

GEOLOGICAL INVESTIGATIONS IN THE CENTRE OF HAARLEM (THE NETHERLANDS) AND THE DEVELOPMENT OF THE RIVER SPAARNE¹

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ABSTRACT

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The Spaarne river, exists since the Early Subboreal and drains into the former IJ estuary. Its main sand deposits date from the Early Subatlantic, other deposits from after the beginning of the Christian era. Sands of medium grain size are obviously derived from reworked dune and beach sands. They were deposited partially as point-bar deposits, but dune sands blown into the water of the Spaarne may also be present. Substantial amounts of organic material were deposited after the beginning of the Christian era. A clay bed Bakenes clay, covers the much older Holland Peat along both sides of the Spaarne. The clay probably dates from the XIIth century and reflects a period of flooding, including some storm surges which are mentioned in historical sources. In late medieval times a strip of land along the Spaarne was reclaimed; the resulting shift of the Spaarne bank is discussed.

INTRODUCTION

This report is based on data which were collected over the last twenty years and which were derived mainly from incidental excavations for civil engineering works (sewerage trenches, construction pits). Supplementary data came from borehole information available at Haarlem's Department of Municipal Works, and from a few shallow boreholes made in selected spots.

Most of the data is presented in four sections that vary in length between 100 and 370 m. These sections are drawn on the basis of irregularly spaced vertical profiles which were studied in detail; the intervening spaces are either interpolated or drawn from spot observations in the field.

The ongoing investigations are aimed at collecting detailed information on the development of the coastal barrier and the Older Dunes on top of it, and on the behaviour and the geological history of the local river Spaarne. The latter is the subject of this report.

The age of the deposits is estimated from pollen analysis, archaeological finds, and radiocarbon dates. The late

medieval (i.e. AD 1000-1500) deposits are rich in archaeological objects, among which pottery sherds are most appropriate for dating purposes. They will not be described here and have only been used to estimate the age of the deposits. Only a few basic data obtained by pollen analysis will be given. For other sections that have been investigated in larger or smaller detail the interpreted results are mentioned only as pollen zones (cf. Fig. 1).

A considerable proportion of the sediments consists of organic material of highly variable composition and habit. Besides peats and gyttjas, which are rather easy to determine, there are a number of sediments which are difficult to classify, in particular those which have been strongly influenced by man. These have been indicated as 'organic material'. This term is also used in a general sense, e.g. for sediments whose genesis is not understood. Part of the information has already been published elsewhere (DE JONG, 1971; 1976).

GEOLOGICAL SITUATION

The town of Haarlem lies in the coastal area of Holland, i.e. the western part of The Netherlands (Fig. 2). The centre of the town was built on a dune ridge that lies on top of a coastal barrier (JELGERSMA ET AL, 1970). This barrier belongs to a complex of more or less parallel barriers which diverge toward

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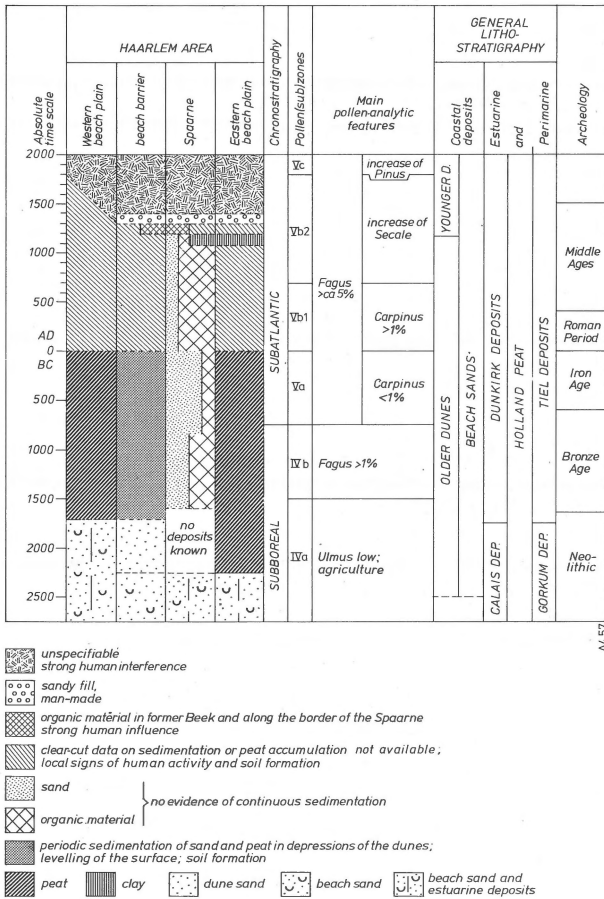


Fig. 1 Stratigraphic position of the main deposits in the Haarlem area, with pollen zones and archaeological periods.

former estuaries. In the case of Haarlem this is the former IJ estuary, to the NW of the town. The orientation of the coastal barrier parallels roughly the recent coastline. Since the barriers were formed from east to west, their age decreases in a westward direction. Between the barriers there are beach plains in which initially estuarine sediments accumulated. Later, peat started to grow in these depressions and, depending on the distance from the estuary and its activity, it became the dominant situation in most places. In the Haarlem area there are three barriers: from east to west, the Spaarnwoude, the Haarlem and the Overveen-Bloemendaal barriers. They are still visible in the present landscape.

Fig. 3, a schematic W-E section through the centre of the town, clarifies the geological situation. The age of the underlying barrier can be estimated from a radiocarbon dating of the directly overlying peat in the Velslerbroekpolder (just N off the map, Fig. 2): 4250 ± 60 BP (GrN-5916; DE JONG, 1971).

Marine shells are found at various depths but not above -2.25 m NAP (Dutch Ordnance Datum, i.e. practically mean sea level). The peat layers that are intercalated in the Older

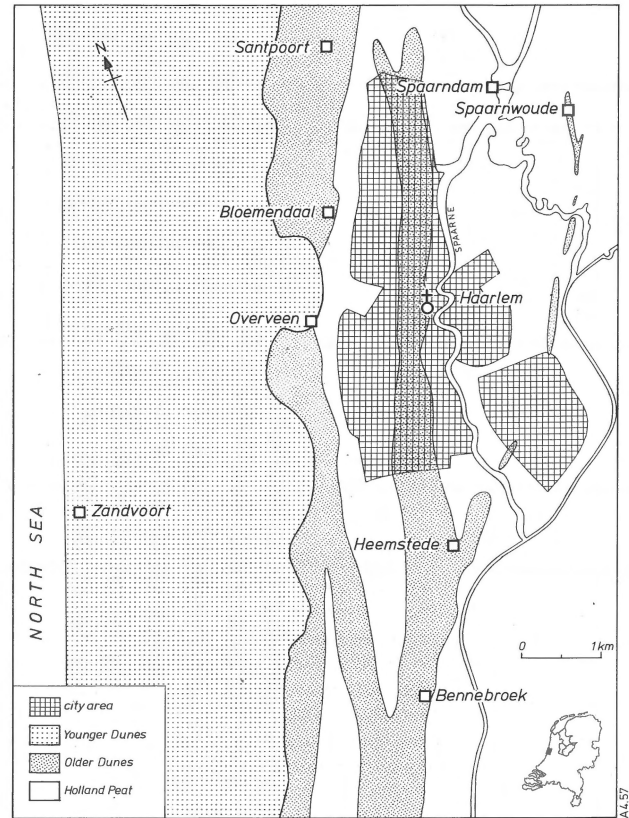


Fig. 2 Simplified geological map of Haarlem and environs, showing the built-up area of the town and the course of the river Spaarne. Superficial clay beds east and north of the town (Dunkirk III deposits) have been omitted as well as those in the SE in the Haarlemmermeerpolder (Calais deposits).

Dune sands developed in depressions with a maximum depth of about -2 m NAP, and are overlain by wind-blown sand. This filling of dune pans indicates transport of substantial amounts of dune sands, which led to a levelling of the dune morphology, a process which probably ended almost completely around the beginning of the Christian era.

At the eastern of the section a thin clay bed, the Bakenes clay, should be noted; it is present throughout a large area east of Haarlem and its origin will be discussed later.

The younger Dune sands west of Haarlem are important for the region. These deposits did not reach as far as the Haarlem area, but exerted an influence on the landscape in two ways: by considerably reducing the medieval forested area (Haarlemmerhout) and by changing the hydrological situation.

The table in Fig. 1 summarizes the lithologies observed, the main pollenanalytical features and archaeological zones, the general litho-stratigraphy, etc. as used in this paper.

General description of the history of Haarlem can be found in ALLAN (1874-1888), KURTZ (1946), SPEET (1982), TEMMINCK (1971) and VAN REGTEREN ALTENA & SPEET (1982).

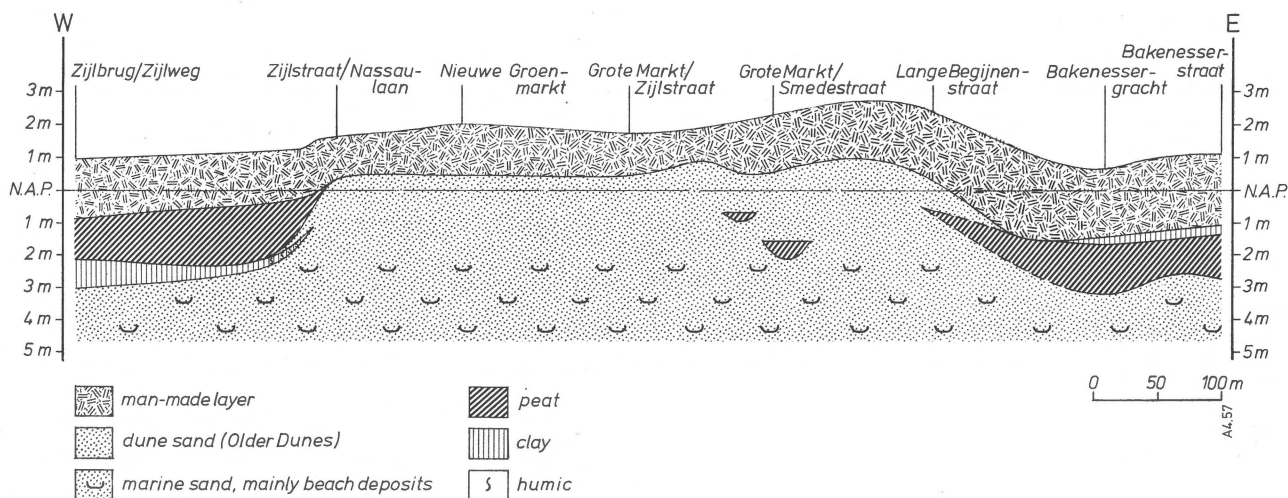


Fig. 3 West-east section through the centre of Haarlem; section not indicated in Fig. 4. Slightly modified after De Jong, 1971. Note: all depth figures below NAP (Dutch Ordnance datum) should be marked with a minus sign.

HISTORICAL DATA

The town of Haarlem received its charter in AD 1225. 'Haralem' is mentioned in the 'Goederenregister' (property Register) of St. Martin's Church in Utrecht, which dates from the Xth century. This register indicates that Haarlem probably already existed in the VIIIth century (BLOCK, 1975). Although there are a few finds of Carolingian (Frankian) pottery (VAN REGTEREN ALTENA & SPEET, 1982) no signs of a real settlement have been detected. Pottery of Pingsdorf, Andenne, Paffrath, and Kugeltopf ware which was found in the centre of town, suggests a concentrated habitation during the XIth to XIIIth centuries.

The oldest quarters of the town are situated around the present Grote Markt (Main square, Fig. 4) on the W bank of the Spaarne and date from about the same time. Some authors (e.g. HUIZINGA, 1948) consider Bakenes as the oldest quarter of town, but it is now generally accepted – on archaeological evidence (DE JONG, 1971; POLDERMANS, 1983a) – that Bakenes became only part of the town in the XIVth century, i.e. in the same century as the Burgwal area on the right bank of the Spaarne.

The Beek (the 'brook'), is a watercourse which once ran through the centre of town and connected the western beach plain with the Spaarne. The Beek was first mentioned in the beginning of the XIVth century (GROESBEEK, 1982); it was later vaulted, and finally it was used only as a sewer. Most of the vaulting has been demolished, but part of the course is still used in the town's sewer system but remains hidden from view.

The Spaarne river should be mentioned here as well. It runs east of the dune ridge (Fig. 2) and has a strongly meandering character in the centre of Haarlem. The Spaarne originated possibly as a drainage channel for the raised bogs in the present Haarlemmermeerpolder (to the SE of Haarlem, for the greater part outside the map area of Fig. 2); it flows in the

direction of the former Y estuary (to the N of Spaarndam, Fig. 2) and still functions as an important drainage channel. Until recently, virtually no geological data were available on the age of the river. In AD 1220 a dam was built at the confluence with the IJ estuary, i.e. the site of the present village of Spaarndam (FOCKEMA ANDREA, 1954).

SURVEY DATA

The Beek (see map, Fig. 4)

Between 1966 and 1975 surveys were made in sewer trenches along the Oude Groenmarkt, Spekstraat and Grote Houtstraat (see Fig. 4, a streetmap of the centre of Haarlem). Below subrecent layers there are organic deposits down to a depth of -1m NAP. They contain pottery fragments that date back to the XIIth and XIIIth century. The organic material consists of freshwater deposits, part of which is disturbed and even removed by man since the Middle Ages. This organic material is found along the Damstraat, Oude Groenmarkt, the Spekstraat and Grote Houtstraat, but near the Lepelstraat it is absent, probably as the result of later human activity. Although not mapped in detail, the width of the area underlain by this organic material increases toward the Damstraat. Pollen-analytical studies show an abundance of cereals throughout the whole vertical profile, indicating intense medieval agriculture (DE JONG, 1971). Fig. 5 is a S-N section along part of the Grote Houtstraat, crossing the Beek and indicating the N-S extent of the organic deposits (DE JONG, 1974; see also Fig. 11).

Spaarne section (section II-II', Fig. 6)

This W-E section is along the left bank of the present Spaarne; it is based on observations made in sewer trenches in 1964 and

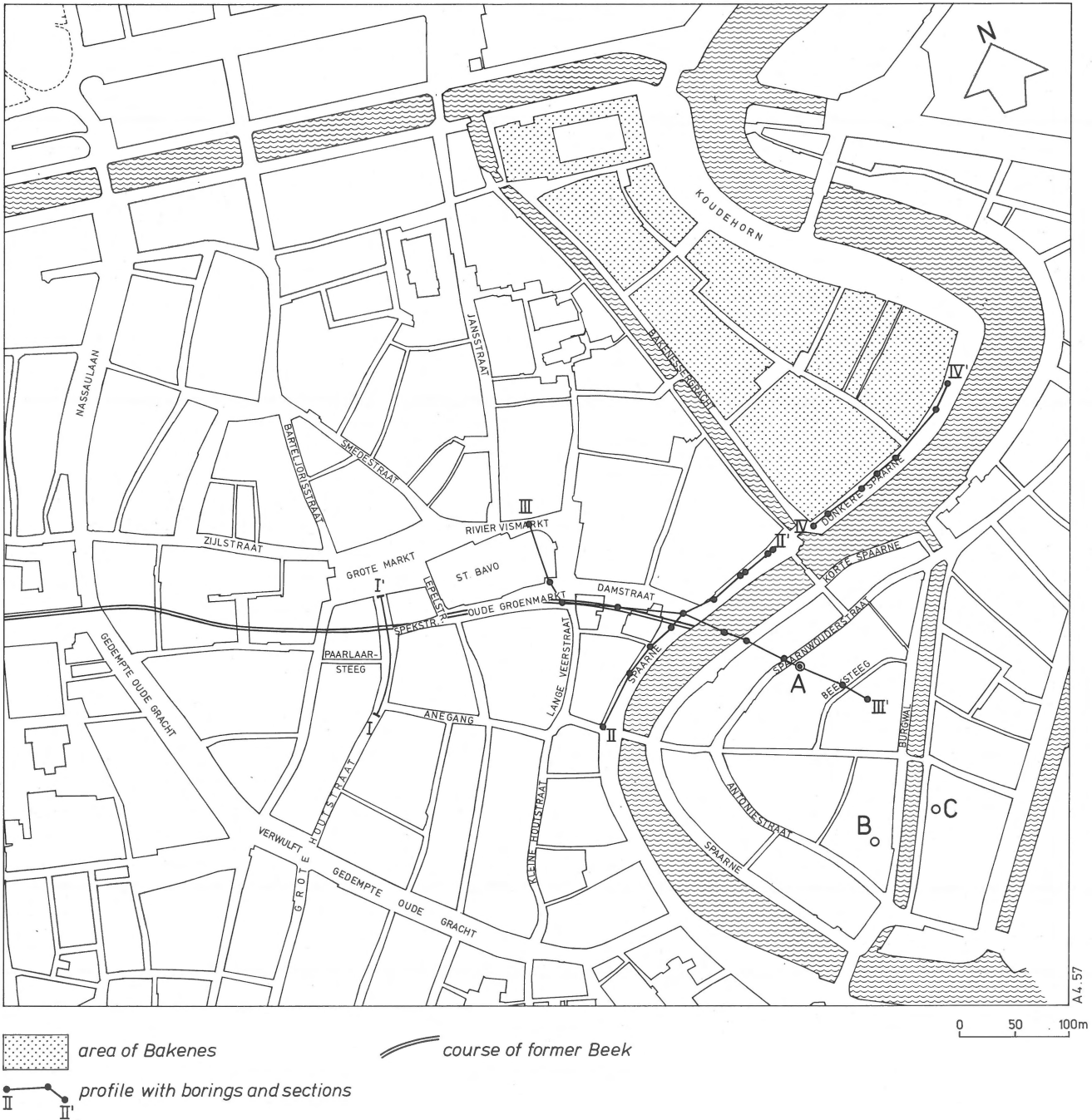


Fig. 4

Haarlem; situation map of the area under study. Sections: I - I' see Fig. 5; II - II' see Fig. 6; III - III' see Fig. 8; IV - IV' see Fig. 7. The dots on the section lines are reference points of the soil profiles used. Observation sites in the Burgwal area:

A - Borehole Spaarnwouderstraat, pollen diagram Fig. 9;

B - Excavation Antoniestraat, pollen diagram Fig. 10;

C - Borehole Burgwal, radiocarbon date for basal part of Holland Peat at -3.30 to -3.32 m NAP: 4075 ± 35 BP (GrN-9042).

is supplemented by a number of boreholes. The surface layer (bed 1) consists of heterogeneous sandy material; it is underlain by bed 2, which locally shows abundant traces of human influence, such as pottery, charcoal and bones. Parts of this characteristic and highly organic material suggests a natural deposit, but thin layers of straw and dung are present as well.

This bed 2 can be interpreted as a water-lain deposit, partially man-made to reclaim the bank of the Spaarne. Fragments of pottery indicate the same age as the freshwater deposits of the Beek: XIIth and XIIIth century.

Bed 2 passes downward into a gyttja (bed 3) in which distinct signs of human influence are lacking. The transition is

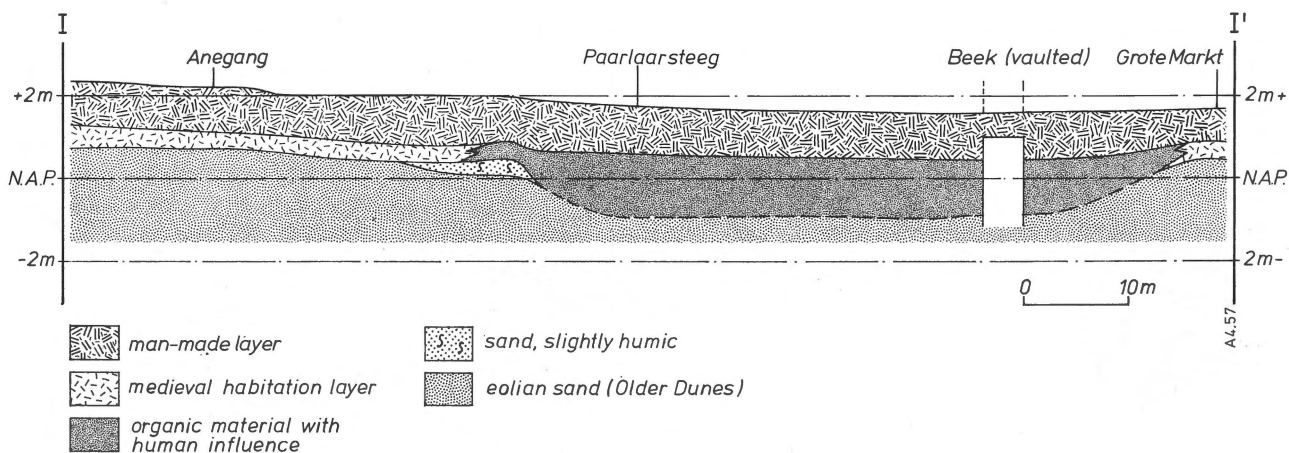


Fig. 5
Section I - I' Grote Houtstraat; from survey in sewer trench in 1975. See Fig. 4 for location.

often difficult to distinguish, especially in boreholes. Pollen-analytical data obtained from the Damstraat borehole indicate an age after the beginning of the Christian era (pollen subzone Vb, cf. Fig. 1). Below the gyttja follows a sandy layer (bed 4) of considerable thickness and with locally intercalated organic layers. Pollen-analytical dating of some organic layers (in holes Damstraat and Spaarne 8) indicate a Subboreal age, i.e. during the interval around the transition of pollen zones IVa and IVb, or around 3500 BP.

Donkere Spaarne and Bakenes (section IV-IV', Fig. 7)

The section of Fig. 7 (for location see Fig. 4), exposed in a sewer trench, is very different from the Spaarne section although it is a direct continuation along the left Spaarne bank.

In the west part of the section there is a thick organic layer (bed 3b), whose basal part is of Subboreal age. This bed shows signs of erosion and is partly overlain by a layer of sand (bed 4a) with intercalated thin organic layers and streaks dipping toward the Spaarne. Pollen-analytical data indicate a Subatlantic age after the beginning of the Christian era. It is not clear whether parts of these deposits date from the Middle Ages.

The sand body is overlain by an organic layer (bed 3a) with abundant remains of wood (mainly alder), followed upward by a thin sandy layer (bed 10), on top of which follows the main habitation layer (bed 2a). The whole sequence above the sandy layer (bed 4a) probably dates from the late Middle Ages, and there may be a disconformity between the beds 4a and 3a. As indicated in Fig. 7, there is no evidence for a correlation between the beds in the western and eastern part

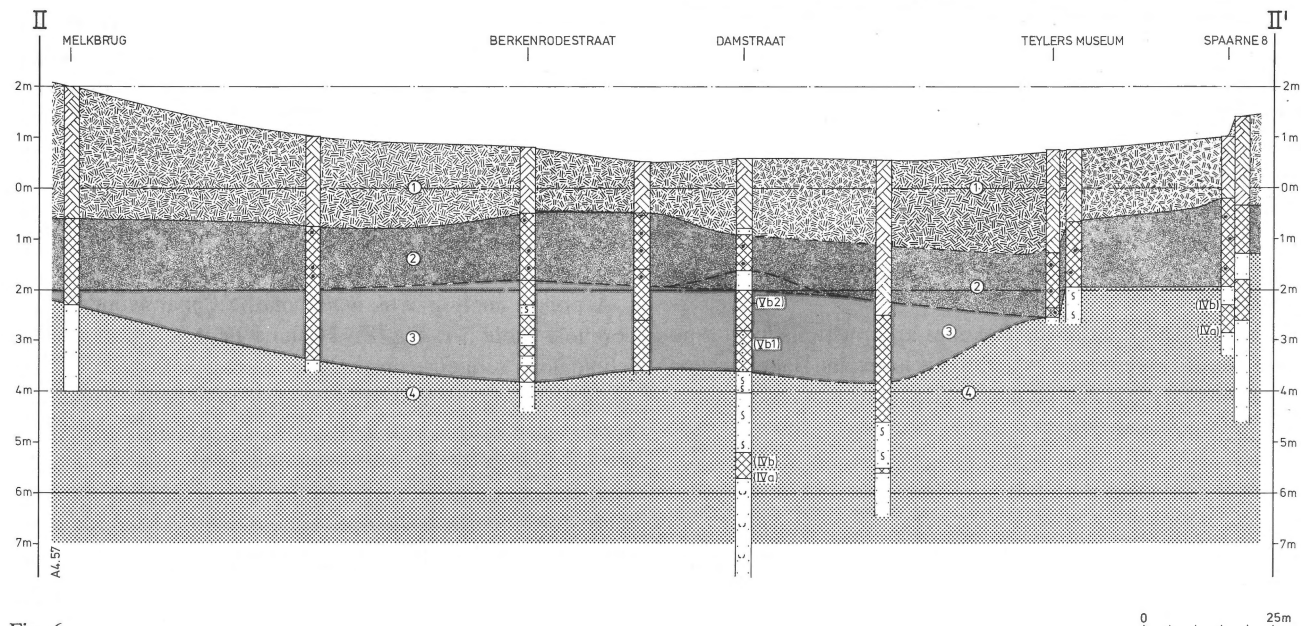


Fig. 6
Section II - II' along Spaarne left bank; based mainly on survey in a sewer trench in 1964, supplemented by borehole data. See Fig. 4 for location and Fig. 8 for legend. The depth scale should be marked NAP; all depths below 0 should have a minus sign.

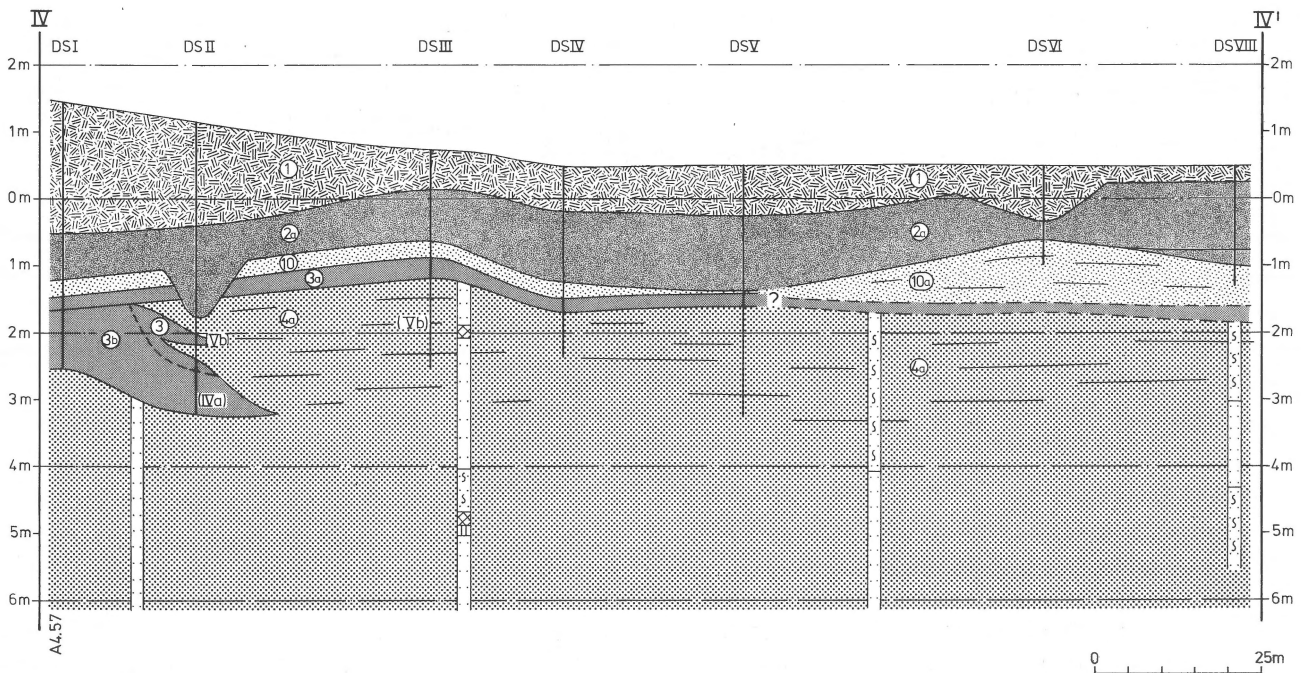


Fig. 7
Section IV - IV' Donkere Spaarne; DS I, II, etc. mark to profiles studied in a sewer trench in 1967. Additional information from boreholes for the basal parts only. See Fig. 4 for location and Fig. 8 for the legend. Depth scale: 0m = NAP (Dutch Ordnance datum).

of the section, i.e. between beds 10 and 10a nor in the underlying bed 3a.

Bakenes (stippled area in map of Fig. 4)

The centre of Bakenes is situated on Holland Peat, which is pollen-analytically dated as Subboreal and Subatlantic – the top locally dating from about the beginning of the Christian era. The peat is in places overlain by a 10 cm thick, aquatic sandy layer which on pollen-analytical evidence (cereals, rye) must be dated to have been deposited in medieval times after about AD 700. Hence there is a hiatus between the end of the peat growth and the layers which cover it. The sandy layer is probably connected with the sand body (bed 4a) along the Donkere Spaarne (Fig. 7), giving this body a probable age of after about AD 700. No conclusive correlation can be made as long as the geological position of the sand beds 10 and 10a is uncertain.

The Holland Peat in the Bakenes area, with its local sand layer, is entirely covered by a thin clay layer, the Bakenes clay; under this clay layer no archaeological finds have been made. The dating of the Bakenes clay is discussed below.

Burgwal area (Figs 4 and 8)

The Burgwal area lies on the eastern or right bank of the Spaarne opposite the Damstraat (Fig. 4). Written history places its incorporation into the town in the XIVth century. The area is situated in the eastern beach plain and, except for a zone along the Spaarne, Holland Peat is present under a thin

layer of clay that is very similar to that in Bakenes. On this clay lies a man-made bed composed partly of organic material. The present buildings are placed on top of this bed. The surveys have not answered the question as to whether man-made beds existed before construction began here, or whether the present thickness of the bed was reached in stages during the period of habitation. Along the right bank of the Spaarne, in between the Spaarne and the Spaarnwouderstraat/Antoniestraat, (Fig. 4) there is also organic material with signs of human influence (Fig. 8, bed 2). Little detailed information is available for the dating of these beds. Pottery fragments may suggest an older age (XIIIth-XIVth century, DE JONG, 1971) than would be expected on historical grounds. In the man-made beds on top of the clay, there are no indications for a date earlier than the XIVth century. Below the organic material along the Spaarne, there are gyttja layers (bed 3 in Fig. 8) and sands (bed 4, Fig. 8) of medium grain size.

A pollen analysis was made of the Spaarnwouderstraat borehole (hole 3A, Fig. 8). Holland Peat is absent and the lithological sequence reveals a strong influence of the Spaarne. The pollen diagram (Fig. 9) indicates a Late Subboreal age for the lowest gyttja layer and a transitional age to the Subatlantic for the overlying sand. High values of *Pedicularis* indicate deposition in freshwater. There are no indicators for a marine influence. The pollen of *Chenopodiaceae* might indicate that there were salt marsh plants in the vicinity, but it is more probable that the pollen came from vegetation that was associated with agriculture in the Bronze Age.

Between 2.20 and 3.37 m below the surface (-1.2 and -2.3 m NAP) the pollen diagram indicates an age after the beginning

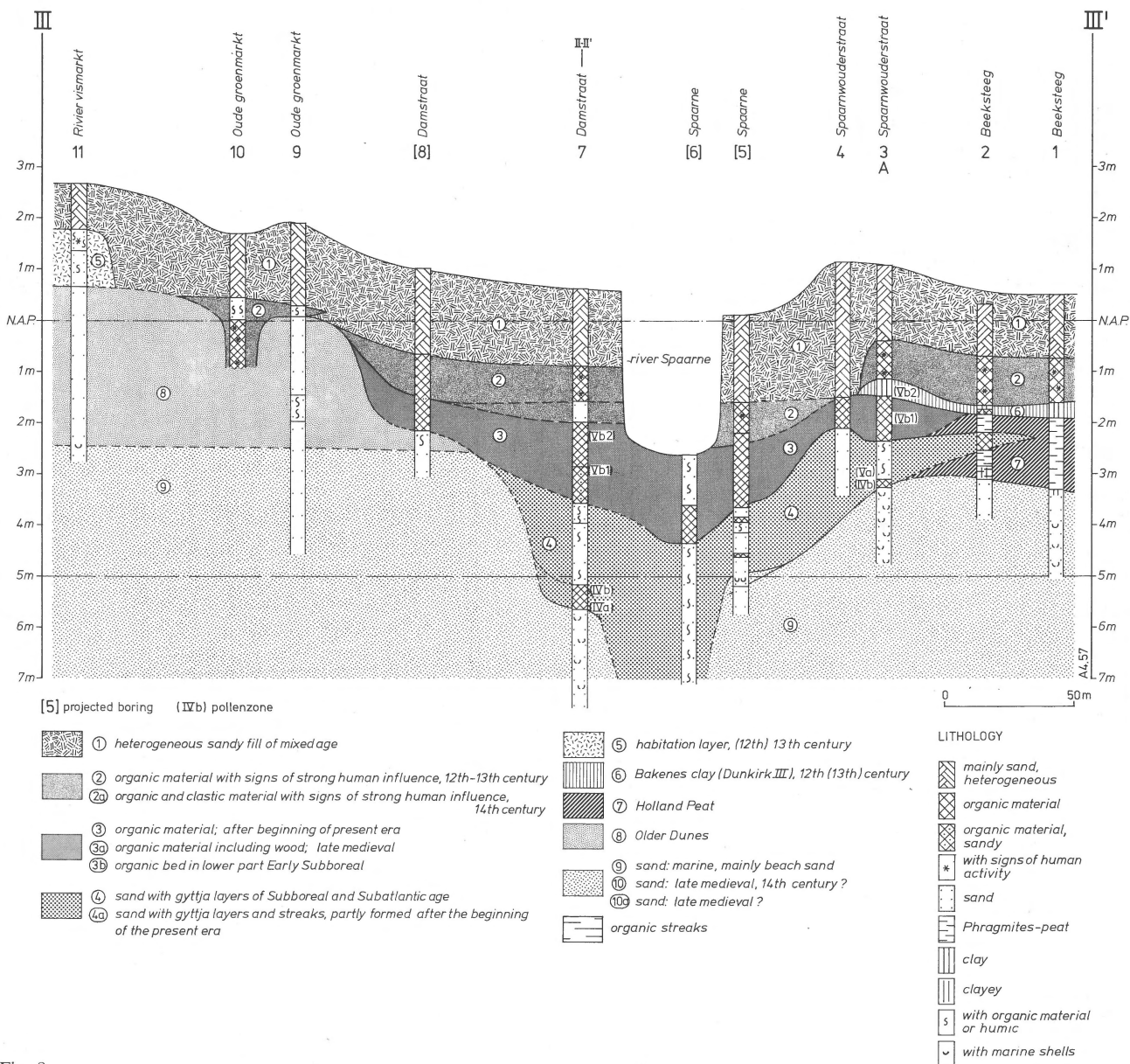


Fig. 8
Section III - III' across the Spaarne. See Fig. 4 for location. Legend also valid for Figs 6 and 7.

of the Christian era (subzone Vb: *Fagus*, *Carpinus*). This part of the borehole includes two beds: gyttja and overlying clay. The spectra obtained from the gyttja show only weak traces of agriculture (subzone Vb1); the overlying clay has an abundance of pollen which points to medieval agriculture (*Cerealia*, *Secale*). This indicates an age after about AD 700 and probably even several centuries later. No marine influence has been detected in this borehole. The presence of *Sphagnum* and *Ericales* shows that there were raised bogs in the hinterland.

Another pollen-analytical profile (Fig. 10) was obtained from material collected in a trench, dug for an archaeological investigation by the "Archeologische Werkgemeenschap voor Nederland" in the Antoniestraat (marked B, Fig. 4). In

this profile the Holland Peat is overlain by a clay layer, which is partly humic, while the black colour of the top of the peat is evidently the result of oxidation. This is a common sequence in the area east of Haarlem. In this profile, a pottery sherd of local production was found in the oxidized top of the Holland Peat (Mr. A. M. Numan, 1983, pers. comm.). This sherd can be dated in the centuries around the beginning of the Christian era.

The investigated part of the Holland Peat dates from the Subatlantic (subzone Va), whereas a Late Subboreal age can probably be assigned to the lowest level (subzone IVb: *Fagus*). Pollen of *Sphagnum* and *Ericales* in the Holland Peat (*Phragmites* peat) must come from raised bogs in the surrounding areas. The distinct agricultural influence (*Cere-*

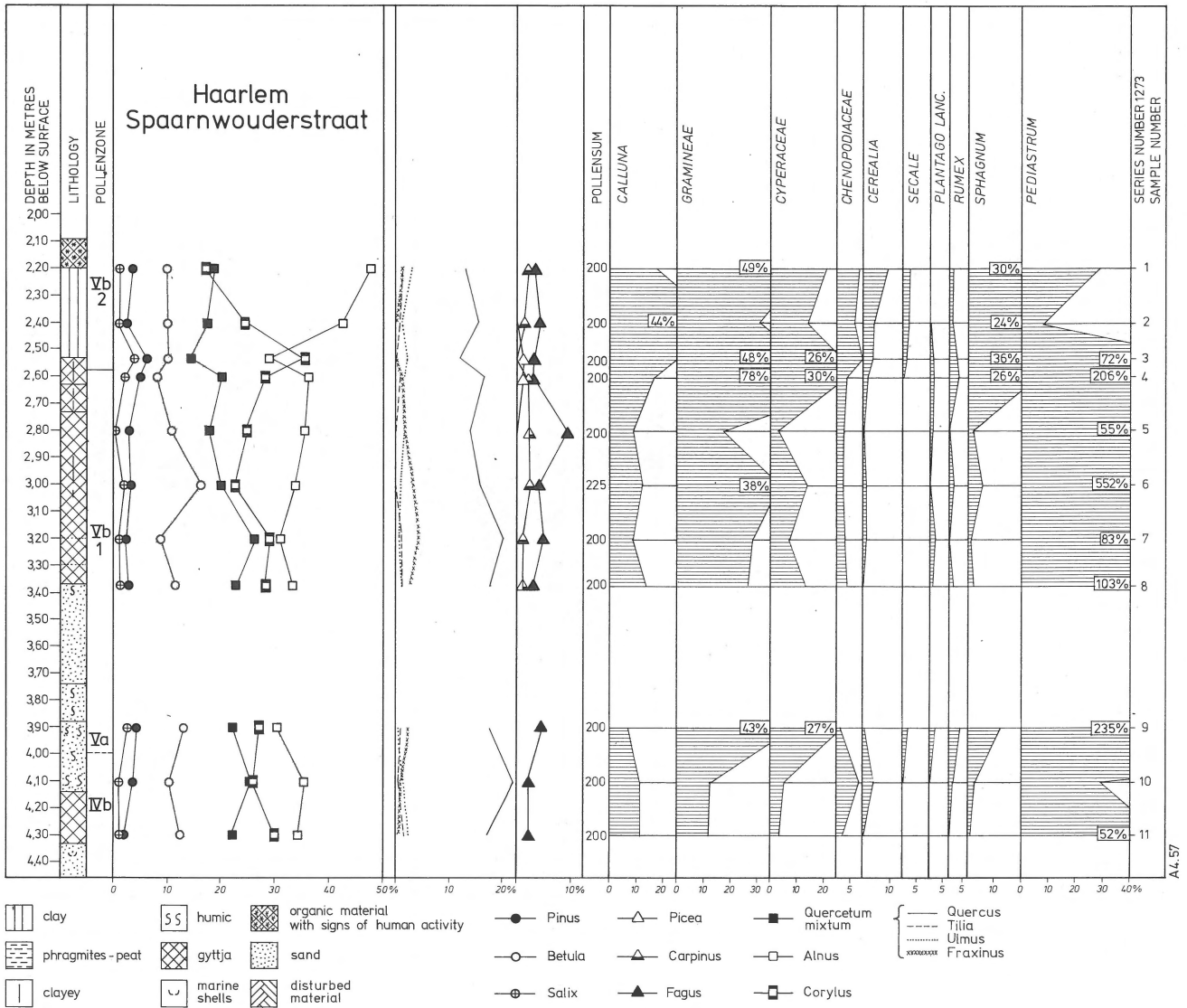


Fig. 9
Pollen diagram of Spaarnwouderstraat profile; only selected curves are shown. See Fig. 4, site A for location.

alia, *Plantago lanceolata*) must be related to prehistoric settlements.

The pollen diagram clearly reflects a hiatus at the transition from peat to the overlying Bakenes type clay. The clay dates from subzone Vb2 (with *Cerealia* and *Secale*), i.e. late medieval age. There are no indications of a marine influence.

Spaarne section III - III' (Fig. 8).

This section across the Spaarne crosses the section II-II' (Fig. 6) in borehole 7: Damstraat. In the east of the section (borehole 2: Beeksteeg) a gyttja layer is intercalated in *Phragmites* peat; this marks the transition from the Holland Peat into the Spaarne deposits. West of the Spaarne the section is somewhat schematic; going west it shows (i) the transition from Spaarne deposits to the Older Dunes, (ii) the filling of the Beek (profile 10: Oude Groenmarkt), and (iii) a

habitation layer of the XIIth/XIIIth century on top of Older Dunes (bed 5 in profile 11: Riviervismarkt; DE JONG, 1982).

There may be some difference in age between the organic layers (bed 2) with a strong human influence that lie on opposite banks of the Spaarne, as discussed in connection with the Burgwal area. The main organic bed, number 3, as well as the underlying sandy bed 4 have been distinguished on the basis of lithological features. They may alternate to some extent, however. No attempt has been made to establish a more detailed picture as the available data and datings are scarce and do not permit more detailed stratigraphic interpretation.

The sandy deposits (e.g. bed 4) are in general sloping towards the centre of the Spaarne; they may be pointbar deposits or natural levees, as suggested by borehole 4: Spaarnwouderstraat.

Based on the lithological sequence and the general geologi-

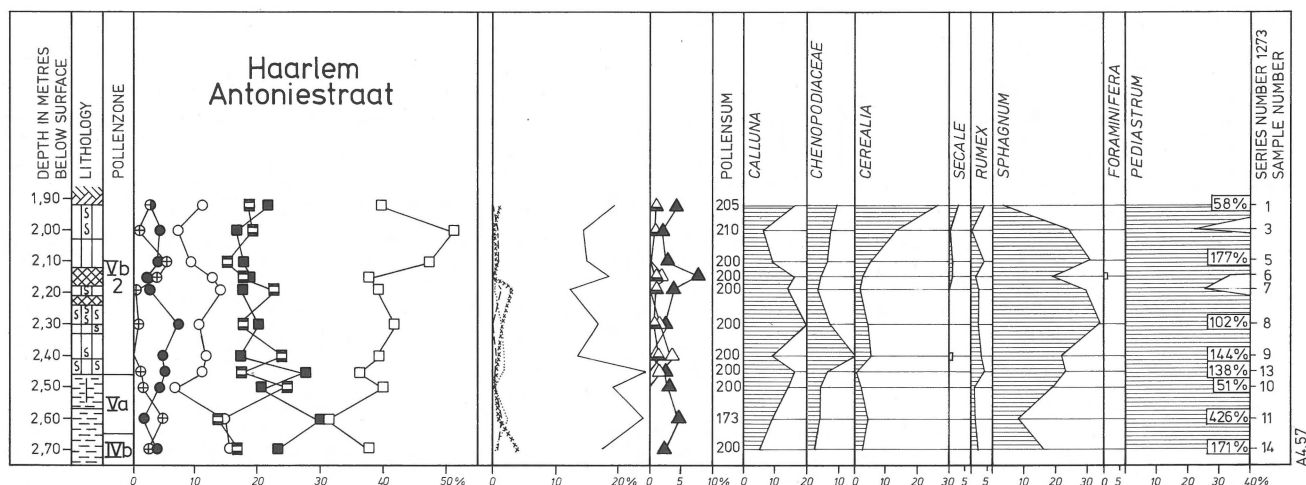


Fig. 10
Pollen diagram of Antoniestraat profile; only selected curves are shown. See Fig. 4, site B for location, and Fig. 9 for legend.

cal position, erosion levels are to be expected, especially on the west side of the Spaarne, but sufficient data to localize them are not available – more so as it is often difficult to distinguish the dune sands of the Older Dunes from the sandy deposits of the Spaarne. The Holland Peat is strongly eroded (DE JONG, 1976) in the area of the Teylers Museum, between the Damstraat and the Bakenessergracht (Fig. 4). On top of the erosion level there are organic layers, mostly with traces of human activities dating from the late Middle Ages.

DISCUSSION

Pollen-analytical data place the oldest deposits of the Spaarne in the Early Subboreal. In organic beds underlying or intercalated in sands the transition between pollen subzones IVa/IVb can be distinguished; profiles DS II (Fig. 7), Spaarne 8 (Fig. 6) and Damstraat (Fig. 8). The great depth of these deposits in the Damstraat, as compared with the top of the older marine deposits in the beach barrier as well as in the beach plain to the west and east, indicates active erosion by the Spaarne after cessation of the marine deposition, i.e. during the earlier part of the Early Subboreal. On the eastern beach plain, peat started to form on top of the marine beds around 4200 BP (sample Schalkwijk I, -3.01 - -3.03 NAP, base of Holland Peat: 4200 ± 60 BP, GrN-10921). Radiocarbon dating of the basal part of the Holland Peat in the Burgwal area near the Spaarne (site C, Fig. 4) gives an age of 4075 ± 34 BP (GrN-9402). This suggests that peat formation in the vicinity of the Spaarne began later than elsewhere in the eastern beach plain. It therefore seems likely that the Spaarne was already in existence around 4075 BP.

The sandy deposits of the Spaarne are all of medium grain-size without appreciable variation and are very similar to dune and beach sands. Only intercalated organic streaks and layers can help to identify them. It is evident that these sands originated from eroded beach and dune sands and may have been transported over only a short distance.

The age of the sandy deposits of bed 4 (Fig. 8) is not yet precisely known. They overlie material of Late Subboreal age (Damstraat, Spaarnwouderstraat) whereas the basal part in the Spaarnwouderstraat boring is of Early Subatlantic age. The sandy deposits are overlain by organic material dating from after the beginning of the Christian era. This means that the greater part of the sands included in bed 4, (Fig. 8), dates from the Early Subatlantic (subzone Va). Other sand deposits date from after the beginning of the Christian era. They are most abundant along the Donkere Spaarne (beds 4a, 10, 10a; Fig. 7), and occur as high as -1 m NAP. Some of them are of late medieval age. Some thin sand deposits of similar age are also present in areas where organic deposits of this age are dominant, for instance in the Damstraat boring (Figs. 6 and 8).

The investigation has made it clear that the meandering pattern of the Spaarne is related to the presence of the beach barrier. The organic layers that date from after the beginning of the Christian era indicate a low activity of the river since that time.

An interesting question concerns the extent to which eolian sand affected sedimentation in the Spaarne. In the estuary of the IJ, of which the Spaarne was a tributary, wind-blown sands have been found over large areas (unpublished data; WOLTERING, 1979, pp. 252-256). These sands date from the Early Subatlantic and in part they fill gullies in the estuary. These sands derive from the Older Dune sands. Substantial amounts of wind-blown sands are also known from the centre of the town of Haarlem as fillings of former dune pans. Some of these sands are from the same period. This may indicate that deposition of wind-blown sands also affected the behaviour of the Spaarne where this river was in contact with the Older Dunes.

The Bakenes clay also deserves attention. This clay occurs at Bakenes and in the Burgwal area, and no medieval pottery has been found below it. Pottery dating from about the beginning of the Christian era is only known from the

Antoniestraat site (B in Fig. 4). Above the clay, an excavation has recently yielded Pingsdorf pottery (POLDERMANS, 1983a), which can be dated before AD 1300. Pollen analyses has dated the clay as subzone Vb2. This indicates a medieval age, i.e., after AD 700, but in view of the rather abundant pollen of *Cerealia*, the date should probably be put a few centuries later. Pollen of *Centaurea cyanus* has been found at Bakenes in the top part of the clay-layer, which was disturbed after deposition of the bed. This confirms the conclusion drawn from the archeological finds, i.e., that the bed was already present around AD 1300.

Dam construction in AD 1220 near the mouth of the Spaarne at Spaarndam makes it possible that the Bakenes clay was deposited even before that time. This means that the deposition of the Bakenes clay, which is certainly of medieval age, may have been caused by floods in the XIIth century. GOTTSCHALK (1971) mentioned storm surges during that period, but the geological data make it more likely that the clay was deposited as the result of a longer process characterized by high water levels, rather than one or two catastrophic events.

Since the exact date of the first construction of the dam at Spaarndam is still under discussion (HUIZINGA, 1948) and since little is known about the effectiveness of the dam and dikes in the initial phase, clay may still have been deposited during a considerable part of the thirteenth century.

Concerning the dating of the Bakenes clay it should be borne in mind that, in the area under discussion, the first major inundation after the beginning of the Christian era took place in the later part of the Middle Ages (after AD 1000). From pollen-analytic data (see above) and diatom analysis

(JANSMA, 1979; DE WOLF, 1983 pers. comm.), it may be concluded that the Bakenes clay was deposited in a freshwater environment. The clay is connected with clay beds in the IJ estuary, which were deposited in an environment under a stronger marine influence (Dunkirk III deposits).

THE SPAARNE BANK IN LATE MEDIEVAL TIMES

The available data permit a reconstruction of the banks of the Spaarne, although some uncertainties still exist in the datings and in the distribution of some of the deposits.

In the twelfth and thirteenth century (Fig. 11) the west bank was situated along the Lange Veerstraat and Kleine Houtstraat, and may have carried a dike (POLDERMANS, 1983b). The bottom of the Spaarne was rather shallow and muddy, and received the wastes of habitation. The Beek joined the Spaarne to the east of the present St. Bavo Church. Part of the bank north of the Damstraat has been reconstructed to coincide with the western limit of the Bakenes clay, which in this area is related to the boundary of the eroded Holland Peat (DE JONG, 1976).

The course of the Beek in the town has already been discussed. The stretch from the Grote Houtstraat to the Damstraat, characterized by organic material in the subsoil, was oriented toward the Spaarne. It is not clear whether originally there was a connection with the western beach plain. In the segment west of the Grote Houtstraat no organic material of the kind described above has been found (NUMAN, 1982). The meaning of the widening of the Beek in the Grote Houtstraat is unknown, but it might represent a harbour which also served as water reservoir (for fire-fighting and drinking-water).

Some authors consider the Beek a natural watercourse (HOEKSTRA, 1947; GROESBEEK, 1982) but until recently there was no geological evidence in support of this assumption. (STEENHUIS, 1942; DE JONG, 1971). The Beek must always have played an important role in the drainage of the western beach plain into the Spaarne and was also used for shipping.

Fig. 12 is a reconstruction of the situation around AD 1300. According to historical as well as archaeological date, the Bakenes area was not yet part of the town. The reconstruction is based on the assumption that the organic beds, with their many traces of human activity, represent a subaqueous deposit. Its deposition was promoted by man in an attempt to reclaim the shallow Spaarne. The sand bed that is found near the surface and that was raised by man, may have completed the reclamation and therefore must also be rather old. Because most of the material was reworked frequently by human activities, it is difficult to find sufficient evidence in the field to support this assumption. Presumably, around AD 1300 the present position of the west bank of the Spaarne was fixed.

There are reasons to believe that in the centre of the town (Grote Houtstraat, Grote Markt, Riviervismarkt) the beds

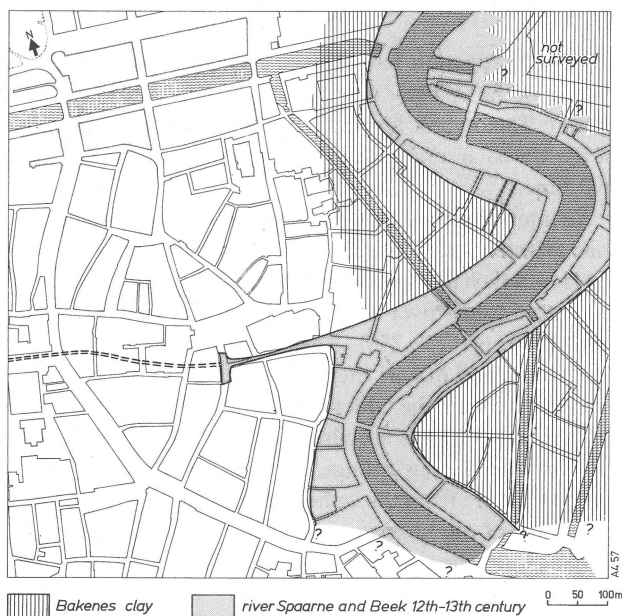


Fig. 11
Tentative reconstruction of the banks of the Spaarne in the area under study; XIIth to XIIIth century. N.B. the east bank of the Spaarne should be identical to that of Fig. 12.

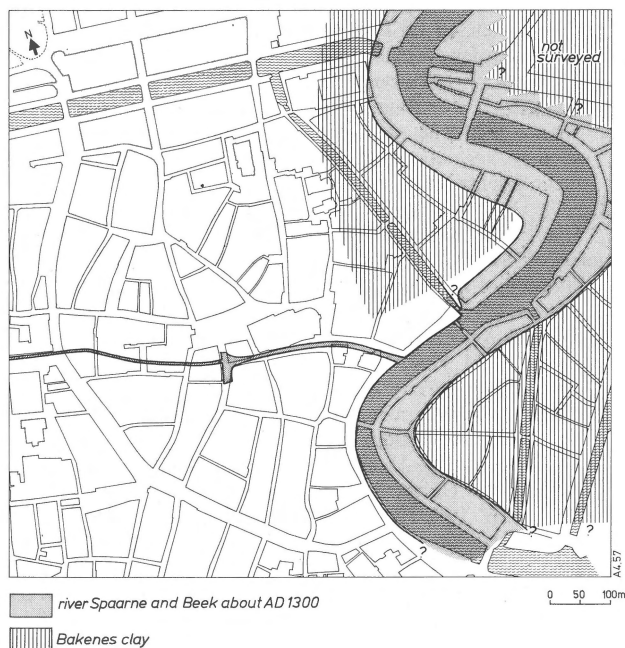


Fig. 12
Tentative reconstruction of the Spaarne banks and the course of the Beek about AD 1300.

that are now found at the surface, were raised by man predominantly during the XIVth century (DEJONG, 1982). The situation along the Spaarne is obscure at the level of the Bakenessergracht ('gracht' = town canal). Within the distribution area of the Bakenes clay, the clay bed extends to the very edge of the gracht. Hence, the gracht was dug after the deposition of the clay. It may be assumed that at that time the Bakenes area was flat, the surface being formed by a thin clay bed which was inundated periodically. This might explain why the area was not included in the town. Although the Bakenessergracht may have been dug mainly for defense, it probably also had a function in the drainage of the – small – Bakenes area. The man-made raised beds of Bakenes, that date from a later time, contain much organic material, perhaps representing a natural deposit dredged from the Spaarne.

The southern distribution limit of the Bakenes clay roughly coincides with a curve in the Bakenessergracht and the fixed building-line. It indicates a later extension of the gracht in the direction of the Spaarne.

The widening of the Beek in the Grote Houtstraat, although indicated in Fig. 12, may already have been filled around AD 1300. Also the reclamation of the Spaarne bank in the Burgwal area may have been started even before AD 1300.

HISTORICAL RELEVANCE

The data on the development of the Spaarne and its banks may have relevance for certain historical questions:

a. Damstraat and dam. The name of the Damstraat has been the subject of considerable discussion. The etymological meaning of the word *dam* (= dam, dike) is complicated. The most general meaning is a traverse in a watercourse, built to control the water, but also able to serve as a passage across the watercourse. The word is also used to denote a dam or dike (*dijk*) along a watercourse.

The possibility of a dam across the Spaarne in the centre of the town has been extensively discussed (e.g. HUIZINGA, 1948). At present, however, it is generally accepted that the historical documents that make mention of a dam in the Spaarne refer to the dam at Spaarndam, built in AD 1220. In my opinion the name Damstraat is related to the reclamation of the west bank of the Spaarne, possibly indicating the presence of a raised road that was built along the Beek to reach the shifted Spaarne bank, as well as a dam in the Beek at the confluence with the Spaarne. A dam along the Beek is the most likely explanation. This dam may indicate a certain stage in the reclamation. A difference in time between the reclamation of the area south and north of the Damstraat is possible because of the low accuracy of the available datings (SCHIMMER, 1977).

b. Gravensteen. This fortified structure is known from historical documents to have existed in AD 1336 (SPEET, 1982), but has been considered by most authors to be much older. The Gravensteen is situated at the junction of the Spaarne and the Bakenessergracht, which means in the reclaimed area indicated in Fig. 12. Until about 1300, however, the geological conditions were not suitable for the construction of such a building.

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