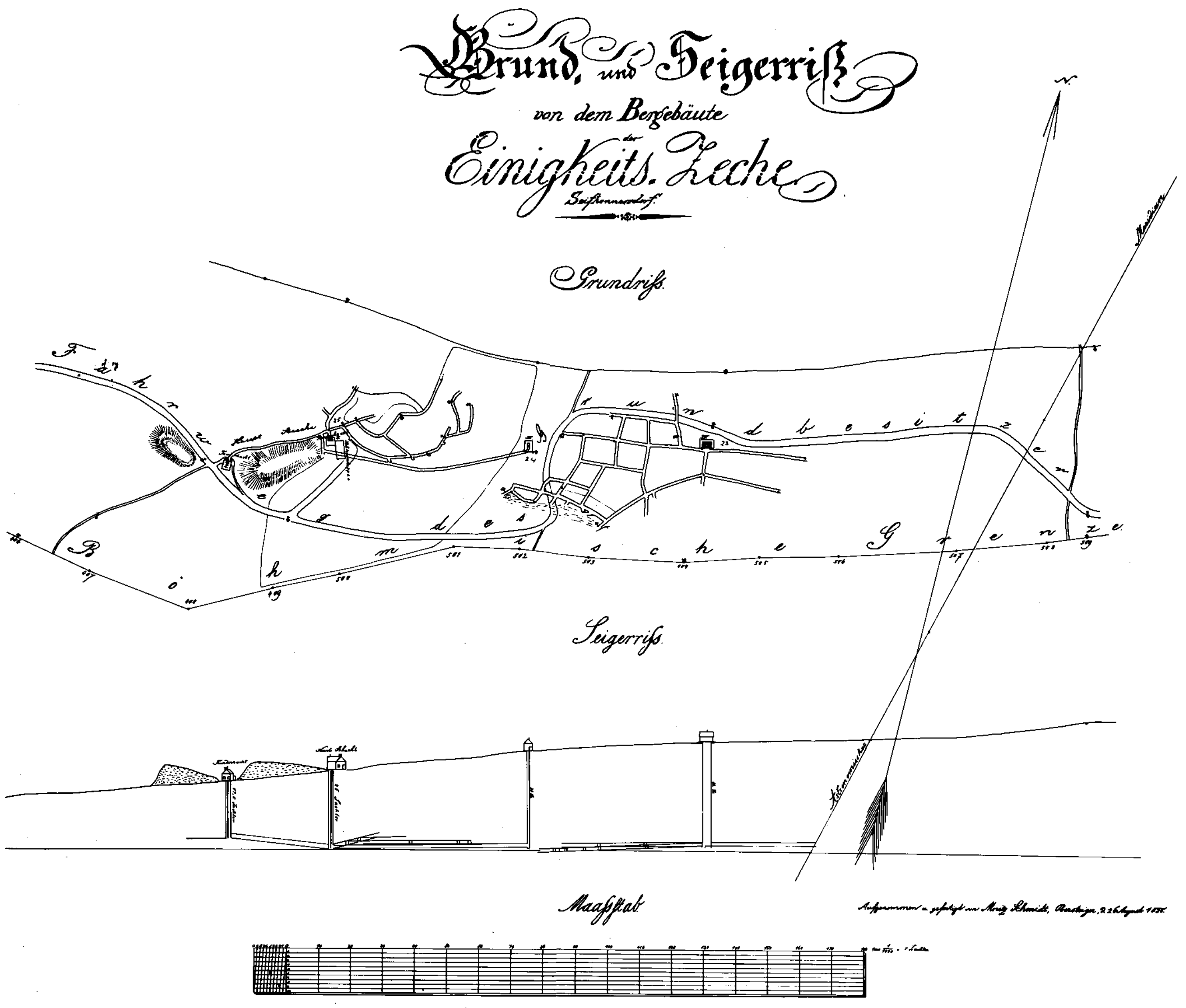
Received March 26, 2007
Issued December 2007

Introduction

During the 19th century in the southern Oberlausitz, in the frontier area of Germany and the Czech Republic, several tripoli-deposits were discovered and exploited in small underground mining pits. The tripoli-localities of Seifhennersdorf (Germany) and Varnsdorf (Czech Republic) are separated by the state frontier but their formation seemed to be similar or even coherent. Further tripoli-deposits e.g. the locality of “Breiter Busch near Hainspach” (Lipová), Czech Republic, gave evidence of a wider distribution of diatom-bearing sediments of Oligocene age but they were not mined (Herrmann 1893). On the German territory the mining pit “Einigkeits-Zeche” of Seifhennersdorf was working from 1837 until 1901 and a detailed mining-map was handed down (see text-fig. 1). From 1951 until 1956 the mining pit was opened for a second period under the name of “VEB Polierschiefergrube Freundschaft” and tripoli was mined to produce “Polisit”, an initial material similar to kieselgur for industrial purpose (Walther 1988). Siliceous microfossils from the tripoli-deposit of Varnsdorf were described by Taránek (1881) for the first time. Another short note about the Oligocene diatom flora of Seifhennersdorf in comparison with the finds from the locality of “Breiter Busch near Hainspach” in Bohemia and the Quaternary diatomite of Kleinsaubernitz were given by Herrmann and Reichelt (1895). In 1956, Sallum presented his unpublished diploma study about microfossils of the tripoli of Seifhennersdorf. Since then no modern study dealing with the Oligocene diatom concerning the deposit of Seifhennersdorf directly has been released. At last in 1999 Reichardt gave a short overview of several gomphonemoidal diatoms of Oligocene tripoli-deposits of Northern Bohemia.

Geological setting

In search for combustible rocks like brown-coal, dysodile and bituminous sediments the tripoli-deposits of Seifhennersdorf and Varnsdorf were detected. The mining on brown-coal in wider sense was the cause for geological examination of these deposits (see Hazard 1895). Whereas in the 19th century the exploitation of bituminous sediments was the principal aim to generate energy and the mining was carried out randomly, additionally in the 20th century the deposit was prospected for scientific purpose. A detailed sketch profile (see Walther and Kvaček, this volume p. 88) is the contribution of Ahrens (1957), who enforced a geological subsurface mapping of the different seams exposed in the mining galleries. Ahrens (1957) depicted a succession of 5 seams of laminated tripoli separated by volcanic tuff and mudstone. Unfortunately, mining was given up before the deposit could have been investigated in detail and the seams could be examined petrologically.



Text-fig. 1. Redrawn mining-map of the "Einigkeits-Zeche" of Seifhennersdorf from 1850.

The tripoli-deposit of Seifhennersdorf/Varnsdorf is superpositioned on deeply weathered Lausitzer Granodiorite. The kaolinization of the feldspar minerals in that crystalline basement rocks is an indication of terrestrial weathering depending on (para-)tropical climate and might have started in the Palaeogene or even Cretaceous. In the Oligocene (presumably Early Oligocene) volcanic activity began by producing pyroclastic material. Ahrens (1957) described the transition-zone as "(volcanic) tuff with clastic material from the bottom" overlain by "granitic arkose" which itself is overlain by "a fine-grained clayish tuff with tripoli-streaks". Furthermore Ahrens (1957: 6) made a reference to a core-drill (Seifhennersdorf 1/54, later cited in Pietzsch 1962: 470), where basalt was found as the underlying stratum of the (oldest) tripoli-seam. Altogether 5 seams of tripoli could be distinguished, but the already mentioned tripoli-streaks might give evidence of assorted tripoli-sediments of even older formation. The nature of deposition is not yet clarified. The hints given by mining speak for a Palaeogene paleorelief where weathering of feldspar and argillaceous alteration of volcanic tuff material formed impervious layers on the ground of depressions in the landscape. These hollows were likely to be created because of tectonic activity e.g. trench faults. The direction of dip is south-east with angles of 5 to 20 degrees. Because of its easy disintegration the tripoli does not crop out at the landscape surface. Therefore, the geological mapping of the whole deposit will be dependent on geophysical investigations or several core drills in future.

Material and methods

Samples of tripoli containing remains of higher plants and animals were collected by the staff of the local museum of Seifhennersdorf and the "Staatliches Museum für Mineralogie und Geologie zu Dresden". For the most part Prof. H. Walther collected these samples himself at the waste heaps of the tripoli-pit at Seifhennersdorf during the last decades and assigned the samples of tripoli to the sequence of the five known seams. Selected samples from the museums have been available for microscopical examination for this study. The numbers of the following samples represent catalogue markings and no chronological or stratigraphical order.

1.	Sf	18	seam 5: tripoli, yellowish-grey
2.	Sf	28	seam 4: tripoli, yellowish-grey
3.	Sf	33	seam 4 basis: mudstone/tripoli, greyish
4.	Sf	47	seam 4: assorted mudstone/tripoli, greyish
5.	Sf	241	seam 4 roof: tuff-horizon with tripoli, yellowish-grey
6.	Sf	365	seam 4: tripoli, yellowish-grey
7.	Sf	367	seam 4 floor: tripoli, greyish
8.	Sf	380	seam 4: tripoli/mudstone, greyish-brown
9.	Sf	381	seam 5: tripoli, yellowish-grey
10.	Sf	429	seam 5: obscure bedding tripoli, yellowish-grey
11.	Sf	473	seam 5: tripoli, yellowish-grey
12.	Sf	562:2	seam 4 roof: tripoli, yellowish-grey
13.	Sf	588	seam 4 interbedding: obscure bedding tuffite, greyish
14.	Sf	669	seam 5 roof: tripoli, yellowish-grey
15.	Sf	732	seam 5: tripoli, yellowish-grey
16.	Sf	754	seam 4 floor: tripoli, ochre-yellowish
17.	Sf	756	seam 4: obscure bedding tuffite, greyish
18.	Sf	832	seam 4: tripoli with lentil of mudstone, yellowish-grey
19.	Sf	1582	seam 5: roof: tripoli, yellowish-grey
20.	Sf	1646	? seam 4: tripoli/mudstone, greyish
21.	Sf	1649	presumable interbedding of seam 4 and seam 5: unbedded tuff/mudstone (?assorted)
22.	Sf	1938	presumable interbedding of seam 4 and seam 5: unbedded tuff/mudstone (?assorted)
23.	Sf	2031	seam 5 roof: tripoli, yellowish-grey
24.	Sf	2585	? seam 4 roof: unbedded tuff, greyish
25.	Sf	3736	seam 4: tripoli/mudstone, greyish
26.	Sf	4042	? seam 4: assorted mudstone (material from waste heaps)
27.	Sf	7605	(no details) old collection, coll. Engelhardt: tripoli yellowish-grey with plant remains
28.	Sf	7733	(no details) collection MMG (Schmidt): tripoli, yellowish-grey
29.	Sf	7734	(no details) collection MMG (Schmidt): tripoli, yellowish-grey
30.	Sf	7741	(no details): tripoli/mudstone, brownish-grey, laminated
31.	Sf	7745	seam 1: tripoli, dark-greyish
32.	Sf	7751	seam 5: subaquatic slide, tripoli, brownish-grey, laminated, folded
33.	Sf	7813	(no details): tripoli, brownish-grey, finely laminated
34.	Sf	7851	seam 1 roof: tripoli, brownish-grey, finely laminated
35.	Sf	7855	seam 5 floor: tripoli, brownish-grey, finely laminated (coll. Prof. Walther 1956)
36.	Sf	YYY	seam 5 roof: subaquatic slide, tripoli/mudstone, light reddish-brownish
37.	Sf	##	seam 1 roof: brown-coal, dark brownish, glossy
38.	Sf	ZZZ	seam 1: bedded brown-coal, black-brownish, glossy
39.	Sf	XXX	seam 1: "pyroshale", splintery, dark brownish with light streaks
40.	Sf	#	seam 1: brown-coal, black-brownish, glossy
41.	Sf	Polisit	(no details): material from the waste heaps
42.	Sf	(no number)	collection MMG (Prof. Walther) seam 1 roof: bituminous laminated sediment, black-brownish with light streaks
43.	Vd	28	(no details) collection MMG (H. Andert): tripoli from Varnsdorf (reference sample)

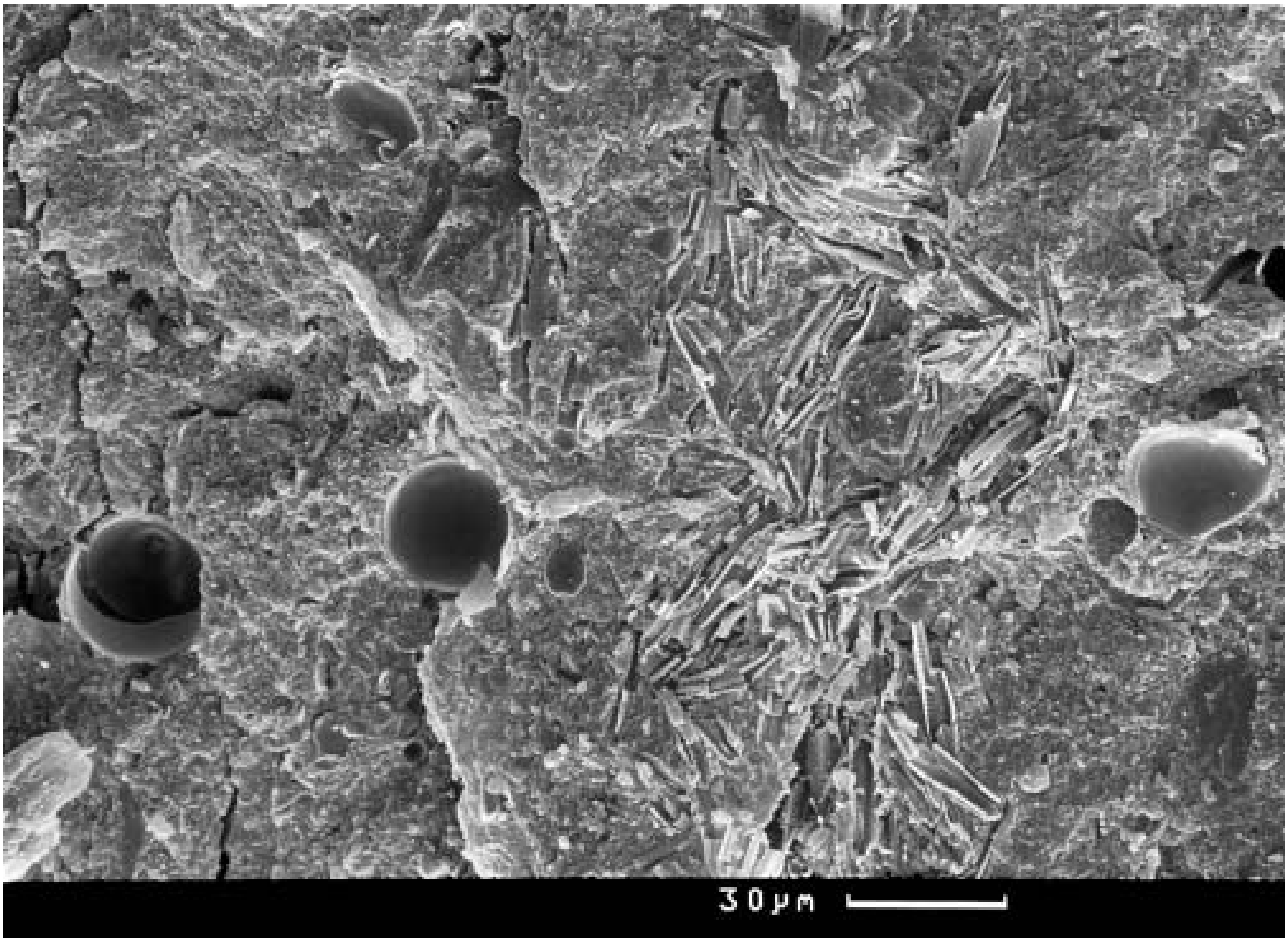
All samples were prepared for SEM-observation. No acceptable results have been obtained by using techniques of light microsopy because the most part of the diatom valves were cracked by diagenesis of the tripoli-sediments. Therefore, the non-manipulated sediment samples were carefully split parallel to its lamination, trimmed for the size of standard specimen holders, glued and coated with gold. This method of preparation facilitates that cracked diatom valves were not ripped apart by imbedding elutriated sample-material. The observation of split bedding-sheets of that kind of tripoli-sediments by means of SEM-techniques reflects furthermore the state of sedimentation for a certain situation: microfossils and detritus components laying close together on a bedding-sheet have been deposited almost synchronized (depending on the specific sinking velocity in the water column of the lake). This easy use of preparation allows also a statement of the association of the preserved microfossils.

Description of the tripoli-seams by analysing selected and characteristic SEM-samples

(Not mentioned samples represent layers of tripoli of almost shattered and disarranged siliceous microfossils)

Seam 1 roof (see text-fig. 2):

Sample Sf (no number) seam 1 roof is composed of a variety of cysts of chrysophytes, conspicuously lying not closely together, embedded in a bituminous and clayish matrix. The cysts could not easily be determined because most of them cracked when splitting the sample for SEM preparation. A huge type of spherical chrysophycean-cyst is remarkable for its outstanding diameter of 25–32 µm. Broken cysts show thin-walled shells with smooth insides and densely spined outer surfaces. The porus is simple obconical. In addition there are several types of small-sized spherical and oval smooth cysts. The mass production of chrysophycean-cysts indicates decreasing living conditions presumably by alluviation or dehumidification of the limnic habitat. The amount of spicules of freshwater sponges is increasing, while the diatom population is decaying. The pennate diatom *Gomphonema bohemicum* Reichelt et Fricke 1902 is concentrated in nest-like accumulations.



Text-fig. 2. Cracked chrysophycean-cysts and nest-like accumulation of the pennate diatom *Gomphonema bohemicum* REICHELT et FRICKE 1902 embedded in a bituminous and clayish matrix, SEM-photograph, sample Sf (no number), seam 1 roof.

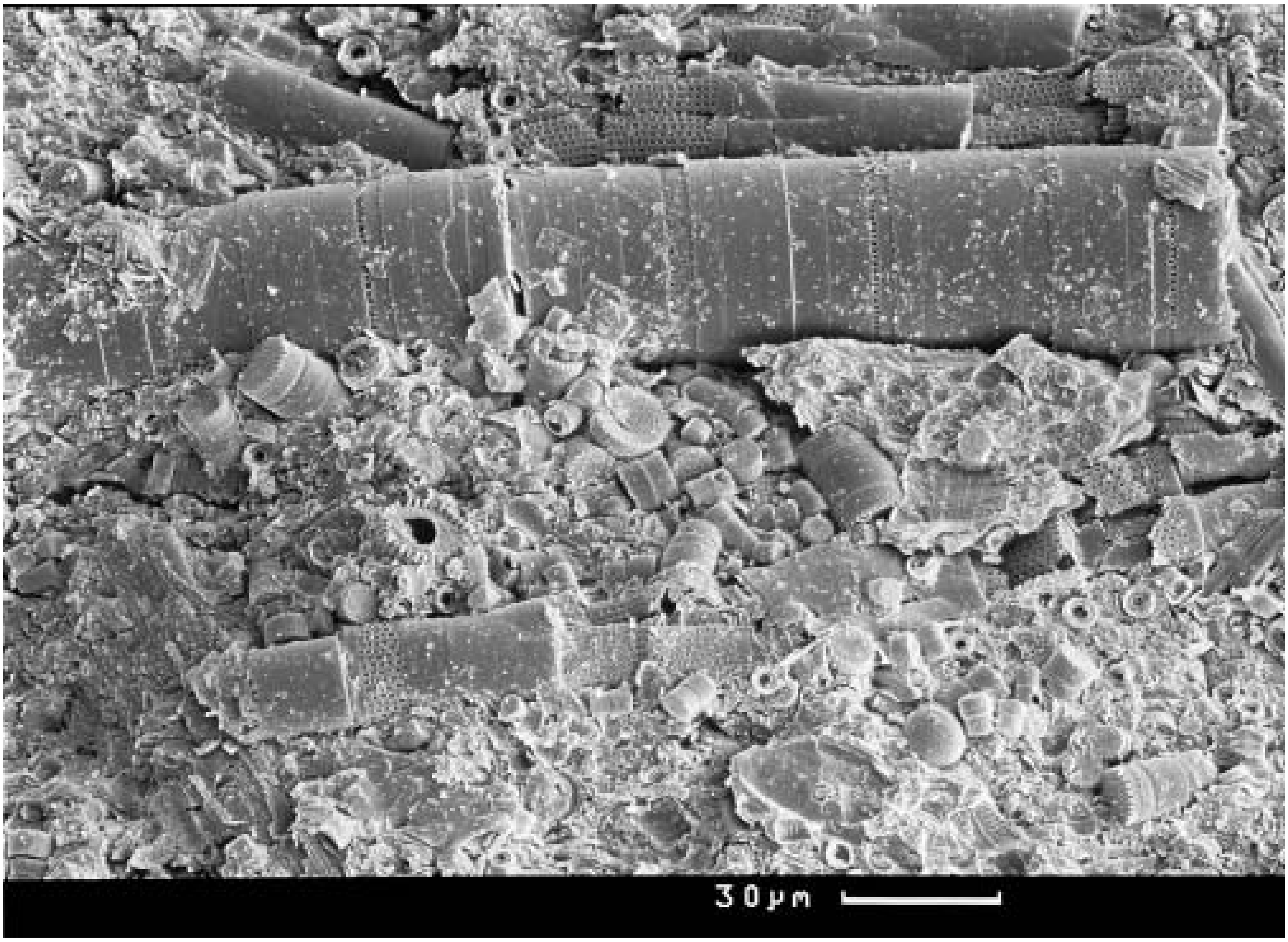
Seam 1 (see text-fig. 3):

Sample Sf ZZZ (bedded brown-coal) is laminated brownish sediment consisting of a bituminous matrix of optical indeterminable clay minerals and many volcanic minerals of idiomorphic and subhedral shape. These minerals (presumably pyroxene) reach a size of about 500 µm. The thin intercalated layers of tripoli are mainly composed of valves of diatoms. The centric diatom *Ellerbeckia arenaria* (MOORE) CRAWFORD 1988 is remarkable because of its large size of colony-formation. Details of broken frustules show extraordinary thick-walled shells, which might indicate a silting up water-habitat of high electrolyte concentration. The planktonic diatoms *Aulacoseira distans* (EHRENBERG) SIMONSEN 1979 and *Aulacoseira* cf. *crenulata* (EHRENBERG) THWAITES 1848 are common, even very frequent in that sample. Pennate diatoms are represented by small-sized isolated valves of *Fragilaria construens* (EHRENBERG) GRUNOW 1862. Characteristic benthonic genera of diatoms are absent in sample Sf ZZZ. The diatom valves are well preserved, showing little signs of diagenetic dissolution. The vela of the areolae are visible and excellently maintained, speaking for none or very little transformation of the opaline siliceous substance of the diatoms. On the other hand, spicules of freshwater sponges are strongly corroded showing spot-like channels of dissolution. Similar marks are known from Tertiary siliceous sponge spicules from Messel (Martini and Rietschel 1978), Enspel (Schiller 2000) and many other localities. Sample Sf ZZZ provides a few isolated gemmoscleres which could be identified to belong to the genus *Ephydatia* LAMOUROUX 1816.

Deplorably no sample material has been available which could be assigned to seam 2 and seam 3. These two seams were unimportant for mining activities because of their slight thickness.

Seam 4 roof:

Sample Sf 562 is characterized by compacted and cracked frustules of diatoms. Almost any valve is crumbled, even small and thick-walled thecae of diatoms. *Melosira undulata* (EHRENBERG) KÜTZING 1844 and *Ellerbeckia arenaria* (MOORE) CRAWFORD 1988 could be easily identified because of their size, their shape and remarkable colonies. The smaller centric diatom *Aulacoseira distans* (EHRENBERG) SIMONSEN 1979 is very common and also forming colony-chains but these cells are normally separated and distributed in the sediment. *Aulacoseira distans* (EHRENBERG) SIMONSEN 1979 seems to form several groups (morphotypes), which could be distinguished by their ratio of diameter to height. Isolated valves of different sized auxospores of *Aulacoseira* are also common, but do not allow classifying the exact species. *Tetracyclus ellipticus* (EHREN-

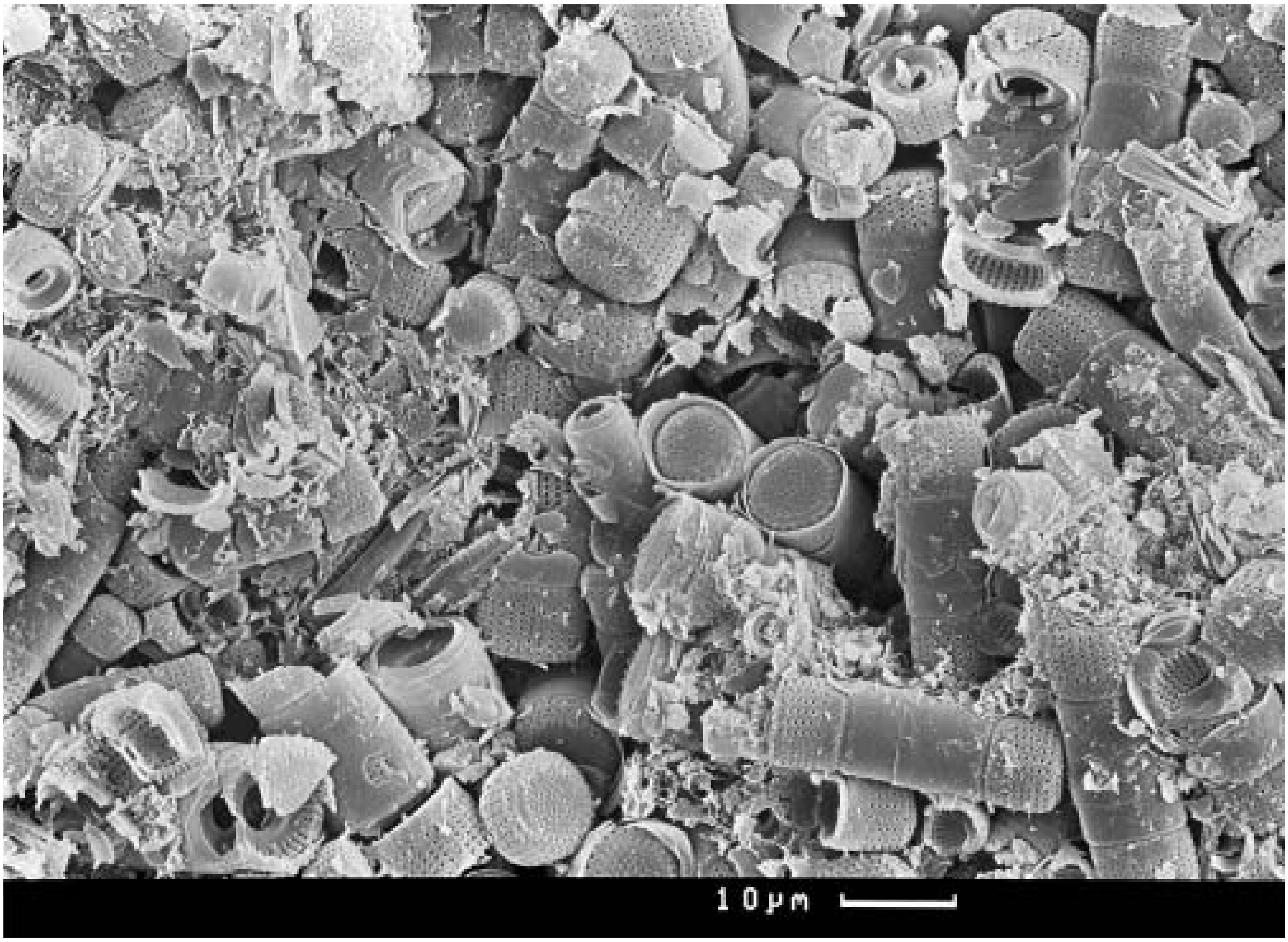


Text-fig. 3. Long colony-chain of the centric diatom *Ellerbeckia arenaria* (MOORE) CRAWFORD 1988 and scattered valves of *Aulacoseira distans* (EHRENBERG) SIMONSEN 1979 and *Aulacoseira* cf. *crenulata* (EHRENBERG) THWAITES 1848, SEM-photograph, sample Sf ZZZ, seam 1.

BERG) GRUNOW 1862 is the dominant pennate diatom, as well as the inconspicuous *Achnanthes delicatula* (KÜTZING) GRUNOW 1880.

Seam 4 (see text-figs 4, 5):

Seam 4 is the main-seam of the tripoli deposit of Seifhennersdorf because of its thickness and variability of diatom species and further siliceous microfossils. Sample Sf 365 shows a clayish matrix with finely crumbled valves of diatoms. *Aulacoseira granulata* (EHRENBERG) SIMONSEN 1979 is very common, in places forming nearly pure laminae and producing several morphotypes. Corresponding auxospores could not be recognized. The chain-colonies of *A. granulata* (EHRENBERG) SIMONSEN 1979 fell mostly apart, presumably during sedimentation through the water column. An alignment of the valves in the sediment is frequent which could be interpreted as a hint of a smooth current. Most of the valves of *A. granulata* (EHRENBERG) SIMONSEN 1979 were cracked and strongly corroded. The part of *Aulacoseira distans* (EHRENBERG) SIMONSEN 1979 is also important and amassments of that small-sized planktonic diatom (with several morphotypes) are common. On the other hand, *Ellerbeckia arenaria* (MOORE) CRAWFORD 1988 could be proved easily. Even the thick-walled valves of *E. arenaria* (MOORE) CRAWFORD 1988 are strongly corroded at their outer surfaces, while the inner surfaces of split frustules are preserved well. These indications speak for diagenesis caused by compaction of the sediment and not for migration of aqueous solutions after embedding. Rare valves of *Melosira undulata* (EHRENBERG) KÜTZING 1844 show the same traces of diagenesis. In places, *Eunotia* cf. *pectinalis* (KÜTZING) RABENHORST 1864 is very common and forms short colony-chains. Unfortunately, these valves were corroded very strongly so the classification is not quite clear. *Tetracyclus ellipticus* (EHRENBERG) GRUNOW 1862 could be found easily whereas its shape and size shows a huge variability. Small sized valves of *Fragilaria* sp., *Achnanthes* cf. *conspicua* A. MAYER 1919 and *Achnanthes delicatula* (KÜTZING) GRUNOW 1880 of different state of preservation could be identified by higher magnification with the SEM. Large valves of scattered deposited *Pinnularia* sp. are cracked into small fragments, which do not allow the determination of the species. Siliceous cysts of Chrysophytes are very common in that sample but do not form laminae or nest-like accumulations. The cysts are small sized with diameters of 3 to 6 µm and their surfaces are smooth and also short-spiny. Megascleres of freshwater sponges are very rare. Their size is up to 100 µm and their surface is coarsely spiny.



Text-fig. 4. Amassment of *Aulacoseira distans* (EHRENBERG) SIMONSEN 1979, SEM-photograph, sample Sf 1646, ?seam 4.

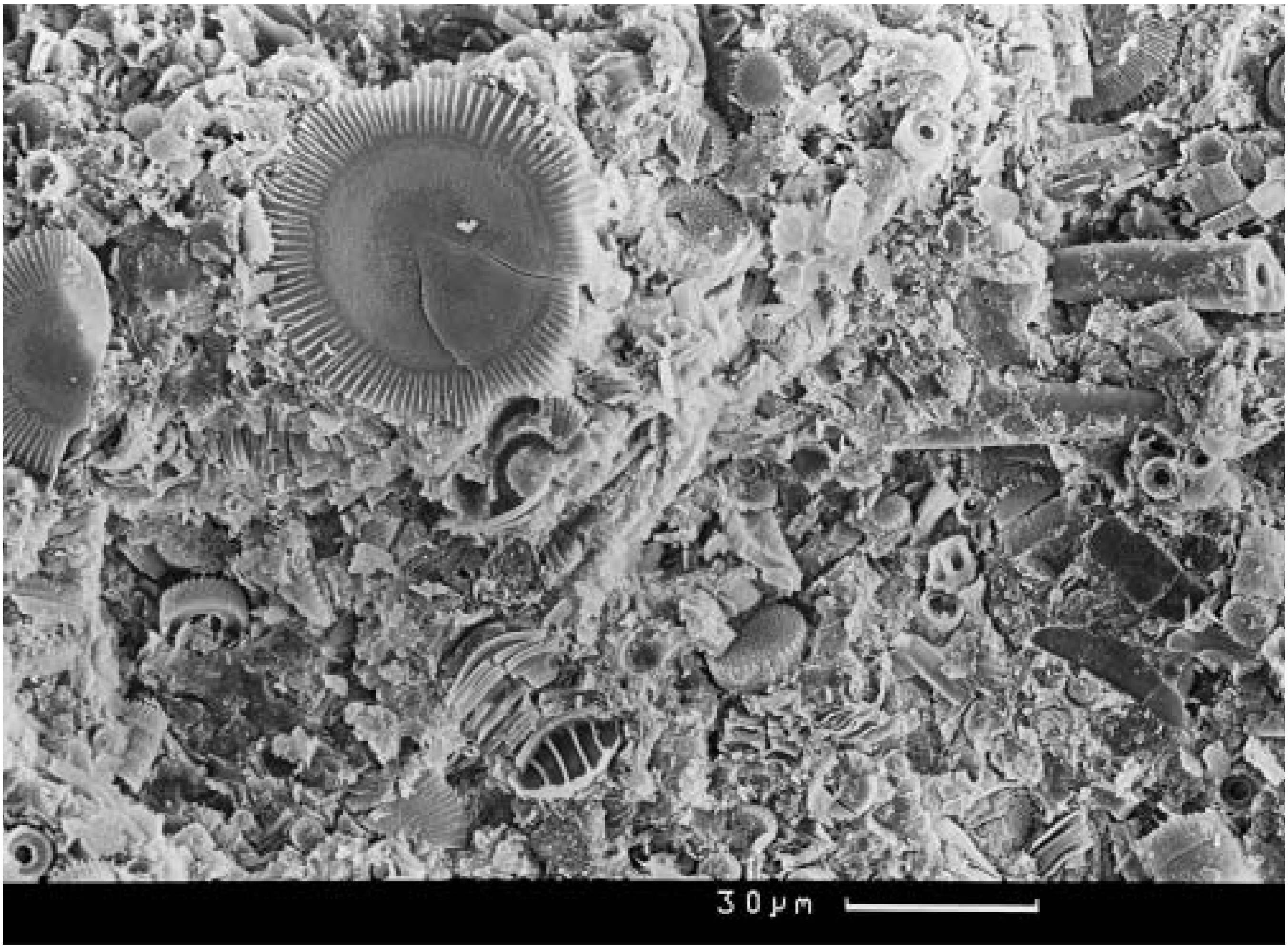
Sample Sf 28 furthermore comprises nest-like accumulations of the pennate diatom *Cymbella*. Because of strongly cracked valves the identification of several different species is not yet successful.

Seam 5 roof (see text-figs 6, 7):

The preservation of the diatom valves in sample Sf 1582 is much better than in sample Sf 365. Actually the valves are cracked into pieces but there exists no distinctive clayish matrix which might be responsible for diagenetic pressure solubility of the sediment. The delicate structures of the diatoms like the vela of the areolae and the weakly silicified connecting bands are preserved in some cases, indicating that little diagenesis concerned that sedimentary layer. The most common centric diatoms in that sample are small sized valves of the planktonic living *Aulacoseira distans* (EHRENBERG) SIMONSEN 1979. These valves and frustules are forming the main part of the sediment. Because of their small size and stable construction the valves are not smashed; however, the linking spines of sibling-cells are broken and the valves are isolated for the most part. The larger cells and colonies of *Melosira undulata* (EHRENBERG) KÜTZING 1844 (very common) and *Ellerbeckia arenaria* (MOORE) CRAWFORD 1988 (less common) could be easily identified, even at low magnification with the SEM. *Cymbella* sp. and *Pinnularia* sp. are very rare and cracked beyond recognition. As usual for the tripoli of Seifhennersdorf, *Tetracyclus ellipticus* (EHRENBERG) GRUNOW 1862 shows the tendency for amassments and forms long colony-chains. Chrysophycean-cysts of smooth shape are scattered distributed in the sediment. Sample Sf YYY provides the first proof of siliceous shell plates of the testate amoeba *Trinema* sp. (see text-fig. 8) from Seifhennersdorf.

Seam 5 (see text-fig. 8):

Sample Sf 473 shows a well preserved tripoli-sediment of diatom valves; however, it consists of a small amount of clayish matrix. As seen in the previous described samples, the valves of diatoms are usually cracked by compaction of the sediment. Surprisingly the compaction of the tripoli-sediments is not increasing according to the depth of the profile of the deposit. This phenomenon could be explained when recognizing the intercalations of volcanic tuff, which prevented pressure from overlying strata. The most common diatoms in that sample are *Aulacoseira distans* (EHRENBERG) SIMONSEN 1979 (with several morphotypes), *Melosira undulata* (EHRENBERG) KÜTZING 1844, *Tetracyclus ellipticus* (EHRENBERG) GRUNOW 1862, *Gomphonema bohemicum* REICHELT et FRICKE 1902, *Cymbella* sp., *Pinnularia* sp. and *Achnanthes* cf. *conspicua* A. MAYER 1919. *Ellerbeckia arenaria* (MOORE) CRAWFORD 1988 is lacking and chrysophycean-cysts are very rare.



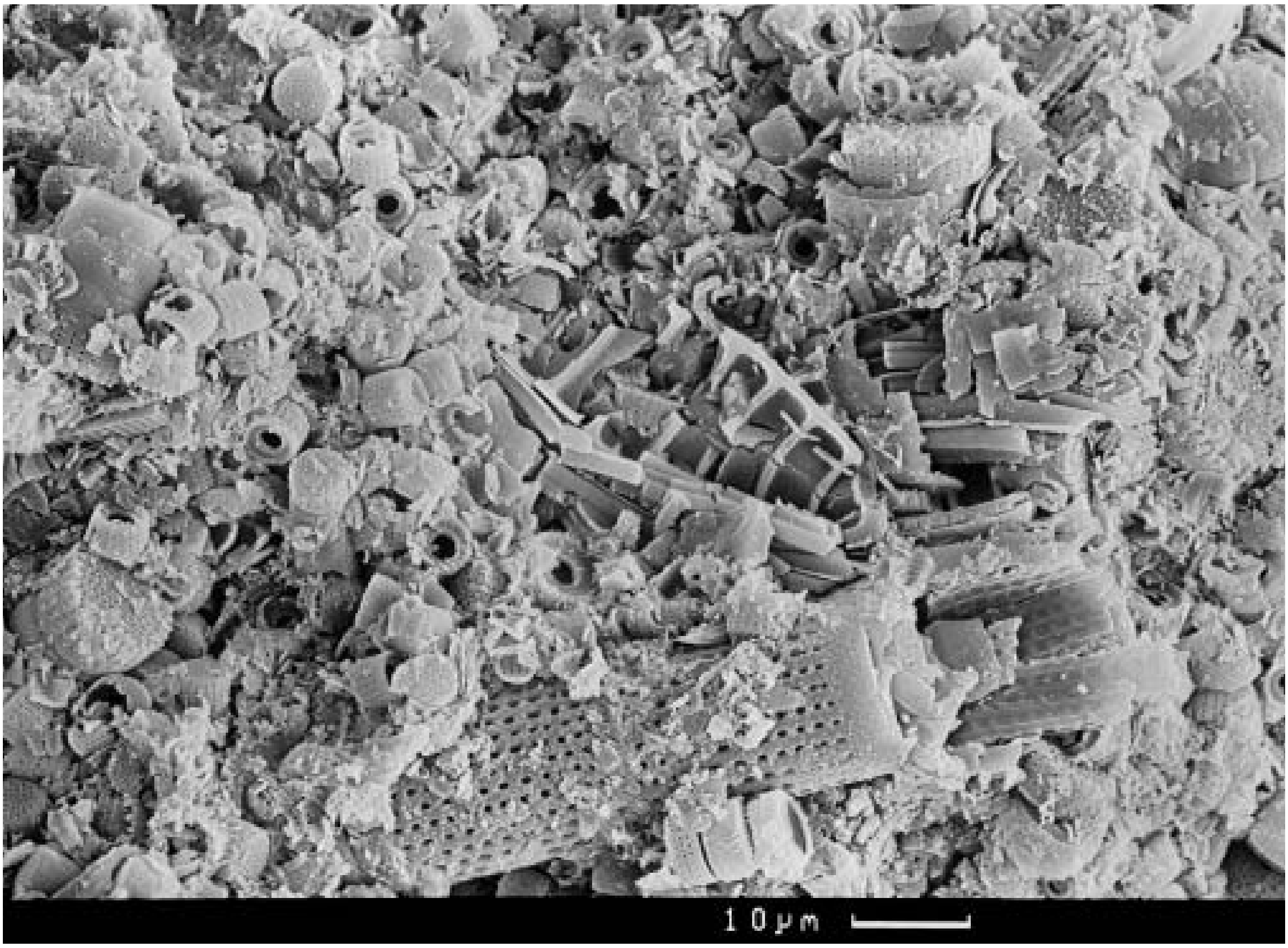
Text-fig. 5. Scattered valves of *Aulacoseira distans* (EHRENBERG) SIMONSEN 1979, cracked valves of *Ellerbeckia arenaria* (MOORE) CRAWFORD 1988 and *Tetracyclus ellipticus* (EHRENBERG) GRUNOW 1862 as well as broken scleres of freshwater sponges (on the right hand) are lying in a clayish matrix. SEM-photograph, sample Sf 380, seam 4.

Seam 5 subaquatic slide structures (see text-fig. 9):

Subaquatic slide structures were reported exclusively from seam 5. This type of sediment is very remarkable because of its slip folding structures. Light layers of nearly unconsolidated kieselgur (thickness of layers is about 0.5 to 2 mm) have been folded synsedimentaryly, causing thickening of the kieselgur-layers. SEM-sample Sf 7751 reveals weakly compacted sediment consisting of diatom valves and cysts of Chrysophytes of very little diagenetic stress. Ordinary the siliceous microfossils are well preserved but do show little corrosion on their surfaces. Nest-like accumulations of nearly monotypical diatom valves, e.g., *Aulacoseira granulata* (EHRENBERG) SIMONSEN 1979, *Aulacoseira* cf. *crenulata* (EHRENBERG) THWAITES 1848 as well as *Aulacoseira distans* (EHRENBERG) SIMONSEN 1979 (several morphotypes) indicate times of quiescent-area facies. The amount of auxospores of these centric planktonic living diatoms is very high. *Ellerbeckia arenaria* (MOORE) CRAWFORD 1988 and *Melosira undulata* (EHRENBERG) KÜTZING 1844 are very rare. *Tetracyclus ellipticus* (EHRENBERG) GRUNOW 1862 is very common, whereas *Pinnularia* sp. is not frequent. Sample Sf 7751 provides a rich flora of various but isolated chrysophycean-cysts.

Conclusions

The fossil diatom association of the tripoli-deposit of Seifhennersdorf corresponds in a large degree to that of Varnsdorf as seen in the SEM-reference sample Vd 28. However, none of the above mentioned SEM-samples revealed a very special pennate diatom, called *Gomphopleura nobilis* REICHELT ex TEMPÈRE 1894, known from the Czech locality “Breiter Busch near Hainspach” (Lipová), from where it was described first by Herrmann and Reichelt (1895) (also see Mahoney 1989). *G. nobilis* REICHELT ex TEMPÈRE 1894 is an extinct species and marker fossil for the Late Oligocene to Early Miocene and it is also known from the Late Oligocene kieselgur-deposit of Kleinsaubernitz. The lack of *G. nobilis* REICHELT ex TEMPÈRE 1894 in tripoli sediments of Seifhennersdorf might not be substantiated by facial arguments, but by stratigraphical determination. The tripoli deposit of Seifhennersdorf seems to be older than the sediments of the Late Oligocene maar of Kleinsaubernitz, where the diversity of diatoms is much more distinctive. The fossil diatom flora of Seifhennersdorf might be more similar to that of Kučlín at Bílina in Northern Bohemia (because of its association of small centric diatoms), which is discussed to be of Lower Oligocene age. (For stra-



Text-fig. 6. Short colony-chain of *Aulacoseira* cf. *crenulata* (Ehrenberg) Thwaites 1848, cracked valve (inner side) of *Tetracyclus ellipticus* (Ehrenberg) Grunow 1862 and several morphotypes of *Aulacoseira distans* (Ehrenberg) Simonsen 1979, SEM-photograph, sample Sf YYY, seam 5 roof.

tigraphical comparison see Bellon et al. 1998, Kvaček and Walther 2001 and Walther 2004). The number of examined samples by SEM-techniques so far will merely provide an overview of the siliceous microfossils of Seifhennersdorf. The proof of remains of the testate amoeba *Trinema* sp. reveals the potentiality of "exotic" finds. For further investigations low stressed fine laminated tripoli- or kieselgur sediments should be examined layer by layer to determine the succession and probable periodicity of sedimentation of the microfossils. Most desirable is the investigation of orientated core material.

References

Ahrens, H. (1957): Stratigraphisch-tektonische Untersuchungen im Tertiär von Seifhennersdorf O/L. – Nonpublished diploma thesis, Humboldt-Universität, Berlin, 57 + 6 p., 13 pls.

Bellon, H., Bůžek, C., Gaudant, J., Kvaček, Z., Walther, H. (1998): The České Středohoří magmatic complex in Northern Bohemia ^{40}K–^{40}Ar ages for volcanism and biostratigraphy of the Cenozoic freshwater formations. – Newsletters on Stratigraphy, 36(2/3): 77–103.

Hazard, J. (1895): Erläuterungen zur Geologischen Specialkarte des Königreichs Sachsen, Blatt 87, Section Rumburg-Seifhennersdorf. – W. Engelmann, Leipzig, 62 pp.

Herrmann, O. (1893): Erläuterungen zur geologischen Specialkarte des Königreichs Sachsen. – Bl. 70, Section Schirgiswalde-Schluckenau. – W. Engelmann, Leipzig, 37 pp.

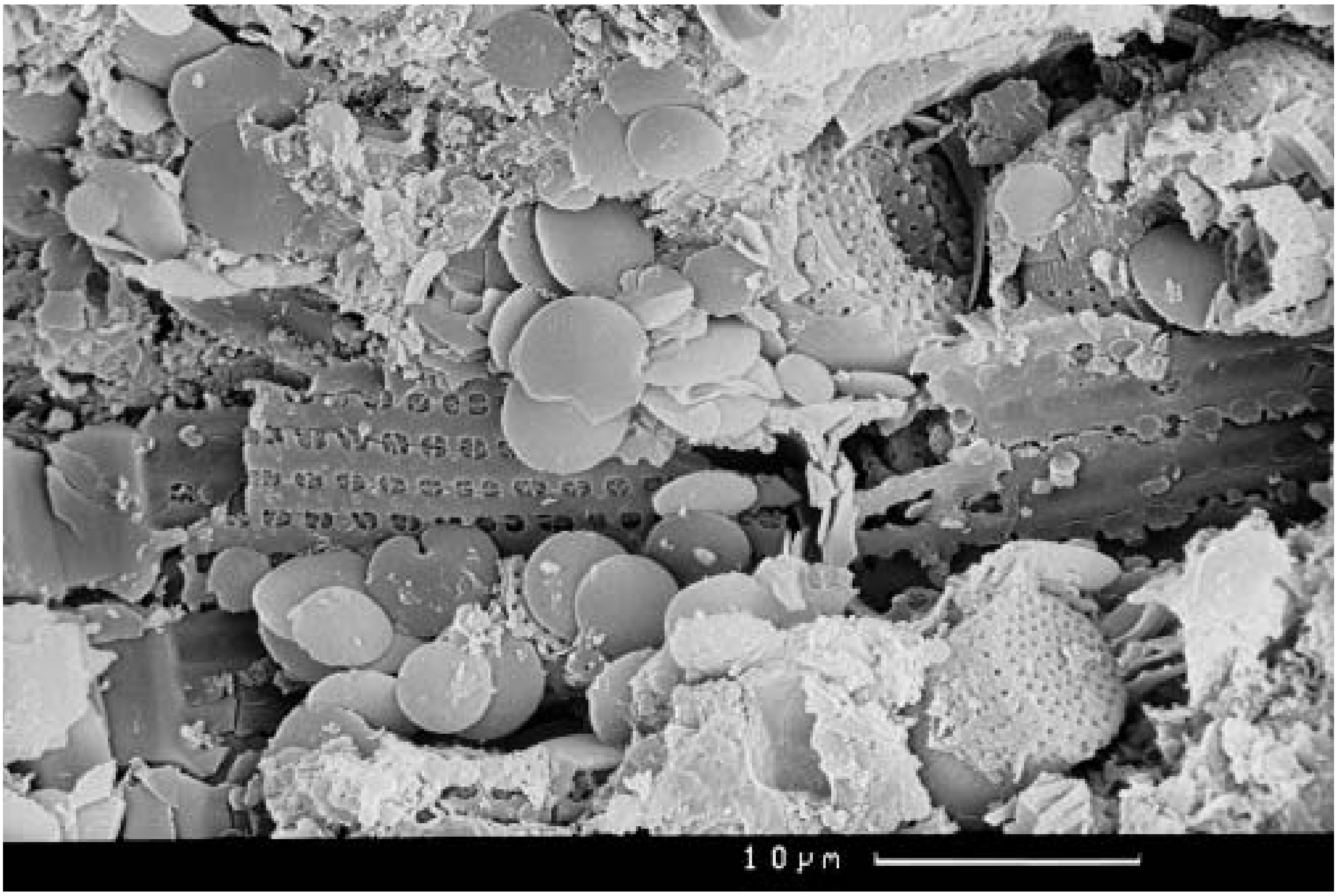
Herrmann, O., Reichelt, H. (1895): Ueber Diatomeenschichten aus der Lausitz. – Sitzungsberichte der Naturforschenden Gesellschaft zu Leipzig, 19–21 [for 1892 to 1894]: 67–77.

Kvaček, Z., Walther, H. (2001): The Oligocene of Central Europe and the development of forest vegetation in space and time based on megafossils. – Palaeontographica, Abt. B, 259(1–6): 125–148.

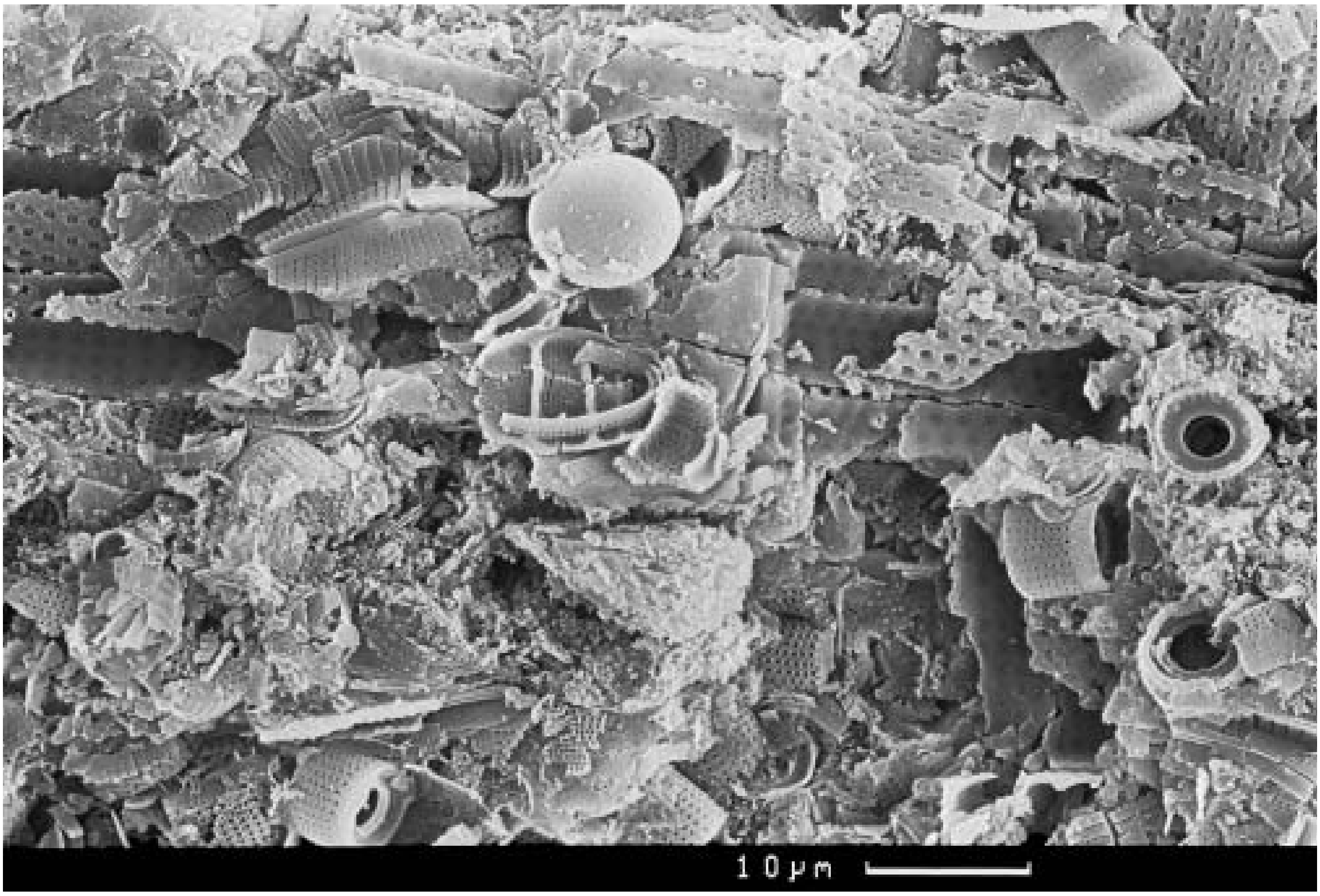
Mahoney, R.K. (1989): Observations on the Diatom *Gomphopleura nobilis* Reichelt ex Tempère (Bacillariophyceae). – Proceedings of the Academy of Natural Sciences of Philadelphia, 141: 251–261.

Martini, E., Rietschel, S. (1978): Lösungserscheinungen an Schwammnadeln im Messeler Ölschiefer (Mittel-Eozän). – Erdoel-Erdgas-Zeitschrift, 94: 94–97.

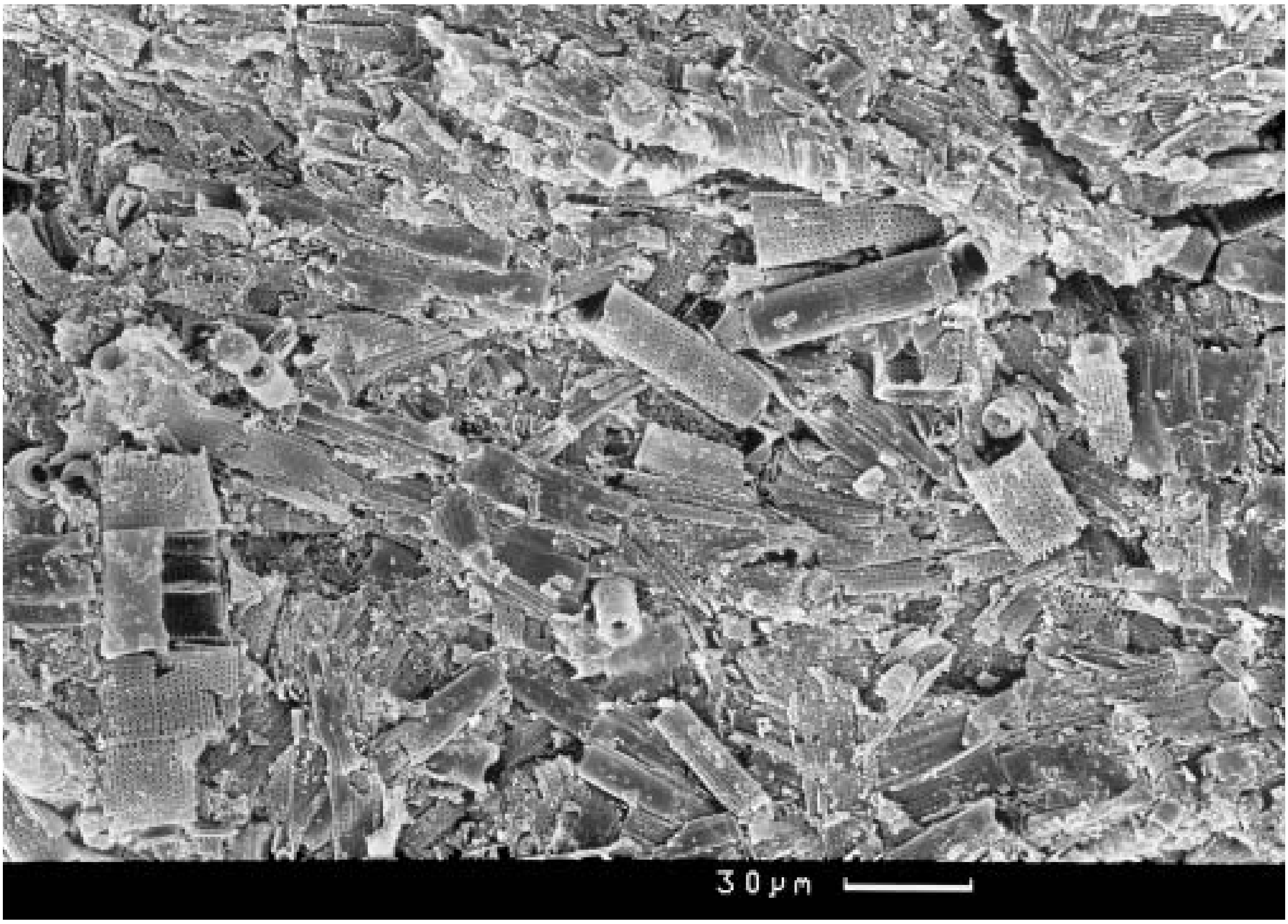
Pietzsch, K. (1962): Geologie von Sachsen. – VEB Deutscher Verlag der Wissenschaften, Berlin, 870 p., 300 figs.



Text-fig. 7. Disintegrated siliceous shell plates of the testate amoeba *Trinema* sp, SEM-photograph, sample Sf YYY, seam 5 roof.



Text-fig. 8. Cracked valves of *Aulacoseira* cf. *crenulata* (EHRENBERG) THWAITES 1848 and a small sized valve of *Tetracyclus ellipticus* (EHRENBERG) GRUNOW 1862 (centre), SEM-photograph, sample Sf 473, seam 5.



Text-fig. 9. Accumulation of shattered valves of *Aulacoseira granulata* (Ehrenberg) Simonsen 1979 and *Aulacoseira* cf. *crenulata* (Ehrenberg) Thwaites 1848, SEM-photograph, sample Sf 7751, seam 5 subaquatic slide.

Sallum, R. (1956): Mikrofloristische Untersuchungen des Polierschiefers von Seifhennersdorf als Mittel zur Deutung seiner Genese. – unpublished diploma thesis, Bergakademie Freiberg, Freiberg. 50 p., 14 encl.

Schiller, W. (2000): Feinstratigraphische Untersuchungen der Kernbohrung Enspel 1991(2) unter besonderer Berücksichtigung der kieseligen Mikrofossilien. – Mainzer naturwiss. Archiv, 38: 39–91.

Taránek, J. (1881): Ueber die Süsswasserdiatomeen a.d. Tertiärschichten von Warnsdorf. – Sitzungsbericht der königlichen böhmischen Gesellschaft der Wissenschaften. p. 291; Prag.

Walther, H. (1988): Die geologische, paläontologische und bergbaugeschichtliche Ausstellung des Museums Seifhennersdorf. – Zittau-Görlitz, 43 pp., 40 figs.

Walther, H. (2004): Vulkanische Floren aus dem höheren Paläogen (Oligozän) Zentraleuropas. – Abhandlungen der Naturwissenschaftlichen Gesellschaft ISIS Dresden 1997/2003: 191–261.