DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2009/78

Characterisation of diatomite from Ulyanovsk, Russia

Scannning electron microscope analysis and X-ray diffractometric characterisation of Palaeogene diatomite from the central south-eastern part of the Russian platform

Stig A. Schack Pedersen, Jørgen Kystol
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Prepared for SKAMOL A/S

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Introduction

In the last part of the year 2009 Skamol A/S prepared to acquire the majority of the Russian Diatomovy Kombinat (Diatomite) high temperature diatomite-brick factory. The preliminary investigation of the raw material for the Russian diatomite exploitation indicates that the diatomite deposit in Inza in the Ulyanovsk provins, approximately 800 km east of Moscow is very similar to the moler (clayey diatomite) in the western Limfjorden Region in Denmark.

Director Torkil Krag, Skamol A/S, carried a back of diatomite with him back from the Inza diatomite deposit, and asked Dr. Stig Schack Pedersen, GEUS, to make a brief description of the diatomite with special reference to comparison of the Russian diatomite with the Danish diatomite. At the first look on the Russian diatomite it was obvious that it was quite similar to the well known diatomite from the “moler fields” in the vicinity of the Skamol factories on Fur and Mors in northern Denmark (Fig. 1). However, it can also immediately be seen that the Inza diatomite is missing lamination or clear signs of bedding. In that respect it is only similar to the structure-less type of diatomite of the Fur Formation (Pedersen & Surlyk 1983) in Denmark.

The aim of this report is to give a description of the Inza diatomite from the Ulyanovsk province in the Central Volgaland in Russia. The sample from Inza have been analysed with scanning electron microscope (SEM) and X-ray diffractometry. The characterisation of the Inza diatomite is carried out similar to characterization of the diatomite from Denmark and other places in Europe (Pedersen 2000, Pedersen et al. 1998, 1999 & 2002, Steffensen et al. 2000).

Figure 1. *Three samples of diatomite represented by a laminated diatomite to the left and a structure-less diatomite in the middle, both from Skarrehage, Mors, and to the right a structure-less diatomite from Inza, Central Volgaland in Russia.*

Geological setting of the Inza diatomite

The Inza diatomite deposit is located in the Central Volgaland Basin, in the south-eastern part of the Russian Platform west of Ural (Fig. 2). In the Early Tertiary (the Palaeogene) this area formed a part of the shallow marine basin extending from the Black Sea towards the Caspian Basin with an ocean connection to the Indian Ocean (Fig. 3). The epeirogenic, continental movements in the transition from the Cretaceous to the Tertiary resulted in the closure of a directly sea-connection from the Norwegian-Danish Basin to the Volgaland Basin. Therefore the diatom species in the diatomite deposits of the Limfjorden–North Sea region vary significantly from Volagaland Basin. Moreover, the Volgaland Basin was located on a lower altitude, which resulted in blooming of more thermophilic species than the species characterising the moler deposits in the Limfjorden region. The diatom assemblage of the Palaeogene Central Volgaland Basin is more similar to the assemblages found on the easternslope of the Uralsa and in the Indian Ocean. However, a smaller group of diatoms have been recognised as similar to the species found in the Fur Formation in Denmark (Benda 1972, Fenner 1994, Mukhina 1976).

Figure 2. *Location of the Inza diatomite deposit in the Ulyanovsk province in the Central Volgaland, Russia. Map source:* **www.diatomit.com.**

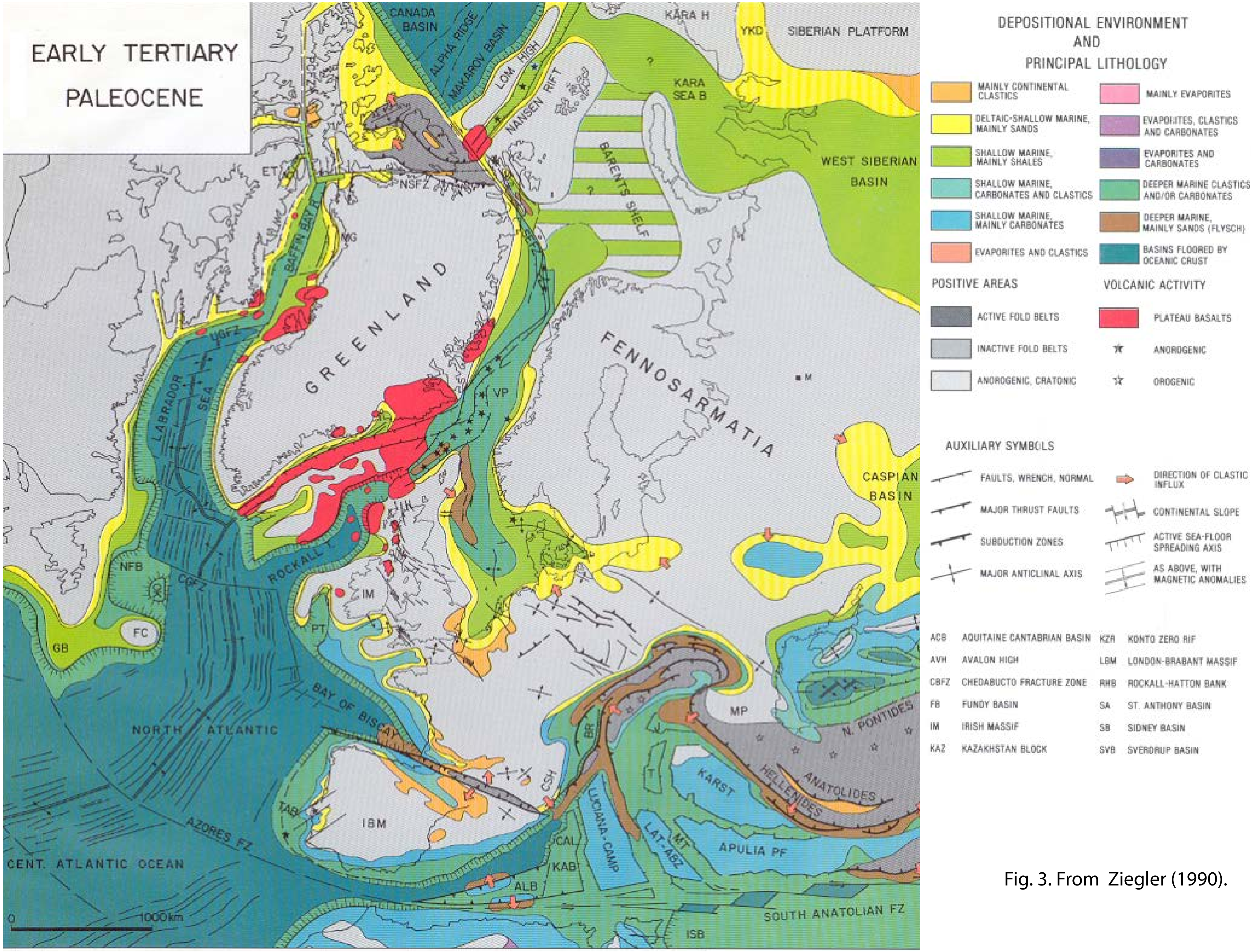

Fig. 3. From Ziegler (1990).

Scanning electron microscopy of the Inza diatomite

The most significant character of the Inza diatomite is the complete lack of lamination and bedding. This is naturally caused by a high grade of bioturbation, which consequently also will disturb the preservation of complete diatom frustules. In Fig. 4 the significance between laminated and bioturbated diatomite is illustrated by putting the two types of sediment structures next to each other.

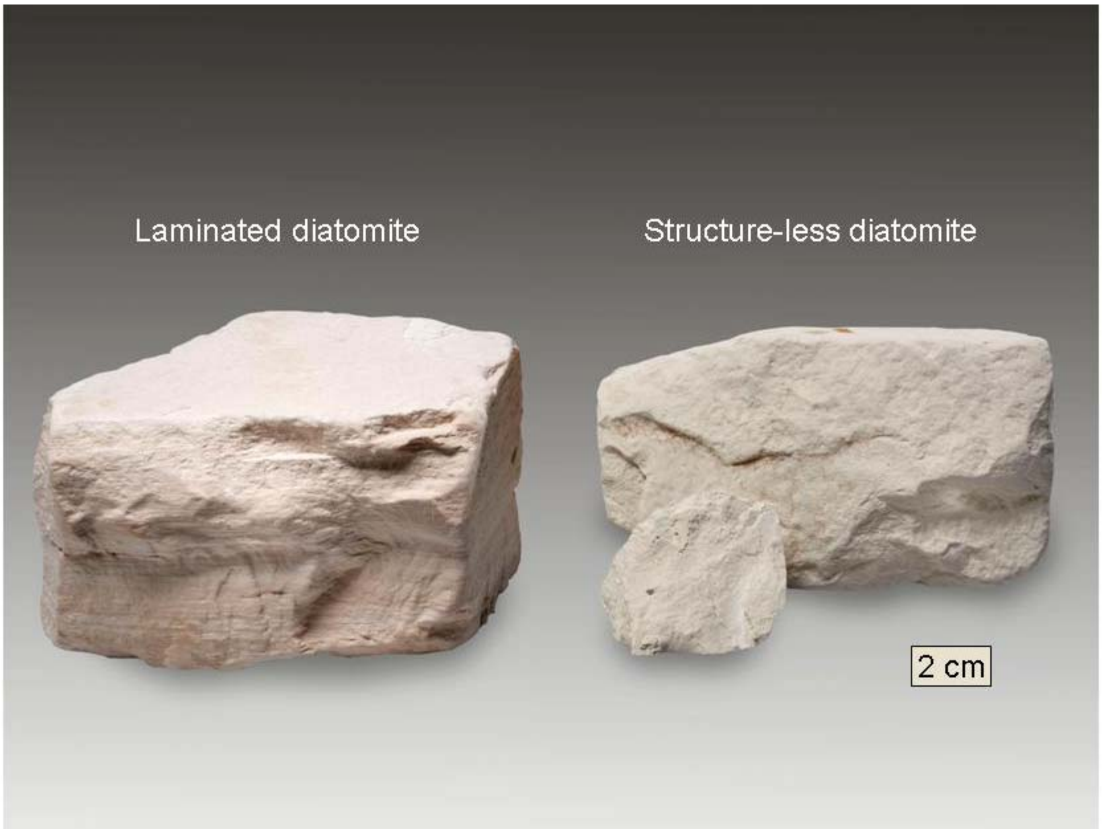

Figure 4. *The difference between laminated and structure-less diatomite is illustrated by the sample to the left from the Lower Molerseries in the Skarrehage Moler pit, Mors, and the sample of structure-less diatomite from Inza, Central Volgaland.*

The most abundant diatom species in the Inza diatomite are *Hemiaulus Ehrenberg, Stephanopyxis Ehrenberg, Frinacria Heiberg, Triceratium Ehrenberg* and *Melosira Agardh* according to Mukhina (1976). Furthermore it should be noted that the planktonic species *Melosira sulcata* is reasonably represented, which is typical for shallow waters (Mukhina 1976). In the following pages representative images from the scanning electron microscopy of the Inza diatomite are shown.

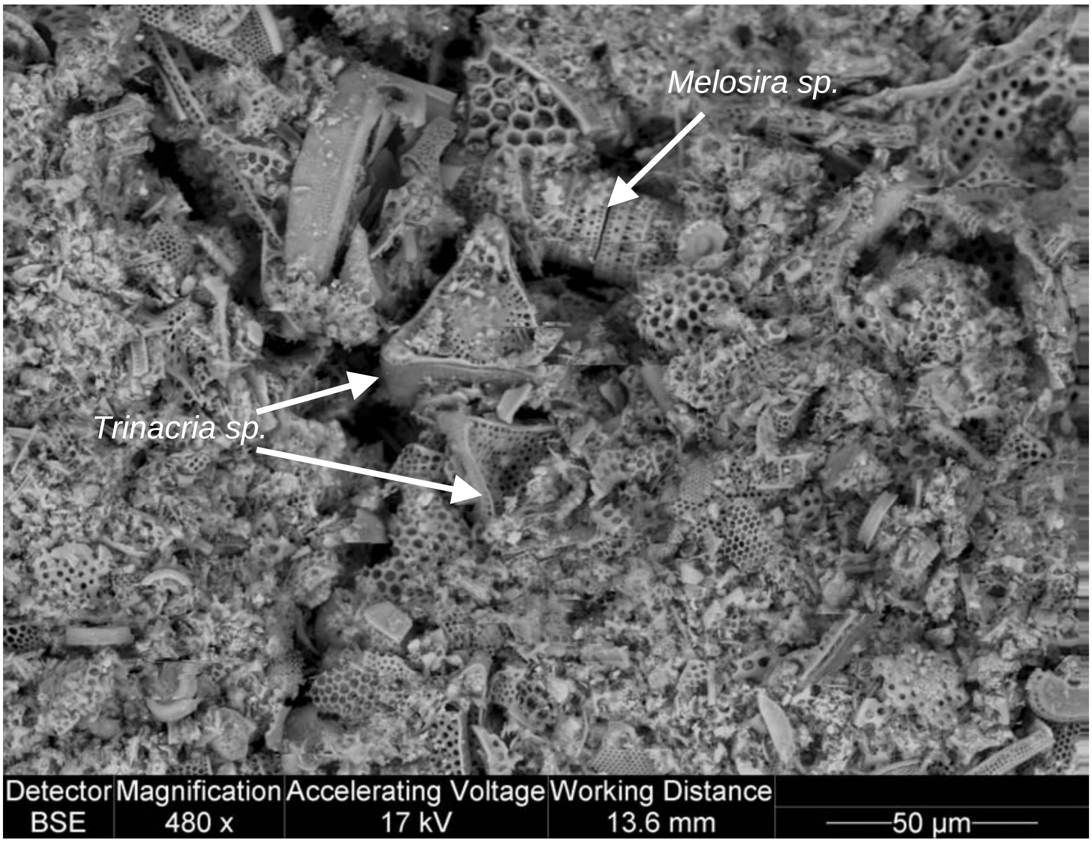

Figure 5. *Scanning electron microscopy of the Inza diatomite with two abundant occurring species recognised: the Melosira sp. which form a long chain of easily broken discs, and the triangle shaped Trinacria sp.*

Figure 6. *A Trinacria sp. is situated in the centre of this SEM image. Two pins of silicoflagge-lates are also present and a bunch of Melosira sp. fragments.*

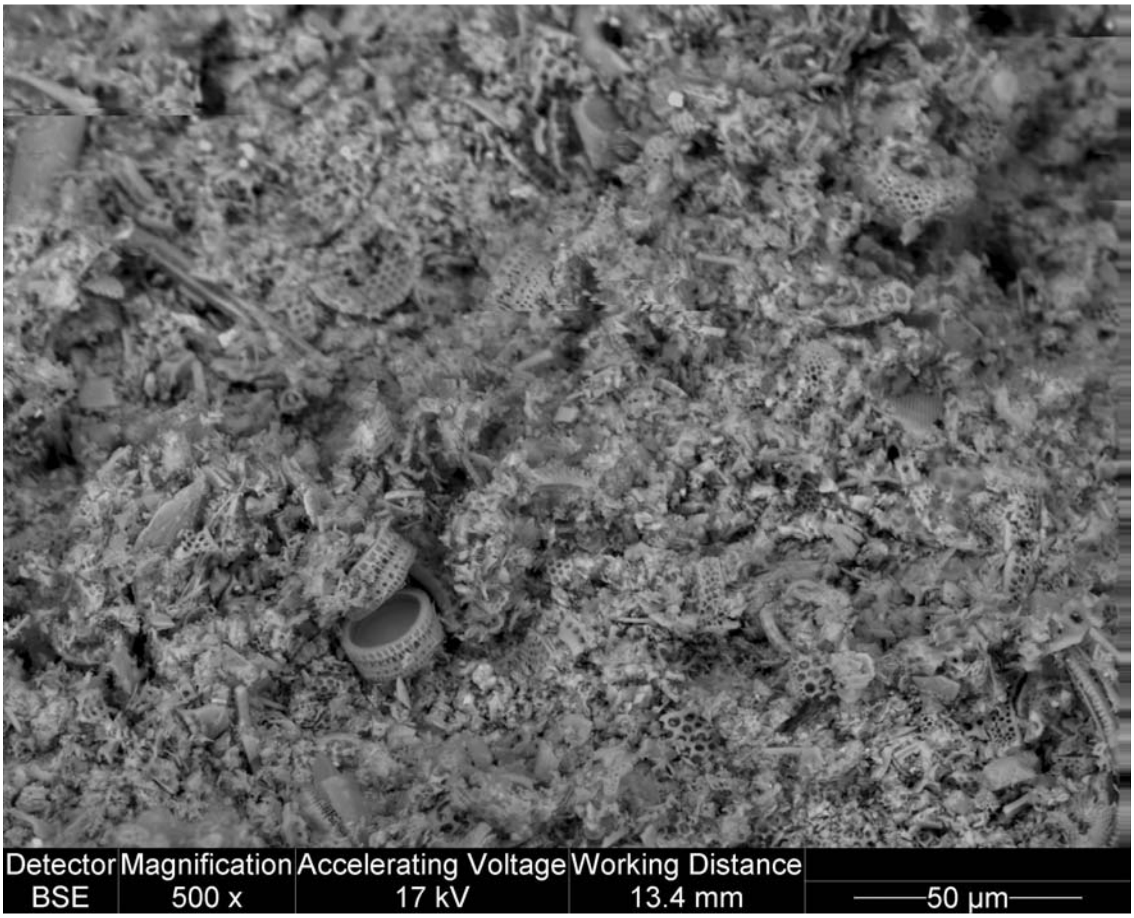

Figure 7. *A bunch of Melosira sp. fragments among others in the Inza diatomite.*

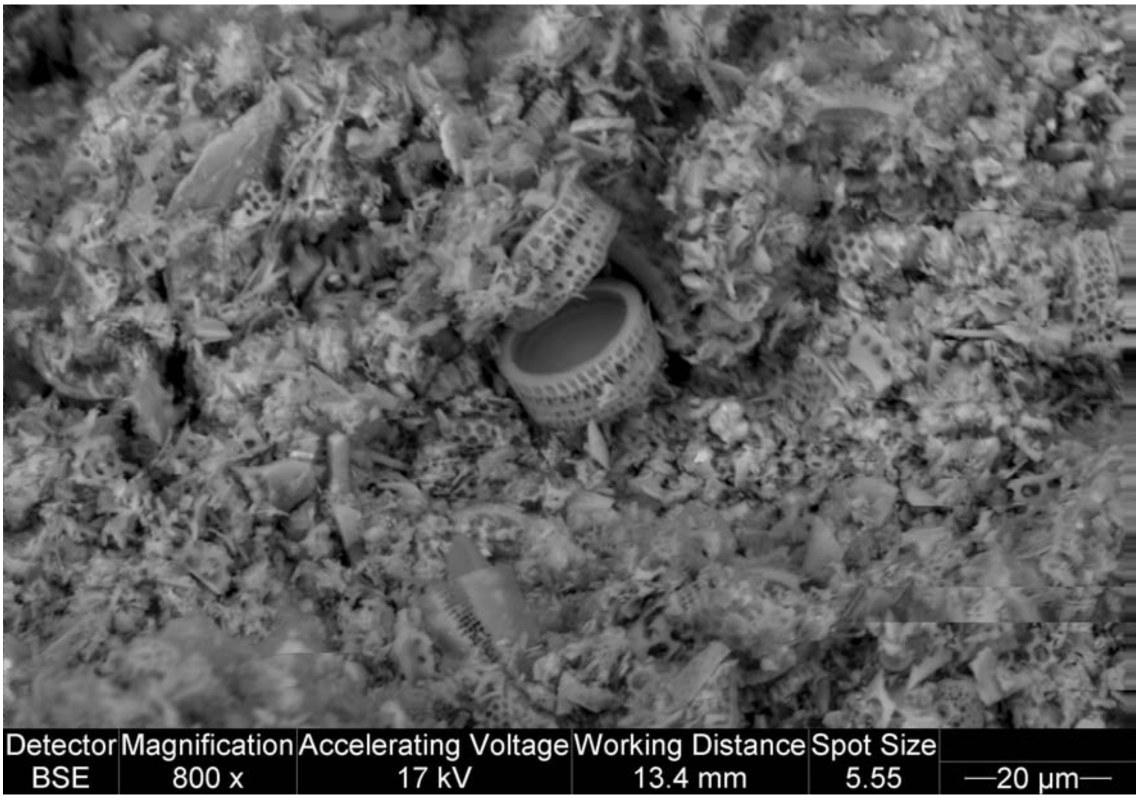

Figure 8. *A close up view of the Melosira sp. here located in the centre of the image.*

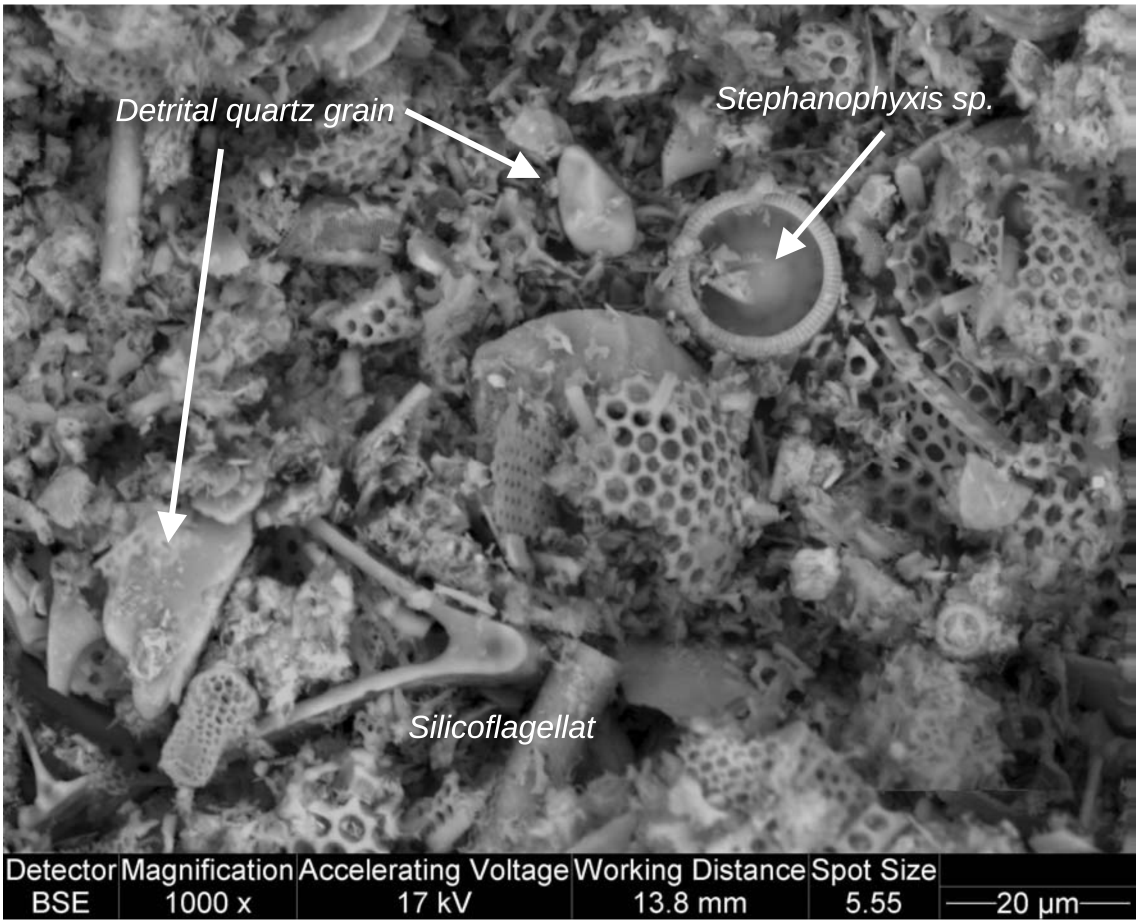

Figure 9. *SEM image of various fragments in the Inza diatomite.*

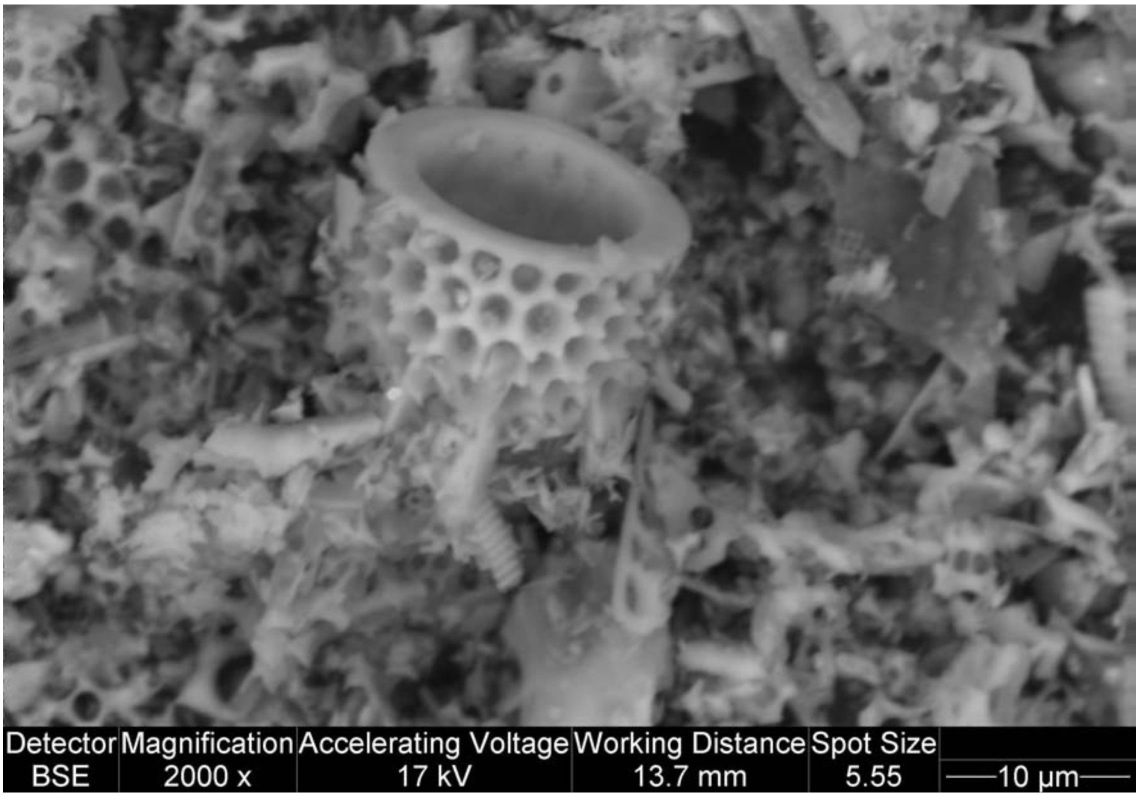

Figure 10. *A close up view of the Stephanophyxis sp. occurring in the Inza diatomite.*

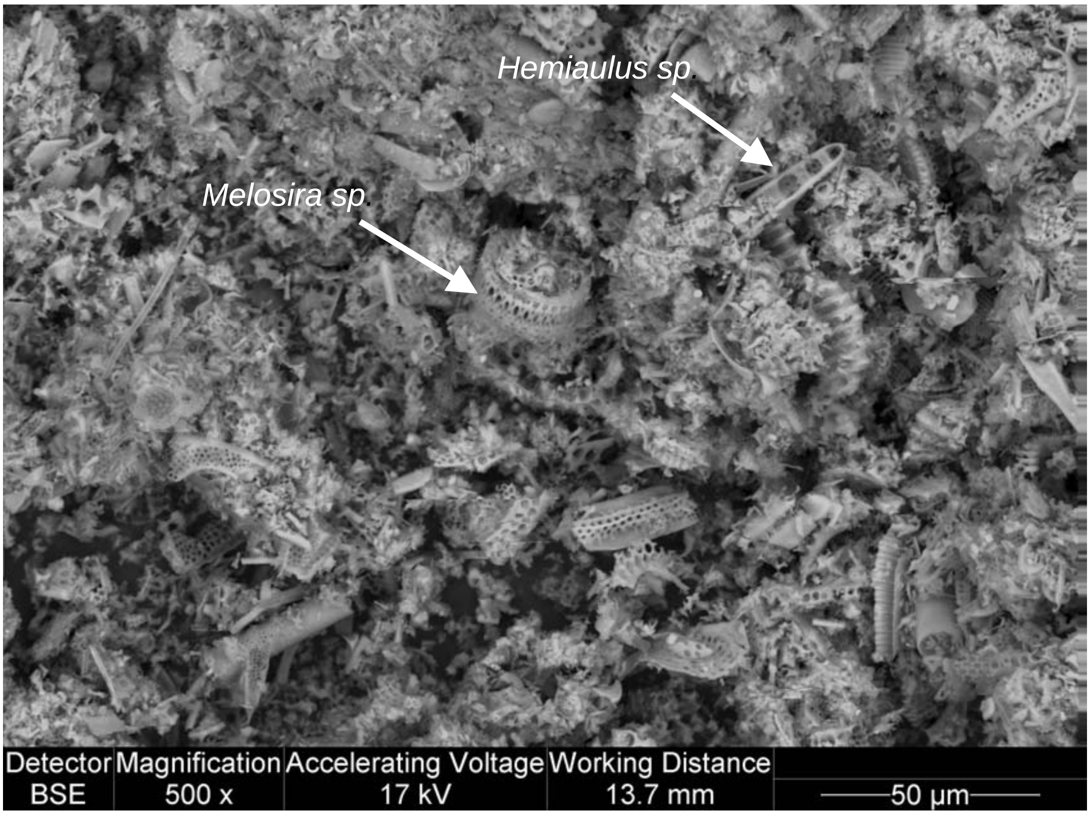

Figure 11. *Fragments of Melosira sp. and Hemiaulus sp. can be identified in this SEM image of the Inza diatomite.*

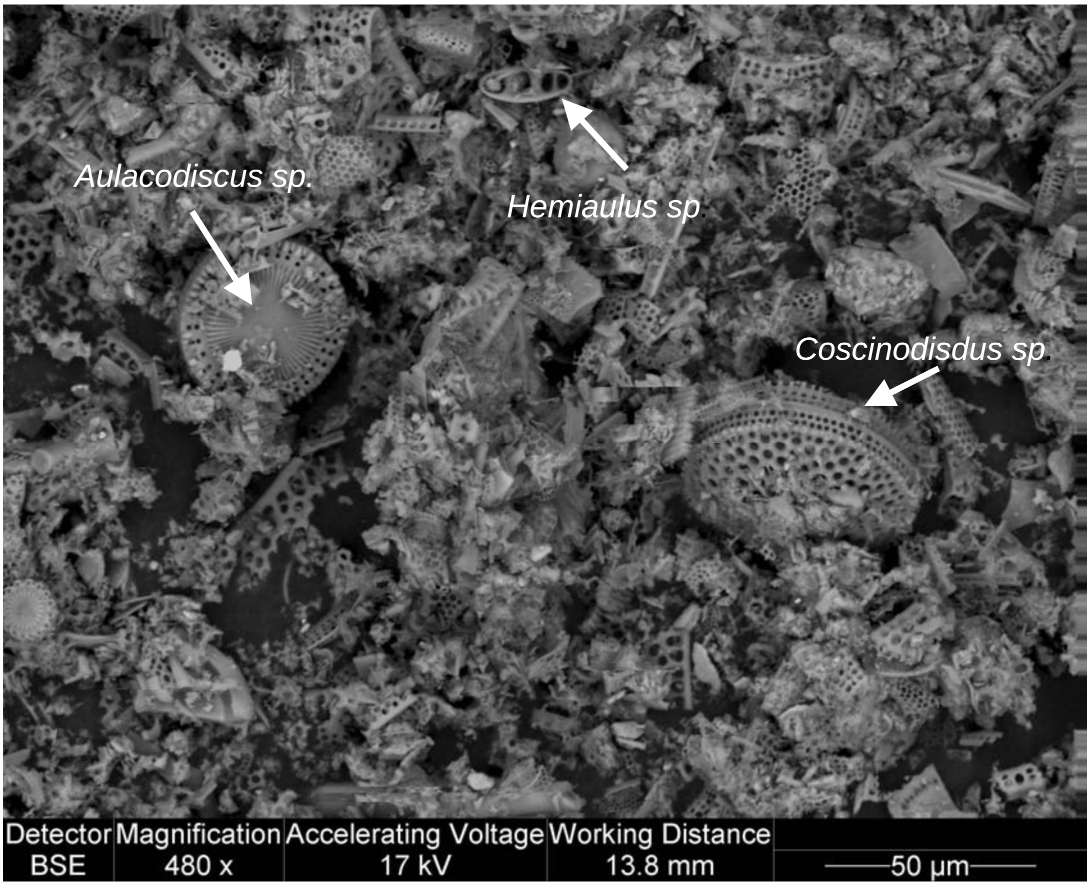

Figure 12. *Fragments and frustules of diatoms in the Inza diatomite.*

Figure 13. *A well preserved Coscinodiscus sp. among fragments of common appearing species in the Inza diatomite.*

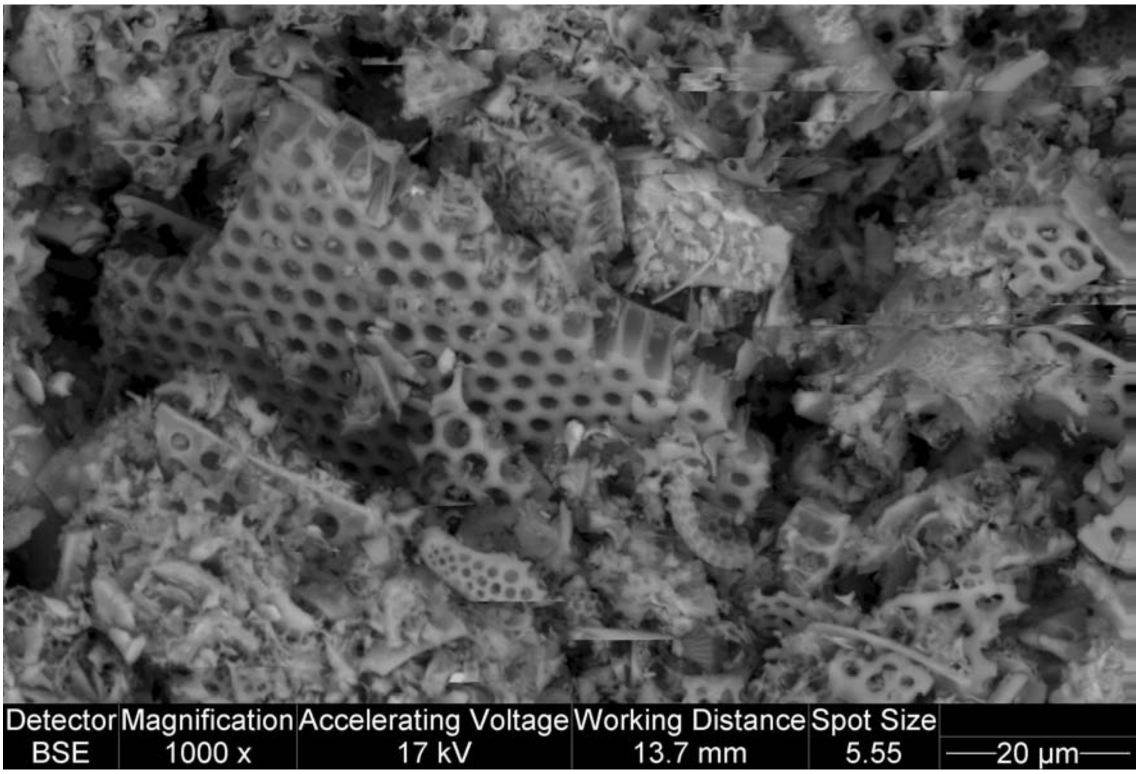

Figure 14. *The large fragment here preserved in the Inza diatomite most likely represent a Coscinodiscus sp.*

X-ray diffraction analysis of Inza diatomite

A single x-ray diffractometric analysis has been carried out on the Inza diatomite. Compared with the Danish Palaeogene diatomites the Inza diatomite show the same characteristic X-ray diffraction pattern (Figs 15–17). The pattern is dominated by the opal-A bulge, which show the dominance of the diatomite frustules. The single high top for quartz is interpreted as representing detrital quartz grains (compare with Fig. 9), and the clay in the sample is interpreted to be smectite, similar to the dominant clay content in the Danish diatomite (Pedersen et al. 2004). It is emphasised that no other clay minerals were identified in the X-ray diffraction analysis.

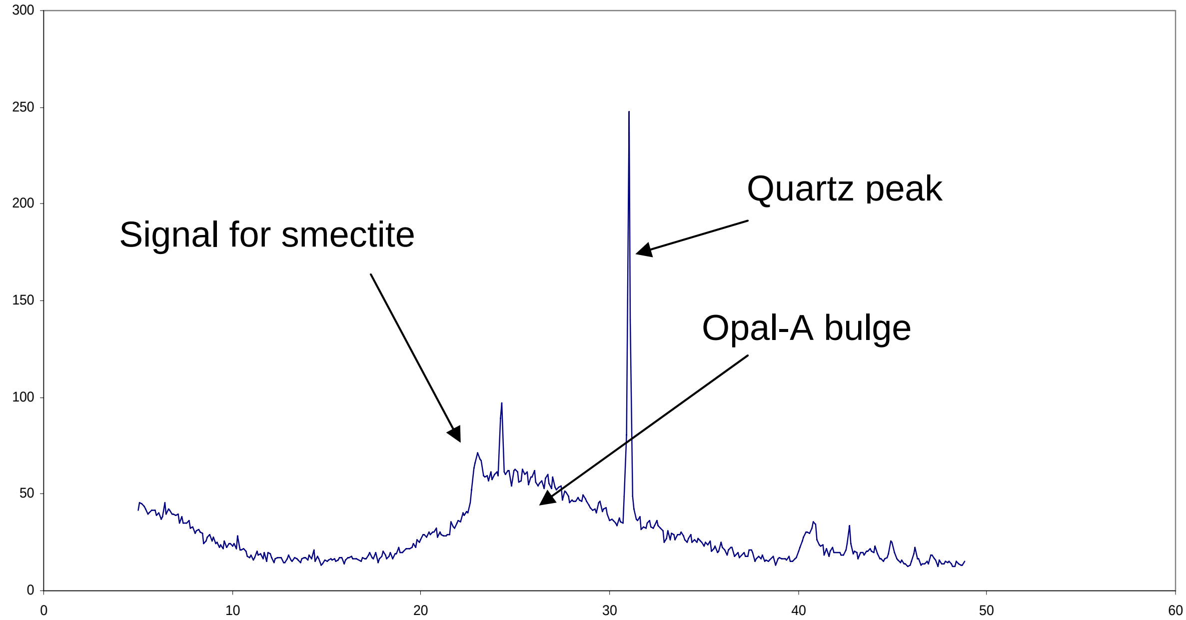

Figure 15. *X-ray diffractogram of the Inza diatomite. The x-axis is the degrees of 2 theta times 100, and the y-axis is the intensity. The opal-A bulge has an intensity indicating about more than two thirds of amorphous silicate in the sample. On the left side of the opal-A bulge the signal of smectite is interpreted to be present. Note that no other clay minerals have been identified. The quartz peak is interpreted to represent detrital quartz grains.*

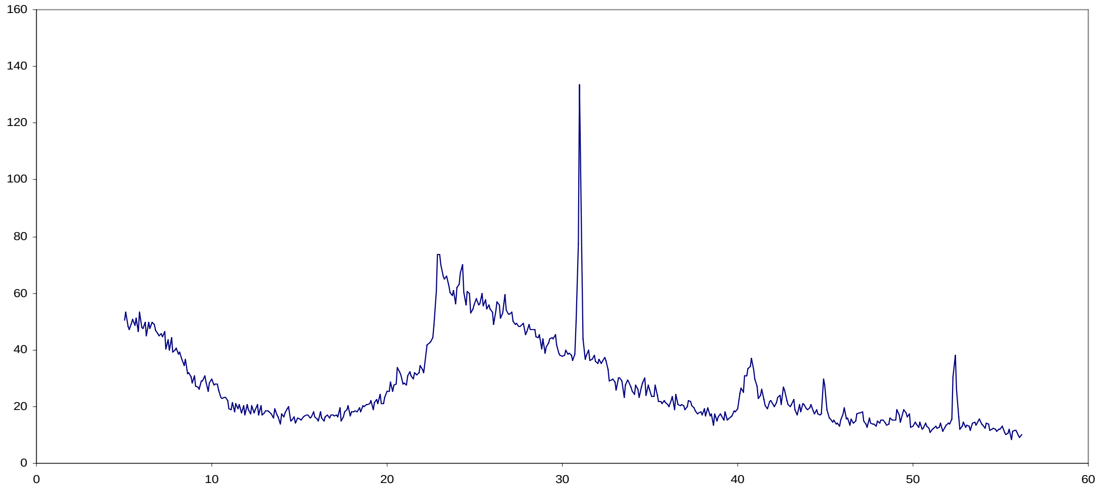

Figure 16. *X-ray diffractogram of the structure-less moler from the Ejerslev moler pit, Mors. The x-axis is the degrees of 2 theta times 100, and the y-axis is the intensity. Note that the intensity of the opal-A bulge is nearly the same as in the Inza diatomite.*

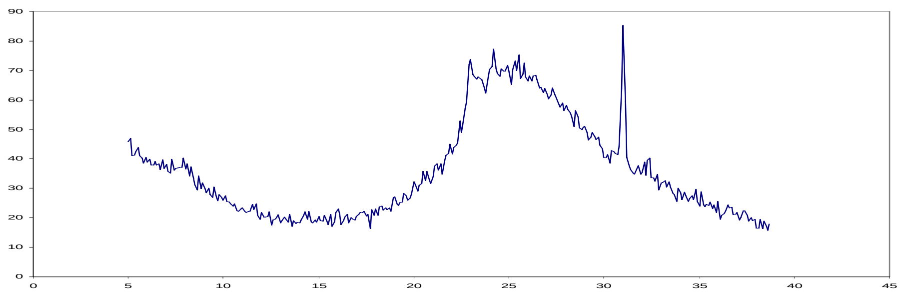

Figure 17. *X-ray diffractogram of the laminated moler from the Skarrehage moler pit, Mors. The x-axis is the degrees of 2 theta times 100, and the y-axis is the intensity. The intensity of the opal-A bulge is nearly the same as in the Inza diatomite, and on the left side of the bulge the signal for smectite can be recognised.*

Discussion and conclusion

The diatomite from Inza is very similar to the Danish diatomite judged from the X-ray diffractogrametric analyses (Fig. 15–17). Especially the structure-less diatomite from the Ejerslev moler pit show a similar diffractometric pattern. The quartz peak in the X-ray diffractogram from Inza is interpreted to represent detrital quartz grains, although it can not be excluded that autogenic quartz may be present. However, no signs of opal-C/T has been recognised, which indicates that diagenetic alterations have not affected the Inza diatomite.

It has to be emphasised that no other clay mineral than smectite has been interpreted to be present in the Inza sample. According to the calculation method applied by Pedersen et al. (2004) it is estimated from the chemical analyses provided by Diatomovy Kombinat (SiO2=86%, Al2O3=6%) that the clay content amounts to about 25% in the otherwise opal-A dominated diatomite.

The variation in diatom species gives a distinct tool for identification of diatomite from the Inza region compared to diatomite from the Limfjorden region (Fig. 18). However, this has little (or non at all) influence on the raw material characterization of the two types of diatomite sediments, which appear to be very similar.

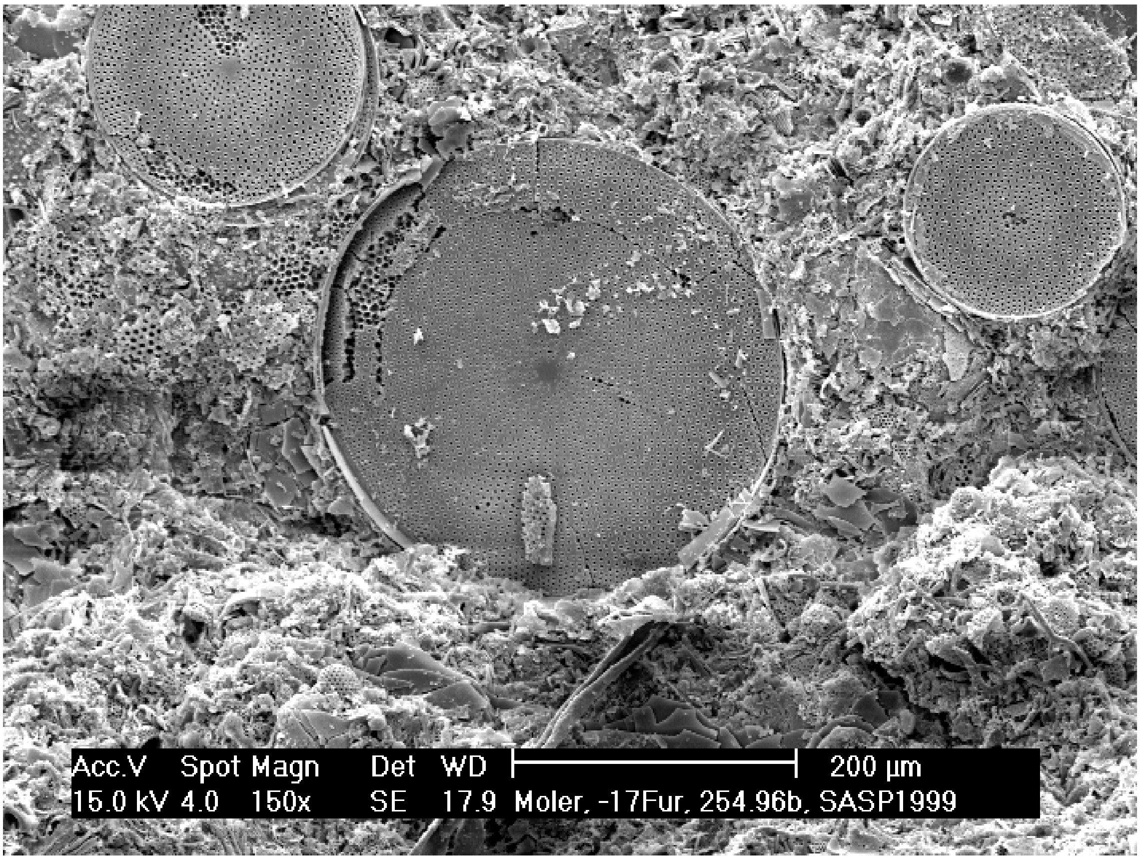

Figure 18. *The diatomite from the Limfjorden Region is characterised by the frequent occurrence of the Coscinodiscus sp. diatom frustules.*

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