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Joachim Albrecht

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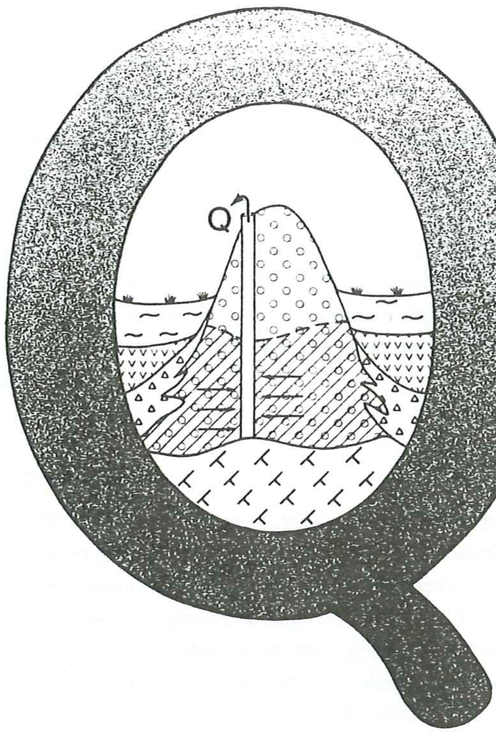

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Lund 1993

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Abstract

The investigated gravel-pit lies in the hinterland of the Pomeranian end-moraine zone. The structures in the sediment are strongly influenced during the glacier's recession. Especially the margins of the pit show strong deformation. Until now the sediments have been interpreted as subglacial tunnel deposits. Moreover the whole sequence is considered to be discontinuous. It has been suggested that Weichsel-2, Saale-2 and possibly Weichsel-1 diamicton should occur in the outcrops. Several organic layers have earlier been identified as Eemian peats, which should divide the Weichselian from the Saalian diamicton.

According to this study the sediments in the southwestern part of the pit represents a continuous sedimentary sequence, laid down during the disintegration of stagnant ice of the Pomeranian stage. The sediments consist of interbedded diamictons and fluvial sands.

The diamicton beds are interpreted as flow tills, deposited in troughs parallel to the stagnant ice margin. Thus the stacked diamicton beds does not represent several glacier advances or oscillations, as previously suggested. Since the Quarternary stratigraphy in northeastern Germany is based on borings, it has possibly to be controlled by lithostratigraphical and sedimentological principles.

Kurzfassung

Die untersuchte Kiesgrube liegt im Hinterland der pommerschen Endmoräne. Die Strukturen im Sediment sind sehr von Vorgängen beim Gletscherrückzug geprägt. Besonders die Randteile der Grube weisen starke Deformationserscheinungen auf. Bisherige Interpretationen dieser gehen auf Ablagerungen in subglazialen Rinnen ("Tiefe Grundspalten") hinaus. Außerdem sieht man die Lagerfolge als diskontinuierlich an. Jedoch sollen sowohl Weichsel-2, Saale-2 und eventuell auch Weichsel-1-Moränen im Aufschluß zu finden sein. Mehrere organische Ablagerungen sind als Eem-Torfe identifiziert worden und sollen demnach die Weichsel- von der Saale-Moräne trennen.

Nach den kürzlich durchgeführten Untersuchungen jedoch handelt es sich bei dem Anstehenden im südöstlichen Teil um eine kontinuierliche Lagerfolge, in der lediglich Toteissedimente vom Rückzug des Weichsel-Gletschers vertreten sind. Das gesamte Sedimentpaket besteht aus flow tills und fluviatilen Sanden. Mehrere Geschiebemergel übereinander bedeuten nicht, daß es sich unbedingt um verschiedene Gletschervorstöße oder Oszillationen handeln muß. Da die quartäre Stratigraphie im nordöstlichen Deutschland vielfach auf Bohrungen beruht, muß eventuell auch diese nach lithostratigraphischen und sedimentologischen Prinzipien korrigiert werden.

This paper constitute a part in a project within the Peribaltic Group (leader: E. Lagerlund) which is connected to the IGCP 253. The project's aim is to correlate the Quarternary stratigraphies in the countries around the Baltic Sea. In recent years investigations have been carried out in Poland, Germany and Sweden (eg Malmberg- Persson & Lagerlund, in press).

There are a lot of differences and disagreements between the Polish and German Quarternary stratigraphies. The Polish geologists are of the opinion that the deglaciation after the Weichselian maximum extension of the ice sheet was a continuous process (Kozarski 1981, 1987; Karczewski 1985, 1989, 1990; Mojski 1992). The ice marginal deposits are considered to be witnesses of ice stagnation or smaller oscillations. According to the German point of view they constitute the margins of ice readvances (Cepek 1965, 1967, 1972; Rühberg 1987).

The general Quarternary stratigraphy in this part of Germany is according to Cepek (1967) as follows:

Weichsel-2 (Pomeranian stage)

Blankenberg interstadial

Weichsel-1 (Brandenburg stage)

Eem interglacial

Saale-3 (Lausitz glacial)

Rügen interglacial

Saale-2 (Fläming glacial)

Treene interglacial

Saale-1 (Lausitz glacial)

Holstein interglacial

Elster-2 glacial

Elster-1/2 interglacial

Elster-1 (Helme glacial)

To distinguish the tills of the different glacial periods from each other lithologic analyses of the clast content (4-10 mm) are used (Krienke& Harff 1979; Rühberg & Krienke 1977). This method considers the percentual share of Scandinavian crystalline (NK), Paleozoic limestone (PK), Paleozoic shales (PS), dolomite (D), flintstone (F or Ffr) as well as sandstone and quartzite (S). These and the quotients NK/PK, NK/D, (PK+D)/S, (PK+D)/(PS+S) and the percentual part of PS of the sum F+PK+PS are used as distinguish marks to determine the stratigraphic position of the diamicton. In this work these operations were realized, too (Table 4). According to the standard TGL25232, the counting results are plotted against their PS/PK/F relations in a triangel diagram (Figs. 2, 38).

According to Cepek 1976; Krienke & Harff 1979; Rühberg & Krienke 1977 and the standard TGL 25232 the lithologic composition in Weichsel-2 diamictons should be as following: high content in Paleozoic shale, thus low NK/PS-quotients (<1 in Mecklenburg).

The investigated gravel pit "Hinterste Mühle" is situated in the county Mecklenburg/ Vorpommern in northeastern Germa-

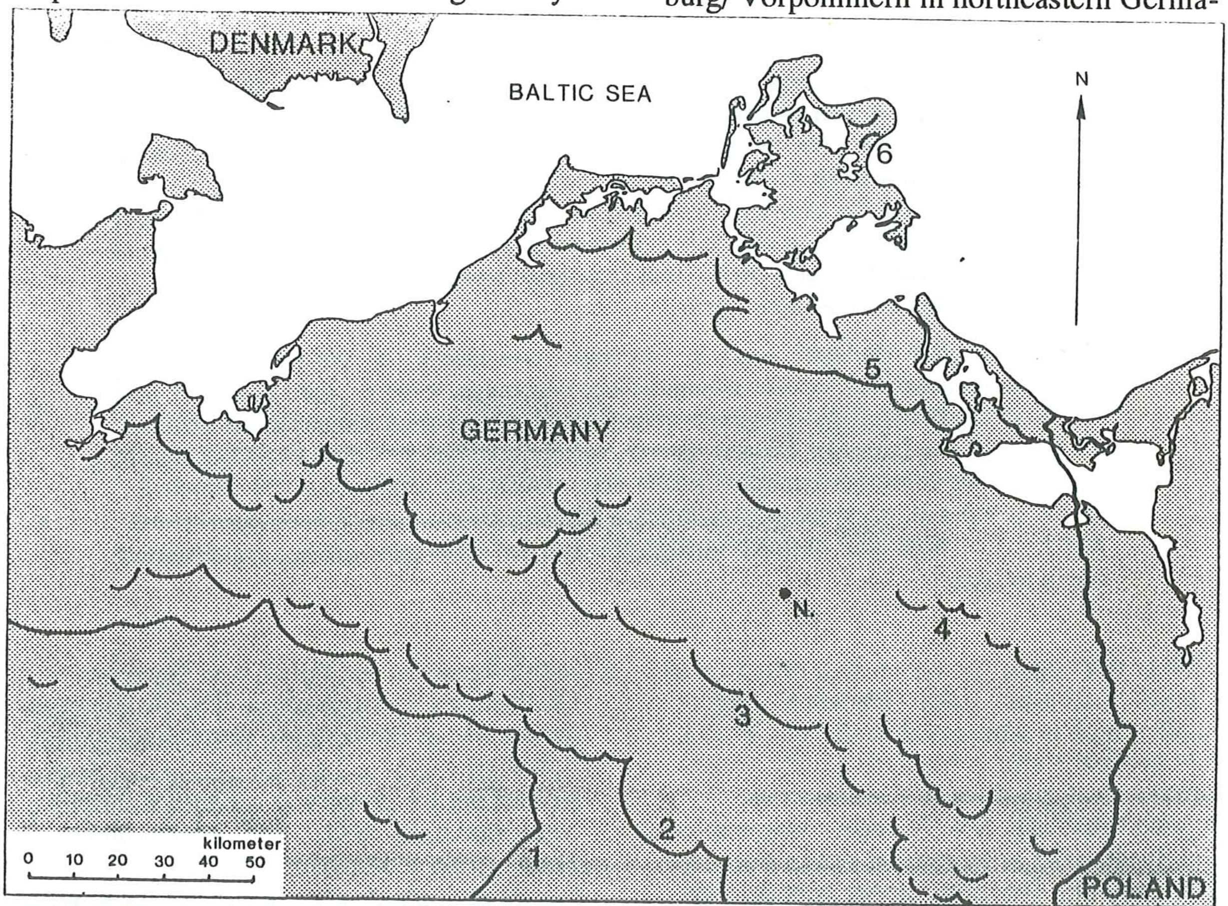

Fig. 1. The location of the gravel pit near Neubrandenburg (N.) in relation to the ice margins during the Weichselian. 1) Brandenburg stage (Weichselian maximum), 2) Frankfurt stage, 3) Pomeranian stage, 4) Rosenthal line, 5) Velgast line, 6) North Rügen line

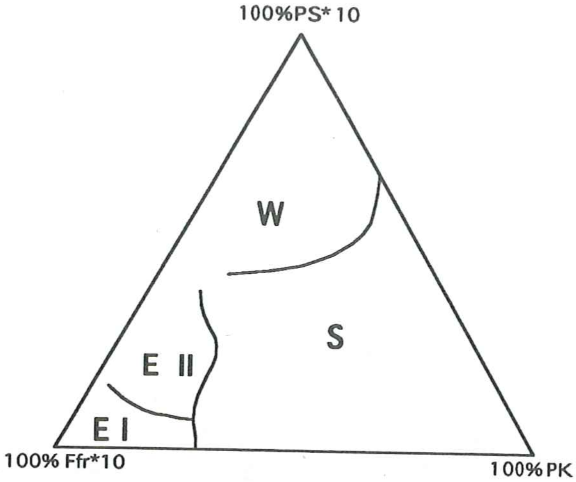

Fig. 2 The standard triangel diagram of the TGL 25232. W - Weichsel, S - Saale, E - Elster, F - flint, PK - Paleozoic crystalline, PS - Paleozoic shale

ny, near Neubrandenburg (Fig. 1 and Fig. 3). The surrounding landscape is formed by the last glaciation. When the ice sheet retreated it left small hills and shallow valleys. Between the highest and the lowest point in this area the difference is about 80 m. Often the depressions are filled with water, so a lot of smaller and larger lakes make the landscape varied. The lake Tollensesee coming near to the town Neubrandenburg is one of the larger ones. It extends about 10 km towards south southwest, the ice movement direction of the last ice sheet. Approximately 30 km south of Neubrandenburg the landscape is more hilly and it is interpreted as an end moraine zone of the Pomeranian stage (e.g. Cepek, 1972). Ridges, appearing as small peninsulas in lake Tollensesee and lying transverse to the ice movement direction are interpreted as recessional moraines, deposited during the continued ice retreat (Reinhard 1965). North of Neubrandenburg the landscape is characterized by the wide and even valley of the river Tollense, which stands for the main drainage of this area towards the Baltic.

The gravel pit at Neubrandenburg was opened more than 100 years ago when the the railway between Berlin and Stralsund was built. Since then the quarrying has been going on (Steusloff 1888). Its name "Hinterste Mühle" means backmost mill and it is

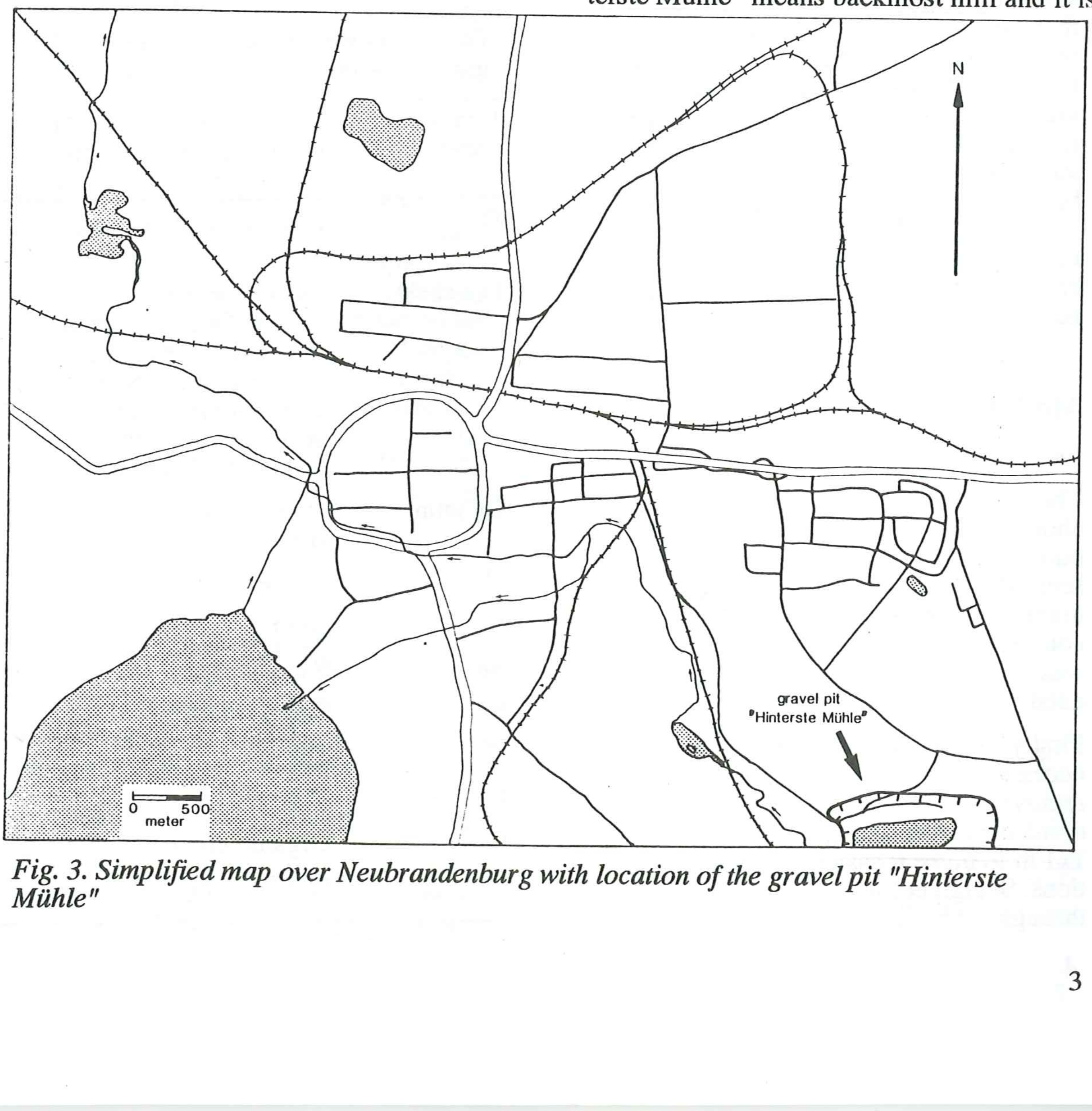

Fig. 3. Simplified map over Neubrandenburg with location of the gravel pit "Hinterste Mühle"

named after the nearby old water mill.

Unfortunately, former investigations were carried out only in economical purposes. Thus the geological background is not especially well-known. Most of the stratigraphical classifications are based on gravel counts on samples from bore holes (Cepek 1967, 1972; Rühberg 1987) or due to differences in color, silt/ sand- proportion and clay content (Reincke, pers. communication). Because of the political situation in the former DDR, results could not always be published. Just a few internal reports exist, which contain only small chapters on the geology of the area. Therefore a lot of information have been lost, for example about a peat sequence which does not exist any more.

Schulz and Reincke (1992, pers. communication) have proposed that the gravel and sand in the central part of this pit was deposited in a large west-northwest-directed subglacial tunnel. This tunnel is thought to be re-established as drainage conduit of glacial meltwater during the deglaciation stage of several glacial periods. It is proposed that there are deposits of Elsterian age at the bottom of the sequence. At both margins of the tunnel deposits, deep and steep unconformities (German: "tiefe Grundspalten") has been observed. These are characterised by folded and deformed silt and sand beds, in most cases steeply dipping. Reincke and Schultz (1992, pers. communication) interpret them as the result of deep erosion at the margins of the subglacial tunnel.

Methods

Field work

The southeastern part of the gravel pit was choosen for investigation because of its outcrop conditions. Moreover, this part seemed to be the most interesting as diamicton and sand beds form a nearly continuous sequence. Also an organic layer was observed which possibly could be datable.

Firstly suitable sections were cleaned and, if necessary, slumped and slided masses were removed. Then the cleaned surfaces were divided by nails and cord into squares of 1x1 m to make it easier to sketch the sections. Sediment logs were also made through each section, or over parts of sections which were not documented in full. The abbreviations used in the headline of the logs mean:

C = clay

Si = silt

f = fine

m = medium

c = coarse

Every lithotype has got its own pattern. Average grainsize corresponds to the drawn width according to the grain size sectors mentioned above.

Then a thorough description of all beds and their contacts was made. These descriptions are summarized in Appendix were the first column indicate the depth of the lower contact of the described bed. Its thickness is given in the second column. The codes used in the third column are lithofacies codes modified from Eyles et al. (1983) and Möller (1987) and these are used according to the following scheme (Table 1):

Table 1: Legend to the lithofacies codes used in the logs and the Appendix

Lithofacies code	Lithofacies type description (grain size, grain support system, internal structures)
D	Diamicton in general, unspecified
D(s,si,c)-	Diamicton, sandy, silty or clayey. One or more grain-size code letters within brackets. This specification does not mean the average grain size, but the predominance of a fraction.
D( )mm	Diamicton, matrix-supported, massive
G	Gravel
S-	Sand
Sm	Sand, massive
Ss	Sand, stratified
Si	Silt
C	Clay
O	Organic matter
-/-	Interbedding

In the fourth column at last follows a bed description in the following order: general remarks, sediment colour and structures, special features (humus, larger clasts, lenses etc.), lower contact.

Often interesting details and sometimes whole sections were additionally documented by photographs.

Because of the strongly deformed sediments in the majority of the sections, it was not suitable to make large-scale pebble fabric measurements. Only the uppermost diamicton bed, which lies almost horizontally, and another even, slightly dipping diamicton sequence were choosen for this purpose. In every analysis, dips and strikes of the longitudinal axises for between 25 and 30 particles were measured. Measurements were made on medium-gravel size particles, having a pronounced long axis (about two times longer than the particle's width). In the uppermost diamicton (at site C), fabric analysis was made at 5 different levels with an interspace of about 50 cm. In an other sequence (site A) two thin diamicton beds lying above or beneath an organic bed respectively were analysed. All data were evaluated with statistical methods according to Mark (1974).

Diamicton samples were taken in order to determine their relative ages according to Cepek (1972). If suitable, samples were taken where fabric analyses had been made (Figs. 8, 9, 10, 20, 21). Three samples were taken in different organic layers. These were thought to give some information on the sedimentation conditions and age of deposition. Moreover a very few sand, silt and clay samples were taken for grain-size analysis. All sampling points are shown in the drawn sections and logs (Figs. 8, 9, 10, 20, 21, 26, 27) and in the map (Fig. 7), respectively.

Laboratory work

Laboratory analysis of grain-size distribution was made by sieving of the coarse fraction (>0,063 mm) and by sedimentation analysis of the finer fraction. The results are illustrated in plots of grain size (in mm) versus mass-percentage and grain size versus cumulative mass-percentage (Talme & Almén 1975).

The lime content of the sediment samples was determined according to Talme & Almén (1975). Because of the deformation it was not possible to make diagrams showing the change of the lime content through a whole sequence. Therefore it is illustrated in stack diagrams, where the lime content is plotted against the sample number (Figs. 16, 24).

Lithologic analysis was carried out on the gravel grades 2,8-4 mm, 4-5,6 mm, 5,6-8 mm and >8 mm. However, due to its low absolute content in particles, the fraction >8 mm was not taken into consideration for statistical comparison.

The grains, identified under the microscope, were divided into a lot of groups and subgroups:

1. Crystalline
   - a) acid plutonites
   - b) acid volcanites
   - c) basic plutonites (gabbro) and amphibolites
   - d) basalt
   - e) dolerite
2. Dolomite
3. Paleozoic limestone
   - a) red limestone
   - b) grey limestone
   - c) grey sandy limestone
   - d) grey glauconitic limestone
4. Cretaceous
   - a) chalk
   - b) glauconitic chalk
   - c) flint
5. Danien limestone
6. Sandstone
   - a) violet sandstone
   - b) red sandstone (occurs sparsely)
   - c) green (glauconitic) sandstone
   - d) quartzitic sandstone
   - e) other sandstone
7. Quartzite (sometimes difficult to distinguish from 1a) and 6d))
8. Shales/Siltstones
9. Alumshale
10. Others (limonite, pieces of wood, unidentifiable)

Only the groups (1-10) are shown in the stack diagrams (Figs. 11, 12, 13, 22, 28, 34, 35). Every stack represents one fraction. In the uppermost stack all fractions are summed up. In this way it is possible to compare the individual fractions and notice occuring differences. At the end of every stack the absolute number of counted particles is noted.

The subgroups are in most cases represented by just a very few particles, therefore statistical comparison between them is not possible.

Even if the samples 8, 9 and 15 contain only a very low number of countable particles, they were taken into consideration anyway. They show at least no deviating pattern in their rock type distribution, but follow the general trends.

To make the counting results comparable with other gravel countings carried out by German scientists, a calculation procedure generally used in eastern Germany (Krienke & Harff 1979; Rühberg & Krienke 1977) has been applied. This method considers the percentual share of Scandinavian crystalline (NK), Paleozoic limestone (PK), Paleozoic shales (PS), dolomite (D), flintstone (F) as well as sandstone and quartzite (S). These and the quotients NK/PK, NK/D, (PK+D)/S, (PK+D)/(PS+S) and the percentual part of PS of the sum F+PK+PS are used as distinguish marks to determine the stratigraphic position of the diamicton. In this work these operations were realized, too (Table 4). According to the standard TGL25232, the samples were plotted against their PS/PK/F relations in a triangel diagram (Fig. 38) and compared with the standard.

In accordance with Cepek (1969) special weight has lain to dolomite. Unfortunately his method could not be used, because of the lack of the ingrediences. Nevertheless the dolomites has been distinguished to my best ability.

In two of the samples containing organic matter the pollen assemblage and the makrofossil content were analysed. The pollen spectrum is illustrated in a stack diagram, where the individual pollen species are plotted against their number.

The result of the makrofossil analysis (by Keding, pers. communication) is illustrated in a simple table form (Table 2 and 3).

In Figs. 8, 9, 10, 20, 21 the measured trends of the fabric analyses are plotted in circle diagrams.

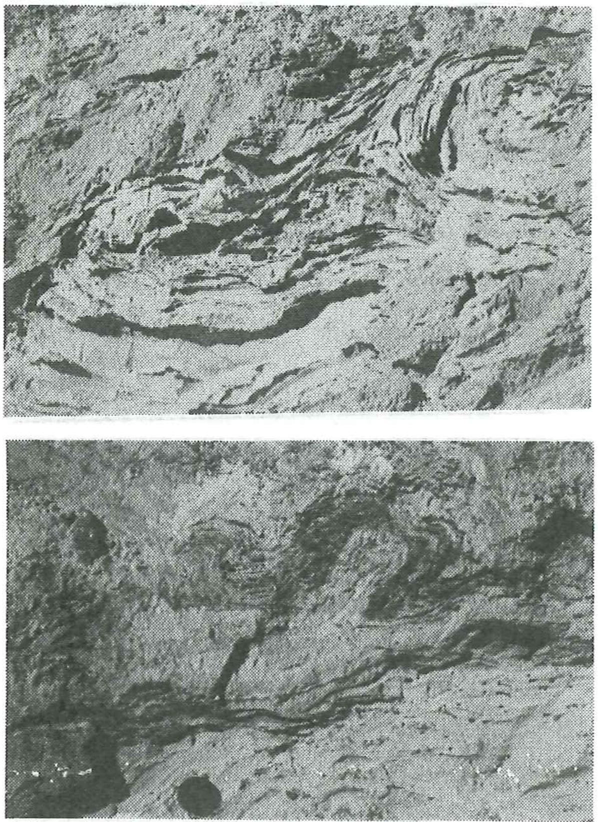

Fig. 4. Flow structures at site D

General description

The central part of the pit consists of a body with sorted sediments, which strokes ESE-WNW (parallel to the former glacier front). The grain size varies between fine sand and fine gravel, and cross-bedding, ripples (A, B and C), and planar lamination structures can be observed, indicating fluvial sedimentation regimes (Fig. 6). Measurements indicate a mean stream direction towards the

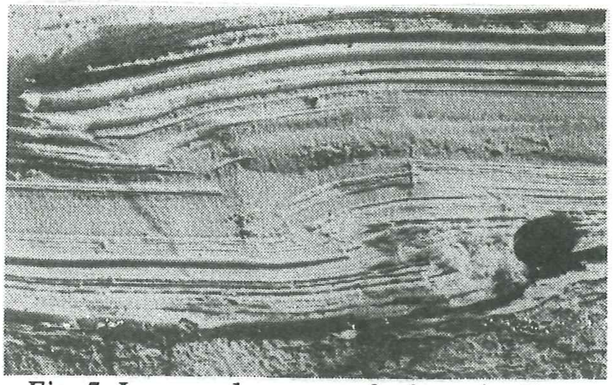

Fig. 5. Low-angle reverse fault at site B

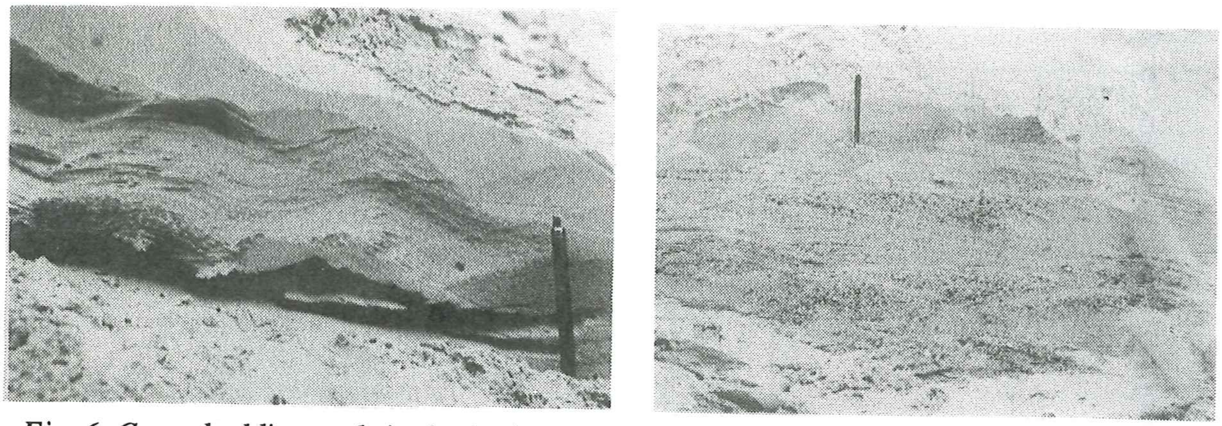

Fig. 6. Cross-bedding and ripples in the central parts of the gravel pit

westnorthwest. The sedimentation structures are not or just slightly deformed.

At its both margins, ie at the northern and southern part of the gravel pit, a lot of deformation structures can be observed, eg. faults and flexures in the sand (Fig. 5). Simultaneously, diamicton and finer sediments as silt and partly clay occur more frequently. In these sediments faults (displacement some mm), folds and flexures occur. Neither the fold axises nor the beds dip follow a regular pattern in their spacial location.

All these are covered by an about 2 m thick diamicton. Typical flow structures are common here (Fig. 4).

There is no unconformity continuing over the whole area, only smaller ones, which disappear after a couple of meters.

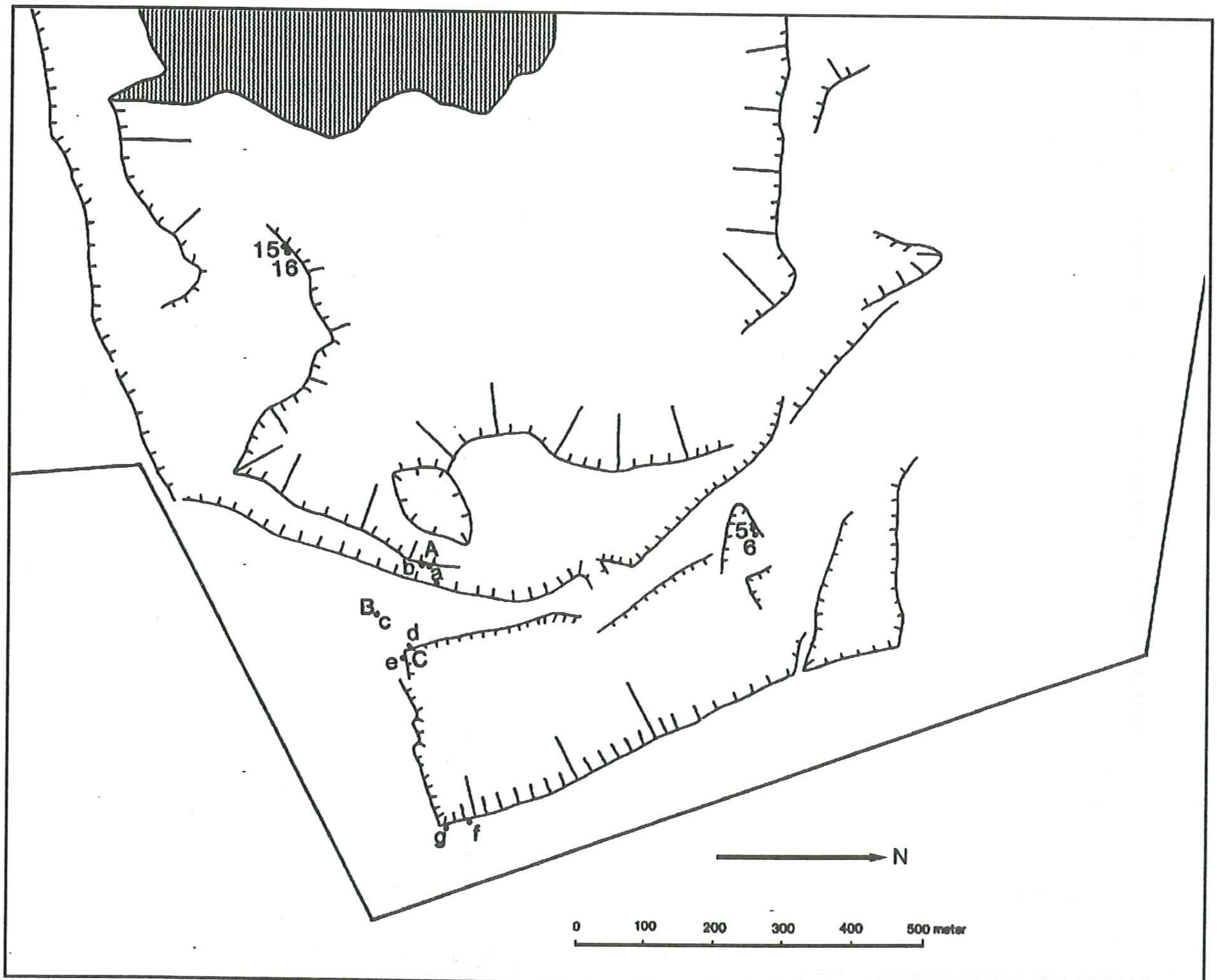

Fig. 7. The eastern part of the gravel pit with the location of sites and logs

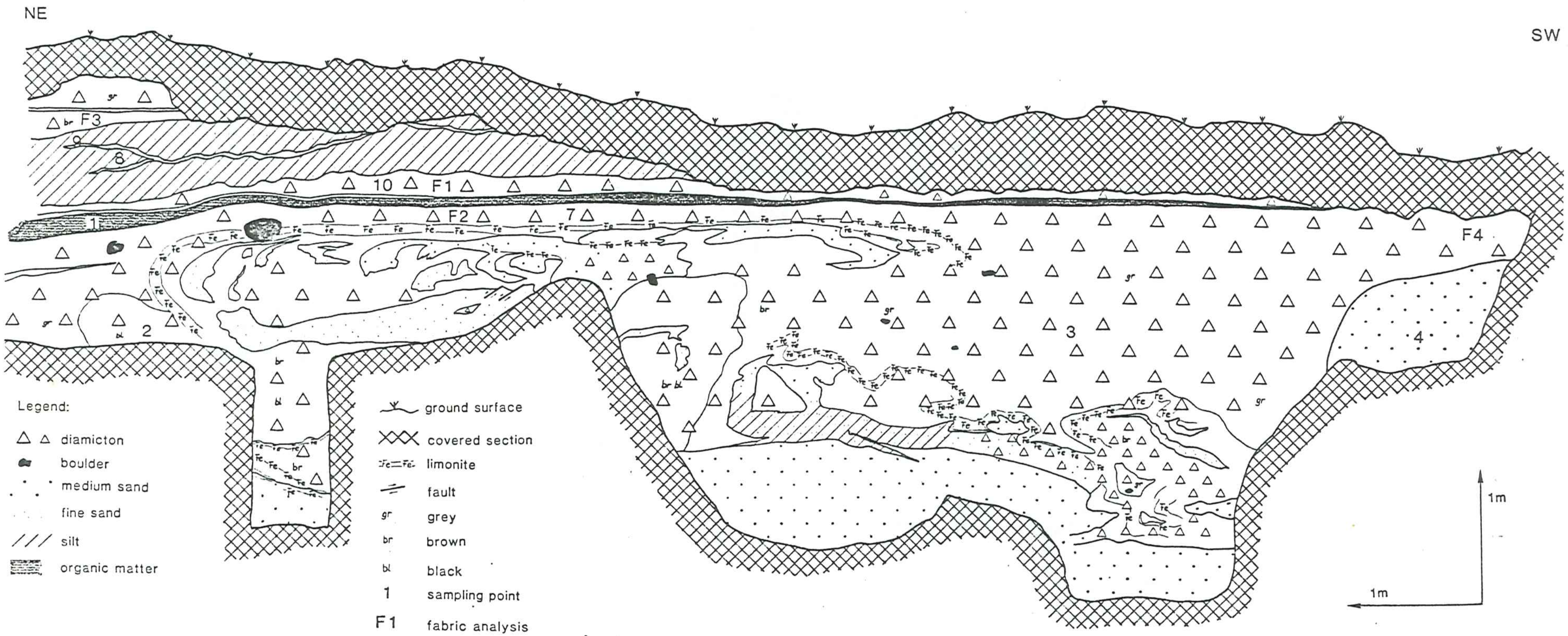

Fig. 8. Section at site A. The location of log a (Fig. 5) is indicated. Log b (Fig. 6 is situated ca. 10 m sothwest of the section

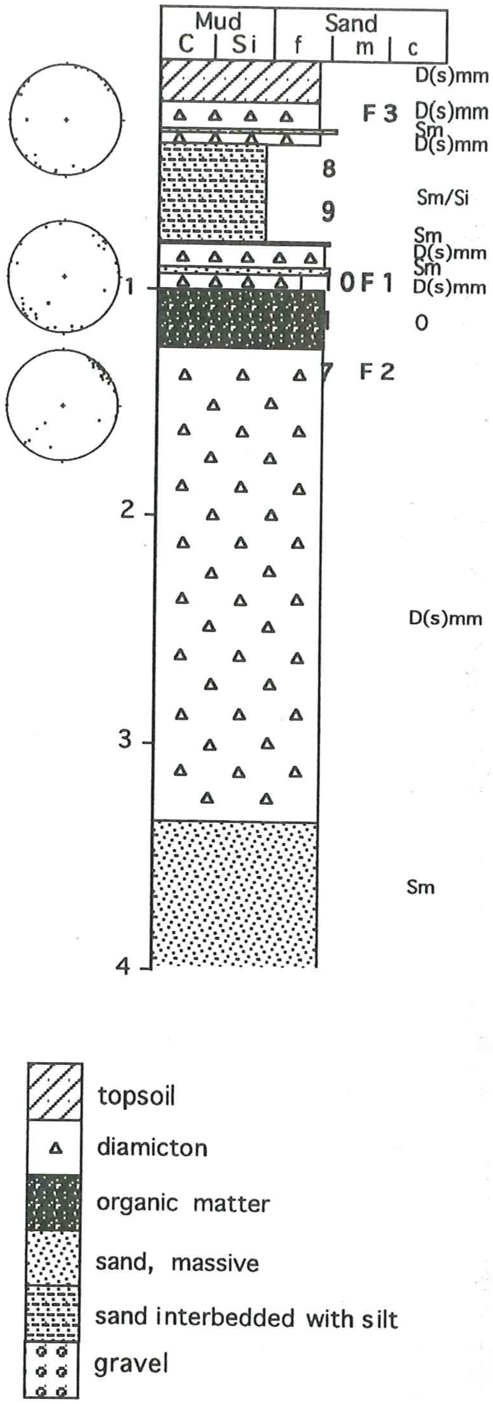

Fig. 9. Log a. Legend also valid for log b

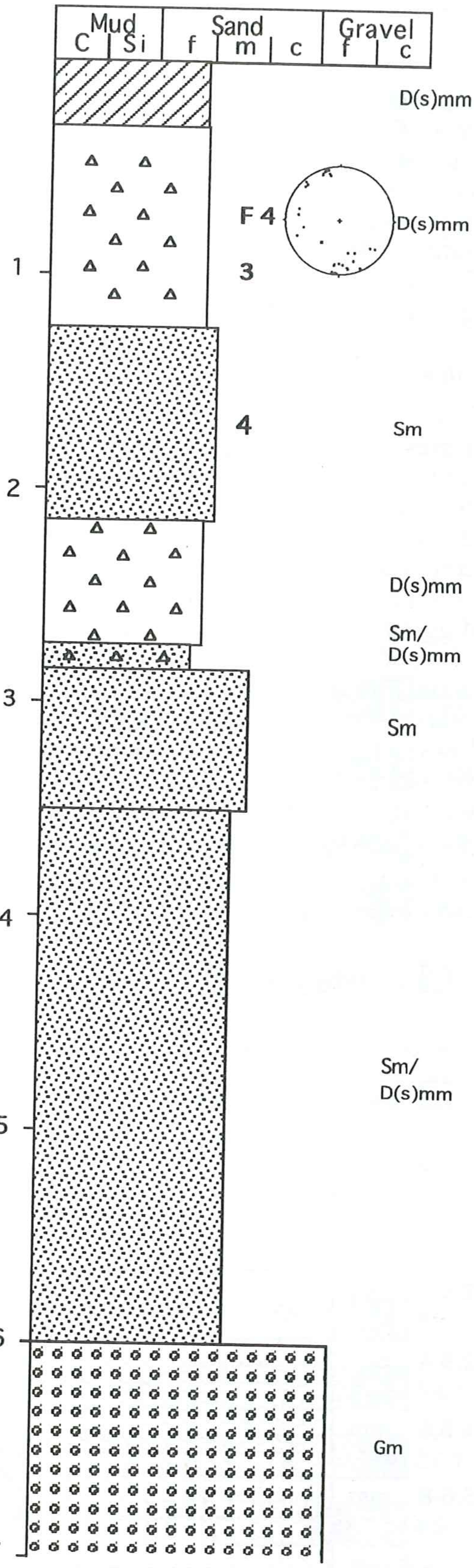

Fig. 10. Log b. Legend see at log a

Description of the sites

Site A (logs a and b)

The sediments in site A consist of diamicton, sorted sand, fine sand and silt in interbedding and a layer consisting organic matter (see Fig. 8). The original bedding in the lower part of the sequence is disturbed by folding and minor faults. Often the internal contacts have been erased, they remain as mixture of the neighbouring sediments. The sand lying beneath is of medium sand grain-size and continues probably a couple of meters downwards, with minor changes in grain-size. The following part consisting of diamicton, sand and silt is heavily deformed. Folds occur and even low-angle normal faults. The grain-size of the sand varies between fine and medium. The diamicton appears massive, matrix-supported and sandy. Larger boulders occur only sparsely. The colour of the diamicton shifts from grey to black and brown. In connection with sand occurs ironoxide (FeOOH) and manganeseoxide (MnOOH) in precipitaton.

The upper unit of the sequence consists of almost horizontally lying beds of organic matter, diamicton and interbedded silt and fine sand. The organic bed at the bottom of this unit is about 10 - 15 cm thick, but it continues only 30 m (the right margin can be seen in the site, the left was checked by digging). This bed contains a lot of pieces of wood (undefinable) and other plant remains, for example a shell of hazelnut (*Corylus*). A thinner beds of diamicton follows, which is similar to that described above. Above sand and silt are interbedded with an interspace of about 10 - 20 cm. On the top a brown, sandy diamicton occur which include some thin uncontinuous streaks of sand.

Fabric analysis

Stress direction analysis was carried out by fabric analysis. In Fig. 8 the measure points of fabric analysis are shown. Naturally, the horizontally lying beds was of most interest. Fabric 2 shows a strong dip direction towards NE. Just a very few particles are orientated in the opposite direction. This indicates a transport from NE (stress from NE). In fabric 1 however, the orientation pattern has changed. The orientation is more random, even if a poor preferation to SW can be recognized. The majority of the particles lies more or less in NE-SW direction. A secure stress indication can not be made out. Fabric 3 shows a similar pattern as fabric 2 with a more or less horizontal position of the particles and a preferred orientation towards SW-NE. It is remarkable that both in fabric 2 and fabric 3 a low number of particles have a orientation in NW-SE, twisted nearly exact 90° against the preferred orientation. Fabric 4, however, measured just a few meters away from fabric 1, 2 and 3, shows a completely different pattern. The trend direction is NNW-SSE, with a slight predominance to SSE. Thus, a possible stress direction is in this case from SSE.

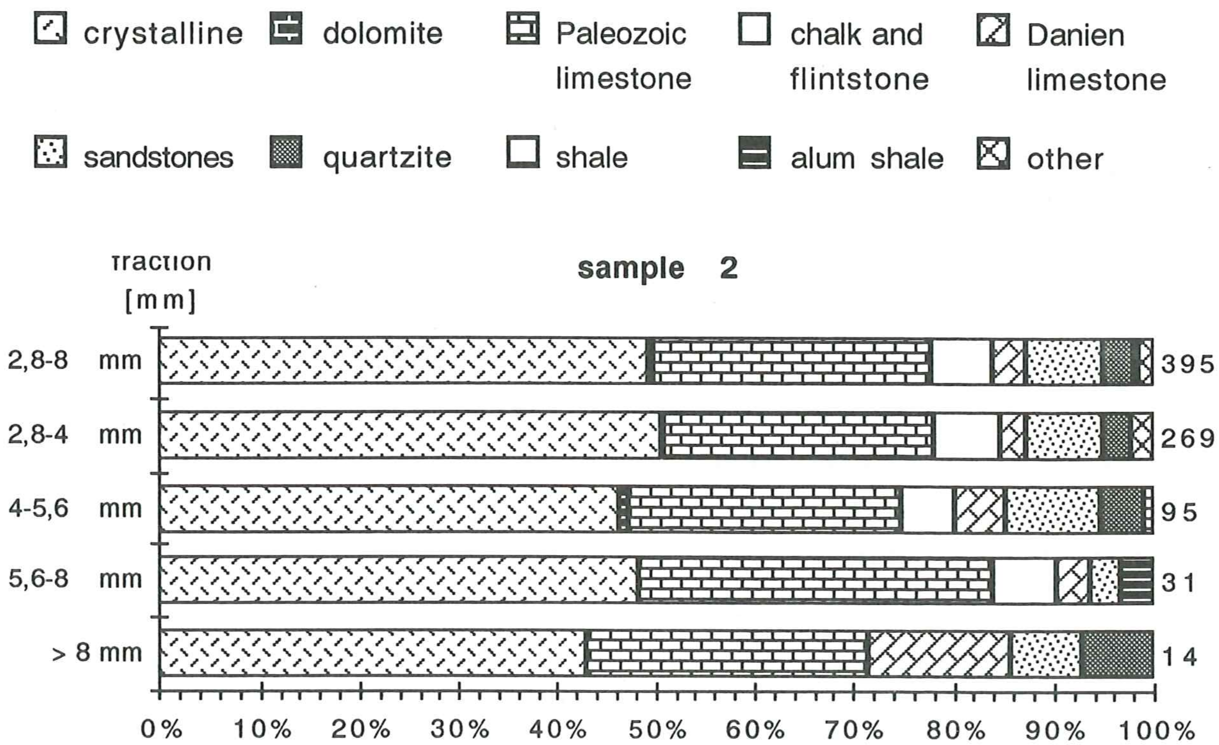

Fig. 11. Lithologic composition of samples 2, and 3

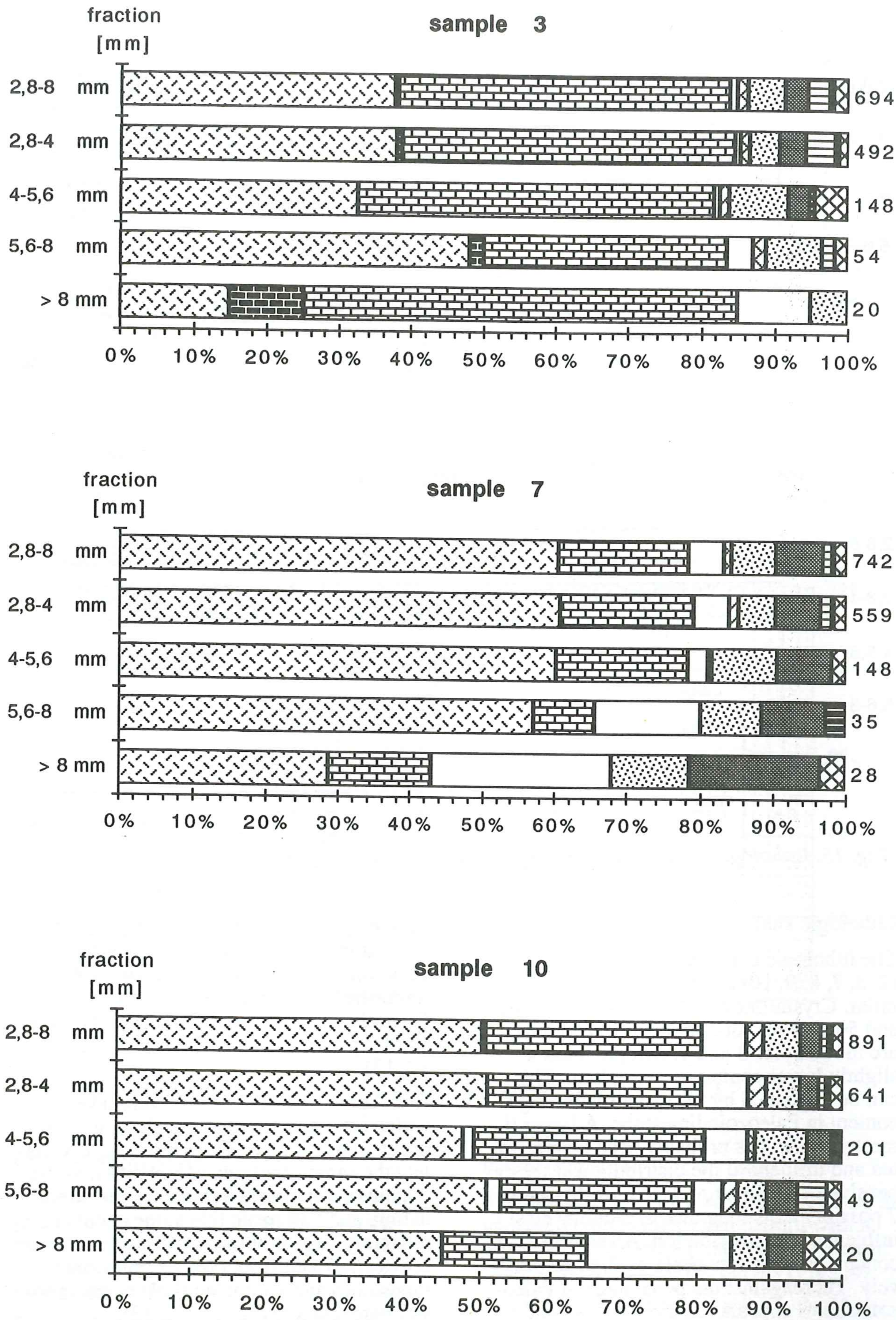

Fig. 12. Lithologic composition of samples 3, 7 and 10

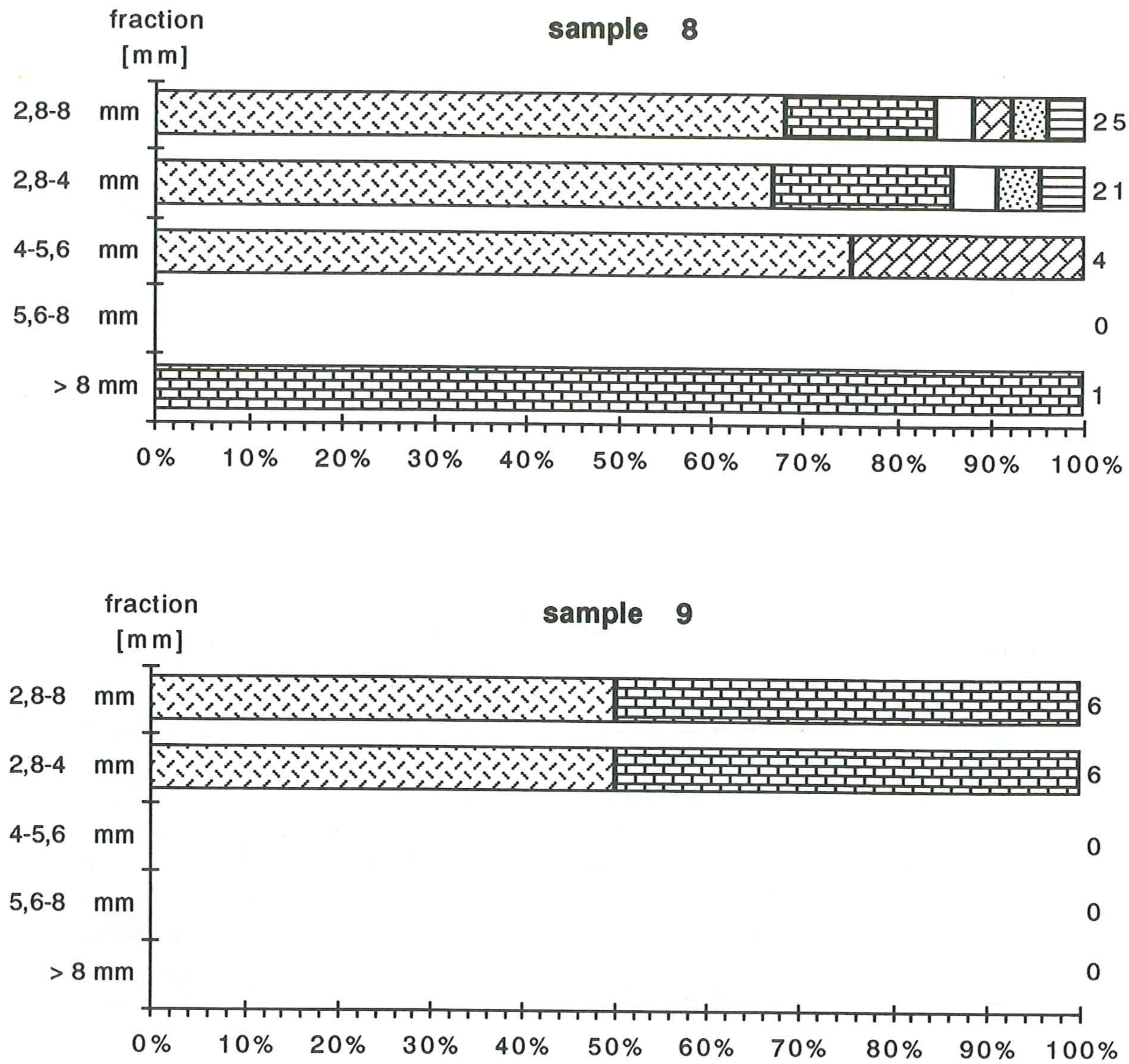

Fig. 13. Lithologic composition of samples 8 and 9

Lithologic analysis

The lithologic composition in the samples (2, 3, 7, 8, 9, 10) appears to be strikingly similar. Crystalline constitutes between 40% and 50% of the total number. Exceptions are the samples 3 and 7. Sample 3 has a slightly lower content in crystalline. This can be explained by the synchronous high content in Paleozoic limestone. A larger limestone clast has probably been disintegrated and influenced the distribution at the expensive of the other rock groups. In sample 7 possibly a disintegrated crystalline clast influenced the distribution. All samples contain more or less chalk or flint, respectively. Thereagainst the percentage of Paleozoic shales appears relativelily low, seldom it exceeds the chalk/flintstone percentage. Dolomite occurs rather sparsely in all samples, its percentage do not exceed 2%. The content in Danien limestone varies heavily. This can be due to that it was hardly distinguished from silicified cretaceous chalk. Quartzite and sandstone occur in relatively similar percentages in all samples (Fig. 11, 12, 13).

Even if the samples 8 and 9 were taken in sorted sand and silt, the few clasts which occur were counted. They show approximately the same lithologic composition as the diamicton samples. Crystallines are dominating, and Paleozoic limestone occurs in relatively large content, too. Besides Cretaceous chalk and flint, Danien limestone, sandstones and Paleozoic shale occur in lower percentages (Fig. 11, 12, 13).

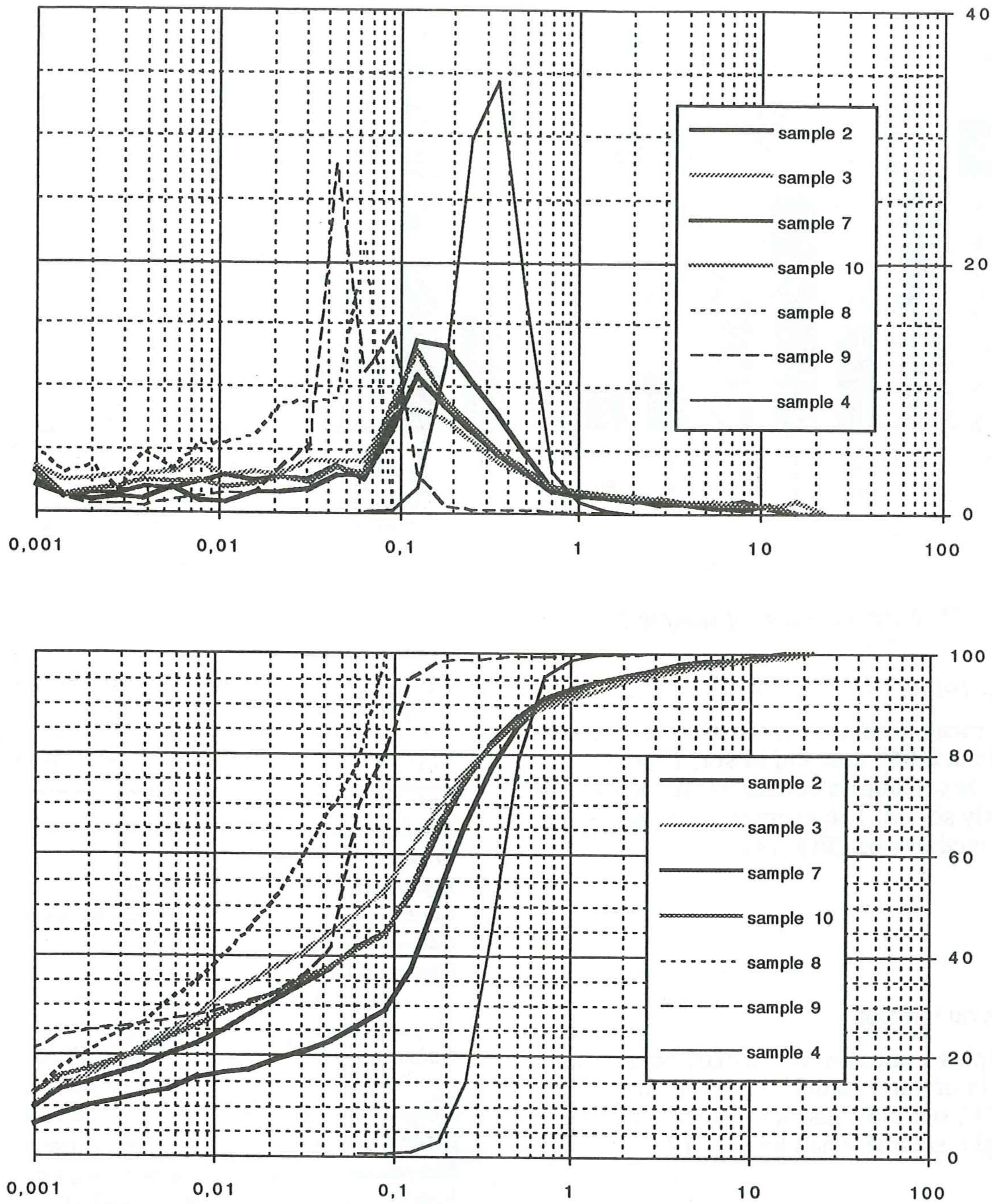

Fig. 14. Grain size and cumulative grain size diagrams of samples at site A

Grain-size analysis

The diamicton samples show a quite similar grain size pattern. The mean grain size is between 0,1 and 0,2 mm in all cases, with other words in the upper part of the fine sand fraction (Fig. 14).

Sample 3 is the only unusual sample. It is characterized by a relatively significant silt fraction, but fine sand is nevertheless dominating (Fig. 14).

The cumulative grain size diagrams show in general a typical diamicton pattern with a broad spectrum and a relatively low ascent even in the middle of the curves (Fig. 14).

Sample 4 is a well-sorted sand with a dominating grain size of between 0,1 and 1 mm. Its maximum lies at about 0,35 mm and corresponds so to the medium sand fraction

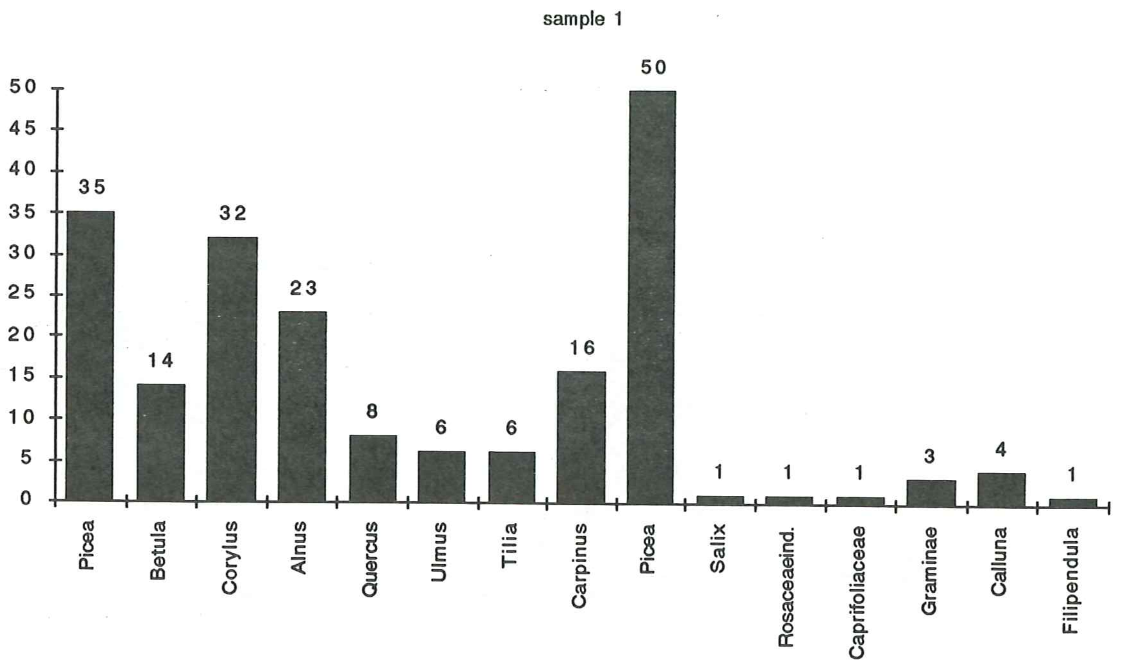

Fig. 15. Pollen content of sample 1

(Fig. 14).

The mean grain size in the samples 8 and 9 is about 0,063 mm and lower. That means that these samples consist of coarse silt, but poorly sorted. The average grain size is fine and medium silt (Fig. 14).

Loss on ignition

Samples 1 and 2 were checked on their content in organic matter. After warming upto 550°C, sample 1 had lost 7,783 % of its weight, sample 2 had lost 1, 319 %.

Pollen analysis and plant remains analysis

Sample 1 has a very manifold pollen spectrum. In most cases the pollen grains are not corroded and clearly identifiable. Species as *Pinus*, *Picea*, *Corylus*, *Betula* and *Alnus* dominate, but more warmth-demanding trees like *Carpinus*, *Tilia*, *Quercus* and *Ulmus* occur in valuable numbers. Moreover pollen of *Salix*, Rosaceae, Caprifoliaceae, Graminae, *Calluna*, *Filipendula* and *Lycopodium* occur to a lesser degree (Fig. 15). This is a typical pollen spectrum for a

Table 2: List about the plant remains in sample 1 (after E. Keding, 1992)

Upper part of sample 1	Lower part of sample 1
Andromeda polifolia	*Alisma sp.*
Betula alba s.l.	*Alnus incana vel viridis*
Brasenia holsatica	*Betula alba s.l.*
Bryophyta	*Brasenia holsatica*
Carex sp.	*Bryophyta*
Carpinus betulus	*Carex sp.*
Ceoncoccum geophilum	*Carpinus betulus*
Corylus avellana	*Cenococcum geophilum*
Dulichium arundinacaeum	*Comarum palustre*
Eriophorum vaginatum	*Cristatella mucedo*
Lycopus europaeus	*Eriophorum vaginatum*
Menyanthes trifoliata	*Hippuris vulgaris*
Najas flexilis	*Myriophyllum spicatum*
Najas marina	*Nitella sp.*
Pinus sp.	*Nuphar lutea*
Potamogeton sp.	*Nymphaea sp.*
Rubus sp.	*Potamogeton natans*
Salvinia natans	*Potamogeton sp.*
Schoenoplectus lacustris	*Ranunculus aquatilis s.l.*
Taxus baccata	*Salvinia natans*
Tilia tomentosa	*Schoenoplectus lacustris*
Typha sp.	*Tilia tomentosa*
Viola sp.	*Typha sp.*
	Vaccinium sp. s.l.

fully developed interglacial and it is probably of Eemian age (Berglund, pers. communication). Above all the high amounts of *Carpinus* and *Picea* indicate a very late stage of an interglacial cycle and do not allow the interpretation as an interstadial. No pollen of *Fagus* has been noticed, thus the interpretation as Holocene can be excluded. The layer in which sample 1 was taken, can be considered to be resedimented, because of its high amount of clastic sand, silt and gravel. Most of the wood pieces are rounded, indicating that they have been transported.

Table 2 illustrates the results of the plant remains analysis carried out by E. Keding (1992, unpublished).

Keding propose, that the species of the so-called "Brasenia-complex" indicate interglacial conditons during the climate-optimum. An Eemian age of the organic matter has to be assumed.

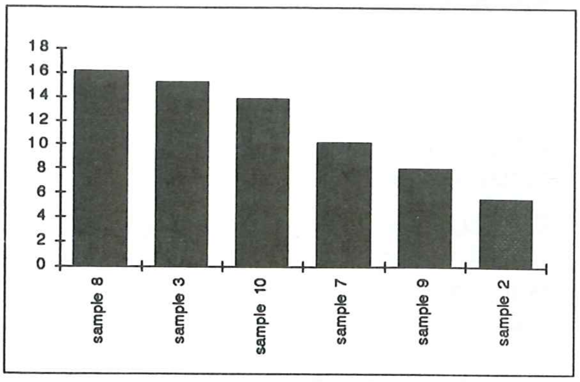

Fig. 16. Lime content of samples at site A

Lime content

There is no direct connection between lime content and stratigraphical level, as illustrated by Fig. 16.

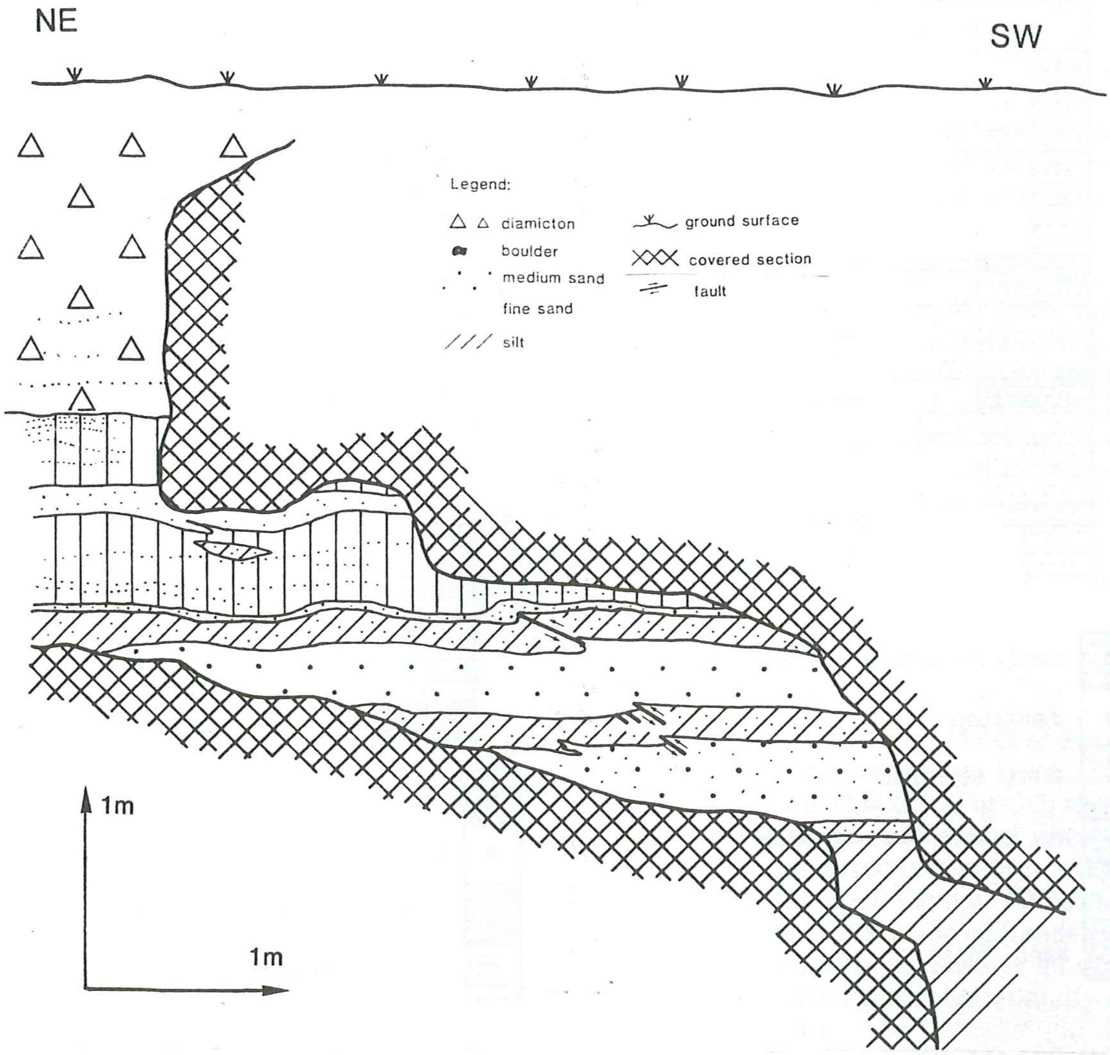

Fig. 17. Section at site B

Site B (log c)

The top of site B lies about 4 meters higher than that of site A. Here silt, sand (fine and medium), interbeddings between sand and silt, and diamicton occur in an almost horizontal bedding.

The sequence starts with interbedded sand and silt, which seem to continue downwards as much as to the bottom of the gravel pit, situated about 15 m below. These interbeddings are similar to those at site A in their grain-size, colour and thickness. The sandy/silty beds are disturbed by minor low-angle reverse faults, which do not continue through the coarser sandy beds. Instead the sandy beds are slightly folded.

The diamicton above is brown and contents small lenses or streaks of sand. Boulders occur only sparsely.

In opposite to site A, site B showes neither large scale folding or thrusting, nor organic matter occur (see Fig. 17, 18).

Because of the similarity to the sediments at site C, this site B was not sampled.

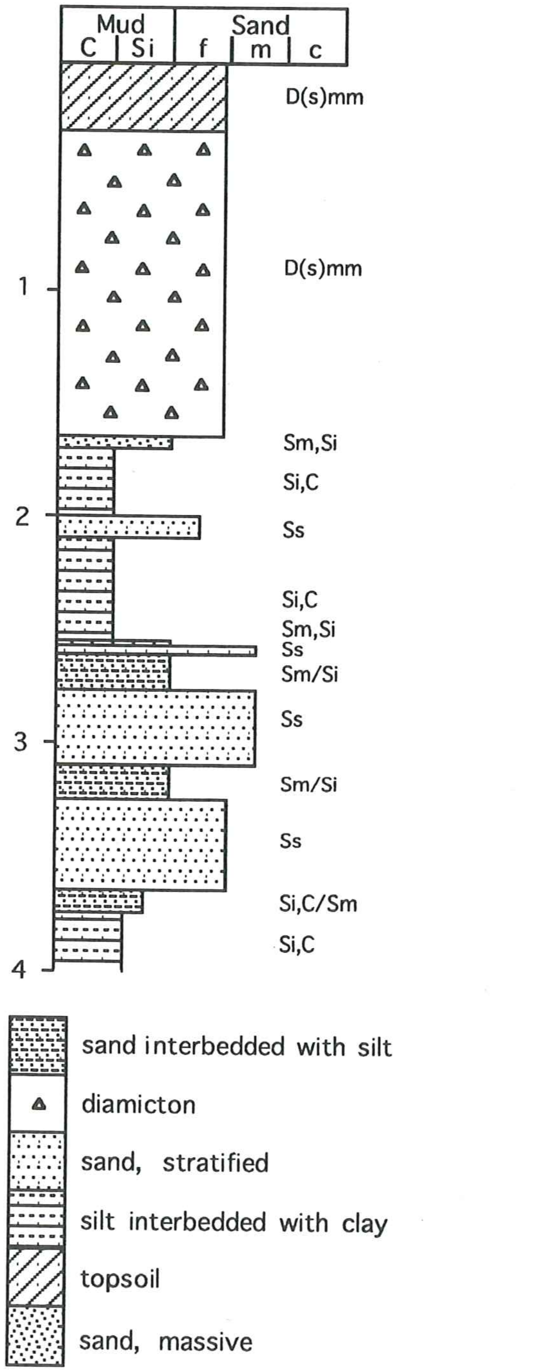

Fig. 18. Log c

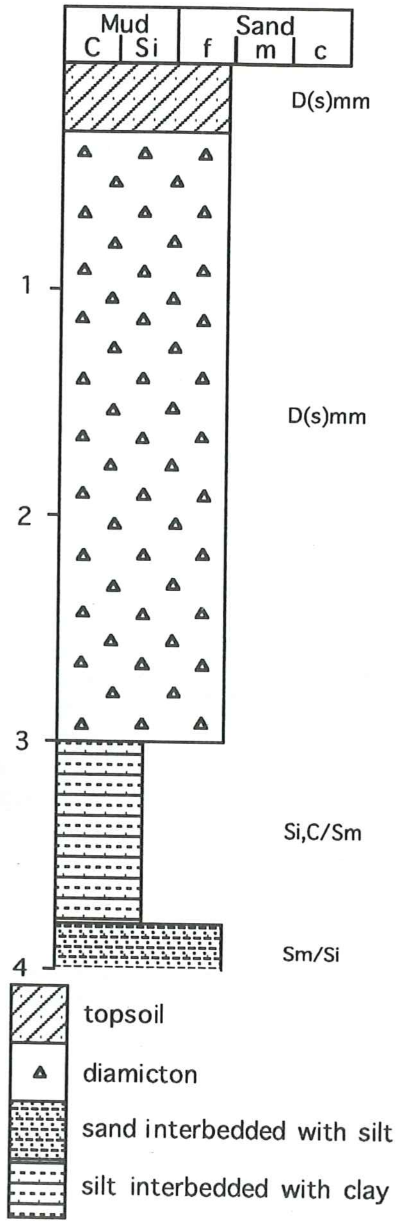

Fig. 19. Log d

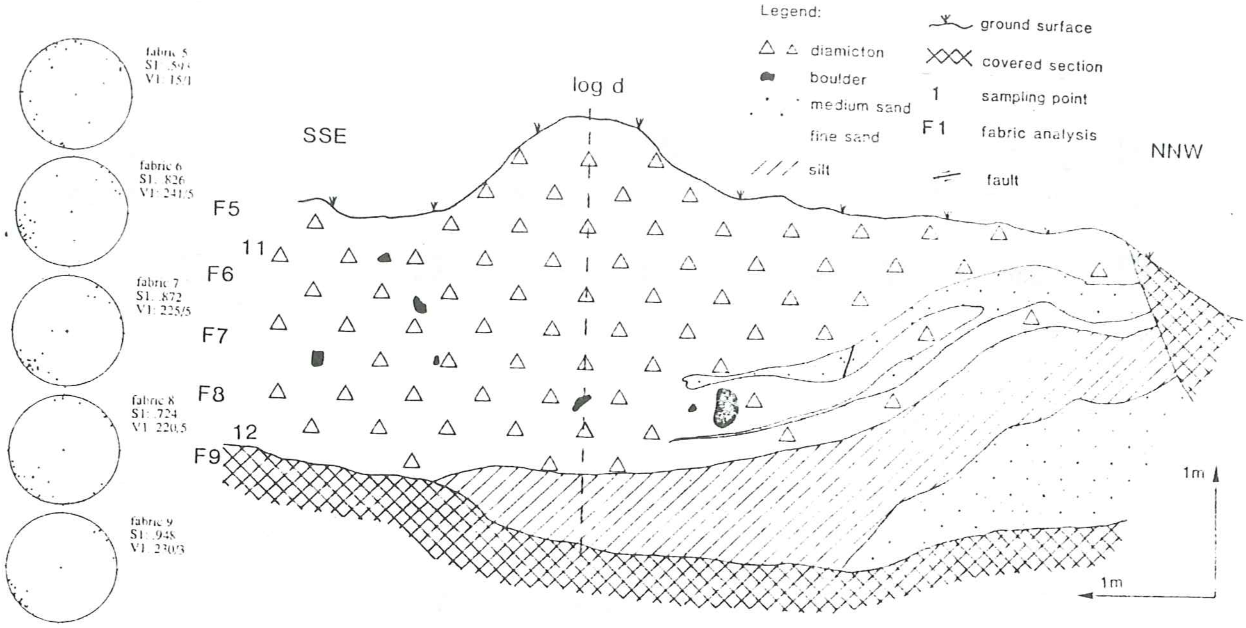

Fig. 20. Section at site C. Log e is situated about 5 m SSE of the section.

Site C (logs d and e)

Site C lies at about the same topographical level as site B. Sand (fine to medium), sandy silt and diamicton occur. The beds are not horizontal, but they are bended up towards the NNW. Even this sequence starts with sand and silt, which probably continue downwards to the bottom of the pit.

The diamicton above is brown, sandy and matrix-supported and contains a couple of larger clasts. To the right (NNW) it is interrupted by a streak of sand, which thins out in the middle of the section. This sand bed is thrusted by a high-angel normal fault with a displacement of about 2 cm (Figs. 19, 20, 21).

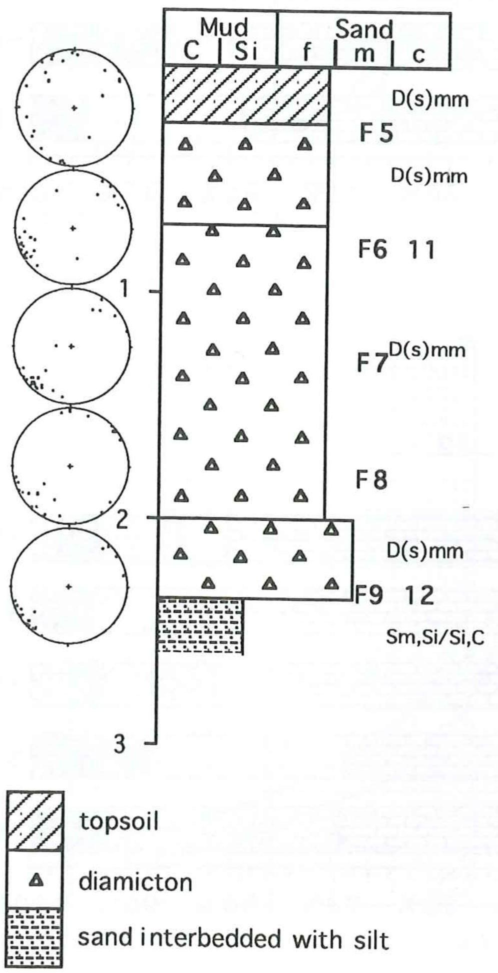

Fig. 21. log e

Fabric analysis

Fabric analysis was carried out at log e (Fig. 21), some meters away from site C. The fabric diagrams at this site (Fig. 20) show a more uniform stress indication. Except of fabric 5 the preferred orientation is SW, but a few particles dip at the opposite direction. In fabric 5 the distribution of trends is random. It is noticeable that nearly all of the particles lie more or less horizontally in all measured layers.

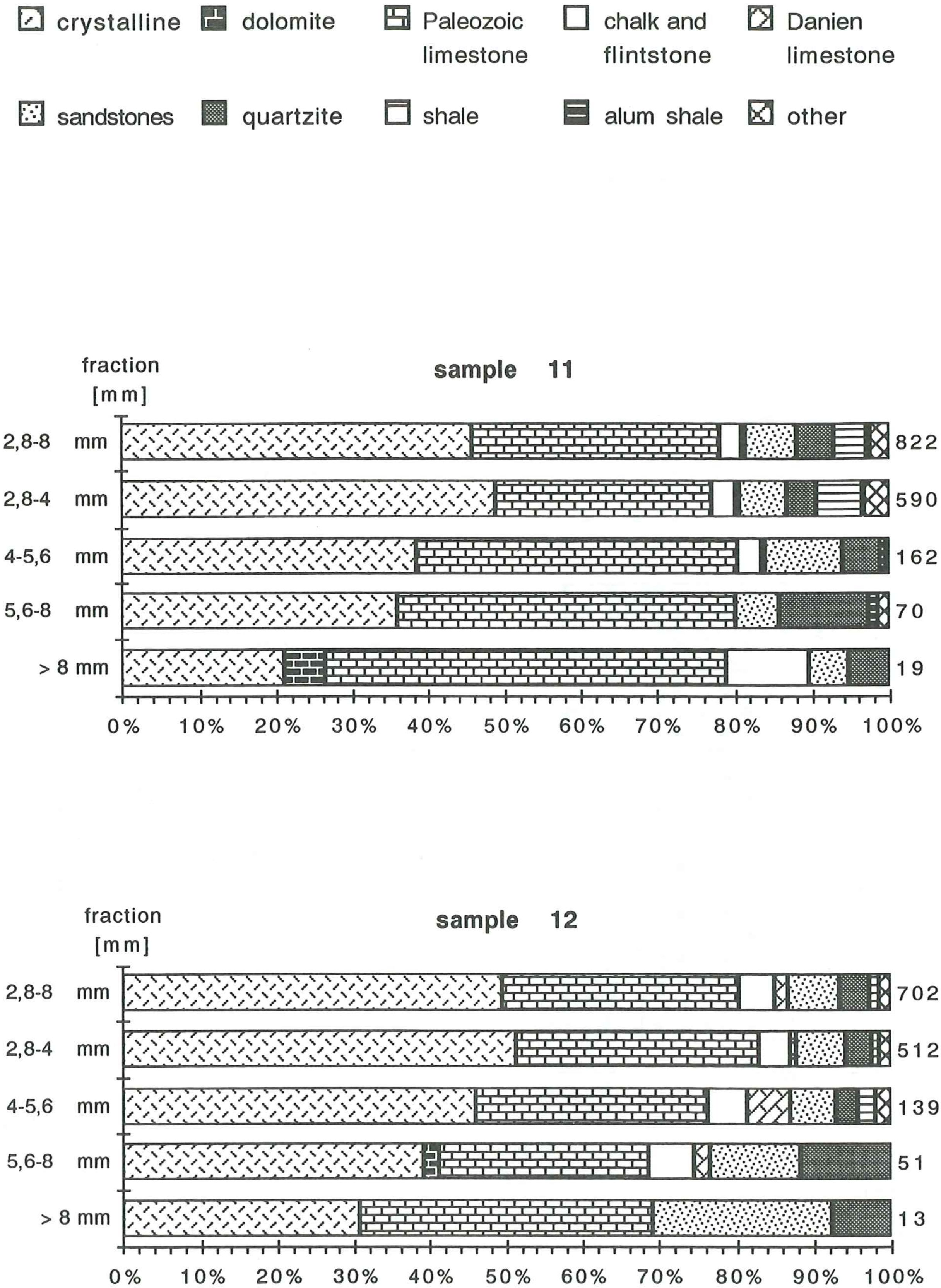

Fig. 22. Lithologic composition of samples 11 and 12

Lithologic analysis

Sample 11 is taken at the top of the diamicton bed, sample 12 at its bottom. They are very similar in their lithologic composition and even similar to the samples from site A (Fig. 22, compare Figs. 11, 12, 13).

Grain-size analysis

The results of the sieving analysis are shown in Fig. 23. Both sample 11 and 12 are similar to the diamicton samples from site A in their grain-size distribution with a main grain size between 0,1 and 0,2 mm (fine sand fraction).

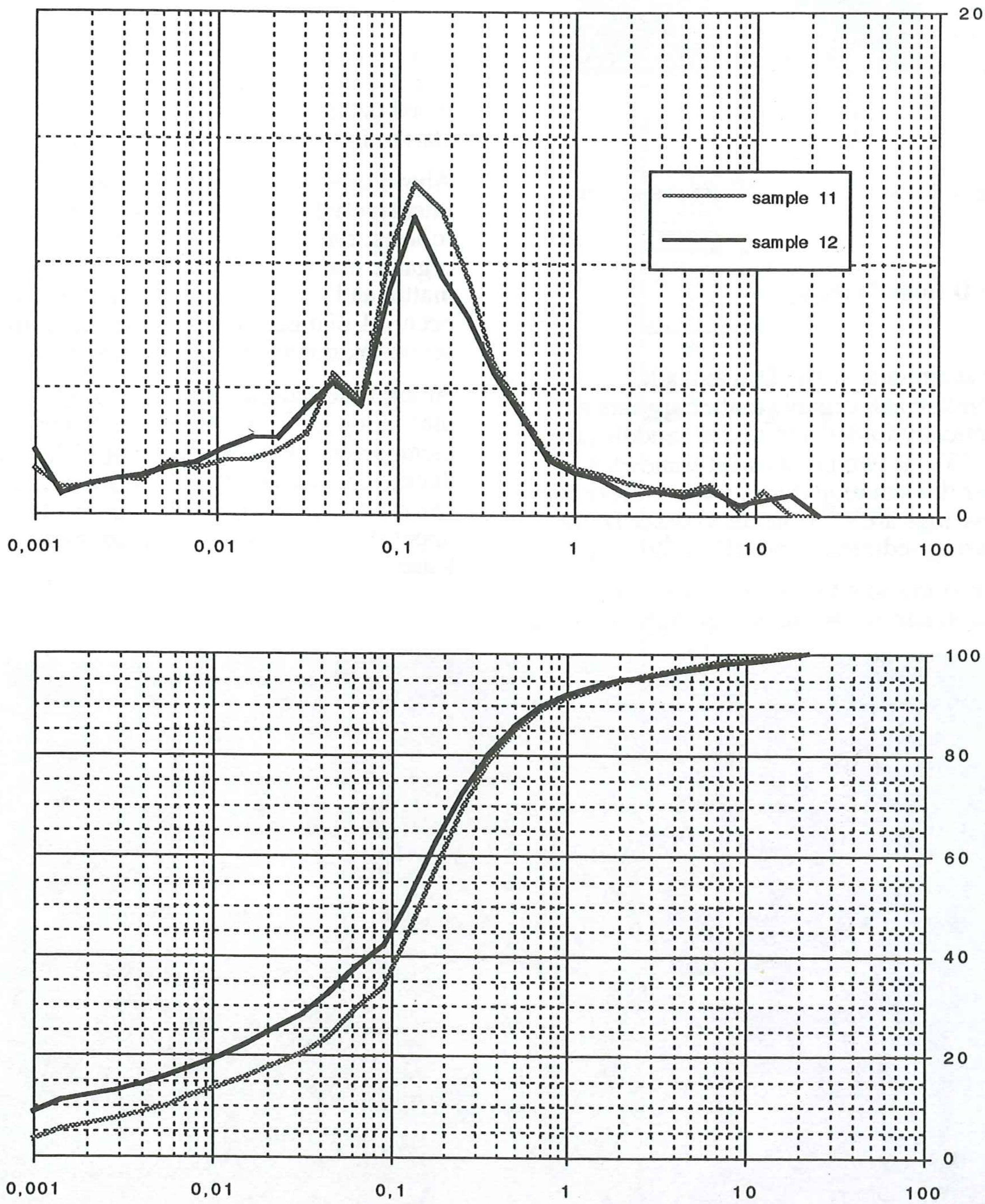

Fig. 23. Grain size and cumulative grain size of samples 11 and 12

Lime content

Sample 11 has a slightly lower lime content than sample 12 (8,2 % and 9,7 %, respectively). They are comparable with the samples 7, 9 and 2 from site A. For illustration see Fig. 24.

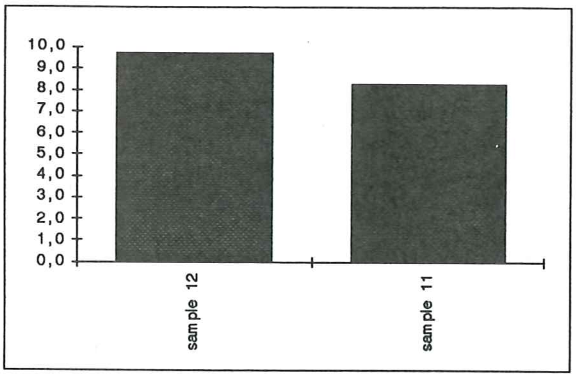

Fig. 24. Lime content of sample 11 and 12

Site D (logs f and g)

The sediments at site D, sand, silt, diamicton and organic matter appears as chaotically folded and mixed muddle (see Fig. 25). At two points with somewhat lesser deformation it was tried to make logs. These logs are only meant to describe the occuring sediment types (Figs. 26, 27).

Even at this site the sediments are similar to those at site A. At the bottom of both logs a sand bed occur which continues downwards. It varies in grain-size from coarse silt to coarse sand. At log g it is remarkable, that a couple of clasts lie in the same horizon, directly above the lower sand. These clasts have a shiny surface on their upper side as well as a surface morphology typical for wind abrasion. The diamicton following above changes in colour from grey to brown and even black. Its average grain size is silt, but contains relatively high amounts of clay. Lager boulders occur, but only sparsely. On the top of this diamicton bed occur a bed containing organic matter, similar to that in site A. Here a 15x7x5 cm large piece of wood (sample 13, Pinus sp., Thomas Bartholin, pers. comm.) was found.

Above these only slightly deformed beds a intensively folded and mixed sequence follows. Diamicton with streaks of sand and organic matter, sand containing organic matter and interbeddings of sand and silt occur. A diamicton lies on the top of the sequence, connected to that at site C.

At log f the sediments are lesser deformed than at log g, even if the distance between them is very close (about 20 m). The lower diamicton and the organic beds are missing. Only the sand/silt interbedding and the upper diamicton occur, divided by a sand lense.

Fig. 25. Site D

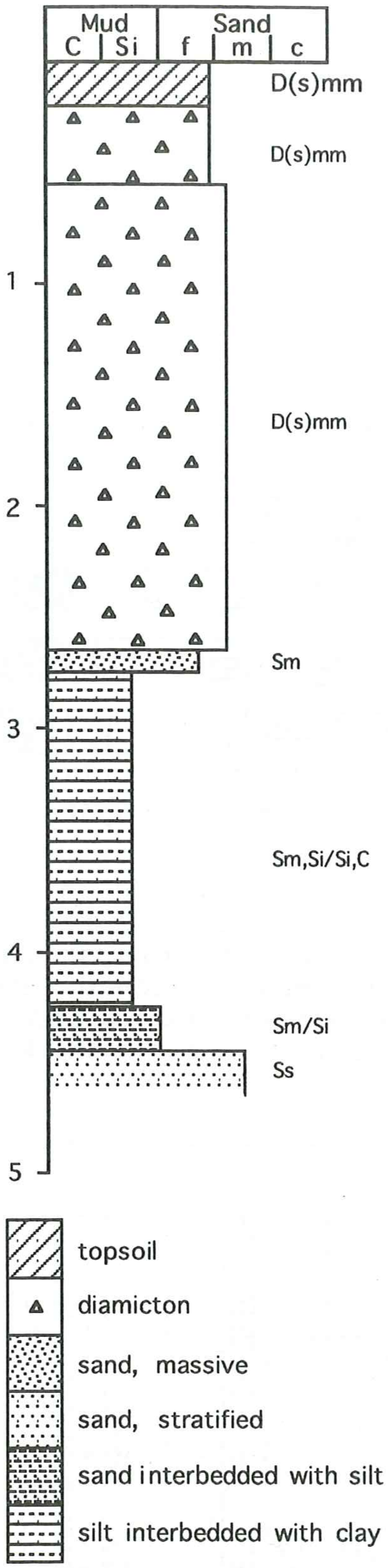

Fig. 26. log f

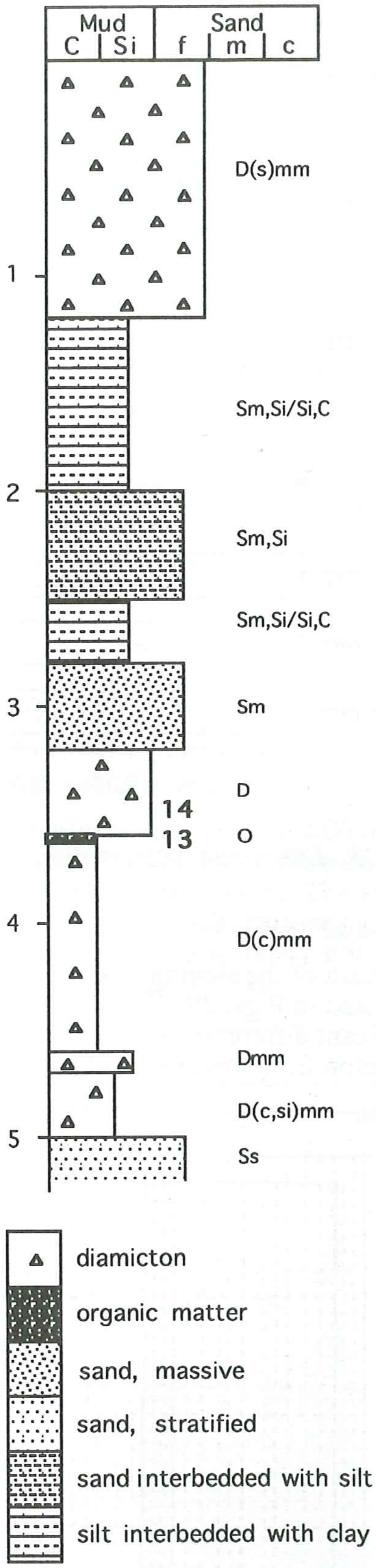

Fig. 27. log g

Lithologic analysis

Sample 14 contains like the other diamicton samples a high amount of crystalline (about 45%) and Paleozoic limestone (about 35%). Chalk and flint are also represented (about 5%), and even Danien limestone occurs. Dolomite does not occur in significant amounts. (see Fig. 28)

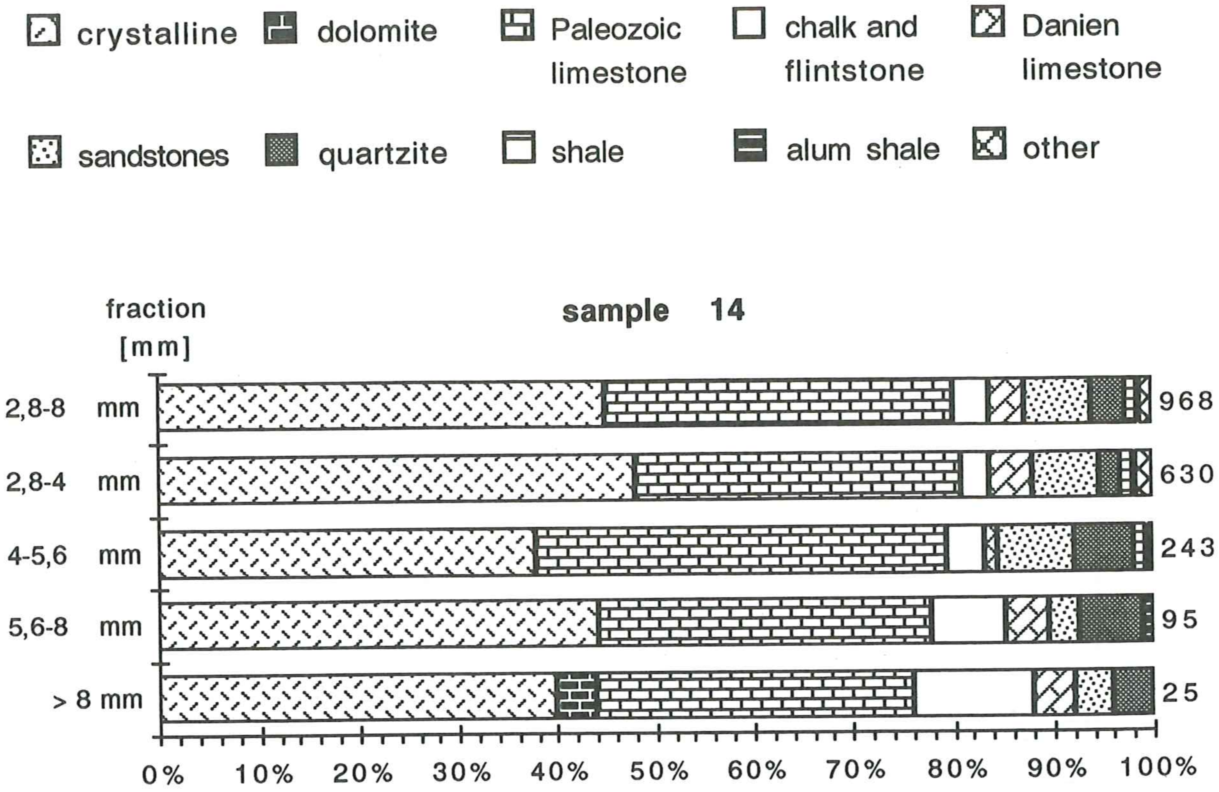

Fig. 28. Lithologic composition of sample 14

Grain-size analysis

The result of the sieving analysis is illustrated in Figs. 29, 30. There is no significant difference between the diamicton from this site and the other diamicton samples. The main grain size is between 0,1 and 0,2 mm, corresponding to the coarser part of the fine sand fraction. Even the sum curve is quite similar to the others.

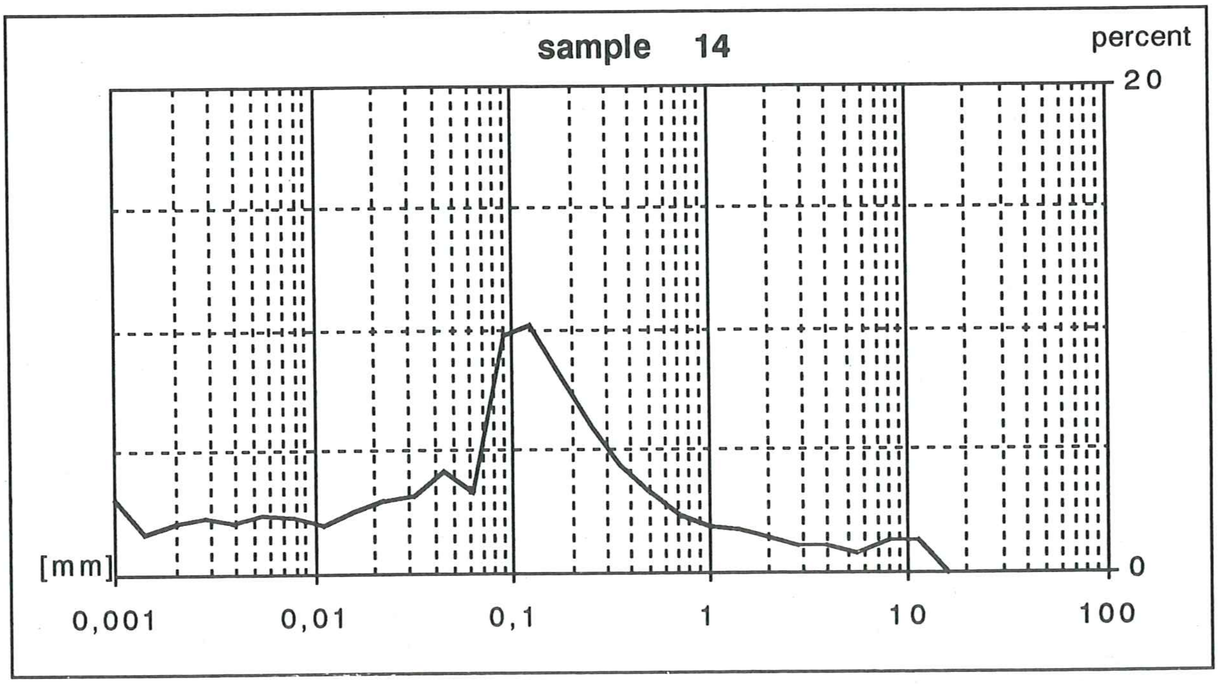

Fig. 29: Grain size of sample 14

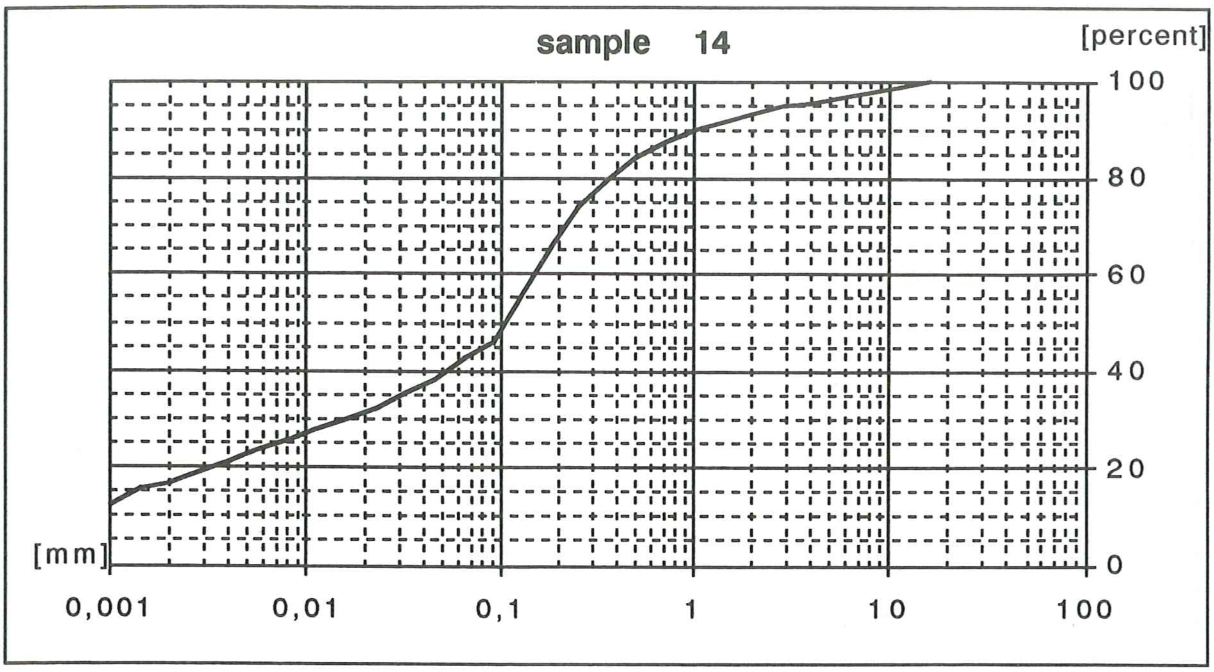

Fig. 30. Cumulative grain size of sample 14

Site E (samples 5 and 6)

At this site a bed with organic matter (sample 6) and clayey silt (sample 5) are imbedded in sand. In the brown silt lime-filled cracks appear. The organic matter is dark brown to black. Neither larger minerogenic particles nor larger plant remains occur.

Grain-size analysis

The predominant grain size is 0,06 mm (coarse silt). The sum curve showes, that this sediment is poorly sorted. The average grain size is medium silt. Particles are not larger than 2 mm (coarse sand). For illustration see Figs. 31, 32.

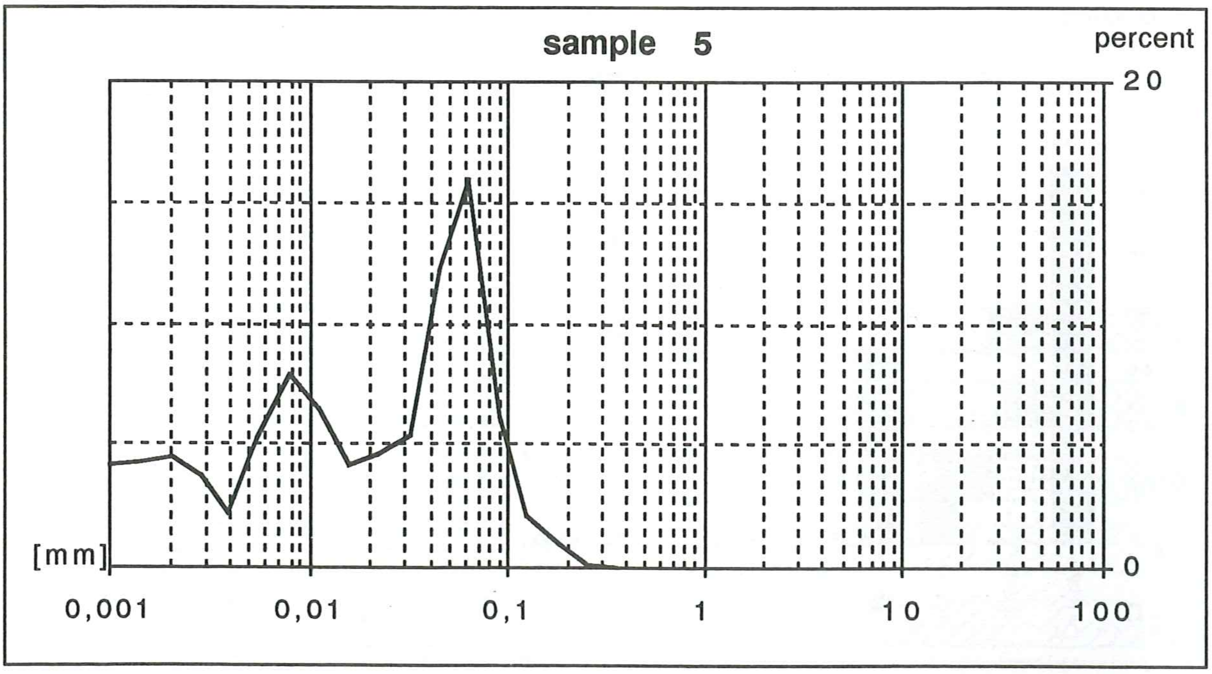

Fig. 31. Grain size of sample 5

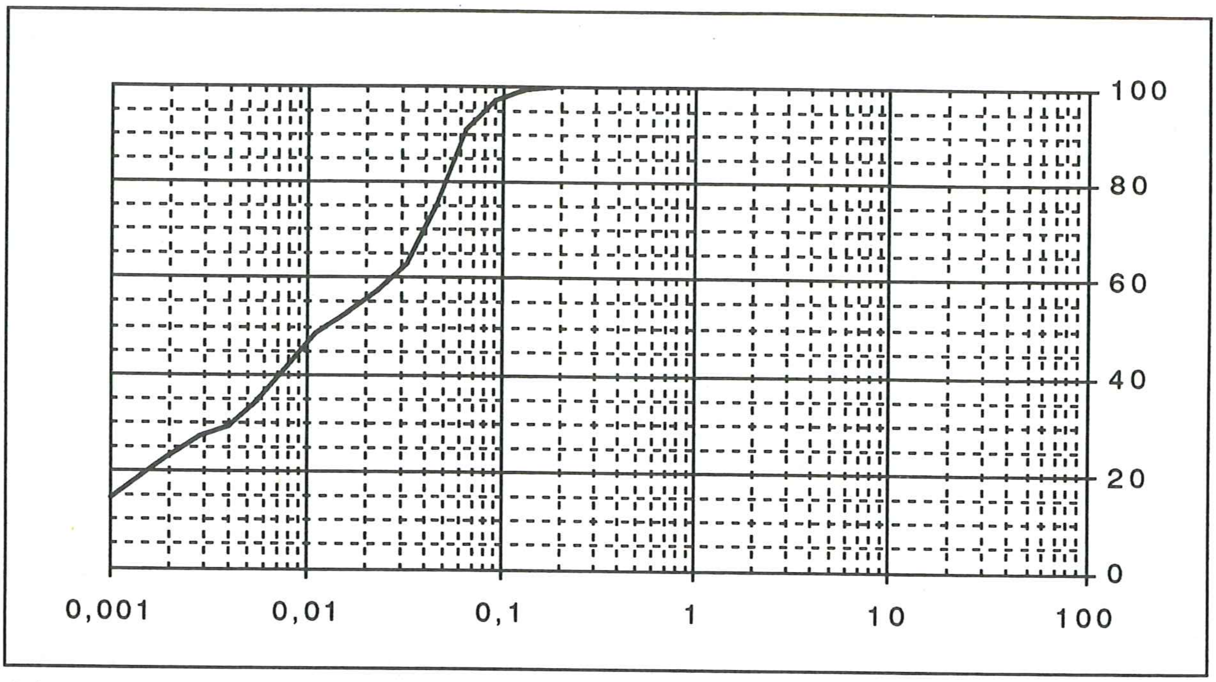

Fig. 32. Cumulative grain size of sample 5

Pollen analysis and plant remains

The samples 1 and 6 have been taken in the same stratigraphical unit, but about 100m away from each other. In both cases it is question about thin strata of small lateral dimensions.

The pollen spectrum of sample 6 (Fig. 33) is poorer than in sample 1. Unfortunately, the majority of the pollen grains are corroded and deformed. Therefore they were not as easy to identify as in sample 1. The very dominating species is Pinus. Even Alnus occurs in quite high amounts. Corylus is represented in a lower degree and Betula has nearly disappeared. However, both Carpinus and Picea are still frequent. All the other tree species do not occur. But anyway this spectrum can be interpreted as of Eemian age (Berglund, pers. communica-

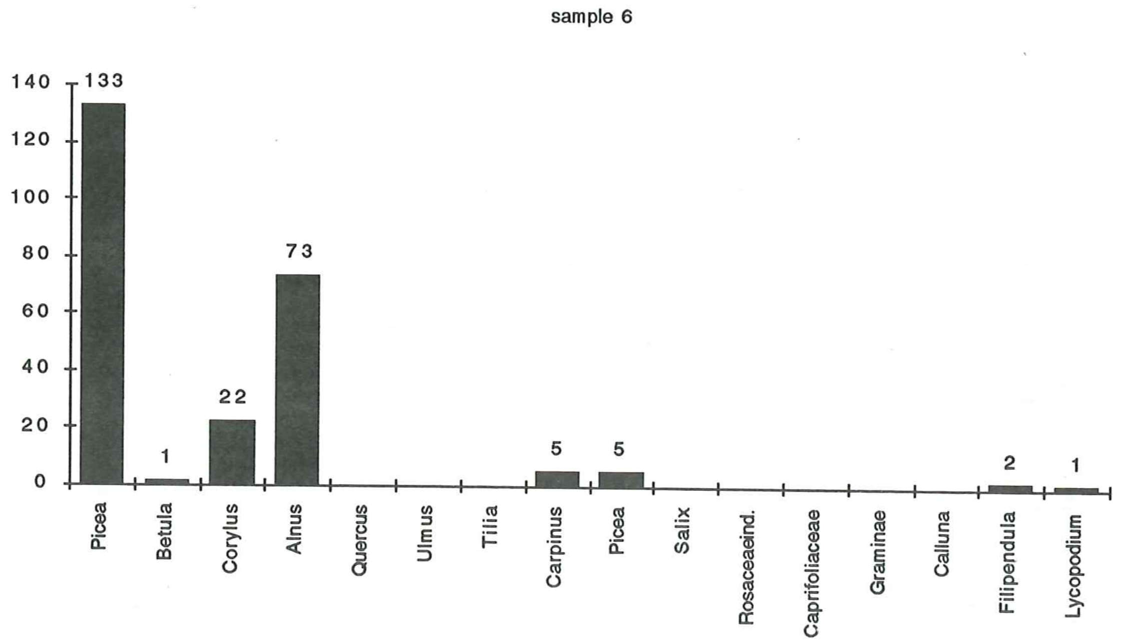

Fig. 33. Pollen spectrum of sample 6

tion), above all because of the occurrence of Carpinus and Picea, but it represents a somewhat later stage than sample 1.

The results of the plant remains analysis carried out by Keding (pers. communication) are shown in Table 3. similar species as in sample 1 occur and according to Keding it is question of the so-called Brasenia-complex and thus the organic matter is of Eemian age.

Table 3: Plant remains in sample 13 (after Keding, pers. communication)

sample 13
Aldrovanda vesiculosa
Andromeda polifolia
Brasenia holsatica
Bryophyta
Carex sp.
Cenococcum geophilum
Chara sp.
Dulichium arundinaceum
Eriophorum vaginatum
Najas flexilis
Najas marina
Potamogeton sp.
Schoenoplectus lacustris
Typha sp.

Lime content

Sample 5 contains lesser than 1% lime, probably because of immediate vicinity of the organic matter.

Site F (samples 15 and 16)

Lithologic analysis

Sample 15 is taken in a sorted clayey silt with a lot of sand and gravel clasts. These clasts were counted, too. The amount of crystalline is about the same as in the diamicton samples, between 40 and 50%. But the lower amount of Paleozoic limestone and above all Cretaceous chalk catches one's eyes, whereas the content in the harder Danien limestone increases (Fig. 34). Sample 16 does not differ from the other diamicton samples. It has high contents of crystalline (almost 50%) and Paleozoic limestone (about 30%). Both chalk and flint and Danien limestone occur, although at lower amounts (5 to 10%) (Fig. 35).

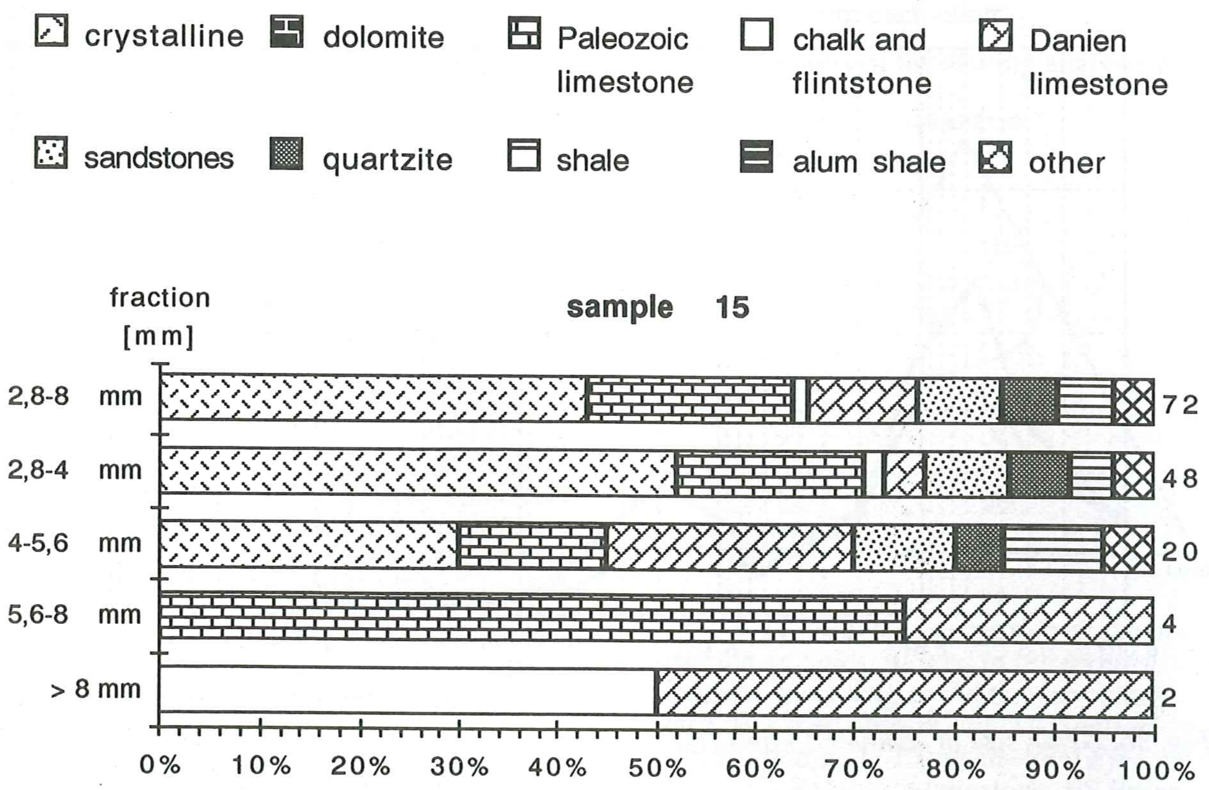

Fig. 34. Lithologic composition of sample 15

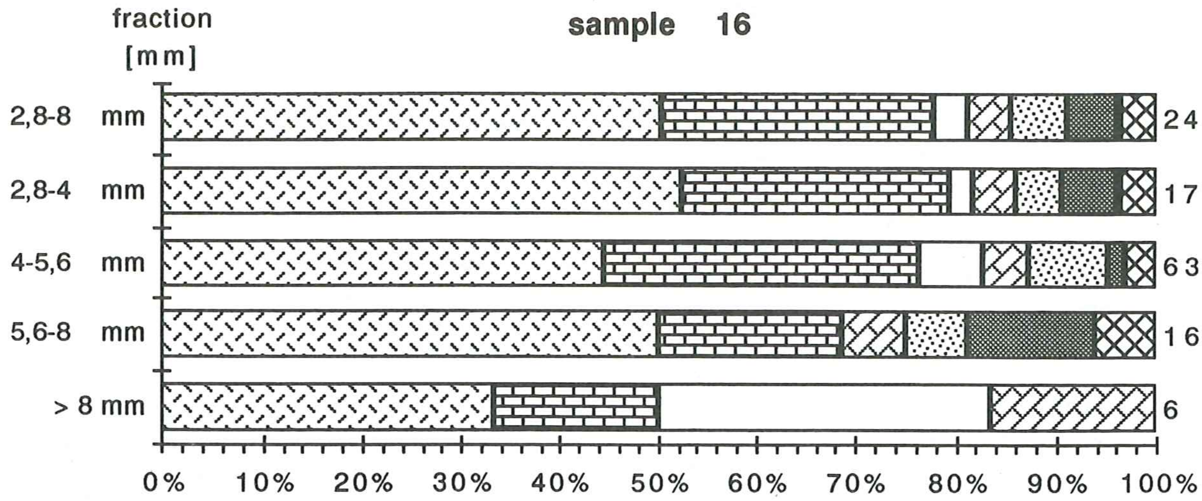

Fig. 35. Lithologic composition of sample 16

Grain-size analysis

Sample 15 has a special grain size distribution. It has a primary top at 0,0063 mm which corresponds to the finer silt fractions. A secondary peak can be seen at about 0,2 mm (fine sand). Its average grain size is about 0,008 mm.

Sample 16 shows two significant peaks, at 0,008 and at 0,2 mm (medium silt and fine sand, respectively), and its sum curve has a low ascent like the sum curves of the other diamicton samples, but it is moved to the finer fractions (Figs. 36, 37). The average grain size is about 0,009 mm.

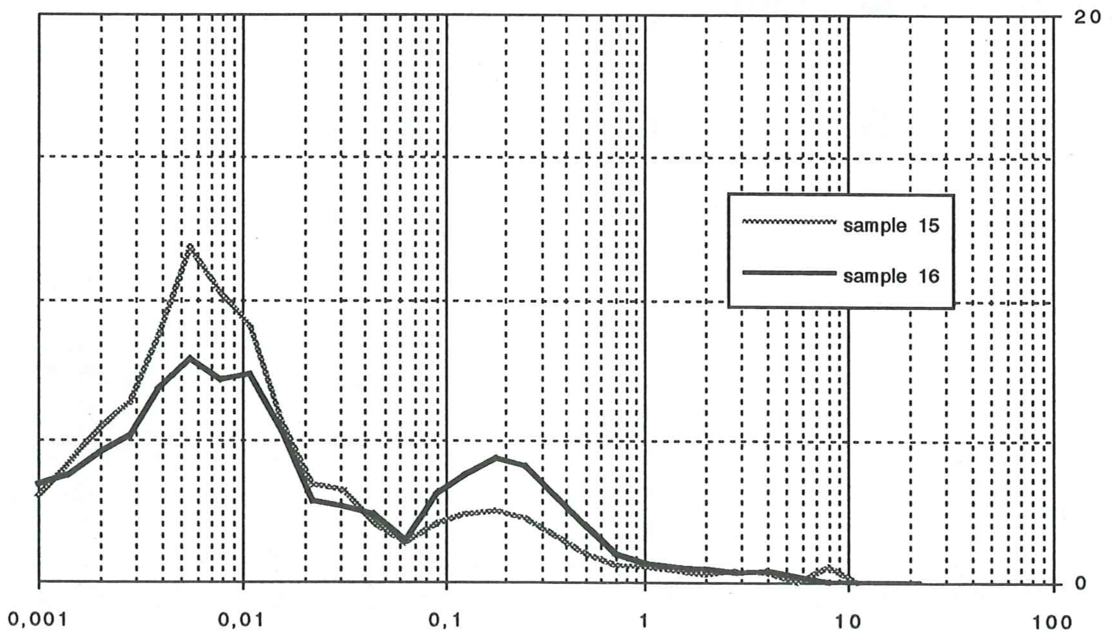

Fig. 36. Grain size of samples 15 and 16

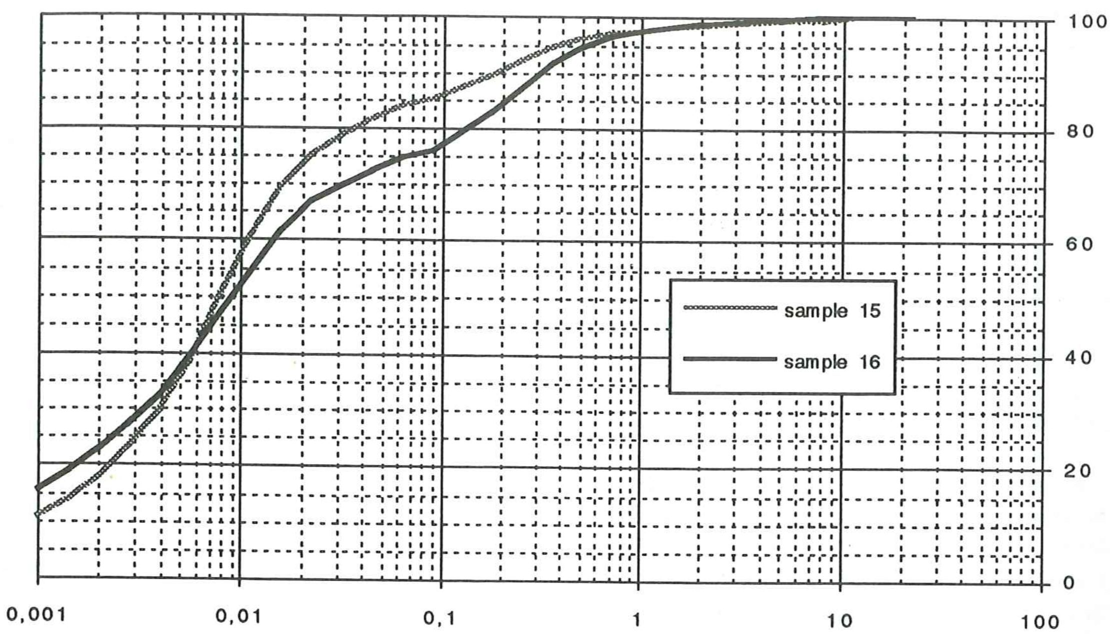

Fig. 37. Cumulative grain size of sample 15 and 16

Discussion

Trying to determine the relative age and the genesis of the investigated sequences the results of gravel counting and pollen analysis must be taken into consideration. According to Cepek (1976); Krienke & Harff (1979); Rühberg & Krienke (1977) and the standard TGL 25232 the lithologic composition of Weichsel-2 diamictons should be: high content in Paleozoic shale, and thus low NK/PS-quotients (<1 in Mecklenburg). However, this quotient is never lower than 28 in the samples. This can be due to that the investigated diamictons are not lodgement tills (germ.: Grundmoräne). It is also possible that the standard is not applicable to such a large area as proposed in the standard. Nevertheless, nearly all diamicton samples are situated in the same small area in the triangel diagram (Fig. 38), it means, they have a similar lithologic composition. But an interpretation as Saale till (according to the standard) seems unprobable.

As already mentioned the whole sequence is continuous from the bottom to the top.There is no unconformity representing the advance of a new ice sheet.

The uppermost diamicton can without doubts considered to be of Pomeranian age as for example Cepek (1972) and Rühberg (1987) propose. And, since there is no unconformity, the whole sequence has the same age.

This agrees with the lithologic composition of the diamicton samples, which do not deviate much from each other.

Even the results of the sieving analysis do

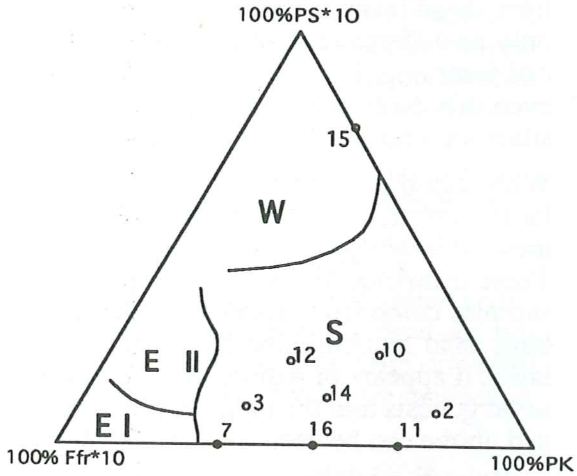

Fig. 38. Lithologic composition of the diamicton samples, plotted in the ternary diagram according to the German standard. W - Weichselian tills, S - Saalian tills, E I and E II - Elsterian tills; Ffr - flint, PK - Paleozoic limestone, PS Paleozoic shale

Table 4: Lithologic compositon of all diamicton samples and calculations according to the german standard TGL 25232

	NK	PK	PS	D	F	S	NK/PK	NK/D	NK/PS	(PK+D)/S	(PK+D)/ (PS+S)	PS% of F+PK+PS
sample 2	59	37	1	1	6	14	1,59	59	59	2,71	2,53	2,27
sample 3	74	91	1	1	2	20	0,81	74	74	4,6	4,38	1,06
sample 7	109	30	0	0	6	30	3,63	-	-	1	1	0
sample 10	121	77	3	4	3	25	1,57	30,25	40,33	3,24	2,89	3,61
sample 11	87	99	0	0	4	36	0,88	-	-	2,75	2,75	0
sample 12	84	56	3	1	6	24	1,5	84	28	2,38	2,11	4,62
sample 14	134	133	3	0	10	42	1,01	-	44,67	3,17	2,96	2,05
sample 15	6	6	2	0	0	3	1	-	3	2	1,2	25
sample 16	36	23	0	0	2	9	1,57	-	-	2,56	2,56	0

not indicate differences between the diamicton samples. As already mentioned, the diamicton grain size distribution do not vary very much, except for the samples 16, 3 and eventually 14. But this fact can be explained as follows: Sample 16 is taken directly above a clayey silt (sample 15). Imagining the diamicton moving as a flow into shallow water, where the silt has been sedimented, the flow till would have eroded the ground surface and overtaken a lot of that material. An indication for this reconstruction is, that the main peaks correspond in both sample's distribution curves. Deducting the amount of the lacustrine sediment, sample 16 would have the same grain size distribution as all "normal" diamicton samples.

But why does sample 3 appear different from the others? It is taken at the same stratigraphical level as the samples 2 and 7 and only its different colour had motivied a special sampling. It is possible, however, that even this diamicton has picked up clay and silt from a not visible lacustrine sediment.

With regard to grain size, sample 14 is similar to sample 3, even if the former has a somewhat lower percentage of silt and clay. There is no clue to why, but because both samples come from diamictons above the huge sand sequence and below the organic layer, it appears probable, that they have the same genesis and the explaination mentioned above can be used for sample 14, too.

Anyway, it seems to be quite improbable, that these small variations should indicate different ages, above all when thinking about the small space between the several samples and the complete lack of any visible contact representing the boundary between two different glacial stages or even oscillations. Thus all indications speak for that all diamictons belong to the Pomeranian stage.

The next question is if the fabric orientation agree with the traditional model. Beginning with section A, it can be noticed that only F2 have a distinct preferred orientation towards NE. All the other analysises show a more random distribution. Their mean vectors points to the west or the southwest, respectively.

At F2, the stress direction from northeast would convincingly agree with the traditional model about lodgement till sedimentation below the moving glacier coming from northeast. However, this model does not correspond to the other fabric analysises at the entire sequence. To explain a stress direction from the west or southwest another model must be used.

The random fabric distribution and the stress direction from the west and southwest exclude any interpretation as lodgement till beneath an active ice. But they encourage an interpretation as flow till. In a dead ice landscape water-saturated masses move downward the hummocks along the highest gradient, while their original internal sediment structures are destroyed. A preferred fabric orientation, which sometimes can be measured, shows only the flow direction, or in few cases it can have been preserved in a frozen clod.

Viewing log e, similar conditions as in section A can be recognized. Even here the fabric distribution is random or shows a more or less preferred orientation to the southwest through the west (Fig. 21). In the upper part of the sequence, the random orientation can be caused by plant roots and ploughing. But also it can be the result of the filling of a hollow by flow till from several different directions.

At the four other levels, the indicated stress direction is southwest. As at section A, it is not question of a lodgement till. The stress direction exclude that interpretation. Because the sequence does not look deformed or dipped, the diamicton can probably only be interpreted as flow till.

To sum it up it can be said that none diamicton in the investigated pit can considered to be a lodgement till. The whole sequence must be taken for deglaciation sediments lain down in a dead-ice landscape during the retreat of the Pomeranian ice-sheet. Their internal structure indicate a resedimentation.

This conclusion can seem to contradict to the results of the pollen analysis. The pollen composition in the organic mattern in section A and in sample 6 shows a distinct Eemian character. However, there is no indication that these layers are in situ. On the contrary, they are resedimented. In sample 1, all wood pieces were rounded and the content in mineral matter is very high (92,2 %). Unfortunately, the lithologic composition was not determined, but flintstone occured as well as limestone and crystalline. Thus there is probably the same lithologic composition as in the diamicton samples.

It is possible, that this organic layer originates from a frozen peat sequence, which was transported by the moving ice. In the dead-ice phase, it melted successively and flowed into depressions in the area, mixed with water-satured diamicton. Probably have both the organic matter in section A, log g and sample 6 the same origination. But at least sample 6 comes from another part in the peat sequence, because its pollen composition differs from the others. It is thinkable, that this clay-peat sequence was imbedded frozen in the surrounding sediments, because its internal structure has not been destroyed. This appears possible, even if the surrounding sediment is medium sand indicating low energy conditions, which are unable to transport large and heavy clusters. But peat and clay usually contain a lot of water, thus the frozen clod should have low specific weight and be easily transported by running water.

Thereagainst, it seems to be quite impossible, that this profile represents a bog sequence in situ. In this case there should be any indication for an Eemian soil profile in the immediate vicinity, but there is none. Instead, the material lies dipping and without lateral extension worth mentioning within the sand.

Does the lime content say anything about the area's genesis? As already mentioned in the chapter "Description of the sites", the lime content in the diamictons is relatively high, except those in the vicinity of organic matter (sample 2 and 5). This lime is probably finely distributed chalk and, to a small amount, pulverized limestone. Thus when containing chalk, the sediment has probably a high lime content. According to Cepek (1972), a signinficant difference between Pomeranian and older tills is, that the Pomeranian contains a high amount of Cretaceous chalk and flint. Thus diamictons of that age should be characterized of a high lime content. In fact, all analysed diamictons have a relatively high lime content, even those which have been exposed for weathering like sample 11. Exceptions are those, which are influenced by organic matter (humus).

Joining together all these puzzle pieces, which depositon model fits all of them? Imagine the following situation: After having reached its maximal extension, the ice sheet slowly began to retreat. Its margin collapsed and disintegrate into ice-cored moraines parallel to the former ice margin. Their appearance was determined by the glaciers's movement along shear planes (Fig. 39). In the troughs between the ridges streams of meltwater would run and deposit sorted and stratified sediment as sand and gravel. Under still water conditions, for example in small lakes finer material as silt and clay would be sedimented. When the buried dead-ice was melting away under these sediments, setting structures, faults and folds would deform their original sedimentation structures. From the dead-ice ridges, flows of diamicton would run downhill and successively cover the entire landscape (Fig. 39).

This course, observed in detail by Boulton (1972) in Spitsbergen at recent glaciers, can be assumed for the Weichselian deposits at Neubrandenburg, too. During the Pomeranian stage the ice sheet had reached its largest extension about 30 km south of the investigated area. In the scenario discussed here, the retreating ice sheet would have left a lot

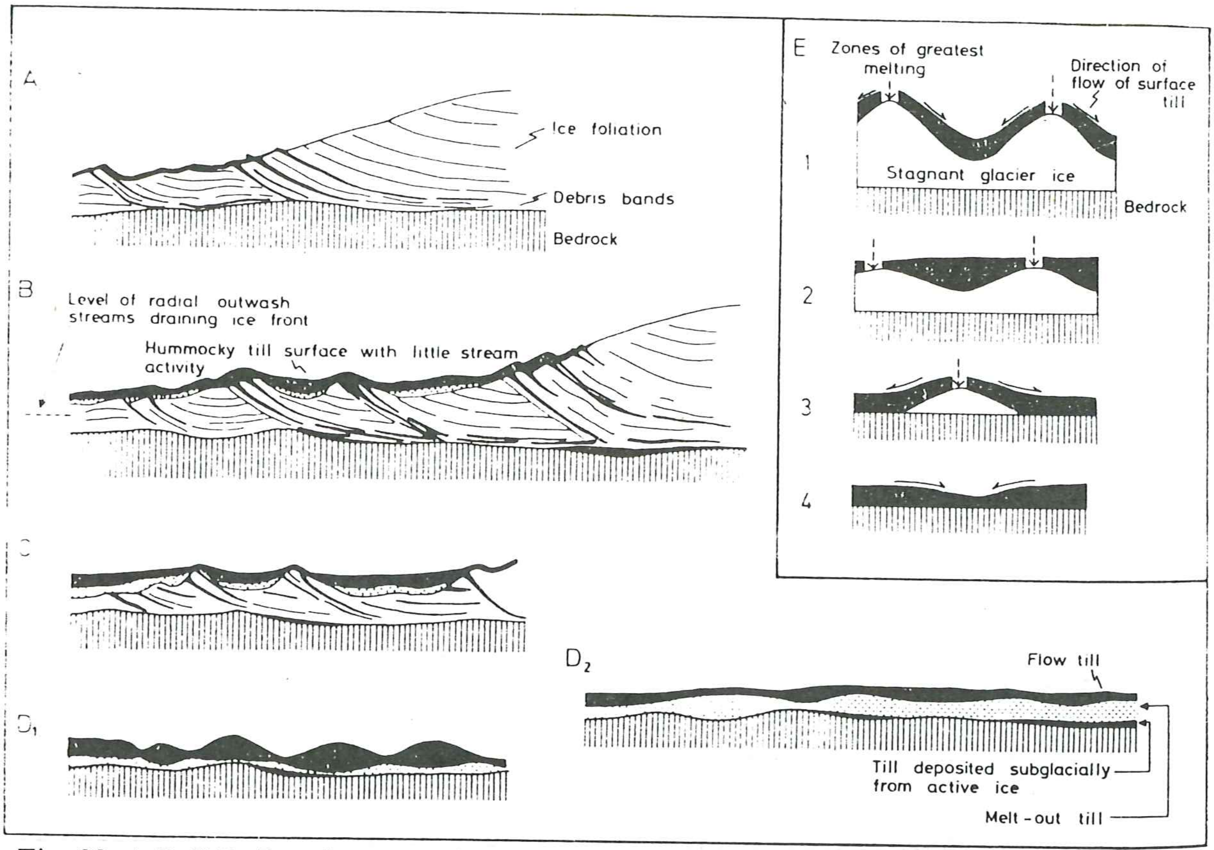

Fig. 39. A-B-C-D. Development of a till plain, in this case the surface till is more fluid. E. Melting of buried ice beneath a fluid till to give a planar till sheet. (from Boulton, 1972)

fluvial sediments, extending eastsoutheast-westnorthwestwards, parallelly to the former glacier front. The sorted sediment in the gravel pit can considered to be such a trough filling.

At the northern and southern margin of the gravel pit the deformation increases as already described. But neither the fold axises nor the beds dip follow a regular pattern in their spacial location. This agrees with the model mentioned above. The stress direction is strongly depending on where and how fast the buried ice melts away. Naturally, the deformation will be strongest at the contact between the sand body and the finer sediment and diamicton containing more buried ice.

Viewing section A (Fig. 8), a lot of the existing structures can be explained this way. The fold at left was probably created when dead ice northeast of it melted away. That is why the faults in the sand are normal ones. When in this way the soil sank, the water-saturated organic matter ran into the depression and its thickness increased. The contact sand/diamicton appears very deformed and both units are often mixed. According to Boulton (1972), this happens, when a supraglacial sequence flows down the flank of an ice-core.

In the upper parts of the section, flows of fine outwash material (silt and fine sand) cover the more heavily deformed lower parts, sometimes interrupted by diamicton flows. And as everywhere in the whole gravel pit, the sequence is completed by a relatively thin diamicton flow (a few meters) on its top. Typical flow structures are common in this sequence (Fig. 4).

In the section B is the situation more simple, but follows the same pattern. Obviously, the layers are not especially influenced by deformation. Probably, this sequence is situated above the central part of a sandy outwash sediment. In fact, there is such a sediment beneath, but some meters apart in lateral direction, however. Therefore it could not directly be related to the sequence above. Site B can be considered to be a glacilacustrin sediment with a flow till on its top. The low-angle reverse faults in the silt (Fig. 5) can be explained by pressure from the southwest, possibly caused by the diamicton flow running from this direction.

Even the scene in section C matches the general model. Here the margin of an outwash sequence can be seen. Probably, when buried dead-ice melted away southwest of here, the water-saturated sediment flowed in this direction, even causing normal faults in the sand. This agrees also with the results of the fabric analysis.

At the logs 6 and 7 an ancient wind eroded surface occurs. According to Schulz and Reincke, this part of the pit lies in one of the predicted subglacial tunnels, because of the strong deformation. The ancient surface, however, contradict this interpretation. Furthermore there are no indications of any later ice cover. The uppermost diamicton is interpreted as a flow till. Therefore even the interpretation of the deformed sequences in the other parts of the pit is unsecure. The author prefers an interpretation as deformation at the surface by slumping and sliding downslope the ridge with sorted sediments and diamicton which ran downslope dead-ice bodies as flow till. This has later covered by other flow tills. In this course, the flow tills have levelled out the relief.

Conclusions

The material presented here do not support the theories about tills from different glacial stages and erosion in subglacial tunnels.

It appears instead to be obvious, that not only the uppermost diamicton is Weichsel-2 (Pomeranian) in age, but also the whole other visible part of the gravel pit. All sedimentation can be explained as scenario in a dead-ice landscape.

The entire area consists of streaks with sorted fluvial sediments (sand and gravel) parallel to the former ice margin and flow tills (sand, silt, diamicton, organic matter) between these ridges. The flow tills filled depressions in the area and lies as a thin cover over the whole area. Therefore the relief is not undulating. The layers containing organic matter can not be used for dating the sequence, because they are not in situ.

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Appendix

Description of the logs

Log 1

Depth [m]	Thickness [m]	Designation	Description
0,20	0,20	D(s)mm	yellowbrownish, topsoil, weathered diamicton, contents humus, indistinct contact
0,32	0,12	D(s)mm	colour as above, varying thickness, several cracks in dry condition, relatively many clasts, sharp contact, fabric 3
0,34	0,02	Sm(f,m)	ochre brown in colour, no stratification visible, slightly erosive contact
0,39	0,05	D(s)mm	yellowbrownish, varying thickness, fine and medium sandlenses, sharp contact
0,79	0,40	Sm(f)/Si	sand interbedded with silt, deformed, sharp contact, sample 8 (silt without sand) and 9 (silt and sand)
0,80	0,01	Sm(f,m)	ochre brown in colour, no stratification visible, slightly erosive contact
0,90	0,10	D(s)mm	greyish brown or darker, clasts, distinct contact, sample 10, fabric 1
0,91	0,01	Sm(f,m)	greenish yellow, continous, undulating, but not varying in thickness, relatively sharp contact
0,93	0,02	D(s)mm	greenish, sandy, distinct contact
1,00	0,07	O	brownish black to black, sometimes greyish brown to greyish black (especially at its margins), consists of organic material with plant remains (wood) and inorganic contents (sand and gravel clasts upto 15 mm, among others flint), a greenish brown sandy layer occurs in the lower part (1 cm thick), distinct contact, sample 1
1,25	0,25	D(s)mm	greyish brown (blue), some gravel clasts (<20 mm), some sand and clay lenses, in the lower third secundary limonite occurs (appears banded parallelly to the contact beneath), successive contact, sample 7, fabric 2
4,00+	2,75+	D(s)mm, Sm(f)	diamicton as above, but heavily deformed, sand white, well-sorted, as deformed lenses and streaks in the diamicton, limonite (FeOOH) and manganite (MnOOH) occur at the contact between sand and diamicton, sample 2

Log 2

Depth [m]	Thickness [m]	Designation	Description
0,30	0,30	D(s)mm	greyish brown, topsoil, sandy, no lime, humus, very few clasts (< coarse gravel), successive contact
1,25	0,95	D(s)mm	successive change from greyish brown to grey, poor in clasts, no clefts, now and then streaks of ochre, the lowest 10 cm secundary coloured (ochre and reddish brown), distinct contact, sample 3, fabric 4
2,15	0,90	Sm(f,m)	white and mixed colours, very well-sorted, apart from rust spots and black streaks of heavy minerals no structures visible, sharp and distinct contact, sample 4
2,73	0,58	D(s)mm	greyish brown, partly sandy, partly silty, limonite in cracks, several clasts and sandlenses, sharp contact
2,85	0,12	D(s)mm/ Sm(f)	in the upper part sand interbedded with diamicton (thin strata), ochre, reddish brown and rustred, in the middle part fine sand secondarily banded (limonite), in the lower part diamicton (as above), distinct contact
3,50	0,65	Sm(m,c)/ D(s)mm	streaks of diamicton, fine and medium sand (thickness <10 cm) in matrix of coarse sand, distinct contact (diamicton layer)
6,00	2,50	Ss(m)	white (light yellow), very well-sorted, parallel bedding, dark streaks (heavy minerals), at 4,00 occur two streaks (fine sand/silt and medium/ coarse sand, in general coarser sediment in the lower part (from 4,40 downwards), at 5,90 streak of fine gravel, successive contact (10 cm)
7,00+	1,00+	Gm	consolidated and coloured by limonite, partly very corse material (pebbles and cobbles), moderately sorted, no sedimentary structures visible

Log 3

Depth [m]	Thickness [m]	Designation	Description
0,30	0,30	D(s)mm	yellowbrownish, topsoil, weathered diamicton, contents humus, gradational contact
1,65	1,35	D(s)mm	brownishgrey, few clasts, no cleft system visible, several sandlayers and -lenses (cm), in the lower parts more sandy, gradational contact
1,70	0,05	Sm(f),Si	somewhat lighter and yellower as above, relatively well-sorted, alternating contact
2,00	0,30	Si,C	brown, disintegrate into small cubes (cm and smaller), layers and lenses of finesand occur (thickness <1 cm), CaCO3 in concretions, sharp contact
2,10	0,10	Ss(f)	yellowwhite, stratified, with few clayey siltlenses, sharp erosional contact
2,55	0,45	Si,C	brown, fewer sandlayers as in the Si, c-strata above, lesser disintegration, CaCO3 occur in concretions and thin strata, sharp contact
2,57	0,02	Sm(f),Si	light yellowbrown in the upper part, darker yellowbrown in the lower part, the upper part is partly missing, varying thickness, sharp depositional contact
2,61	0,04	Ss(m)	white and mixed colours, planlaminated, alternating contact
2,77	0,16	Sm(f)/Si	finesand interbedded with silt, individual layers some mm thick, with different colours (brown, yellowbrown, greyish brown), low-angle reverse fault, displacement max. 5 cm, alternating contact
3,10	0,33	Ss(m,f)/ Ss(m,c)	greyish white, horizontal, boulders up to 5 cm diameter, sharp depositional contact
3,25	0,15	Sm(f)/Si	finesand interbedded with silt, individual layers some mm thick, with different colours (brown, yellowbrown, greyish brown), faults and other disturbances, horizontally flamed, faulted and folded, but relatively sharp contact
3.65	0.40	Ss(f)/Ss(m)	white and mixed colours, horizontally bedded, varying thicknesses, low angled reversed faults, erosional contact
3.75	0.10	Sm(f)/Si,C	greyish brown finesand (2-4 cm thick) interbedded (3 times) with brown partly clayey silt (0,5-1 cm thick)
3.75+		Si,C	as above

Log 4

Depth [m]	Thickness [m]	Designation	Description
0,30	0,30	D(s)mm	Topsoil, yellowbrownish, weathered diamicton, contents humus, gradational contact
3,00	2,70	D(s)mm	brownishgrey, few clasts, no cleft system visible, several sandlayers and -lenses (cm), in the lower parts more sandy, gradational contact
3,80	0,80	Si,C/Sm(f)	Sand in deformed lenses, varying thicknesses (up to 10 cm), silt crumbly several coarse-sand and fine-gravel clasts
3,80+		Sm(m)/ Sm(f)/Si	Sand white and mixed colours, silt brown, strongly deformed, faults and folds

Log 5

Depth [m]	Thickness [m]	Designation	Description
0,25	0,25	D(s)mm	greyish brown, rich in clasts, sandy, crumbles easily, no lime, sharp undulating contact, fabric 5
0,70	0,45	D(s)mm	light greyish brown, sandy, sporadic horizontal limestriae, contact appears as 4 cm thick limy band (not continous), sample 11, fabric 6
2,00	1,30	D(s)mm	as above, but lime striae occur more frequently, erosive contact (yellow sandstratum, 0,2-1,0 cm thick, follows the underlying layer's surface), fabric 7 and fabric 8
2,35	0,35	D(s)mm	yellowish brown, more sandy as above, some sandlayers (mm-thick), sharp erosive contact, sample 12, fabric 9
2,60+	0,25+	Sm(f),Si/Si,C	fine-sand and silt interbedded in deformed lenses and streaks, which vary in thickness, sharpcontact

Log 6

Depth [m]	Thickness [m]	Designation	Description
0,20	0,20	D(s)mm	ash-grey, humus, distinct contact
0,55	0,35	D(s)mm	brown, sandy, porous, lime-free, cracks, rooted, successive, undulating contact
2,65	2,10	D(s)mm	greyish brown, cracks when dry, sandy, clasts occur frequently, without clay, several limestriae, distinct erosive non-horizontal contact
2,75	0,10	Sm(f)	white, not continous, sharp contact
4,25	1,50	Sm(f),Si/Si,C	fine-sand and silt interbedded in deformed lenses and streaks, which vary in thickness, sharp contact
4,45	0,20	Sm(f)/Si	white sand interbedded with light brown silt, horizontal, erosive contact
4,45+		Ss(m)	greyish brown, cross-bedded, continouation downwards unknown

Log 7

Depth [m]	Thickness [m]	Designation	Description
1,20	1,20	D(s)mm	light greyish brown, sandy, sporadic horizontal limestriae, at 0,95 occurs a sandlens (1 cm thick), limonite, the upper contact is not clearly identificable, lower contact, successive
2,00	0,80	Sm(f),Si/Si,C	fine-sand and silt interbedded in deformed lenses and streaks, which vary in thickness, some gravel grains, between 1,75 and 1,82 thicker sandlayer, sharp contact
2,50	0,50	Sm(f,m),Si	white sand and brown silt heavily folded and deformed, indistinct contact
2,80	0,30	Sm(f),Si/Si,C	fine-sand and silt interbedded in deformed lenses and streaks, which vary in thickness,dipping and bent layers, sharp contact
3,20	0,40	Sm(f)	white, deformed, dipping and bent layers, at 3,22 2-3 cm thick coarse-sand layer, indistinct contact
3,60	0,40	D	heavily deformed sequence, some distinct internal contacts, but mostly diffuse, fine-sand, diamicton silt, clay and organic matter chaotically folded and mixed, contact folded and indistinct, sample 14
4,60	1,00	D(c)mm	black layer rich in organic matter on the top, partly folded, varying thicknesses, beneath brown or greyish brown, clayey, with streaks of fine-sand and silt, deformed, indistinct contact, sample 13 (organic matter)
4,70	0,10	Dmm	mixture of grey and brown diamictons and organic matter with diffuse contacts
5,00	0,30	D(c,si)mm	upper 5 cm greyish brown, then grey, clayey and silty, more or less horizontally bedded, distinct contact
5,20+	0,20+	Ss(f)	pebbles and cobbles on the top (ventifacts), sand yellow (brownish in silty parts), stratified

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