

THE GEOLOGY OF THE DEPOSITS AT THE
EXCAVATION HAZERSWOUDE
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For the Symposium on Peat Lands below Sea level a study was made of the geology of the deposits in and underneath the peat excavation Hazerswoude. The excavation is situated about 8 km to the southeast of the town Leiden (just north of the polder reclaimed in 1847 on Figure 1, in Chapter 5), about two km south of the river Oude Rijn (Figure 1).

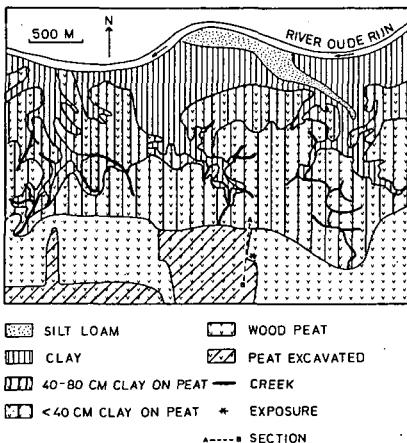


Figure 1. Map of the Hazerswoude area. After Markus en van Wallenburg (1972)

The section Hazerswoude (Figure 2) can serve as a scheme for the Holocene development of the inland part of the marine area.

The top of the Pleistocene subsoil lies between 11 and 13 metres below Dutch Ordnance Level (NAP). No soil is developed on this surface, indicating very wet circumstances in the area in the Early Holocene.

Five clastic and four peat units can be recognized in the Holocene de-

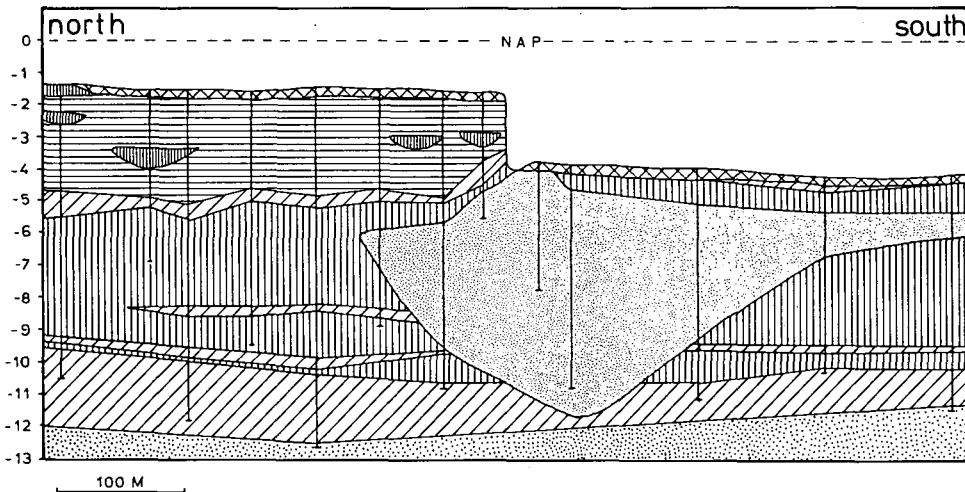


Figure 2. The section Hazerswoude. For location see Figure 1

posit. The lowermost peat unit is the Basal Peat. It consists of a *Carex* peat with some wood remains, grading upwards into a *Carex-Phragmites* and then into a *Phragmites* peat. Over this peat lies the lowermost clastic unit, consisting of humic clay, with many remains of *Phragmites*. The clay was deposited in a very low-energy environment. As the influence of the sea decreased the second peat unit was formed consisting of a *Phragmites-Carex* peat.

Over this peat layer two marine clastic units can be recognized, in several borings separated by a layer of *Phragmites* peat: the third peat unit. The second and the third clastic units consist of marine clay that is in part calcareous. In the third clastic unit a gully, filled with calcareous sand, can be recognized. Over the third clastic unit lies the fourth peat unit that is in part excavated (for a description of this unit see Chapter 22). In this peat unit clay lentils occur that form the fourth clastic unit, consisting of dark humic clay with many fragments of wood. In following the excavation it could be observed that the clay occurs in shallow and mostly very narrow meandering gullies in the peat. Most probably these gullies drained the sphagnum-peat area more to the south. In the gullies clay was deposited during high water stages of the river Oude Rijn.

The fifth clastic unit consists of a very humic clay that forms a sheet over the fourth peat unit. From Figure 1 it can be seen that this clay

is thickening to the north. The clay is a back-swamp deposit of the river Oude Rijn.

No direct datings of the deposits are available. The fourth peat unit dates the top of the third clastic unit as Late Atlantic or Early Sub-boreal (see Chapter 1, Table 1 and 2, and Figure 4). This dating is confirmed by a radio-carbon dating in the boring Nieuw Groenendijk about three kilometres west of the profile Hazerswoude. There the peat growth started at 4780 ± 60 BP (GrN 8088; Bosch & Pruijssers 1979). The third clastic unit is thus a Calais III deposit (see Chapter 1, Table 2).

About seven kilometres to the southwest of the section Hazerswoude, at Boskoop-Puttepolder, a radio-carbon dating was made of a wood peat at about 7.7 metres below Ordnance Level. The age of this peat layer that is probably the same as the second peat unit is 6000 ± 60 BP (GrN 1013; archive Soil Survey Institute). Thus the first clastic unit can be a Calais I deposit and the second clastic unit a Calais II deposit.

The profile at Hazerswoude represents a profile that is often found in that part of the western Netherlands that was early protected by coastal barriers. After about 4800 BP no marine influence is found in the deposits. The Calais IV and Dunkerque deposits are thus missing.

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VEGETATIONAL DEVELOPMENT OF A WOOD
PEAT DEPOSIT, AS READ FROM ITS
POLLEN CONTENT

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Most of the Dutch province of South Holland consists of the low-lying 'Holland peat', mainly formed during the Sub-Boreal period. Near the estuaries behind the coastal dunes and along the present and former, now fossil, river courses, the peat gives way to a marine or river clay deposit. Outside these deposits a thicker or thinner bed of clay often overlies the peat deposit depending on the distance from the supply base of the clayey sediment (cf. Figure 1, Chapter 5).

The Holland peat generally shows a clear zonation parallel to a (fossil) river course, i.e. near the levee along the river course where flooding was frequent, river clay was deposited and peat formed in a more or less simultaneous and joint process, resulting in the formation of wood peat with a varying amount of clay. At an increasing distance from the levee the mass of wood remains and the clay content of the peat decreases the wood peat finally merging in a deposit of sedge peat. At a relatively great distance from the levee, where the flood waters reached their farthest point, the sedge peat adjoins a vast area of Sphagnum peat. At a site near the village of Hazerswoude (Figure 1) peat soil is being excavated to obtain peaty earth for use in horticulture. Here a vertical peat face was visited during the excursion. It is located about 2 km south of the Oude Rijn river, inside the wood peat zone.

In order to show how the various plant species contributed to the formation of the peat deposit at this site, the peat was investigated by means of pollen analysis (Figure 2, see page 277). A number of pieces of wood taken at random from the peat face were analyzed¹; most of them proved to be alder. A few remains of oak and poplar were also ident-



Figure 1. Location of the sampling site

ified.

Having regard to the purpose of the study and the time available a more thorough analysis could not be conducted. This explains why the pollen spectra are often calculated from fairly low pollen counts.

The percentages of the various plant species relate to a pollen sum which includes all species (AP + NAP = 100%).

The pollen diagram clearly shows how the vegetation developed during the formation of the peat deposit and after reclamation of the peat soil. It can be divided horizontally into three sections, viz.:

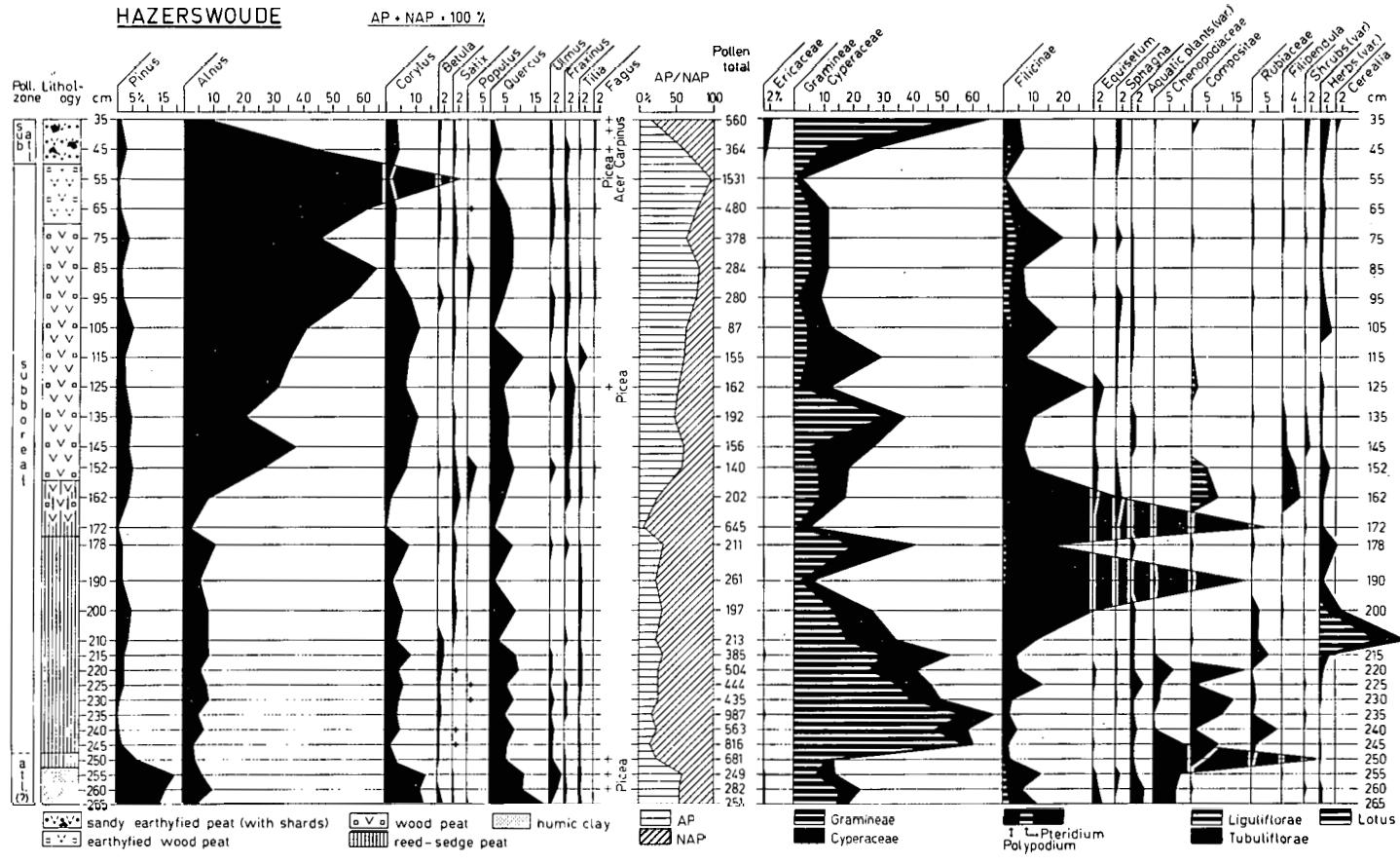
265-253 cm, coinciding with the top of the old marine Calais III deposit at the base of the peat. The later Calais IV deposit is out of the question as *Fagus* does not appear in the pollen spectra at this depth (cf. De Jong, 1970-1971).

253-47 cm, comprising the total depth of the undisturbed peat deposit.

47-35 cm, coinciding with a thin layer at the top of the peat deposit, where the peaty material is mixed with sandy material and some shards from the overlying bed of man-made soil. The latter was not subjected to pollen analysis.

In the bottom section the percentages of the various tree pollen types are not very representative of the vegetation in the environs of the

Figure 2. Hazerswoude pollen diagram



sampling site. The *Pinus* pollen is highly over-represented. This is a common feature of pollen spectra from marine or fluvial clay deposits and has still to be satisfactorily accounted for. The relatively high *Corylus* and *Quercus* values are probably due to pollen supplied from a secondary source, for instance an eroded river deposit originally covered with oak forest. It cannot be assumed that *Corylus* and *Quercus* grew in the marine or brackish environment of the Calais III deposit. The relatively high *Chenopodiaceae* percentage are in agreement with such an environment.

The section of the diagram representing the undisturbed peat spans the Sub-Boreal period, with the possible exception of its base, which may date from the end of the Atlantic period. Up to 178 cm the deposit consists of slightly clayey reed-sedge peat. The pollen spectra have a high non-tree (NAP)/tree (AP) ratio, reflecting a dense and extensive vegetation of grasses, sedges and ferns, here and there in an alternating sequence (cf. Janssen 1966). The main source of the fern spores is no doubt the marsh fern (*Thelypteris palustris*). The fern curve shows very marked peaks and troughs. This is a quite normal feature and is due to a combination of high spore production and low dispersion capacity of the ferns. The sedges, grasses, *Compositae* and trefoil (probably *Lotus paluster*) also show highly fluctuating curves due to local occurrences of these plants. It is noteworthy that the irregularities in the various curves come together in such a way that the joint curve (see the AP/NAP column in the diagram) is fairly straight.

The *Chenopodiaceae* maintain relatively high values near the base of the peat deposit, showing that after the sedimentation of the marine deposit was completed more or less brackish soil conditions first prevailed in the wider environment.

The tree pollen is now a faithful picture of the forest vegetation in this region. Since the *Quercetum-mixtum* and *Corylus* show high percentages as compared with *Alnus*, most of the tree pollen must have originated from the forests on the levees along the Oude Rijn river. The upper part of the peat deposit consists of a rather more clayey wood peat having a composition approximating to an alder carr peat. The varying composition of the successive pollen assemblages parallels the change in vegetative remains; the non-tree/tree ration decreases considerably above the reed-sedge peat; further up the diagram the *Alnus* percentages

reach very high values. Other tree pollen decreases in proportion to total tree pollen but like the *Alnus* it increases as compared with the total non-tree pollen. This may be due to the fact that the pollen spectra in the wood peat mainly reflect tree growth near the sampling site, whereas the spectra in the reed-sedge peat reflect regional tree growth. Although the differences are slight, the percentage of *Corylus*, *Populus* and *Fraxinus* are significantly higher in the wood peat than in the reed-sedge peat. The *Salix* curve already shows a small increase half-way between the bottom and top of the reed-sedge peat. The increase in *Quercus* and *Ulmus* is rather more doubtful.

Considering the fact that *Fraxinus*, *Salix*, and *Populus* in particular are usually highly under-represented in pollen diagrams as a result of their poor pollen dispersion capacity (Andersen 1970) or severe differential decay of their pollen, we can assert that *Fraxinus* and *Salix* made a continuous contribution to the stand and that *Populus* was also involved. It is well-known, however, that the percentage of the latter is impossible to assess from pollen counts. *Corylus*, *Quercus* and *Ulmus* grew as scattered shrubs or trees in the peat wood. *Salix* acted as a pioneer prior to the development of the wood (cf. Ellenberg 1963, p. 371).

We should, however, bear in mind that the stand may have shown local variations which are outside the scope of the pollen diagram.

Not all pollen is of local origin, some of it being carried over long distances, by air or by flood waters. This is particularly true of the pollen of pine, a tree which is represented with relatively high percentages in both the wood-peat and reed-sedge peat section of the pollen diagram.

The low representation of *Betula*, *Tilia* and *Fagus* shows that these trees were absent from the wood on the peat soil. The appearance of *Fagus* at 95 cm is connected with the immigration of the beech into The Netherlands during the Sub-Boreal period.

The *Alnus* curve begins to rise at the same level as the base of the wood peat, showing that alder first had very shallow roots. The slow rise in the curve is an index of the long period of time required for the full development of the alder vegetation.

Gelder rose (*Viburnum opulus*), elder (*Sambucus nigra*) and hop (*Humulus lupulus*), all of which are commonly found in the shrub story of an alder carr or 'peat wood'², are only sporadically represented in the fossil

pollen flora. Apart from hazel they are the only shrubs of which pollen was found.

The appearance of *Filipendula*, probably *Filipendula ulmaria* (meadow-sweet) in a relatively large quantity coincides with the start of the growth of the wood on the peat soil, as determined by the subsequently drier and more clayey soil conditions (cf. Ellenberg 1963, page 371). The *Sphagna* curve is frequently interrupted and only represented in small percentages. The *Sphagna* spores originated from the vast ombrogenous raised bog which once adjoined the sedge-fen peat area about 2 km south of the sampling site. The oligotrophic *Sphagnum* peat was excavated for fuel in historic times the loamy bog floor being reclaimed for arable land. In the short top section of the diagram the total tree pollen falls sharply and finally cereals appear for the first time. The pollen spectra here represent the Sub-Atlantic period when the more Eutrophic fen-peat soils were reclaimed for farmland. In time they became covered by a bed of man-made soil resulting from the application of manure mixed with sandy soil material (cf. Chapter 5, Section 5.3.2). The *Ericaceae* pollen in the two uppermost spectra must have been conveyed with it. It was taken from the older dune landscape west of the peat soils where a heather vegetation occurred on a podzolized soil.

Hitherto pollen analysis has only rarely been applied to a profile from a wood peat area. The only published evidence is by De Jong (1971-1972) who gives a series of pollen diagrams from a fill of a fossil river gully containing wood peat (1), the flank of an accompanying levee (2) and a pure alder-carr peat soil at some distance from the levee (3). The Hazerswoude diagram shows a marked resemblance to De Jong's diagrams (1) and (3) and occupies an intermediate position. Diagram (2) shows much higher values for the *Quercetum-mixtum* than diagram (1).

Notes

¹ The wood remains were kindly identified by Mr. J.M. Fundter.

² Alder wood mixed with more or less ash and other elements of the *Quercetum-mixtum*, depending on the clay content and hydrological conditions of the peat soil.

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