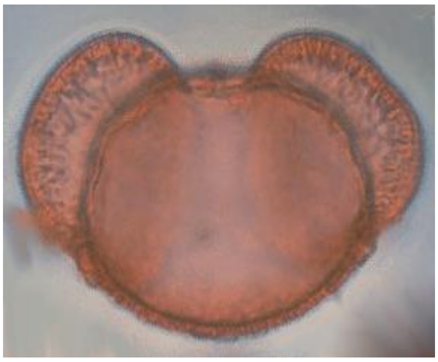
Fluvial response of the river Maas to Lateglacial and Early Holocene climate and vegetation changes in Limburg, S-Netherlands



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Preface & Acknowledgements

This master thesis shows the results of a MSc graduation project forming part of the Master study Earth Sciences within a combination of the tracks Earth, Life and Climate and Earth, Surface and Water at Utrecht University, the Netherlands. Subject of the study is the response of the Maas and vegetation to climate change during the Lateglacial and Holocene. This Master's project contributes to the PhD of Marlies Janssens of the VU Amsterdam in which the impact of faulting on the evolution of river meanders is investigated. Wim Hoek and Kim Cohen from Utrecht University, the Netherlands, supervised the Master project.

Performing this Master thesis was not possible without the help of staff of the department of Physical Geography. Special thanks to Wim Hoek, for all the support during the field work and the supervision during the entire process. I also want to thank Kim Cohen for the valuable comments on the draft version of this thesis and the support during the fieldwork. Further, I want to thank Hanneke Bos and Nelleke van Asch for their patience and help during the pollen analysis. I greatly acknowledge Kees Kasse and Marlies Janssens from the 'Vrije Universiteit Amsterdam' for the help and shared insights during the field visits. I also like to thank Timme Donders, which accompanied me during a southwesterly storm on my fieldwork. Last but not least, I want to thank my family and friends for their helping hands during the field work and their support during the entire process.

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Summary

This thesis focuses on the response of the Maas river to Lateglacial and Early Holocene climate and vegetation changes between Susteren and Venlo, Southern Netherlands. Upstream of the research area, the terrace stratigraphy has been investigated earlier; four different terraces have been distinguished. According to the previous studies, the oldest terraces, the Rijkevoort and Milsbeek terraces were formed during the Late Pleniglacial, by the Maas river that had a braided pattern in this period. Next, the Vierlingsbeek and Gennep terraces were formed during the Bølling; the Maas started to meander and to incise. During the Older Dryas the incision stopped although no change in channel pattern or terrace has been observed. The Broekhuizen terrace was formed during the Allerød with high-sinuous meanders which incised a few meters. During the Younger Dryas the Wanssum terrace was formed by an again braided river Maas. Finally, during the Holocene, a narrow and straight edged floodplain was used with low sinuosity meanders.

In this report, a comparison has been made between the terrace stratigraphy from Born to Venlo and upstream of Venlo. For this purpose, the infills of four different palaeochannels of the Maas between Born and Venlo have been studied. First, lithological cross-sections have been constructed, while at the deepest part of the channel a core was taken for further analysis. In the laboratory loss on ignition and calcium carbonate content measurements were performed. Also pollen samples were taken from most organic layers in the core to reconstruct an age model for each core. These age models were based on correlating the most important transitions in the pollen assemblages in the cores that correspond to the well-known vegetation development in the Netherlands during the Lateglacial to Early Holocene. Some of the selected residual channels did not meet the expectations for organic infill and/or were anthropogenically disturbed; on these locations the age was determined based on a pollen quick scan.

Three out of four of the investigated palaeochannels (Dukkelaar, Houterhof and Katerhof) were located on the Pleniglacial floodplain; initially an infill of Lateglacial age was expected. The other palaeochannel (Casquettenhof) was located on the Holocene floodplain; the time of infill of this channel was expected to be Early Holocene. Pollen diagrams of all these channels show a different outcome than expected. The infilling of palaeochannel Dukkelaar started during the Younger Dryas. The start of infill in Houterhof was Late Boreal-Atlantic. The infill of palaeochannel Katerhof started during the Atlantic-Subboreal. At the palaeochannel Casquettenhof two cores were taken due to the differences in organic infill, the 'oldest' core started during the Iron Age in the Subatlantic, the 'youngest' core started in the Ancient Roman time in the Subatlantic. The differences in lithology and timing can be explained by the geographical location with respect to the present day Maas and the tectonic faults that are present. The palaeochannels Katerhof and Houterhof are probably re-used by the Maas or the Haelensche Beek, which removed/eroded older deposits. Casquettenhof is located nearby the locations of Pannenhof and Schietclub, where pollen quick scans show an Iron Age infill. These were probably connected and shifted during Medieval times more to the East (this is supported by the results of Casquettenhof 1). The meanders at Dukkelaar, Kingbeekdal and Korbusch were abandoned during the Younger Dryas, so the Maas shifted during the Younger Dryas towards the East.

Residual channel fills of the Maas between Susteren and Venlo are very different from palaeochannels downstream. Overall the channel pattern and the time of infill of the channel do not correlate with palaeochannels downstream, while the lithology and the vegetation development seems to correlate with the time of infill. These results are not consistent with the literature and previous investigations upstream of Venlo. Spatial differences in channel pattern are likely to be caused by differences in the local conditions like: tectonic faults, transition zone between the so-called "Gravel Maas" and the "Sand Maas" and differences in elevation. Further research between Susteren and Venlo should resolve these issues.

Table of contents

List of Figures

1. Introduction

During the Lateglacial that marks the transition from the cold Weichselian Glacial to the warm Holocene, climate and environment changed dramatically. In the Lateglacial and the Early Holocene the morphology and styles of various rivers in Europe changed coinciding with climatic warming and developing vegetation (Huisink, 1999; Huissteden and Kasse, 2001; Janssens et al., 2012; Kasse, 1995; Kasse et al., 1995; Kasse et al., 2005; Tebbens et al., 1999; Tebbens et al., 2000a,b). The fluvial deposits of this time period show large differences in successions (van Huissteden and Kasse, 2001). This research focuses on the river Maas, a predominantly precipitation-fed river which flows through parts of France, Belgium, Germany and the Netherlands. During the Lateglacial and Holocene, the river Maas predominantly incised and changed its river pattern. This resulted in the formation of a series of terraces (Berendsen et al., 1995; Kasse et al., 2007; Van den Berg, 1996; Van den Broek and Maarleveld, 1963). Individual age determinations of these terraces have so far been obtained between Venlo and Nijmegen. Each terrace has its own characteristics, and can be described for this specific area. Mainly Van den Broek and Maarleveld (1963) mapped the Maas Lateglacial-Early Holocene valley between Maaseik and Boxmeer and distinguished three terraces. More recently, Huisink (1997) distinguished four terraces in the Maas valley between Venlo and Nijmegen. Changes in morphology of river patterns and terrace formation are linked to climate change, vegetation or tectonic movements (Huisink, 1997; Huisink, 1999; Huissteden and Kasse, 2001; Janssens et al., 2012; Kasse, 1995; Kasse et al., 1995; Kasse et al., 2005; Tebbens et al., 1999; Tebbens et al., 2000a,b). The response of the river Maas to climate change, vegetation and tectonic movements is investigated by many researchers (Berendsen et al., 1995; Huisink, 1997; Kasse et al., 2007; Van den Berg, 1996; Van den Broek and Maarleveld, 1963); these investigations, however, only focus on the Maas valley downstream of Venlo.

1.1 Idea behind the research - Context

Between Susteren and Venlo, many residual channels are visible in LIDAR elevation data of the Netherlands (figure 1), showing consecutive river patterns (braided, transitional, meandering). The Lateglacial and Early Holocene terrace stratigraphy and the response of the Maas to the climate and vegetation changes are not coupled with the terrace stratigraphy downstream of Venlo. The terrace stratigraphy between Susteren and Venlo may be slightly different. This can be caused by differences in tectonic subsidence, valley width and substrate, but also because river response was faster or slower than downstream. This needs to be disentangled and this requires new data.

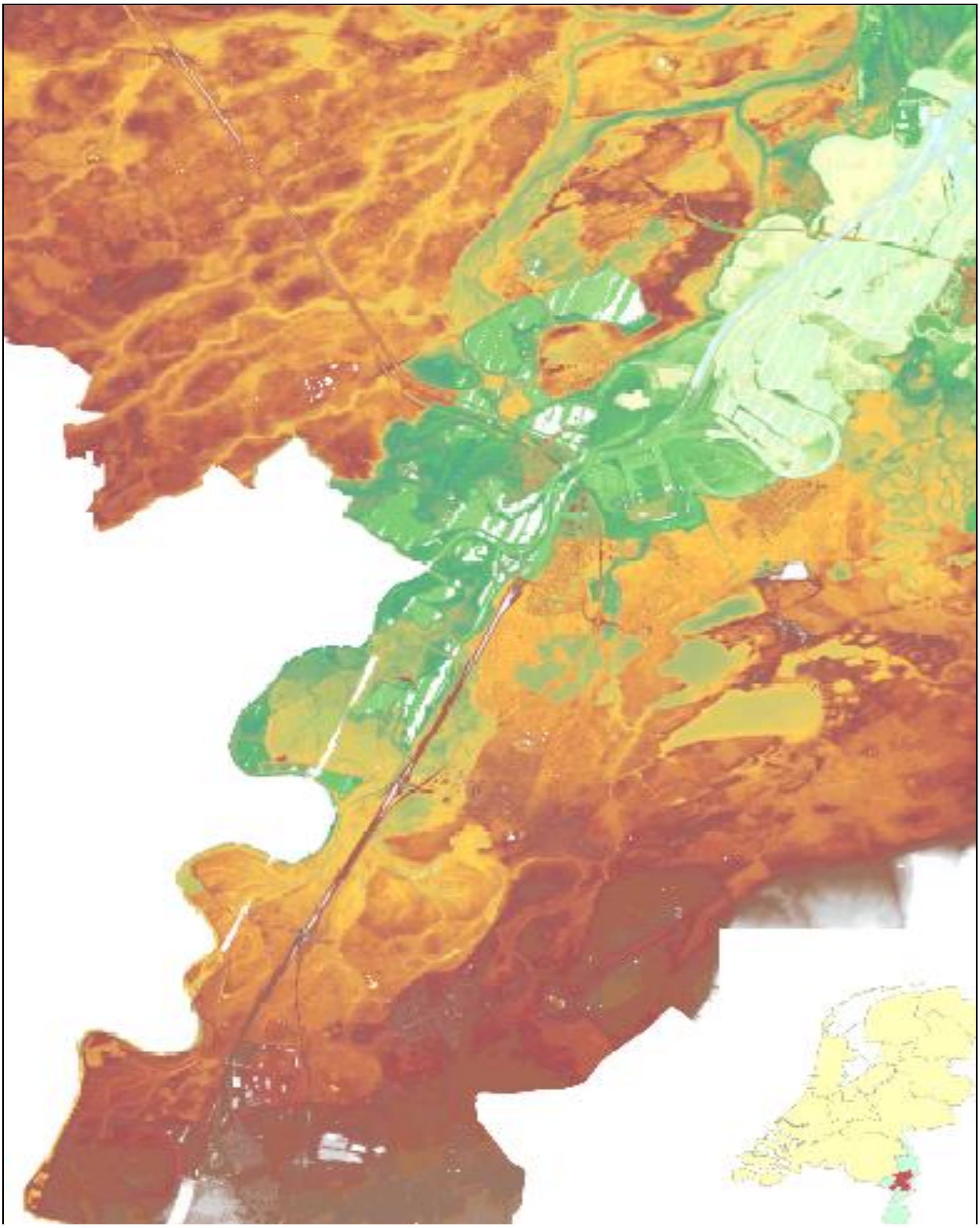

Figure 1. Overview residual channels between Susteren and Venlo (AHN, 2013).

1.2 Thesis objectives

The aim of this research was to reconstruct the fluvial response of the river Maas in the Lateglacial and Early Holocene for the Susteren-Venlo area. The major research question is therefore:

Are Lateglacial and Early Holocene residual channel fills of the Maas between Susteren and Venlo comparable to those further downstream with respect to abandonment, architecture, and residual channel infill and how can differences be explained?

To answer the major research question lithological, chronological and paleoenvironmental information has been collected and, and the sub-questions have been formulated:

1. What are the differences in infill between the investigated residual channels between Susteren and Venlo? How can we explain these differences in lithology and in timing?
2. Can we correlate the terrace stratigraphy between Susteren and Venlo with previously published stratigraphic, past climate and vegetation changes? When they do not correlate, how can we then explain the deviation?

To answer above research questions, an inventory of existing data has been made followed by several coring transects through residual channels, to find the most complete sediment record in the residual channel fills. The selected channels are located at different locations in the Maas valley, because we expect that these channels would have different ages. From the most complete sediment record a core has been taken from which pollen analysis and dating through biostratigraphy has been performed. Fieldwork was carried out in the Maas valley between Susteren and Venlo in September and October 2012 within the framework of an ongoing field-based PhD research project of M.M. Janssens of the VU University in Amsterdam. We expected to recognize some terrace characteristics as described by Huisink (1997) for the Maas valley between Venlo and Nijmegen.

1.3 Thesis outline

This thesis exists out of 8 different chapters. After the introduction in chapter 1, chapter 2 starts with an explorative analysis of existing data. This literature review focuses on the influence of external factors on a fluvial system and the geological and vegetation development of the Maas valley in the last 25,000 years. The collected data in the field and the research methods are further described in chapter 3. The results from the pollen analysis and the cross sections are described in chapter 4. The results are compared with previously published reconstructions and local patterns to understand the processes which are involved in driving the fluvial response. A reconstruction of the terrace stratigraphy is given in chapter 5. This synthesis is followed by chapter 6, which provides conclusions answering the major research question and some recommendations for further research and use of the collected data.

2. The geological and vegetation development of the Maas valley

This chapter provides some theoretical background on the impact of external factors like climate change, tectonic activity, sea level change on the Maas and the development of the Maas valley during the last 25,000 year. Also the development of the vegetation and the terrace characteristics upstream of Venlo are discussed.

2.1 Impact of external factors

In the Pleniglacial, large rivers like Maas and Rijn had a braided character, with considerable changes in discharge and sediment load. During the Lateglacial, the river discharge of the Maas was irregular and concentrated in fewer channels; also the silt deposition occurred only in the higher, abandoned part of the floodplain. Thereby the frozen subsoil, together with the sparse vegetation cover, caused a high sediment supply. The frozen subsoil decreases the storage capacity, which results in relatively increased peak floods. During the climate warming, the vegetation started to develop and soil formation and silt deposition resulted in a decreasing sediment transport. Also the storage capacity of the river system increased and the sediment supply decreased. These factors, together with the increased floodplain stability, result in a meandering river pattern during the BA interstadial (Kasse *et al.*, 2005). The reaction of the river pattern seemed to slightly delayed compared to the climate changes due to the delayed response of the vegetation.

However, temporal variation in a river system is not always the result of climate change. For example, when an external factor other than climate changes, the river system will also adjust to a new equilibrium (Mol, 1995). Rock types, tectonic activity and climate in the Hinterland control the evolution of river patterns. Humid climates are also characterized by abundant vegetation in the source area which favours the formation of clays and their enrichment in fluvial deposits along the river pattern. In combination with lowered relief and decreasing stream gradient, this favours a mixed-load and pre-dominantly suspended-load meandering river pattern (Einsele, 2000). Apart from the discharge, the energy available for the erosion and transport of sediments is determined by the river gradient, a threshold controlled by the local catchment. In braided rivers the river gradient is usually high; this will result in erosion of the previous deposits below the whole river bed. In meandering rivers the river gradient is much lower, only the main channel is eroded (due to the incision of the river) while in the surrounding floodplain past river deposits will be preserved. Changes in fluvial sedimentology are not always preserved due to the response time of the internal river dynamics and the local conditions, while local conditions play an important role in the registration and preservation of these changes (Vandenberghe, 2002). This is because changes of river pattern also depend on physical parameters such as soil conditions, grain size of the bed load and vegetation cover at individual sites (Vandenberghe, 1995). Soil conditions depend on the vegetation, which is linked directly to climate. Also the response time of rivers to adapt their pattern and gradient to the new condition play a role (Vandenberghe, 1995). Therefore, it is very important to consider regional differences during the interpretation of fluvial evolution (Kasse *et al.*, 2010; Vandenberghe, 2002).

The ‘direction’ of the climate change seems to be very important for the accumulation and preservation processes. When the climate changes towards colder conditions, the river gradient will increase due to sea level lowering. This will result in reworked and eroded deposits of previous fluvial deposits. This process is enhanced by the lack of vegetation which will result in easily eroded banks. The previous deposited sediments will therefore not be preserved or only partly, which makes the determination very difficult. The climate change towards warmer conditions will enhance the preservation of river deposits, because the banks are more stable due to the vegetation cover. Due to the fact that the river gradient is lower due to the lengthening of the channel, more fine grained sediments are transported and deposited which enhance the soil formation. Therefore the preservation potential of river deposits during a climatic warming is higher compared with the preservation potential during a cooling of the climate. Major changes in climate conditions usually do cause new erosion or depositional fluvial conditions, causing the development of a river system different from the situation before. When the river reacts only slightly to changes in climate, like the decrease in discharge caused by a drier climate, this can also be reflected in a change in fluvial sedimentology (Mol, 1995).

2.2 Present day geographical setting and limitation

Today the Maas is a predominantly rain-fed river, with a length of 875 km and a catchment area of 33,000 km^2 which covers parts of France, Belgium, Germany and the Netherlands. The mean annual discharge over the Maas is 260 m^3/s. The Maas has a relatively fast response to rainfall, so it is relatively sensitive to both floods and droughts. In summer the river flow is low and the evaporation rates are high, while in the winter the evaporation rates are at the lowest level (Ashagrie et al, 2006). The discharge regime of the river Maas is strongly influenced by the small water storage capacity of the Ardennes section in Belgium. This led to major changes in river pattern between the Lateglacial and the Early Holocene, and is therefore very suitable to investigate the climate dependency (Van den Berg, 1996).

South of Maastricht, the Maas is an erosive system due to tectonic uplifting, North of Maastricht subsidence and various morpho-tectonic units with uplifting and subsiding blocks play an important role. Due to the differences in tectonic settings, different preservation styles occur along the Maas (Van den Berg, 1996). The Lateglacial and Early Holocene terrace stratigraphy and the response of the Maas to the climate and vegetation change downstream of Venlo are investigated previously. Because the residual channels between Susteren to Venlo are not yet coupled with the terrace stratigraphy downstream of Venlo this location has been chosen as research area. This research only focuses on the sandy Maas valley and not on the valley upstream of Susteren were it becomes more gravelly. The area of interest is crossed by different tectonic faults like the Peelrand fault, Beegden fault, Feldbiss fault and the Geleen fault which also will have had an effect on the Maas pattern in the past. The tectonic faults that cross the Maas valley are shown in figure 2. These tectonic faults caused the subsidence of the flat Northern part of Limburg relative to the Southern part of Limburg (South of Venlo). Due to this subsidence, the Maas incised and the hilly landscape of Limburg was formed. In the flat Northern part of Limburg the Maas deposited these sediments because the flow velocity decreased. Active tectonic faults may also influence the groundwater flow; a fault may interrupt the groundwater flow which causes seepage in higher elevation areas. Other differences can be caused by valley width and substrate, but also because river response was faster or slower than downstream.
Today the tectonic faults are supposedly less active, the Feldbiss fault, for example, was last active 200,000 years ago. The Peelrand fault near Roermond was active in 1992. The landscape is dominated by agricultural lands like grasslands, crop fields or orchards. Small nature reserves like old brook valleys or heath fields are still present on a small scale. Different abandoned channels of the Maas are still visible in the landscape, but due to the increased river management they are not in use anymore during high water events.

During this research only Lateglacial and Holocene abandoned channels have been investigated, several available pollen diagrams from this area were used for the interpreting of the, for this study, counted pollen diagrams. During this research the focus lies on the vegetation development and the influences of climate change on the Maas river, the influence of tectonic activity on the Maas river is not discussed.

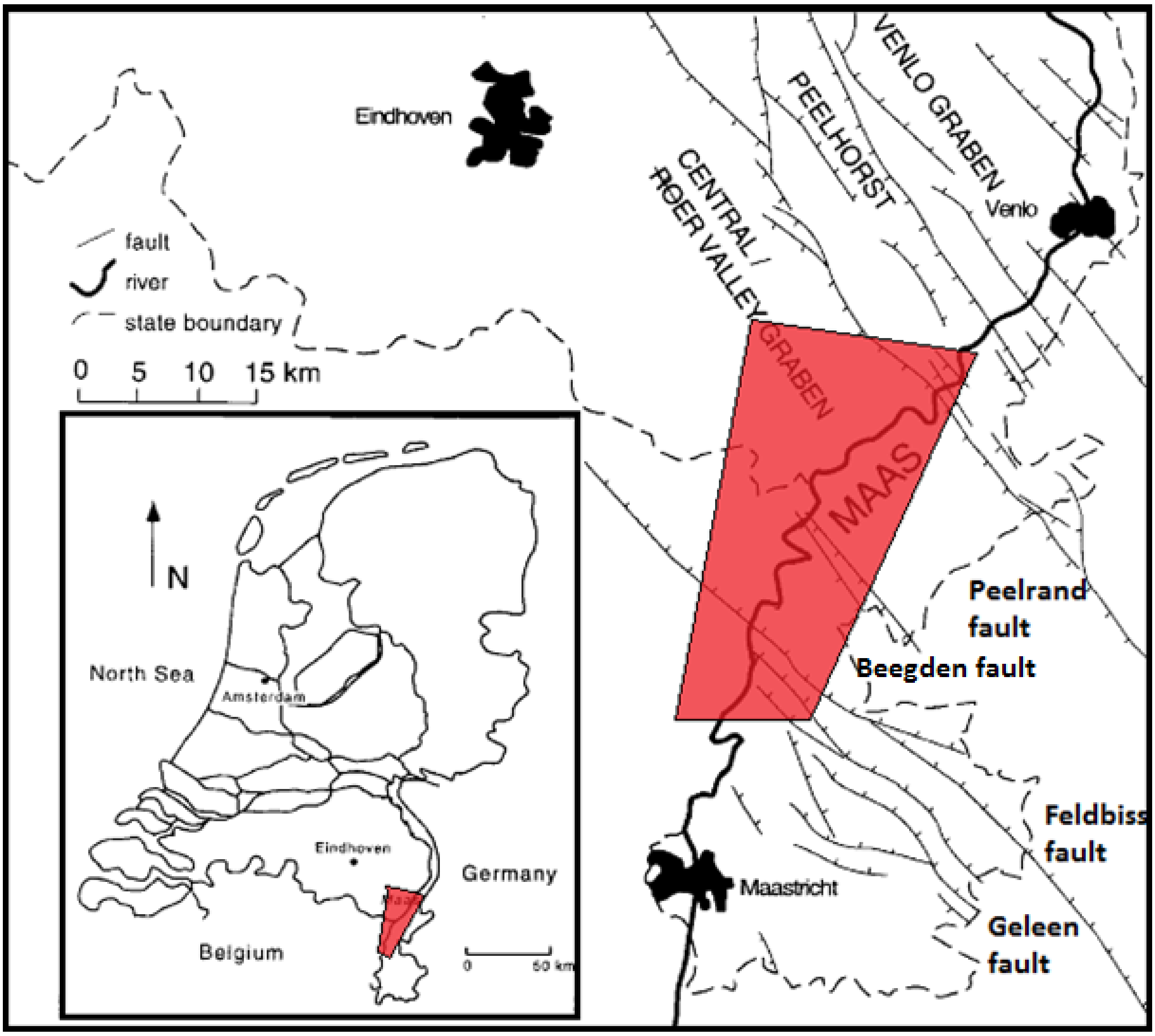

Figure 2. The research area (indicated by the red field) and tectonic faults in according to van Montfrans (1975).

2.3 Geographical setting and vegetation development from the Late Weichselian to present

Between the Lateglacial and the Early Holocene the morphology and patterns of different rivers in Europe changed, linked to climate and vegetation change or tectonic movements (Huisink, 1999; Huissteden and Kasse, 2001; Janssens et al., 2012; Kasse, 1995; Kasse et al., 1995; Kasse et al., 2005; Tebbens et al., 1999; Tebbens et al., 2000a,b). The fluvial sediments of this time period show large differences in successions and grain size (Huissteden and Kasse, 2001). During the period of interest, the river Maas predominantly incised, which in combination with climate changes and the subsequent changes in river pattern resulted in the formation of a series of terraces (Berendsen et al., 1995; Kasse et al., 2007; Van den Berg, 1996; Van den Broek and Maarleveld, 1963). Individual age determinations of these terraces come from studies of terrace deposits between Venlo and Nijmegen. These terraces have their own characteristics and are described for this specific area. According to Van den Broek and Maarleveld (1963), the Maas valley between Boxmeer and Maaseik contains three terraces. More recently Huisink (1997) recognized four terraces in the Maas valley between Venlo and Nijmegen in which three river systems can be recognized which were active between the Late Pleniglacial to the Holocene (see figure 3).

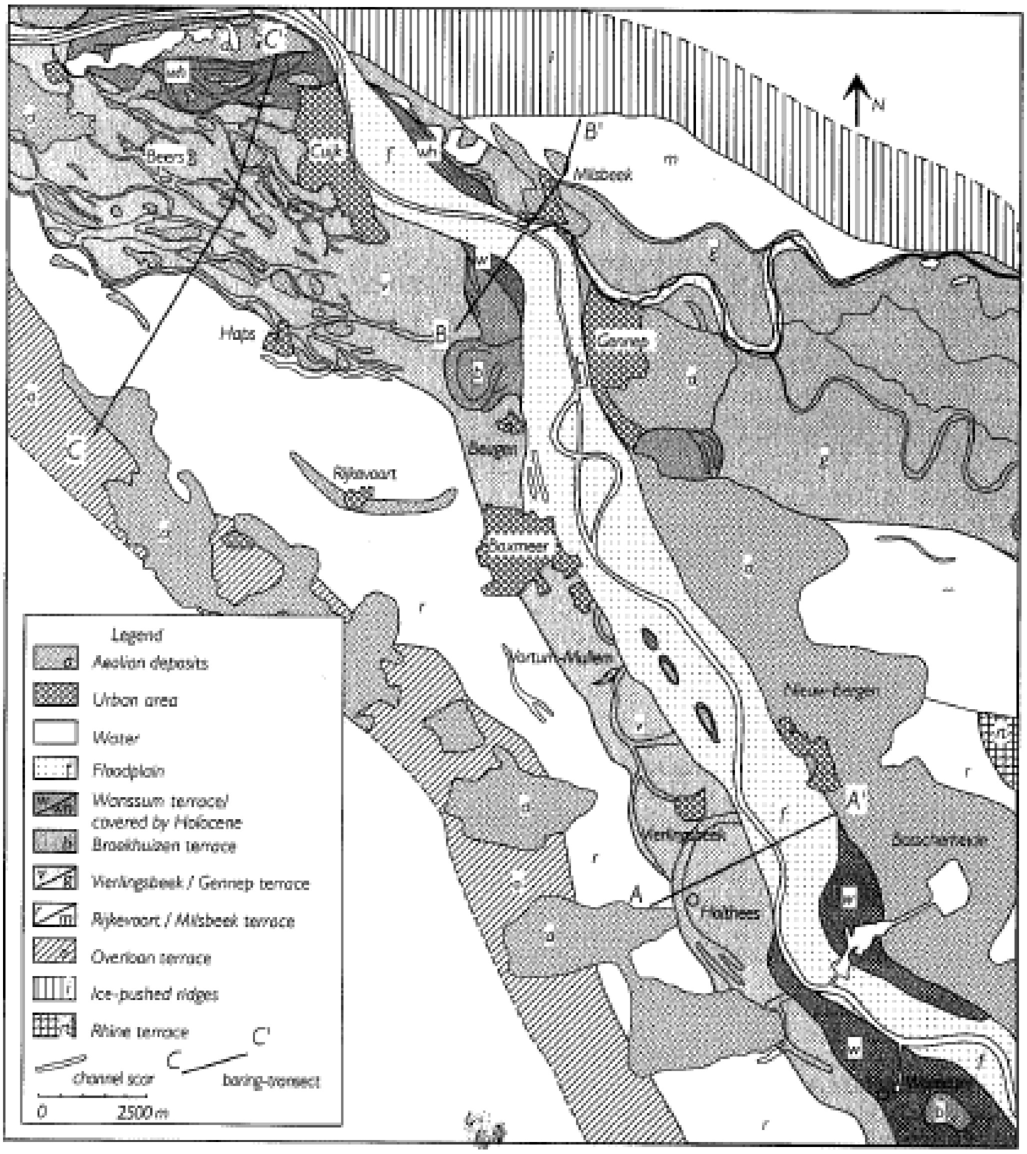

Figure 3. Terrace stratigraphy according to Huisink (1997).

Kasse et al. (2007) described sedimentary successions, depositional environments and cryogenic structures of several terraces between Venlo and Nijmegen which were individually dated by OSL dating. Below the development of Lateglacial and Early Holocene climate, geology, terraces and vegetation is given. In this report, 14C dates are reported as years BP (before present/before 1950 AD), other dates are calibrated to calendar years (cal BP). In general ka is used for thousand years ago (in calendar years). A general overview of the developments between the Lateglacial and Early Holocene as compared to the NGRIP ice core record, 14C dating, stratigraphy, general pollen diagram with pollen zones, the changes in river pattern and the relation with the aeolian erosion and deposition is given in figure 4. All factors in this figure will have influenced the sediment availability and trapping.

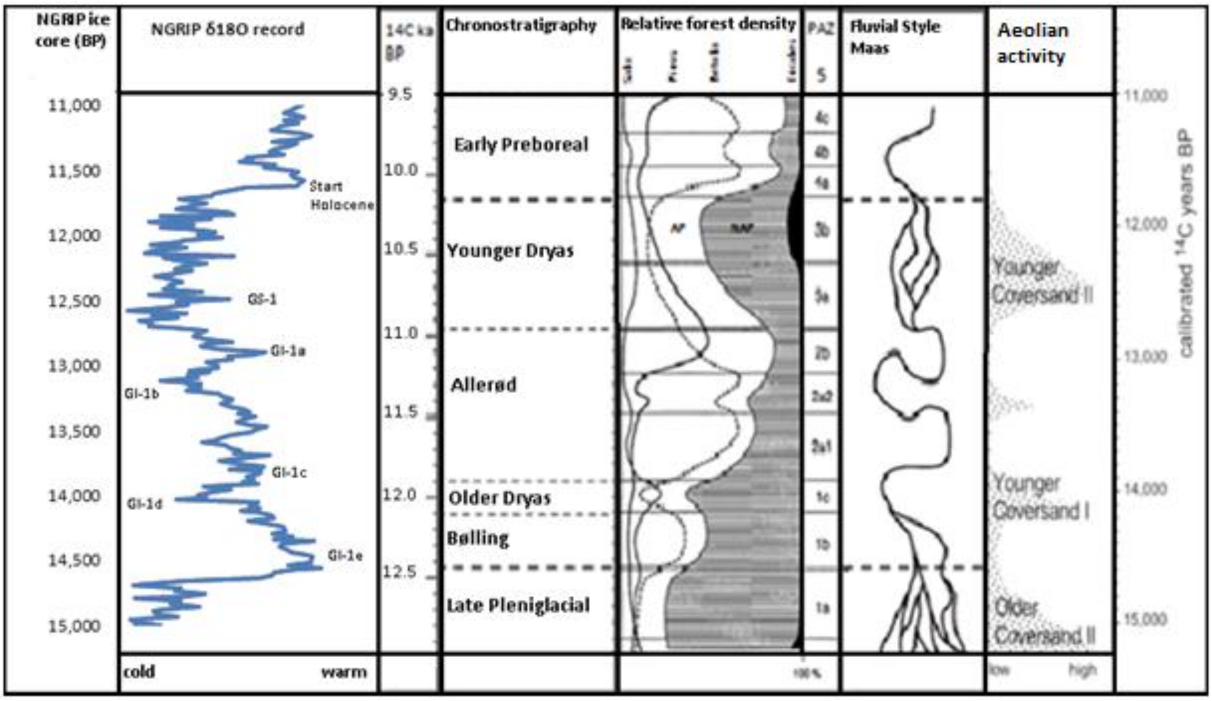

Figure 4. Schematic overview of Lateglacial and Early Holocene developments of climate, vegetation, fluvial style and aeolian activity compared to the NGRIP oxygen isotope record and event stratigraphy after Lowe et al. (2008); Stratigraphy, generalized Lateglacial and Early Holocene pollen diagram and pollen assemblage zones (PAZ) after Hoek (1997); Maas river pattern after Kasse et al. (1995); aeolian activity modified after Hoek and Bohncke, 2002.

2.3.1 Late Pleniglacial (~25-14.7 ka)

During the Late Pleniglacial conditions were extremely cold and dry, the grass or shrub tundra vegetation changed into polar desert conditions (Kolstrup, 1980). During winter, the floodplain was probably frozen and the discharge was low or absent, high discharges occured during spring and summer due to the melting of snow and the limited water storage capacity of the active layer overlying the permafrost. Because of the polar desert conditions, vegetation was virtually absent,only some Poacea, Cyperaceae, Saxifragaceae, *Artemisia*, Chenopodiaceae, *Salix* and some *Betula nana* shrubs were present. At the end of the Late Pleniglacial the summer temperature started to rise towards 15-20°C indicated by the appearance of aquatics like *Nymphaea*, *Menyanthes*, *Nuphar* and *Typha*. This rise in temperature resulted in herbaceous plant communities and dwarf scrubs and the first immigrants arrived such as *Hippopae* and *Juniperus*. This pollen zone 1a, 12,900 to 12,450 years BP, is also characterized by higher values of *Artemisia* (Bohncke et al., 1987; van Geel et al., 1989; Verbruggen and van Dongen, 1976; Verbruggen, 1979). Due to the small amount of vegetation and the absence of organic matter and the sandy fluvial deposits, river banks were unstable and there was a high sediment supply (Kolstrup, 1980; Kasse, 1997). Silt drapes and reactivation surfaces indicate strongly fluctuating discharges in shallow, ephemeral channels which shows a large lateral extension (Vandenberghe and Van Huissteden, 1988; Kasse et al., 1995b). Also a high aeolian activity contributed to the high sediment load of the rivers. Consequently, the Maas was a braided and generally aggrading river system (Van Huissteden and Kasse, 2001).

Downstream of Venlo the Rijkevoort and Milsbeek terraces were formed during the Late Pleniglacial. The base of this terrace is characterized by poorly sorted, medium to coarse gravelly sand with rapidly changing bedding types in both vertical and horizontal directions formed by the interaction of fluvial, aeolian and cryogenic processes in a continuous permafrost environment (Kasse et al., 2007).Towards the top of this terrace the presence of aeolian coversands increases and due to deflation the “Beuningen Gravel Bed” horizon could be formed in many instances. Probably due to the decrease of fluvial activity and the increasing effects of frost and a decreased accumulation rate, the aeolian deposits gain a higher preservation potential (Kasse et al., 1995). The Maas shifted towards the east, the western part of the floodplain became inactive and was overtopped by aeolian Older Coversand II deposits (Bohncke et al., 1993; Huisink, 1997; Kasse et al., 2007). This part of the terrace is better sorted and contains less gravelly sands with wide, dominant intersecting gullies. The Rijkevoort and Milsbeek terrace is overtopped by overbank deposits that accumulated during floods in the Bølling, Allerød and Younger Dryas (Bohncke et al., 1993).

2.3.2 Bølling, Older Dryas and Allerød (14.7.-12.9 ka)

At the start of the Bølling, mean summer temperatures were around 13-15°C and precipitation was high (van Geel et al., 1989). This resulted in a higher humidity, soil formation, and a gradual increase in vegetation cover which stabilized the surface and caused decreasing of the aeolian activity. The presence of *Betula* expanded at the start of pollen zone 1b during the Bølling, more at the end of the Bølling *Juniperus* increased (Hoek, 1997). Due to the vegetation cover and the more stable surface, sediment supply decreased and the river stability increased. This led to a transition phase in the river system between a braided and low-sinuosity meandering pattern and the river started to incise. Due to the incision of the river a new floodplain was formed and the former braided plain, was abandoned and peat started to grow (Kasse et al., 1995). These processes formed the Vierlingsbeek and Gennep terraces at almost the same elevation as the Rijkevoort and Milsbeek terraces. The morphology is characterized by several small gullies which merge into one large sinuous channel which began to incise up to 7 meter and formed small levees. In local wet environments the “Lower Loamy Bed” could be formed containing loam deposits or peat. During the Bølling, the floodplain was tectonically tilted upstream of Venlo which resulted in a lower gradient which caused major incision of the Maas. Downstream of Venlo subsidence occurred which formed a scarp in the valley, downstream of this scarp, sediments were deposited to compensate these changes (Huisink, 1997). The Vierlingsbeek and Gennep terraces are characterized by an incision of 6-7 meter of larger and more curved channels. Probably differential movements of the Venlo Graben occurred during the Lateglacial which caused a low gradient upstream and subsidence downstream due to tilting which was compensated by incision upstream. The activity of the Niers-Rhine through the Niers valley caused large discharges and sediment supply in the Maas around Gennep which resulted in a diminished incision and a more braided river pattern (Huisink, 1997).

During the Older Dryas temperature and precipitation rates decreased which led to higher aeolian activities. During this period the Younger Coversand I was deposited. The Older Dryas is not reflected in a change in river pattern, but may be reflected in a pause in channel downcutting (Tebbens, et al., 1999). The vegetation cover was more open, the amount of *Betula* and other threes declined, and *Salix* shrubs, *Artemisia*, *Helianthemum* and *Thalictrum* became an important constituent of vegetation (pollen zone 1c) (Hoek, 1997). During this period the river had to transport high amounts of melt water which resulted in incision (Bohncke et al., 1993; Kasse et al., 1995).

Early in the Allerød, mean summer temperatures rose towards approximately 13 to 16 degrees Celsius (van Geel et al., 1989). The Maas was a high sinuosity meandering river, probably due to a delayed climate response and a gradual vegetation development in the Late Bølling. The increasing rainfall interception, water-storage capacity of the soil and the dense vegetation cover led to a constant river discharge and a decrease in sediment supply and the river started to incise again (Kasse et al., 1995b). Between 11,900 and 11,250 years BP, *Betula* rapidly expanded (PAZ 2a). While more to the end of the Allerød, between 11,250 and 10,950 years BP, *Pinus* started to increase (PAZ 2b). Due to the more dense vegetation cover, aeolian activity decreased further and a loam bed was deposited in which soil formation took place (Usselo soil). The presence of the Usselo soil indicates land surface stability and soil formation, encountered by the increase of the Pinus (Kasse et al., 2007).

The Broekhuizen terrace that formed during the Allerød is characterized by high sinuous meander scars several meters below the previous floodplain with a fining upward sequence of approximately 5 to 7.5 meter thick. This fining upwards starts with gravelly moderately sorted medium to coarse bed load material with more to the top moderately to well sorted fine point bar sands with thin sandy silt lamina formed by lateral migration of the channel and accretion of the channel pointbar. At the end of the Allerød temperatures started to decline, announcing the start of the Younger Dryas (Huisink, 1997), during which the sedimentary environment changed dramatically.

2.3.3 Younger Dryas (12.9-11.7 ka)

At the onset of the Younger Dryas temperatures rapidly decreased to glacial conditions (summer temperatures were about 11 degrees Celsius). Due to the lower temperatures during particularly winter, melt water runoff increased, evapotranspiration and the water storage capacity of the soil decreased which resulted in higher and frequent peak discharges and higher sediment supply. This led to numerous chute cut-offs and the Maas returned to a braided and generally aggrading river system with shallow channels. The *Pine* and *Birch* forest rapidly decreased, making place for tundra or open *Birch* forest vegetation This period can be subdivided by PAZ 3a, in which the *Pinus* and *Betula* rapidly decreased (10,950 to 10,550 years BP) and, PAZ 3b characterized by *Empetrum nigrum* (10,550-10,150 years BP). During the latter sub-zone, aeolian sands were deposited locally on the terrace level of the Allerod (Younger Coversand II). This coversand indicates a decreased landscape instability caused by the decrease in vegetation cover, increased aridity and climate cooling (Kasse et al., 2007).

The Wanssum terrace was formed during the Younger Dryas, which is a terrace filled with coarse grained, poorly sorted and gravelly sands with on top well-sorted fine sands. The bars in between the channels consist of gravelly sand and short fining upward sequences which are covered by river dune sand (Huisink, 1997).

2.4 Holocene

The Holocene is generally sub-divided into Preboreal and Boreal, Atlantic and Subboreal and Subatlantic. An overview of the vegetation changes is shown in figure 5. The floodplain that was used during the Holocene was narrow and straight edged. The present day Maas meanders have a low sinuosity. This floodplain has a coarse grained base followed by fine-grained and sometimes clayey sand, silt and organic material. These sediments were deposited in levee and overbank environments (Huisink, 1997).

2.4.1 Preboreal and Boreal (11.7- 8.8 ka)

At the onset of the Holocene, temperatures and precipitation values increased. Due to these sudden changes in temperature and precipitation values, the Maas started to incise in the Younger Dryas river terrace. The river style changed toward a meandering river system, the other remaining gullies from the braided river system in the Younger Dryas remained only active during high discharge levels but were generally filled in. Due to the high temperatures and the increased precipitation, *Betula* forest expanded over the Netherlands. Also *Juniperus* increased between 10,950 and 9950 years BP (PAZ 4a), this pollen zone is equivalent to the Friesland oscillation of the Preboreal. During the Friesland Phase minimum mean July temperatures were at least 13-16°C. Due to the development of this more dense vegetation cover, the stability of the soil increased.

The next phase, the Rammelbeek Phase, reflects a period with dry, warm summers, cold winters and relatively low groundwater levels with a minimum mean July temperatures of 13-15°C. The Rammelbeek phase is equivalent to pollen zone 4b from 9950 to 9750 years BP and is characterized by a more open vegetation with Poaceae as defined by van der Hammen (1971) and van Geel et al (1981). Between 9750 and 9500 years BP *Betula* increased again and also *Populus* increased. From 9500 to 9150 years BP, temperatures rose further and the *Pinus* forest expanded again (PAZ 5).

The increase of *Corylus* around 9150 years BP marks the beginning of the Boreal, together with the high values of *Pinus* (PAZ 6). The Early Boreal was a stable period with a densely forested landscape and low sedimentation rates, the minimum mean July temperature was approximately 15-16°C. Later in the Boreal other thermophilous trees as *Tilia*, *Quercus* and *Ulmus* appeared, but *Corylus* was still dominant. Below this close forest, ferns were doing well. *Pinus* was still present on sandy, gravelly nutrient poor river terraces. The development of a closed vegetation cover led to a decrease in aeolian activity. Abundaces of aquatics like *Potamogeton* and *Nymphaea* were high compared with other water plants.

2.4.2 Atlantic and Subboreal (8.8-2.85 ka)

During the Atlantic the Maas was located at almost the same location as present day. During the Atlantic minimum mean July temperatures rose further towards 15-16°C. Precipitation values increased further and the groundwater level rose as well. In the Maas valley vegetation cover was dense, especially *Quercus*, *Ulmus*, *Tilia* and *Coylus* were present. *Viscum album*, *Hedera helix*, *Ilex* and *Humulus lupulus* were also present. *Pinus* was still present on sandy, gravelly nutrient poor river terraces, but decreases. The beginning of the Atlantic is marked by the occurrence of *Alnus*, which was present near the abandoned palaeochannels of the Maas, where there are high water levels. More towards the end of the Atlantic, values of Plantago and Cerealia increased, both are indicators of human activity. The presence of these two species was very local and related to Mid-Neolithic cultures.

During the Subboreal, temperatures were somewhat lower compared with the Atlantic and anthropogenic changes became more important. *Ulmus* and *Tilia* started to decrease; forests were now dominated by *Quercus* and *Corylus*. The disappearance of *Ulmus* and *Tilia* was probably caused by the use of their branches as cattle feed during the winter season. *Alnus* increased rapidly in areas with moist (often seepage) conditions so fluctuations reflect changes in the local abundance. The start of the Bronze Age is characterized by the appearance of *Fagus*. In this period forests became more open due to the construction of agricultural fields. This led to a further increase of agricultural herbs like Plantago and Cerealia. More grass lands were present which were used for cattle grazing, on these grasslands also Ranunculus, *Caucus carota* and *Plantago lanceolata* were present. The presence of ferns in the more moist areas, where *Alnus* growed, indicates a lowering of the groundwater level.

2.4.3 Subatlantic (2.85ka -present)

The Subatlantic contains important vegetation changes so this period has been split up as well into Iron age, Ancient Roman period, Middle Ages and the Modern history. In the Early Subatlantic climate changed towards colder temperatures and higher precipitation rates. Due to the larger influence of humans, the vegetation became more open which could result in more erosion. In the Iron age, *Fagus* expanded further together with *Quercus*. Grasslands contained Ranunculus, Trifolium, *Sanguisorba officinalis* and *Plantago lanceolata*.
Towards the Ancient Roman period, deforestation increased which caused a higher sediment influx in the Maas. The start of the Ancient Roman period is characterised by the presence of *Carpinus*. The remaining forests contained also *Fagus*, *Quercus* and *Corylus* with some *Ulmus* and *Tilia*. *Alnus* was still present in the moist areas. The upland herbs increased on agricultural lands and grass fields. Also Ericales started to grow on nutrient poor soils. The Romans introduced the *Rubus fruticosus*, *Juglans* and the *Castanea sativa* for food.
In the Early Middle Ages, *Alnus* showed an enormous increase towards values between 60 and 80% of the total pollen sum (when *Alnus* is included in the pollen sum). Other trees like *Quercus*, *Corylus*, *Fagus*, *Carpinus*, *Salix* and *Fraxinus* also increased and the vegetation started to close again. This rapid decrease may correspond with an epidemic outbreak. During this period flooding risk decreased because the water storage of the soil increased again due to the closer vegetation. According to Teunissen (1988) the maximum forest expansion was reached 500 years after Christ. Thereafter forest started to decrease again and upland herbs like Cerealia, *Plantago lanceolata* and *Centaurea cyanus* started to increase, which likely grew in nearby fields and pastures.

In the Modern History the Maas showed an increased risk of flooding again which caused a higher sedimentation rate in the surrounding area. This resulted in the formation of thick sandy overbank deposits. The vegetation was open with heath, grass fields and agricultural lands with *Fagopyrum tataricum* and *Bromus secalinus*. Due to the plantation of Pine, *Pinus* pollen percentages started to increase again.

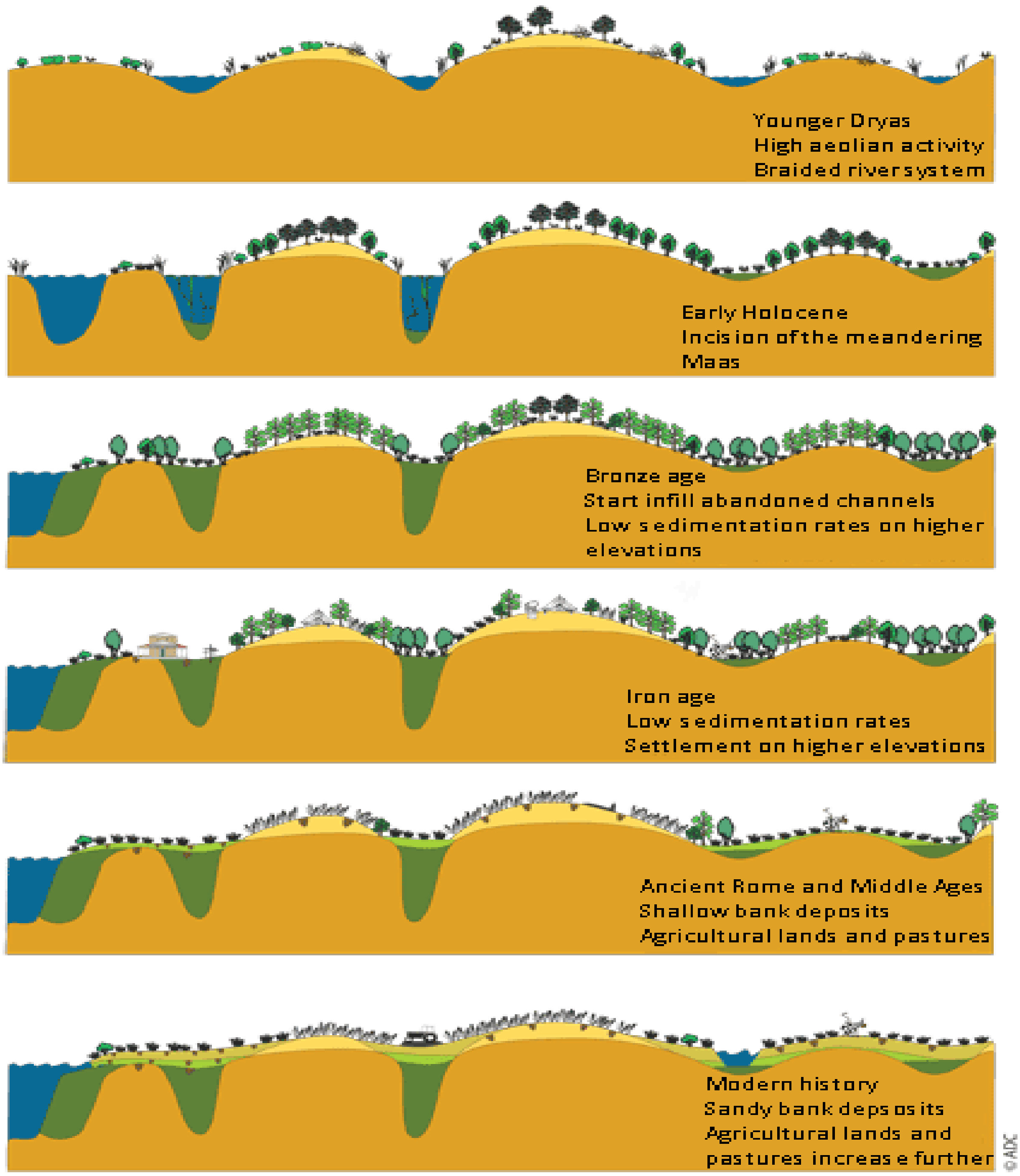

Figure 5. Overview landscape changes Lateglacial and Holocene (ADC http://www.archeologie.nl/projecten/specialismen/landschapsarcheologie/hoogwatergeul-maaswerken-lomm.html).

3. Data collection and research methods

To reconstruct the fluvial response of the river Maas between the Lateglacial and Early Holocene for this area in the Netherlands, several coring transects through residual channels were made, in order to find the most complete sediment record in especially the residual channel fills. These residual channels are selected at different locations in the Maas valley (figure 6), because we expected that these channels were active during different periods. This selection is based on the digital elevation model of the Netherlands in combination with literature of the area upstream, as described in the previous chapter. The investigated channels of VU Amsterdam are shown in appendix I.

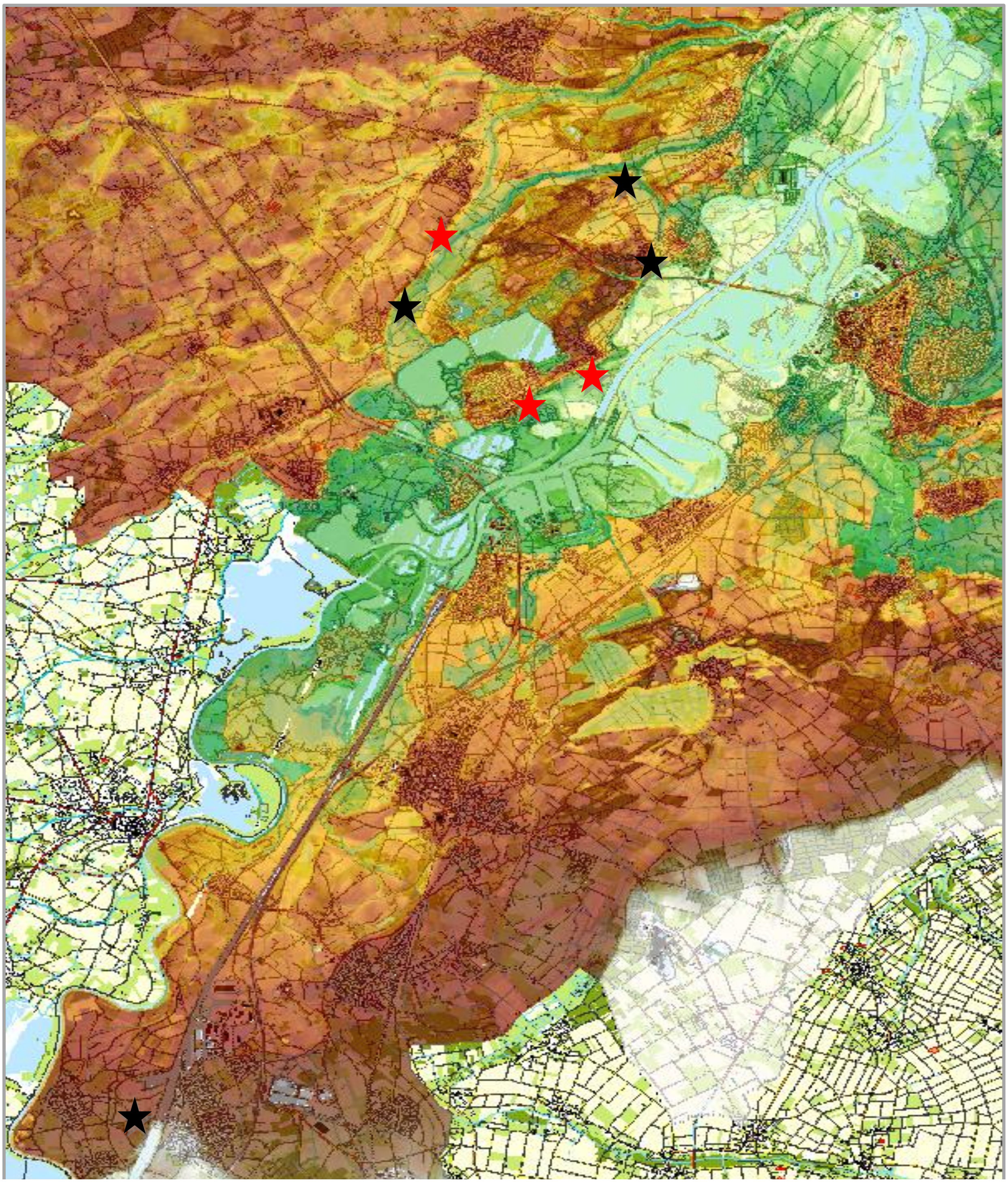

Figure 6. Selected residual channels in the Maas valley between Susteren and Venlo, the Netherlands. The black stars indicate the locations of the cross-sections, the red stars indicate the locations of the pollen samples at the base of some residual channels that did not contain organic fills for palynological investigations.

After the inventarisation phase, several coring transects through the selected residual channels were made to find the most complete sediment records. With these coring transects the type of fluvial system at that time has been distinguished together with the possible influence of aeolian processes and the depositional environment. The investigated sequences have been compared with the well-documented and dated fluvial history of the downstream part of the Maas. If the sedimentary sequence was complete and contained a sufficient amount of organic material, cores have been taken, which were further analyzed in the laboratory. From these cores the pollen analysis and dating through biostratigraphy were performed. The results have been compared with previously published reconstructions and local geomorphology in order to understand the processes which are involved in the fluvial development. From the results and the outcomes of the research a reconstruction of the terrace stratigraphy has been. Below the terrace stratigraphy between Susteren and Venlo is compared with past climate and vegetation changes.

3.1 Coring transects and sediment cores

Different corings have been performed in the selected residual channels. The channels of which a coring transect and sediment core has been sampled for further research are shown in figure 7. Some of the selected residual channels were visible on the digital elevation model but did not meet the expectations for organic infill and/or were disturbed by anthropogenic changes; on these locations no further analyses have been performed. The coring locations are shown in figure 6 and are indicated by red stars. The profiles have been used to investigate the infill of the channels and the sedimentary architecture of the valley.

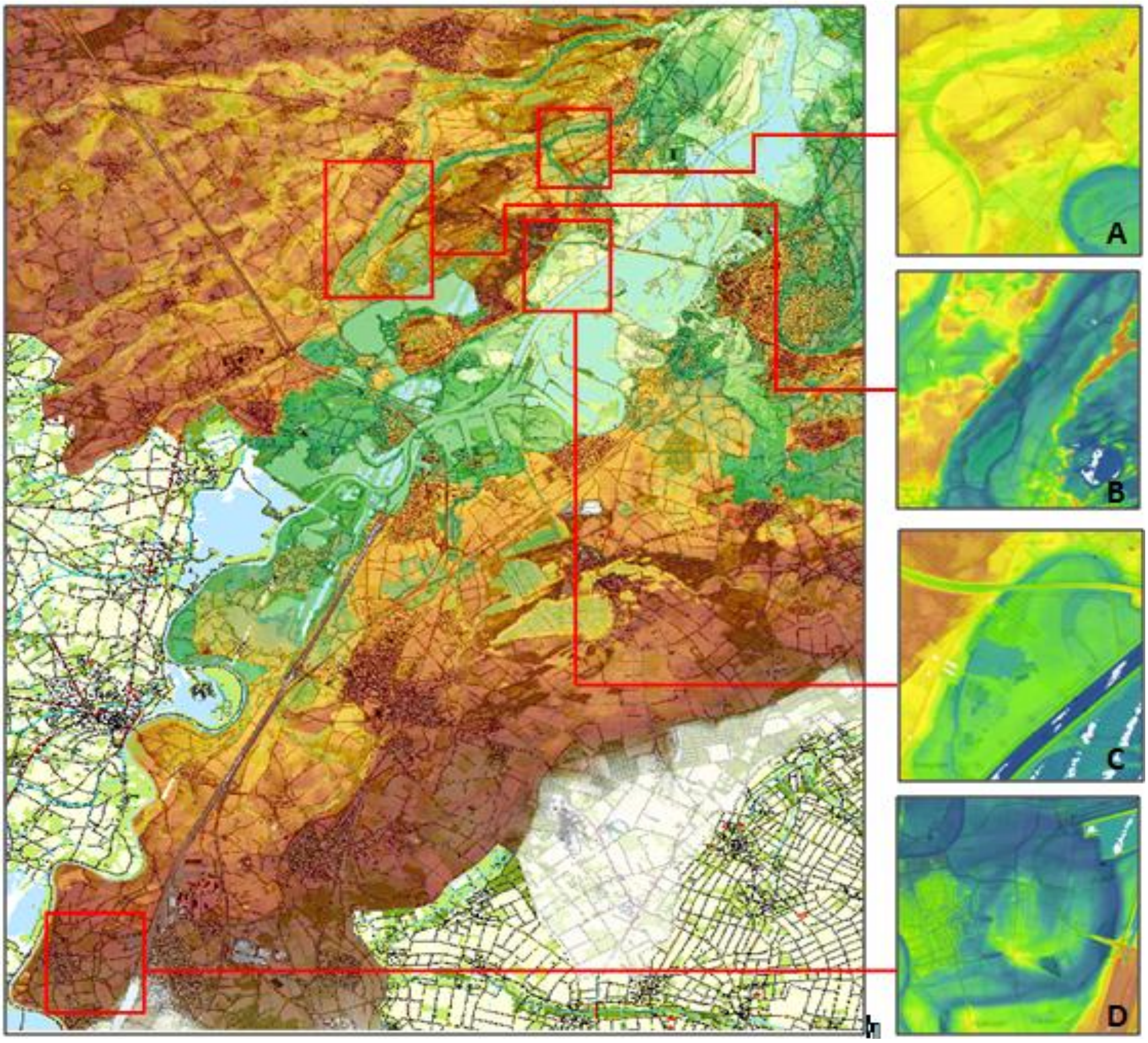

Figure 7. The locations of the coring transects trough residual channels in the Maas valley between Susteren and Venlo, the Netherlands.

One of the selected residual channels (A) is located between Baexem and Haelen at 'Houterhof'. This palaeochannel was probably active during the Lateglacial since it is connected other residual channels. At a different location, 'Katerhof', residual channel B, is located more to the West and is laterally connected with residual channel A. This palaeochannel shows a braided pattern on the digital elevation model and was probably also active during the Lateglacial. South of Horn another residual channel (C) is located at 'Casquettenhof'. This palaeochannel shows a large meander belt probably active during the Early Holocene. More to the south nearby Born, residual channel (D) is located east of the present day Maas. This channel was probably active before the Early Holocene, indicated by the large meander belt.

Fieldwork was carried out in the Maas valley between Susteren and Venlo in September and October 2012 within the framework of an ongoing field-based PhD research project of M.M. Janssens of the VU University in Amsterdam. The exact borehole locations depended on local geomorphology, vegetation and accessibility, and were decided in the field. In total 51 borings were performed between Susteren and Venlo. All borings were all carried out with an Edelman auger and a gouge for deposits below groundwater level. The borings were logged in the field conform the NEN 5104, coordinates and surface elevations were determined with a GPS device in combination with the LIDAR data. In the field, a general interpretation of the distinct sedimentary facies was made while fluvial and aeolian deposits were distinguished. For all transects a lithostratigraphic cross section has been made, which together with the LIDAR DEM, gives indications about the dominant processes during the time of infill.

From the selected locations, presented in figure 7, cores were taken for a detailed sediment analysis and pollen analysis in the laboratory. The cores were taken using an adapted “Piston corer”. In total, five cores were retrieved from the residual channel fills; because Casquettenhof showed at two locations a totally different infill two cores were taken at this location 10 metres apart. The total length of the collected cores is circa 12 meter.

3.2 Laboratory analysis

In the laboratory the core has been described, and sampled for loss on ignition, Calcium Carbonate content (in the case of carbonate rich deposits), and pollen analysis.

3.2.1 Lithological description

The cores were transported in a PVC-pipe sealed with plastic foil and wrapped in a plastic bag to prevent oxidation. At the University they are stored in a refrigerator. In the laboratory cores were cut open from bottom towards the younger sediments to avoid contamination. First photographs were made, to record the colour before oxidation could occur. Changes in colour or lithological breaks have been used to distinguish lithological units.

3.2.2 Loss on ignition

The percentage of organic matter in the residual channel was estimated by the loss on ignition (LOI) method following Heiri et al. (2001) (figure 8). From one side of the core, samples were taken from 1 centimeter wide, 0.5 centimeter deep and 1 to 2 centimeters long depending on visible lithostratigraphic boundaries. No samples were taken across these lithostratigraphic boundaries so sharp changes in the LOI are still visible.

Figure 8. Core samples for the LOI determination. Photograph by S.P.M. Otten (04-10-2012).

The samples are dried in a stove for circa 12 hours at 105°C, and then weighted giving the values of the weight of the dry sample (Wd). Thereafter the samples are combusted in the oven for 4 hours at 550°C. These samples are also weighted which result in the weight of the residual after burning (Wg). The LOI percentage is calculated using the following equation:

$$LOI = ((W_g - W_b)/(W_d - W_b)) * 100\%$$

In which Wb represents the weight of the crucible, Wd is the weight of the crucible and the dry soil and Wg is the weight of the crucible and the residual after burning all organics.

3.2.3 Calcium Carbonate content

Because of the in the field noted presence of Calcium Carbonate in Casquettenhof, samples were taken for carbonate analysis. The carbonate content has been determined by the Scheibler technique (figure 9). This technique uses the principle that $CaCO_3$ can be dissolved by hydrochloric acid (HCl) and thereby produces CO2 which can be measured volumetrically. For the calculation of the amount of CaCO3, a standard amount of dissolved calcium carbonate and a blanco of aqua dest were used. With these to two standards the carbonate content of a dry sediment sample can be determined. This is done with a Scheibler calcimeter, combined with an erlemeijer and small polyethylene jars. The dry sediment sample is mixed with a small amount of aqua dest and put in the erlemeijer together with a small polyethylene jar filled with 5ml hydrochloric acid (4M). The erlemeijer is closed off and the jar is knocked over. Due to the pressure of the escaping CO_2 the Scheibler calcimeter then will give the difference in water level between the sample and the standards. This will conclude in the calculated calcium carbonate weight percentage of the dry sediment sample. Total carbonates in the cores from Casquettenhof consist of a combination of calcite (CaCO3) and siderite (FeCO3) and possibly other carbonates. Because siderite is heavier than calcite, the presence of siderite leads to an underestimation of the total weight percentage of all carbonates.

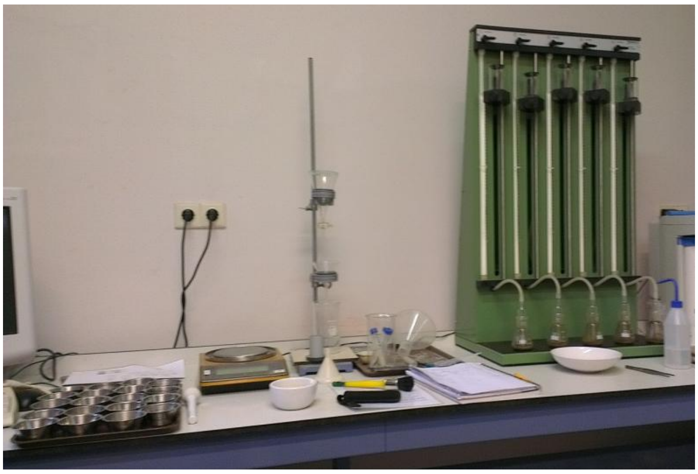

Figure 9. Calcite determination with a Scheiblercalcimeter. Photograph by S.P.M. Otten (17-10-2012).

3.2.4 Pollen analysis

From all cores pollen samples were taken every 10 cm and around visual lithological changes throughout the core. From the lower meter of the Dukkelaar core pollen samples were taken every 2 cm because of the expected Lateglacial age. Some of the selected residual channels did not meet the expectations for organic infill and/or were disturbed by anthropogenic changes; from these channels one single pollen sample has been taken from the base of the channel to give an age indication.
The pollen samples were prepared according to the pollen preparation protocol based on Faegri and Iversen (1989). First the calcium carbonate has been removed from the samples by 5% acetic acid, the acid has been washed out with some aqua dest. The humic compounds have been gently removed with 5% KOH and after 1 hour in the stove at 70°C the samples have sieved to remove the coarse organic components. Then the acetolysis (Faegri and Iversen, 1989) has been performed which removes the excess organic matter that surrounds the pollen grains, so the pollen wall consisting of the resistant sporopollenine is better distinguishable. The silica has been removed by heavy liquid separation. The pollen samples have been washed out with aqua dest and ethanol. They are put in an Eppendorf cup with glycerine jelly to prevent oxidation. After a night in the stove at 70°C the microscope slides have been made.

Pollen types are identified following the identification key by Moore et al. (1991) and from each pollen sample a total pollen sum of 200 has been used. The pollen sum of all pollen diagrams, except Dukkelaar, includes trees and shrubs (including thermophilous trees excluding Alnus), upland herbs (excluding Umbelliferae and Poaceae) and Ericales. The pollen sum of the Dukkelaar pollen diagram includes trees and shrubs (excluding thermophilous trees), upland herbs and Ericales. The final results of the pollen analysis, loss on ignition, calcium carbonate content and lithological characteristics are presented in a pollen diagram that was composed using TILIA (version 1.7.16 of

Grimm, 2011). The pollen zones are visually distinguished based on changes in the main pollen taxa and indicator species.

3.2.5 Age reconstruction

During this study the age construction has been based on the pollen diagram, which represents the vegetation development and the species diversity. The constructed chronological framework of Hoek (1997) for pollen zone boundaries in the Netherlands has been used to interpret the pollen diagrams. Because Hoek (1997) calculated the mean radiocarbon age of the Lateglacial and Early Holocene bio zone boundaries, an age model can be constructed. For all the cores the LOI results, the lithology and the calcium carbonate content have been used by this interpretation.

4. Results

In this chapter, the infill characteristics, cross sections and palaeoecological results are discussed for each of the investigated palaeochannels. The results of the palaeoecological correlation are also given below. The borehole descriptions of all cross sections described below are attached in appendix II. The photographs of the whole cores are attacted in appendix III, pollen counts and extended pollen diagrams are attached in appendix IV and V, while the exact LOI curves are given in appendix VI.

4.1 Dukkelaar

Dukkelaar (183643, 338627, 31) is an abandoned meander channel located west of Born between the Geleen fault (upstream) and the Felbiss fault (downstream). For the cross-section of channel fill sediments of the Dukkelaar system in total seven borings were performed. These borings were set throughout the lowest part of the channel with a maximum depth of 400 cm below surface level (figure 11). The first 310 cm of the infill at boring locations 57, 53, 56 and 55, starts with a small layer of oxidized peat followed by clayey peat, interrupted by a 20 cm thick layer with an alternation of humic clay layers with plant remains (figure 10).

Figure 10. Transition of oxidized peat layer towards clayey peat. Base of the channel to the right.

Towards the base of the channel the infill becomes more clayey. In the lowermost 50 cm of this layer in boring 55, clay was dominant. This clayey peat is underlain by fine sands with sandy clay intervals. The base of the channel is characterized by sandy gravels. Below this sandy gravel layer a thin organic clay layer is found of which one pollen sample is taken. For boring 51, 50 and 54 the infill is somewhat different as described above. At boring location 51 and 50, 25 cm of fine sands is deposited. In boring 50 this layer is underlain by a humic sandy clay which is connected with the top layer of boring 54. In boring 51, the fine sands are followed by a sandy loam of approximately 70 cm thick. In all three the borings the same fine sand layer with sandy clay intervals is found, this layer is found in all the other borings. Below this layer, a layer of approximately 40 cm sandy gravels is found, underlain by a thin loam layer of 10-20 cm. Below this loam layer, medium sands are deposited which coarsen downwards towards coarse sands, this layer of approximately 100 cm is found in boring 51 and 54.

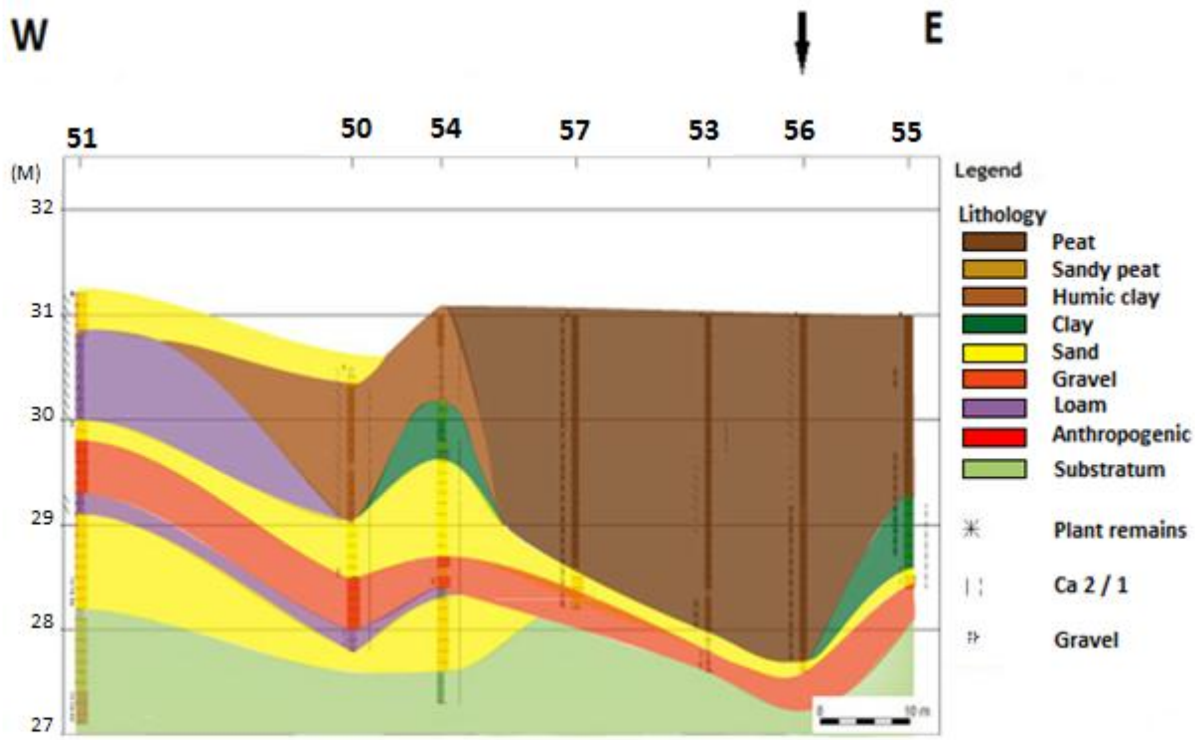

Figure 11. Cross section Dukkelaar, the core location for pollen analysis is indicated with an arrow.

At location 56 a core was taken for pollen analysis, the derived pollen diagram is shown in figure 12. From 350-335 cm the pollen diagram is characterized by relatively high (45-50%) non arboreal (NAP) percentages consisting of Ericales and upland herbs. A notable characteristic of this interval is the presence of *Empetrum* (25%), *Hippophae* (1%), Galium (4%) and Polemonium (3-5%), both species that are characteristic for the second phase of the Younger Dryas biozone (PAZ 3b; Hoek, 1997a). This interval has low values of calcium carbonate and organic matter, suggesting a relatively high influx of silliclastic material. The high amount of reworked pollen percentages from thermophilous taxa like *Alnus*, *Corylus*, *Ulmus*, *Acer campestre* and *Quercus*, points towards a high fluvial activity and erosion upstream. This is supported by the occurrence of *Nyssa*, a tropical tree species that must have been eroded from older deposits. From 335 to 317 cm depth, *Empetrum* start to decrease (10%), *Betula* (25%) and *Pinus* (30%) values are relatively high but upland herbs like Poaceae, *Artemisia*, Umbelliferae and Compositae still dominate the landscape. The next interval, from 315 to 240 cm, shows a *Pinus* phase (60-70%), typical for the Late Preboreal, upland herbs decrease to values of approximately 20%. A small clayey interval in this period is indicated by a fall in organic matter content from 70% towards values of 15%. The presence of *Calluna* and *Helianthemum* between 280 and 275 cm below surface level indicates a period of high water which is very uncommon during the Preboreal. This may have been caused by the activity of the Geleen fault, upstream of the coring location. Towards the end of the Preboreal upland herbs and aquatic species almost disappear while Salix shows an increase. The start of the Boreal (240-200 cm) is indicated by the presence of *Corylus*, somewhat later in the Boreal also *Quercus* and *Ulmus* start to occur. *Pinus* values are still very high (60%) and the vegetation is still very close. The organic matter content is constant at 40-50% with some clastic influxes. From 200 to 175 cm below surface level *Alnus* start to occur, *Pinus* values decrease and *Betula* and *Salix* show a small increase. Somewhat higher in the pollen diagram upland herbs like *Mentha*, *Hedera*, Umbelliferae, Compositae start to occur and also *Calluna* is present. The organic matter content decreases a bit towards values of 35% with some small clastic fluxes. This period correlates with the Atlantic in which temperatures rise and humans start to influence the landscape.

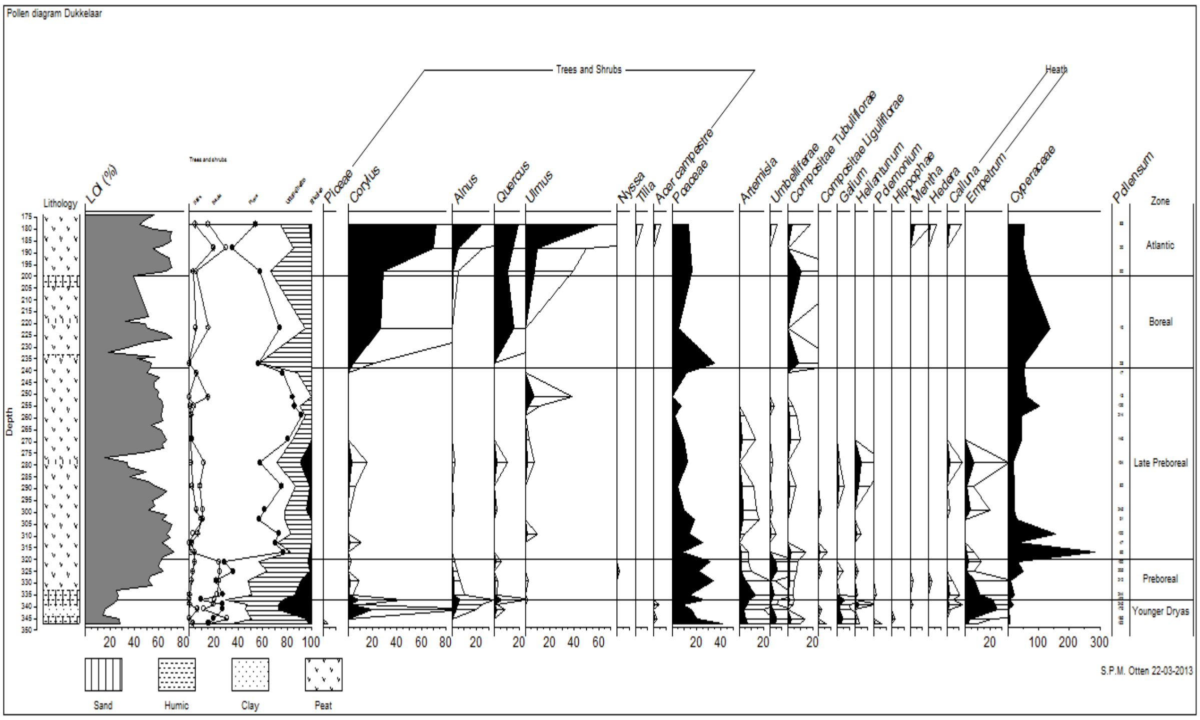

Figure 12. Pollen diagram Dukkelaar.

4.2Houterhof

Houterhof is located southwest of Haelen (193115, 359322, 21.9), in this abandoned meandering channel lots of peat pits are located which show already that almost all the peat has been excavated. The cross section at the palaeochannel Houterhof was performed with 5 borings. These borings were set throughout the lowest part of the channel (figure 13).

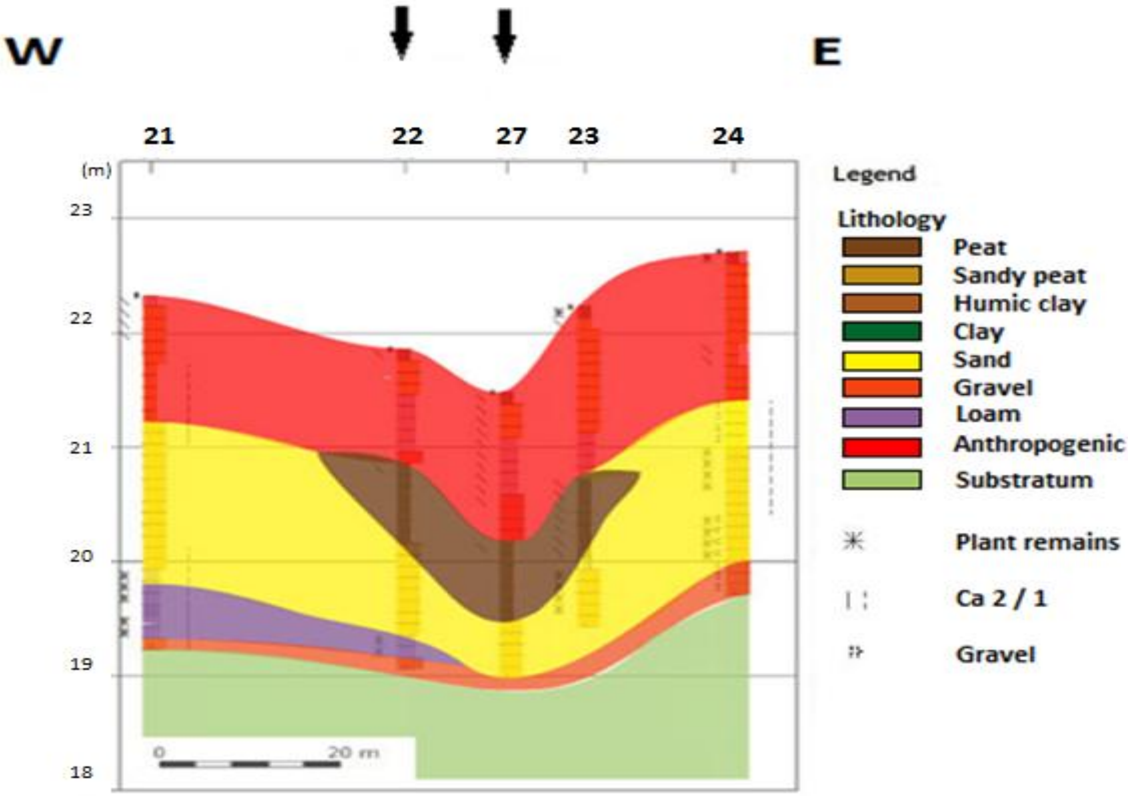

Figure 13. Cross section Houterhof.

The upper meter of all the borings contained anthropogenic material overlying 5 centimeters of moss peat, one meter peat and coarse sands and gravel at the base of the abandoned channel (figure 14).


Figure 14. Houterhof 2 core with sharp transition between peat infill and sandy base at about 72 cm. Base of the channel to the right.

From location 27 and 22 two cores of approximately 100 cm were taken for pollen-analysis, to yield an age indication. The two cores are comparable and are relative homogenous despite of the sand layer at the base; this is supported by the loss on ignition results (figure 15 and 16). Both cores were poor in calcium carbonate. The pollen diagrams of the cores are very similar (figure 15 and 16). The lower part of both diagrams (173-163 cm in HH 1 and 180-176 cm in HH2) shows high *Pinus* and *Salix* values. Also *Corylus* values are high (50%) and *Betula* values are generally low (3%). These values, together with the low values of upland herbs (2%) places the start of organic accumulation probably in the Late Boreal. In the Netherlands the Late Boreal is known as a period in which a more close vegetation cover developed, which led to a decrease in upland herbs. The interval from 163 to 138 cm in HH1, and 176 to 158 cm in HH2, shows an increase in *Alnus*, followed by an increase in upland herbs like; Rumex, *Artemisia*, *Compositae tubiliflorae*, Caryophyllaceae, *Hedera* and Umbelliferae which indicates a change to a more open landscape. This interval is interpreted as the Atlantic, with probably some human interference (pollen zone 8).

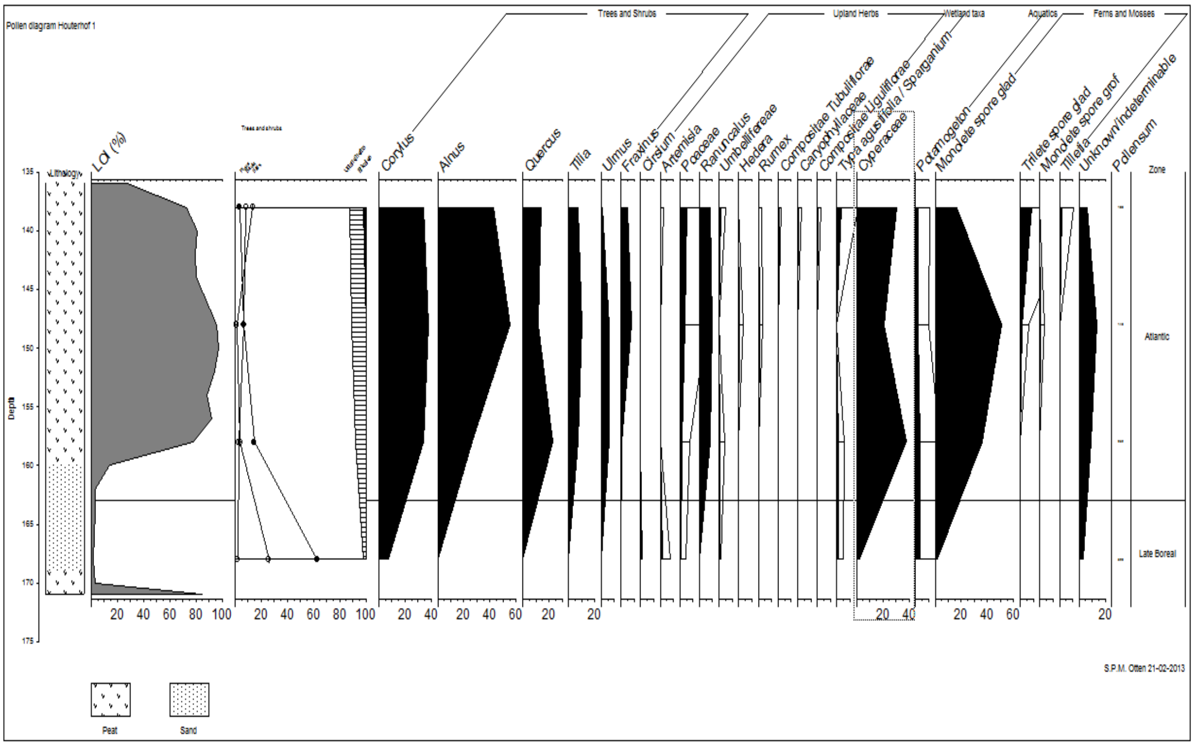

Figure 15. Pollen diagram Houterhof 1.

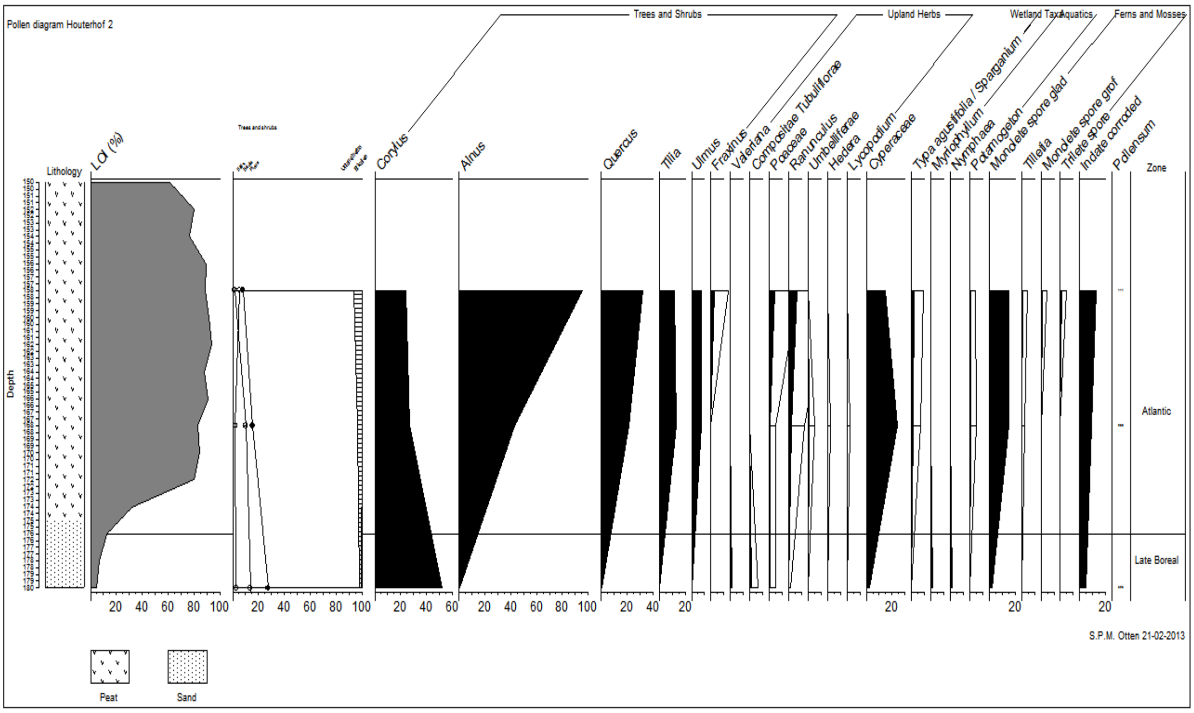

Figure 16. Pollen diagram Houterhof 2.

4.3 Katerhof

Katerhof is located at (188935, 356946, 24) between Baexem and Grathem, on the digital elevation model a braiding river system is visible with numerous interacting gullies. In the present day, the Haelense Beek is located in the valley. The cross section through the palaeochannel Katerhof was performed with 13 borings from east to west (figure 18). These borings were set out through the lowest parts of the channel and the island and had a maximum depth of 340 cm below surface level. The borings 25, 9, 26, 10, 12, 19, 20 and 28 start with approximately 20 centimeters of humic, crumbling sand, this sandy layer is intermittent by a sandy clay layer of 50 centimeters. The borings 33, 32, 31, 29 and 30 start with 10-50 centimeters of humic loamy sand. These sandy clay layer and the humic loamy sands are underlain by 50 to 100 centimeters of well sorted silty sands. Except for borings 12, 10, 26 and 9 these well sorted silty sands are overlying a thin (5cm) gravel layer. Below this gravel layer well sorted fine sands are deposited, sometimes interrupted by small loamy bends. In boring 12, 10, 26 and 9 an oxidized peat layer is found of approximately 50 cm. Below this 100 centimeters of sandy gyttja has been found sometimes interrupted by a few centimeters of aeolian sands. These borings end in well sorted fine sands with thin silt and clay intervals. The transition between both sediment types is very sharp (figure 17).

Figure 17. The lowermost part of the Katerhof core (239-225 cm depth), showing the sharp transition between fine sands (with small silt and clay intervals) and sandy gyttja. Base of the channel to the right.

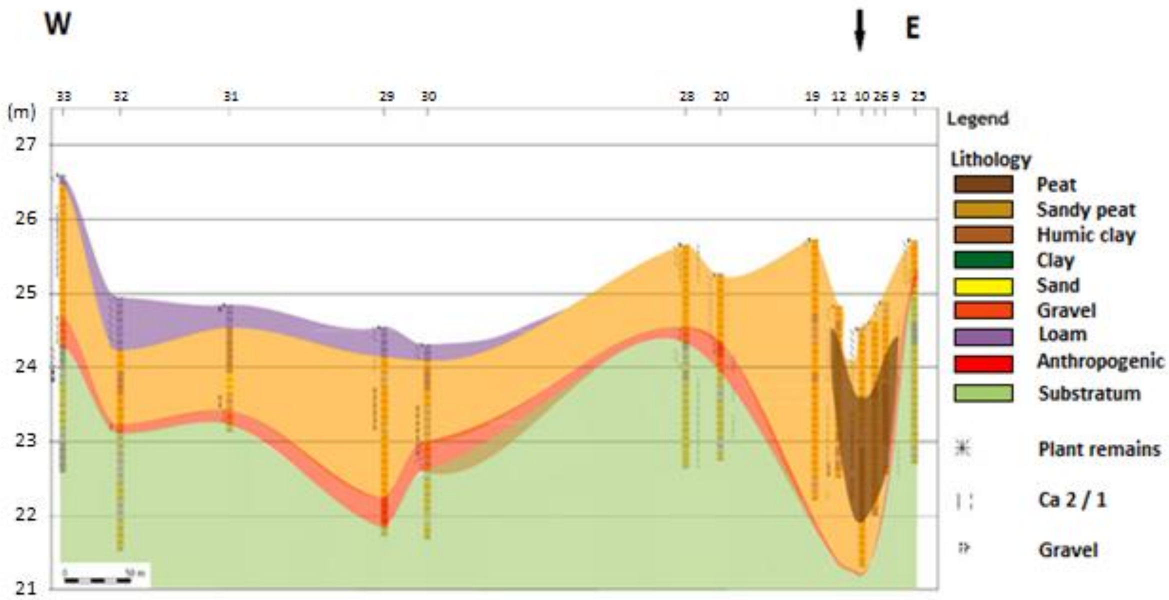

Figure 18. Cross section Katerhof.

At the location with the largest organic infill at boring 10, a core was taken of approximately 100 cm long of which the regional pollen diagram is shown in figure 19 (extended version in appendix V). From 240 to 165 cm the core shows an increase in organic matter content from 5% to 50%, vegetation became denser. The deepest part of the core (240-200 cm) shows a decrease in *Pinus* and *Tilia* (from 35% to 5%), *Alnus* values are low (5%), *Corylus* (20%) and *Quercus* (25%) are the dominant tree species. Upland herbs consist out of low values Poaceae, *Viscum* and *Cirsium*. From 200 to 165 cm *Alnus* increases rapidly to values of approximately 80% at 180 cm and then slowly decreases to values of 25%. Upland herbs start to increase due to the appearance of Compositae, *Artemisia*, Rumex, *Hedera*, Ranunculus and Umbelliferae. However, these values remain still below 5% of the pollen sum. The end of this period is based on the rise of *Fagus* which is an indicator for the Subboreal. At the transition a sandy layer of approximately 5 cm with an organic matter content of 20% is deposited. From 160 to 140 cm upland herbs (55%), *Calluna* (5%), *Fagus* (7%) and *Fraxinus* (17%) start to increase. *Salix*, *Tilia* and *Ulmus* almost disappear. Upland herbs increase further and other species like Caryophyllaceae, Rubiaceae, Chenopodiaceae and *Rhamnus frangula* start to occur. In this part of the core the organic matter content rapidly increases towards values of 90%, at the top of the core this rapidly decreases again towards values of 10%.

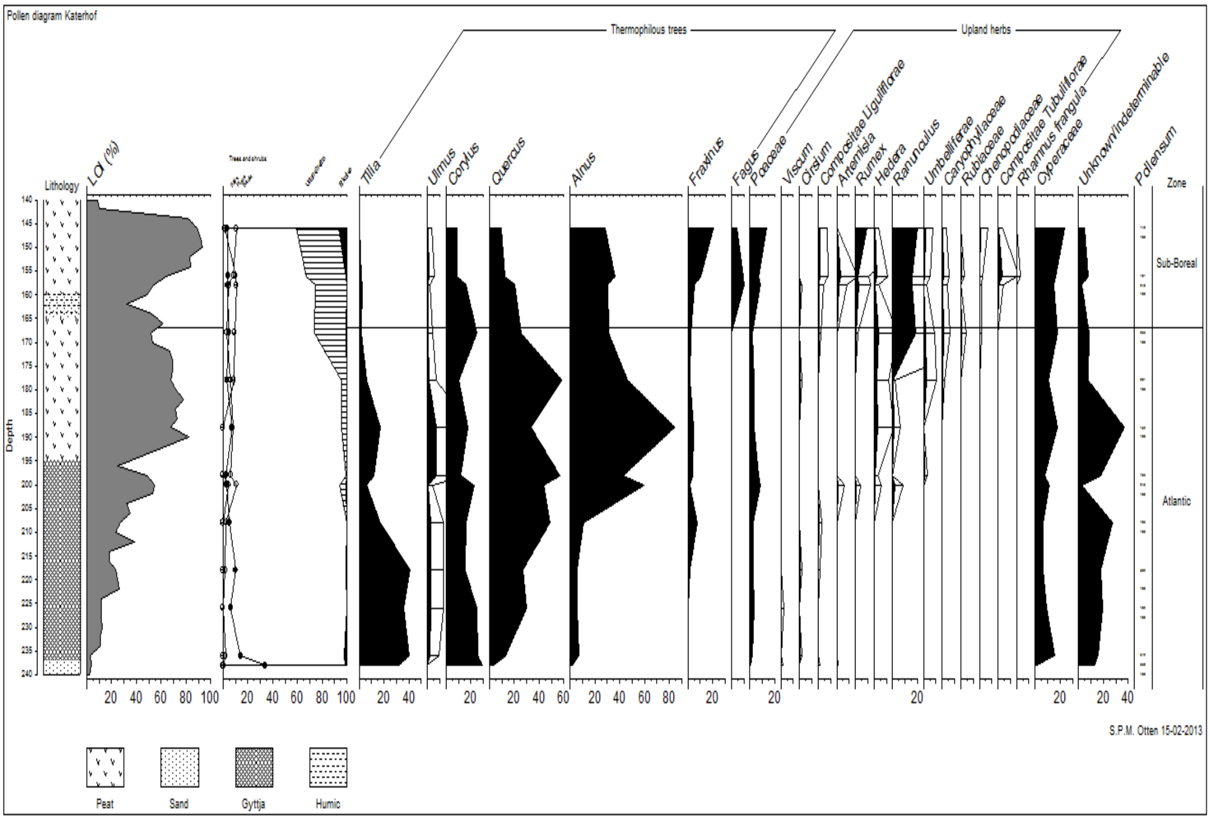

Figure 19. Pollen diagram Katerhof.

4.4 Casquettenhof

Casquettenhof (193441, 357479, 18.2) is a residual channel between Horn and Beegden located west of the present day Maas. From this location two cores were taken approximately 10 meter apart due to the complete different infilling that was discovered during boring the transect. The cross section of the Casquettenhof residual channel (figure 20) is based on seven borings from west to east. These borings were set throughout the lowest part of the channel, and had a maximum depth of 560 cm.

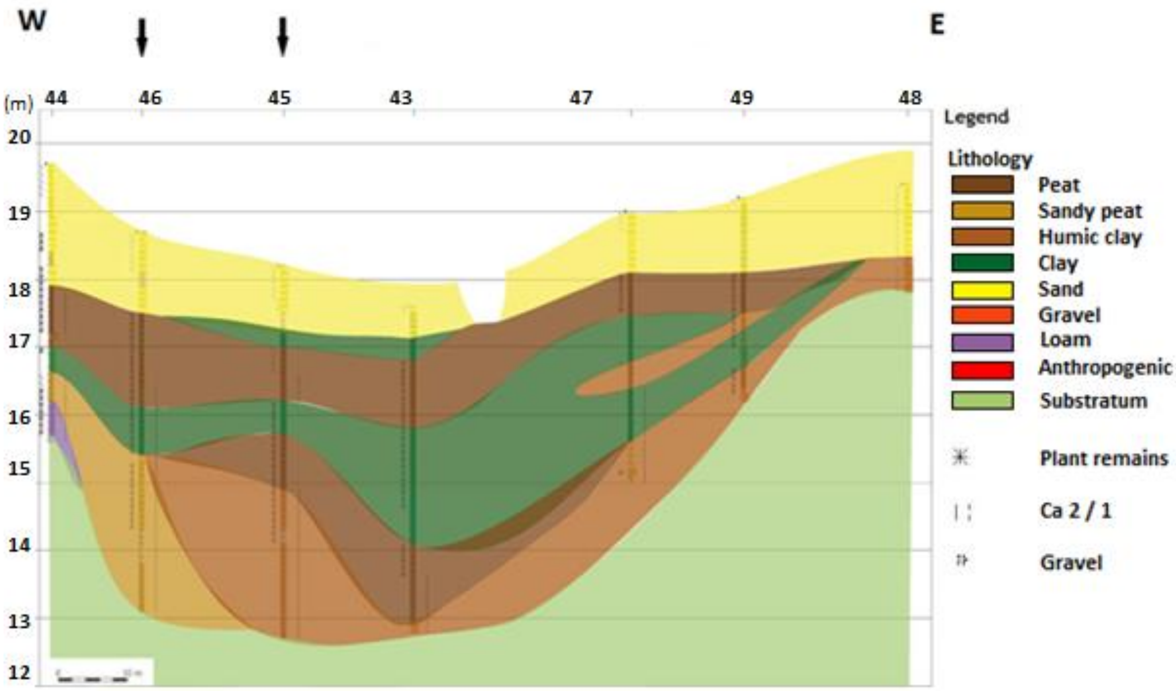

Figure 20. Cross section Casquettenhof.

Except for boring 43 and 49, all borings start with one meter of sandy clay, this material is considered to be disturbed by anthropogenic actions. In boring 43 and 45 this clay layer is overlaying a 75-100 cm thick clayey siderite gyttja with roots and plant remains (figure 21) which smelled like hydrogen sulfide.

Figure 21. Lamina of siderite gyttja, clay and humic clay in the Casquettenhof 1 core. Base of the channel to the right.

Below this siderite gyttja 50 cm of clayey gyttja is present. In boring 47 and 49, this layer is interrupted by a small peat layer of approximately 25 cm. In the eastern part of the paleaochannel (boring 45 to 49), a gyttja layer of 100 cm with clayey lamina and plant remains occur. This peat layer is underlain by a humic clayey gyttja with shell remains and a low organic compound. Towards the base humic clays dominate and lamina of plant remains are clearly visible (figure 22).

Figure 22. Humic clay with plant remains lamina in the Casquettenhof 1 core. Base of the channel to the right.

Strikingly, boring 44 and 46 do not contain these peat layers below the sandy clay layer. In these borings, the sandy clay is underlain by a peat layer with wood remains and in this borings a very compact sandy gyttja with siderite and plant remains is found of 90 cm thick. This layer is interrupted by a humic sand layer which is overlying a humic clayey siderite gyttja of 70 cm with some sandy layers. The base of the abandoned channel is characterized by a gravel layer. Because the infill of boring 45 to 49 differs that much from boring 44 and 46, two separate cores were taken for pollen analysis in order to correlate both infill locations with each other. The core of Casquettenhof 1 was taken at boring location 45, while the Casquettenhof 2 core was taken at location 46. Each core was sampled for LOI and calcium carbonate determination and pollen analysis. Because the cores show very different LOI and calcium carbonate profiles they will be discussed separately, first the results of Casquettenhof 1 are discussed. In the figure below the differences in calcium carbonate content and the occurrence of siderite gyttja is explained. Due to the high terrace next to Casquettenhof 2, seepage could occur on this side of the channel. This was the likely cause for the formation of siderite gyttja.

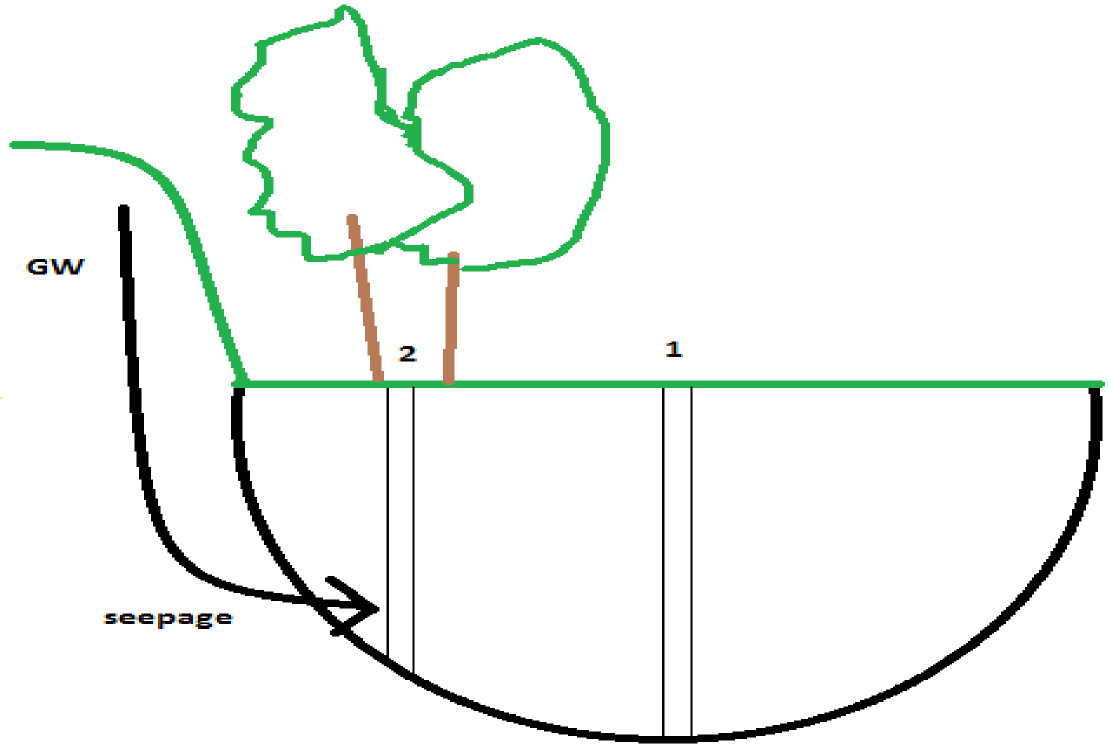

Figure 23. Schematic cross-section explaining siderite formation due to seepage. In this figure Casquettenhof 2 core is indicated with number 2, while number 1 represents the location of the Casquettenhof 1 core.

4.4.1 Casquettenhof 1

At boring location 45 a core of 400 cm was taken of which the regional pollen diagram is shown in figure 24 (extended version in appendix V). The deepest part of the core (550-350 cm) shows a relatively constant organic matter content of about 8%, vegetation was relatively closed. During this period especially *Quercus* (20 %) and *Alnus* were dominant. The presence of Cerealia, *Compositae Liguliflorae* and Plantago indicate the presence of agricultural lands and human activity. Aquatic taxa like *Typa angustifolia*, *Potamogeton* and *Myriophyllum* indicate shallow, gradually running water conditions. At the end of this period *Betula* values start to rise towards 20% and *Alnus* increased rapidly. Because Cerealia is present but *Carpinus* is still missing, this interval is interpreted as the Ancient Roman period. The end of this period is based on the rise of *Carpinus* which is an indicator for the Early Middle ages (350-245 cm). Consequently, a rapid increase in organic matter content of approximately 25% is recorded and calcium carbonate values increased towards a maximum (20%) the vegetation was relatively closed. In the Early Middle ages *Betula* values decreases again while *Salix* values rise towards values of 15%. *Carpinus* dominates about 10% of the vegetation and *Quercus* values decrease. Locally *Alnus* is dominant, and the vegetation cover seemed to close further. Typical for this interval is the lack of Chenopodiaceae and *Compositae liguliflorae* and the decrease of *Compositae tubuliflora*e, Cerealia and Plantago. This probably indicates the Dark Ages in which the forests recovered from the deforestation in the Ancient Roman period. From 245 cm to 150 cm, *Centaurea nigra* starts to occur; other agricultural indicators like Plantago, Cerealia, Compositae, Caryophyllaceae and *Erodium* also increase. Upland herbs and Ericales start to dominate the landscape and forest coverage decreased to a minimum. *Quercus* is the only tree species which remain values of 15%. From 245 to 200 cm the organic matter content of a clayey layer is 7%, somewhat lower compared to the Early Middle ages, above the 200 cm clayey peat is deposited with an organic matter content of 15%, also the calcium carbonate content starts to increase from 200 cm to 150 cm with values between the 3 to 5%. Aquatic species like *Lemna*, *Iris pseudacorus*, Equisetum, Cyperaceae and *Typha angustifolia* increase towards values of 5% between 250 and 150 cm.

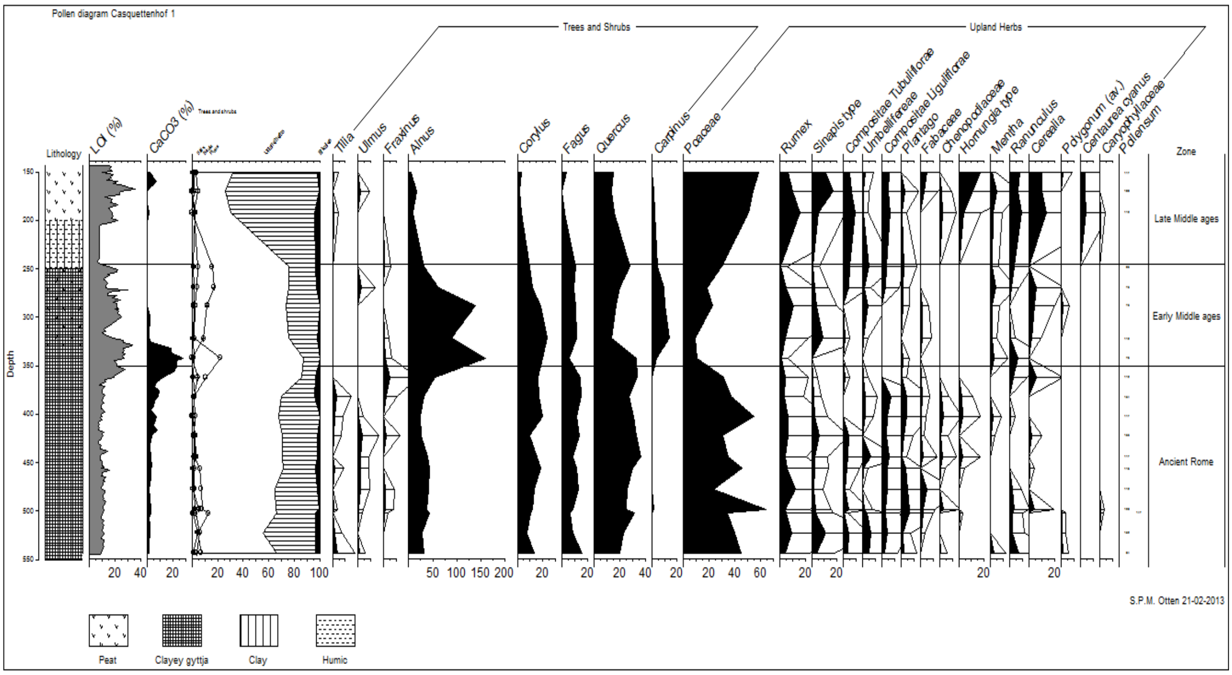

Figure 24. Pollen diagram Casquettenhof 1.

4.4.2 Casquettenhof 2

Boring location 46 was used for the core of Casquettenhof 2, a core of 425 cm, the regional pollen diagram is shown in figure 25 (extended version in appendix V). From 550 to 440 cm, the organic matter content was approximately 10%, the calcium carbonate content decreased from 10% towards 5%. The vegetation cover became closer due to the rapid increase of *Quercus* (from 5% to 30 %), an increase in *Salix* and high values of *Alnus* (50%), other tree species like *Corylus*, *Fraxinus*, *Tilia* and *Ulmus* slowly decrease. From 440 to 240 cm upland herbs start to increase like Compositae, Caryophyllaceae, Poaceae, Chenopodiaceae, Plantago, Rumex, *Sinapis type* and Umbelliferae. During this transition, *Calluna* shows its highest values (3-5%). Forest shrinks back to 40-50% of the total pollen sum. From 440 to 350 cm *Alnus* shows a rapid decrease from 70% towards values of 10%. This decrease is only of a short duration because at 300 cm depth, values of 50% are again reached. From 250 to 240 cm Cannabaceae, *Hornungia type*, *Polygonum persicaria*, *Polemonium* and Cerealia confirm the presence of human activity. Species like Poaceae, *Lotus* and *Polygonum aviculare* indicate that the area was covered with pastures during the time of infill. The pollen samples above 240 cm were all corroded and therefore not used during this research; this part of the core had an organic matter content of approximately 70%. Probably this corroded peat layer corresponds with the lowest part of core Casquettenhof 1. This will mean that this part of the channel (Casquettenhof 2) was closed off (probably due to a high sediment influx from the side) and the channel shifted towards the location of the Casquettenhof 1 core. After full abandonment, peat started to grow at both locations, but at the Casquettenhof 2, groundwater level decreased and the peat started to oxidize.

The Casquettenhof 2 core is correlated to the Subatlantic based on the presence of *Fagus*. Probably the diagram starts in the Iron Age, the decrease in vegetation cover is interpreted as the start of the Ancient Roman period following Teunissen (1990). 14C dating should conclude whether this correlation is correct.

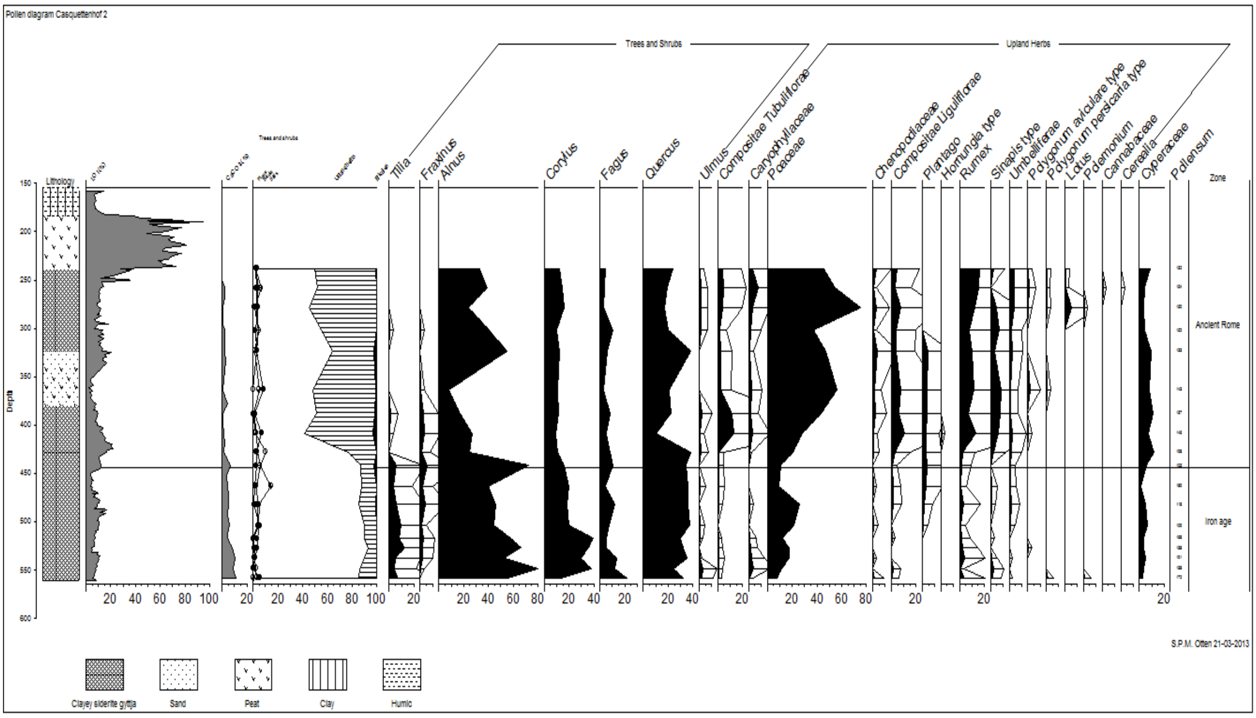

Figure 25. Pollen diagram Casquettenhof 2.

4.5 Pollen samples from other channels

Some of the selected residual channels visible on the digital elevation model did not meet the expectations for organic infill and/or were disturbed by anthropogenic changes, on these locations only a single pollen sample was taken at the base of the channel.

4.5.1 Pannenhof

Pannenhof (191306, 354696, 19.7) is a residual channel between Beegden and Heel, located at the west side of the present day Maas. The cross section of Pannenhof residual channel (figure 26) is based on four borings from east to west. These borings were all located on the west side of a present day gully, so only one site of the residual channel is shown. The borings had a maximum depth of 305 cm below surface level. All borings start with a humic loam layer of approximately 30 cm. This loam layer is overlying sandy clay with some loamy intervals; this layer varies in thickness from 20 cm in boring 52 to 200 cm in boring 36 and 35. Boring 52, 35 and 36 all end in a gravel layer. In boring 34 only 100 cm of this sandy clay is present, which is interrupted by a gyttja clay layer of 40 cm with plant remains. Below this, a 10 cm thick layer of sandy clay is present, underlain by a gyttja clay layer of 40 cm. This gyttja clay layer is interrupted by 10 cm thick humic, sandy clay with leave remains. At the base, a 50 cm thick clayey gyttja layer is present with a high percentage of plant remains.

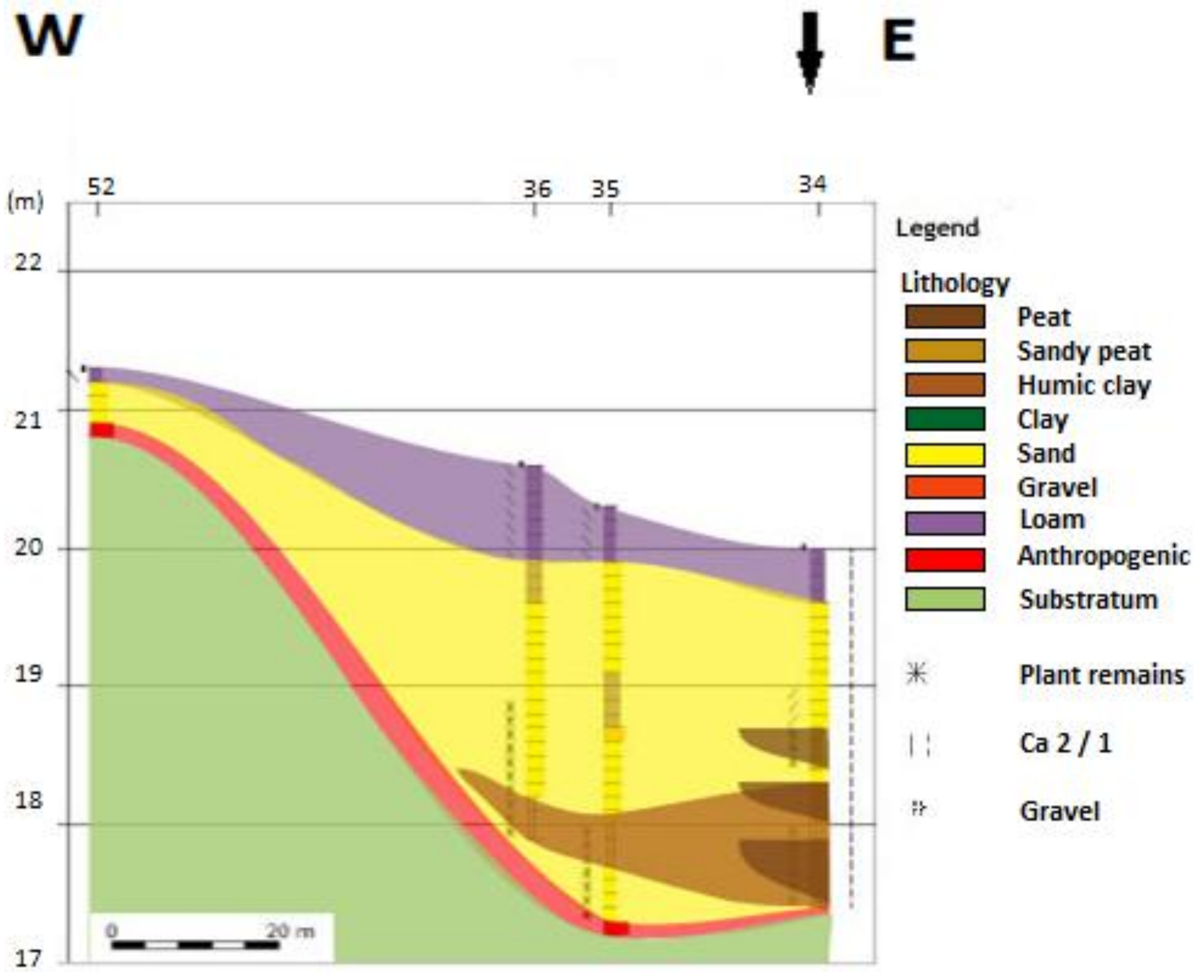

Figure 26. Cross section Pannenhof.

The pollen sample monster was taken from boring 34 at the base of the residual channel, 260 cm. From all the pollen that were present, trees and shrubs percentages were highest (50%). The remaining 50% contained 48% upland herbs and 3% Ericales. The presence of high percentages of *Alnus* (13%) and *Fagus* (11%) and the lack of *Tilia* places the sample in the Iron Age in the Subatlantic. pollen counts and percentages are presented in the Excel worksheet in appendix IV.

4.5.2 Schietclub Beegden

Schietclub Beegden (192443, 355455, 19.9) is a residual channel east of Beegden at the west side of the present day Maas. The cross section of the Schietclub Beegden palaeochannel (figure 27) is based on 5 borings from east to west. The borings had a maximum depth of 300 cm below surface level. The borings 37, 38 and 39 start with a clayey sand layer of approximately 100-150 cm thick. In boring 40 and 41 this clayey sand layer is overtopped with an anthropogenic layer with gravels and roots. Below the clayey sand layer, in boring 38, 39 and 40 a slightly humic clay layer is present of 150 cm thick, this represents the channel fill. In boring 38 this clay layer is underlain by a sandy layer before the base of the channel is reached, indicated by gravel. In boring 39 the clay layer directly lies on the gravel, while in boring 40 a thin loam separates the clay layer from the gravelly base. In boring 41 the clayey sand layer is overlying a gravelly layer of approximately 50 cm thick. Below this the thin loam layer is found in the boring before the base of the channel is reached, indicated by a gravel layer.

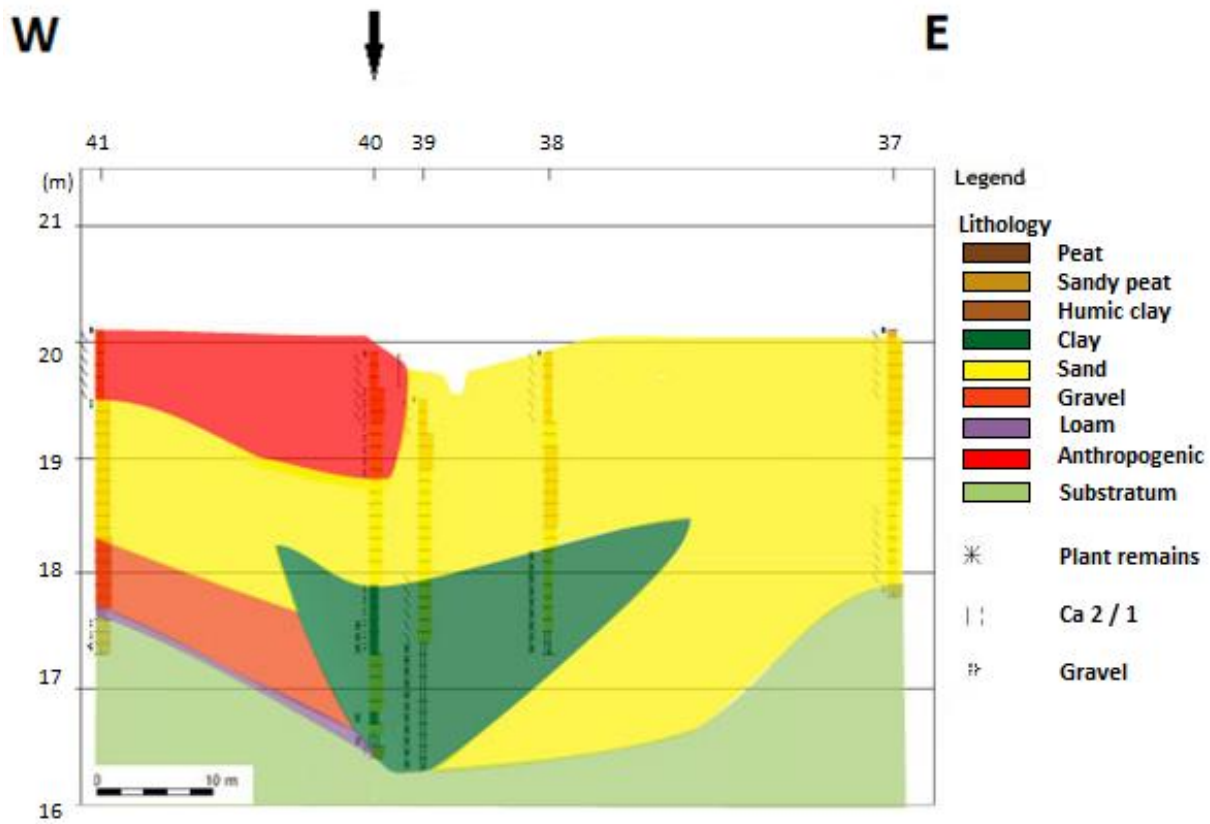

Figure 27. Cross section Schietclub Beegden.

Two pollen samples were taken from boring 40 at a depth of 320 cm (1) and 270 cm (2) below surface level. In pollen sample (1), trees and shrubs are dominant (58%), upland herbs (41%) and Ericales (1%) percentages are low. Especially *Alnus* (39%), *Quercus* (24%) and *Corylus* (13%) are dominant tree species. *Fagus* is already present (6.3%) and *Tilia* (4%), *Salix* (1.4%) and *Ulmus* (0.7%) percentages are very low. This seems to correspond with the Subboreal/Subatlantic. In pollen sample (2), trees and shrubs increased towards 77%, upland herbs decreased towards 23% and Ericales disappeared. *Alnus* percentages are very high (266% of the pollensum) together with *Corylus* (43%) and *Quercus* (21%). Aquatic species decreased rapidly, only some *Typha angustifolia* (7%) and *Potamogeton* (5%) are still present. Overall the infill shows a decreasing open water environment. The pollen percentages of both samples are interpreted as the Iron Age, somewhat older compared with the pollen sample from Pannenhof. The pollen counts and percentages are presented in the Excel worksheet in appendix IV.

4.5.3 Apenbroek

Apenbroek (189930, 358139, 31.5) is a palaeochannel upstream of Katerhof, between Baexem and Grathem, at the west side of the present day Maas. The cross section of Apenbroek (figure 28) is based on 6 borings from west to east. The borings had a maximum depth of 350 cm below surface level. All borings start with an anthropogenic layer with a depth of 20 to 75 cm. This layer is overlying a sandy layer of 225 cm thick. In boring 15, 16, 5 and 6 this sandy layer is interrupted by a small peat layer of 30 cm thick. Then the sandy layer overlies a thin loamy layer intercalated in the sand. In boring 18 the thick sandy layer is interrupted by a small gravel layer.

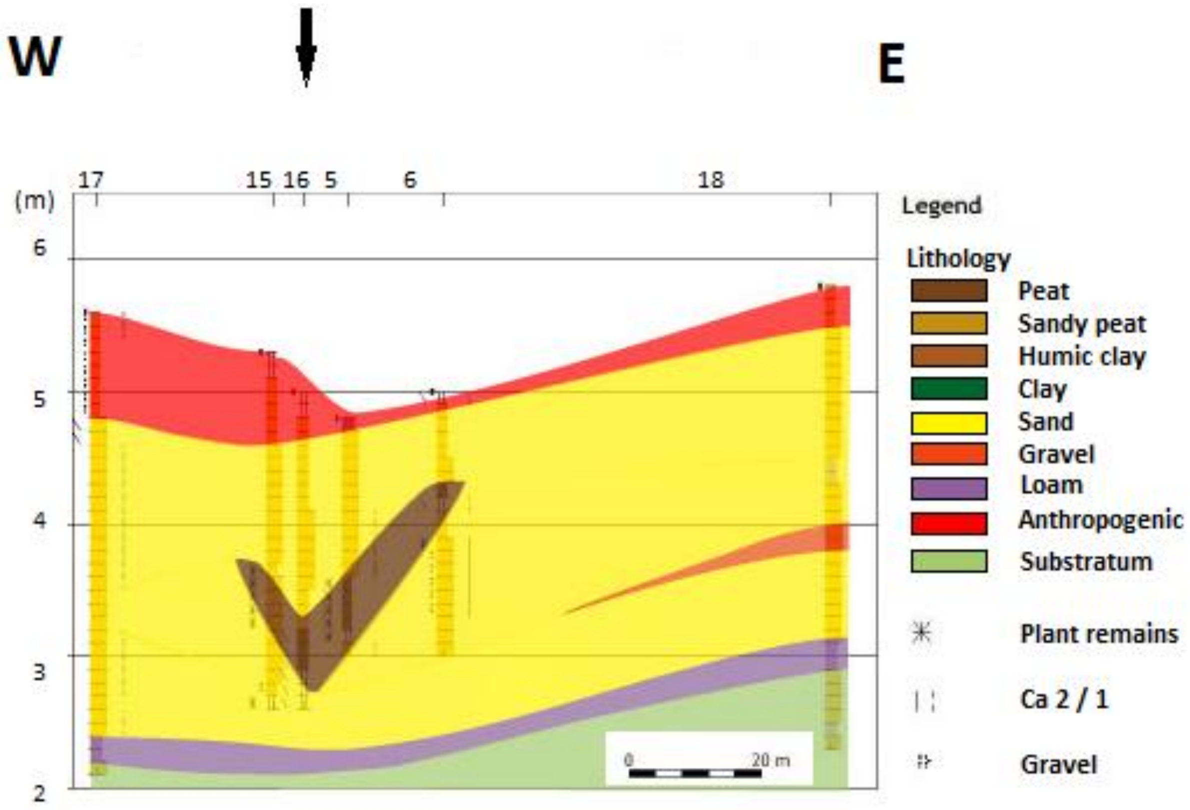

Figure 28. Cross section Apenbroek.

The pollen sample was taken from boring 6 at a depth of 200 cm below surface level. From all pollen that were present, tree and shrubs percentages were dominant (84%), upland herbs shown only a percentage of 12% and Ericales represent 4% of the pollen sum. Trees like *Alnus* show high values (24%) together with *Corylus* (26%) and *Betula* (32%). *Fraxinus* (0.6%), *Tilia* (3%), *Ulmus* (1%) and *Pinus* (2%) percentages are very low. *Fagus* pollen are still absent, this seems to correlate with the Late Atlantic. Pollen counts and percentages are presented in the Excel worksheet in appendix IV.

5. Synthesis

The pollen diagram Dukkelaar, which showed a Lateglacial or Early Holocene signal could be correlated with the well-dated regional zonation scheme for The Netherlands (Hoek, 1997a,b; Hoek, 2001), and for the Early Holocene with the PAZ defined by van Geel et al. (1980). Pollen diagrams from the Middle Holocene: Houterhof, Katerhof, Casquettenhof 1 and Casquettenhof 2 are correlated with the in paragraph 2.4 defined periods (Atlantic, Subboreal and Subatlantic) following ADC archeology and Teunissen, 1990).Biostratigraphic correlation and linkage to well dated pollen diagrams resulted in a tentative chronostatigraphic framework which is given in figure 29. Due to the lack of radiocarbon dates it is emphasized that no clear conclusions can be drawn from this tentative chronostratigraphy.

Zone 1 can be correlated with the Younger Dryas from 12.9-11.7 ka. Vegetation is still open during this cold period. The high percentages of Ericales, grass and herb pollen together with high values of *Pinus* and *Betula* are correlated with pollen zone 3b as defined by Hoek (1997a,b).

Zone 2 is considered to reflect the Preboreal of the Early Holocene, and the pollen biozones 4a, 4b, 4c and 5 as described by Hoek (1997a,b). The different subzones in zone 2 are marked with a dotted line in the used pollen diagrams. The lower contact of zone 2 is marked by an expansion of *Birch* (25%) and high values of *Pinus* (25%). This Early Holocene period is known as the Friesland phase (Van Geel et al., 1981; Hoek, 2001). A rapid increase in *Pinus* concentrations and the sudden decrease in *Betula* is considered to be equivalent to the Rammelbeek phase (Van Geel et al., 1981; Hoek, 2001). *Betula* percentages rise again in pollen biozone 4c. The last part of zone 2 is dominated by *Pinus* percentages which comprises the Pine phase, pollen zone 5, of the Late Preboreal.

Thermophilous tree species appear in the biostratigraphic record from zone 3 onwards, starting with the expansion of *Corylus*, *Quercus*, *Ulmus* and *Tillia*. This biozone correlates with the Boreal stage of the Early Holoceen, pollen zone 6 (Hoek, 1997a,b; Van Geel et al., 1980).

The Atlantic parts of the pollen diagrams are summarized in zone 4. The start of the Atlantic is characterized with the expansion of *Alnus*. During the Atlantic closed forests of different thermophilious trees are dominant. Upland herbs and Ericales are almost absent.

Towards the end of the Atlantic, upland herbs show a gradually increase and *Fagus* starts to occur. The presence of *Fagus* marks the start of the Subboreal, zone 5. The vegetation opened and upland herbs increased rapidly. *Tilia* and *Ulmus* decreased towards only a few percentages, because they were used as cattle feed during the winter (Gerrets, et al., 2011).

Zone 6 represents the Subatlantic which is divided into the Iron Age, Ancient Roman time and the Middle Ages. During the Iron Age forests expanded again, dominated by *Alnus* and *Quercus*. Indicators for human activity like Plantago started to occur (Behre, 1981). During the Ancient Roman time Cerealia started to occur together with other weeds like Rumex, *Artemisia*, *Sinapis type*, Compositae, Plantago and Fabaceae. The transition between the Ancient Roman perriod and the Early Middle Ages (Dark Ages) is marked by an increase in forests and a rapid rise in *Alnus*, *Betula* and *Salix*. During this transition *Carpinus* started to occur in the research area. The Middle Ages itself are characterized by the occurrence of *Centaurea cyanus*, a species that only grows nearby fields and pastures.

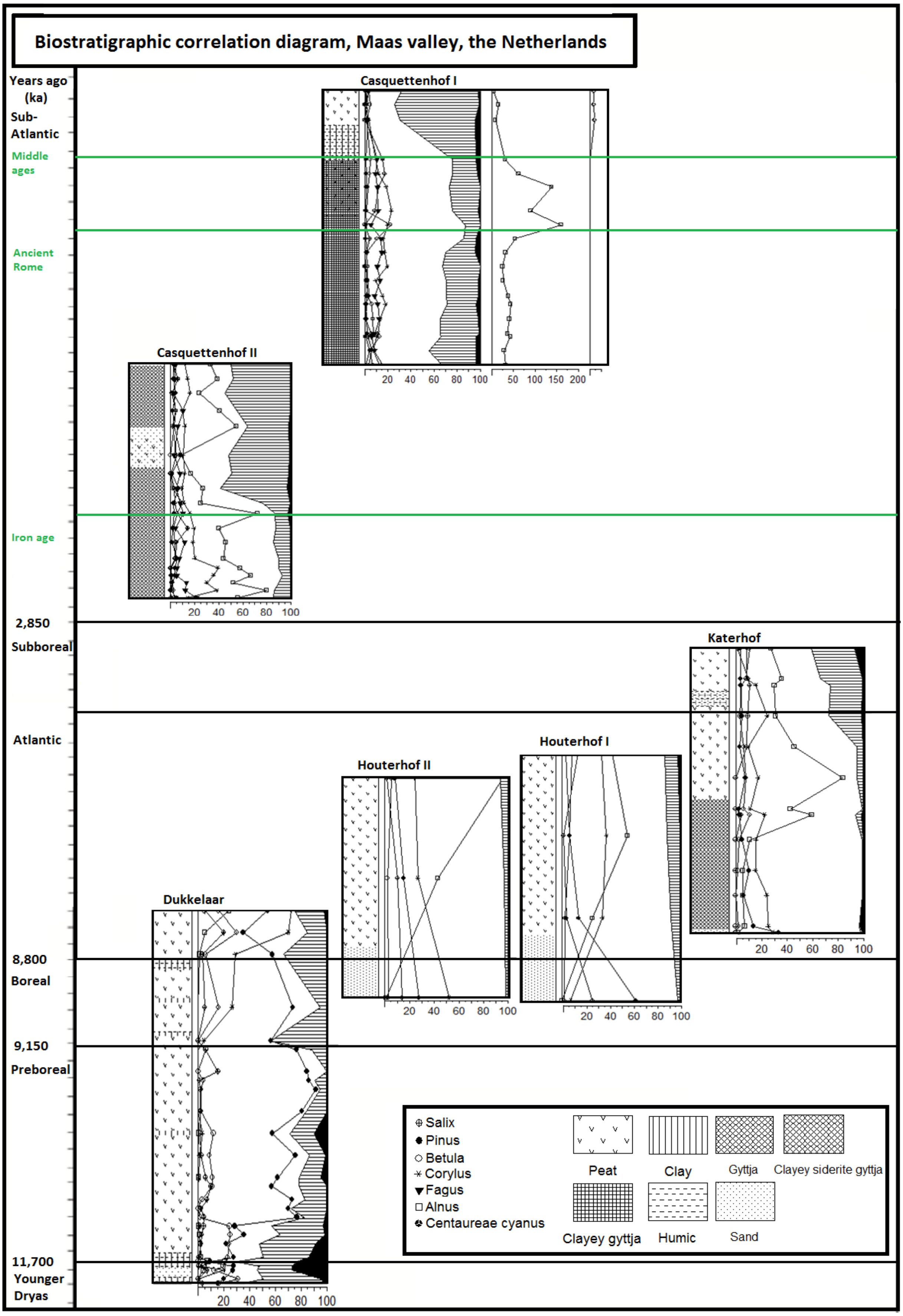

Figure 29. Tentative chronostratigraphy of the Lateglacial and Holocene pollen diagrams from the Maas valley in the Netherlands that were constructed in this study.

5.1 Terrace stratigraphy through time

In this chapter an attempt is made to reconstruct the terrace stratigraphy of the area between Born and Venlo based on the existing and newly obtained data. Besides the new data from the present study, two students from the 'Vrije Universiteit Amsterdam' did perform a pollen analysis on four palaeochannels in the research area; the exact locations are shown on the digital elevation map below (figure 30). The palaeochannel Boukoul is indicated with an H, this pollen diagram showed an infill from the Younger Dryas towards the Late Boreal. The palaeochannel indicated with an I is Hout Baarlo, which shows a Younger Dryas to Atlanticum infill, this pollen diagram seems to be somewhat younger compared with Boukoul. Another palaeochannel (J) is Buggenum, this palaeochannel started to fill in during the Iron Age. Palaeochannel K, Asselt, is due to the presence of Centaurea cyanus correlated with the Late Middle Ages. The palaeochannel that is indicated with an L is called 'de Weerd in Reuver', in this pollen diagram *Fagopyrum* is present, an indicator for the Late Middle ages. Pollen diagrams from palaeochannels in this region like Korbusch (M), Kingbeekdal (N) and Haelen (O) all show an infill from the Younger Dryas towards the Atlantic. In the figure below all the dated palaeochannels are shown, the colours indicate the start of the infill. All the pollen diagrams are presented in attachment IV.

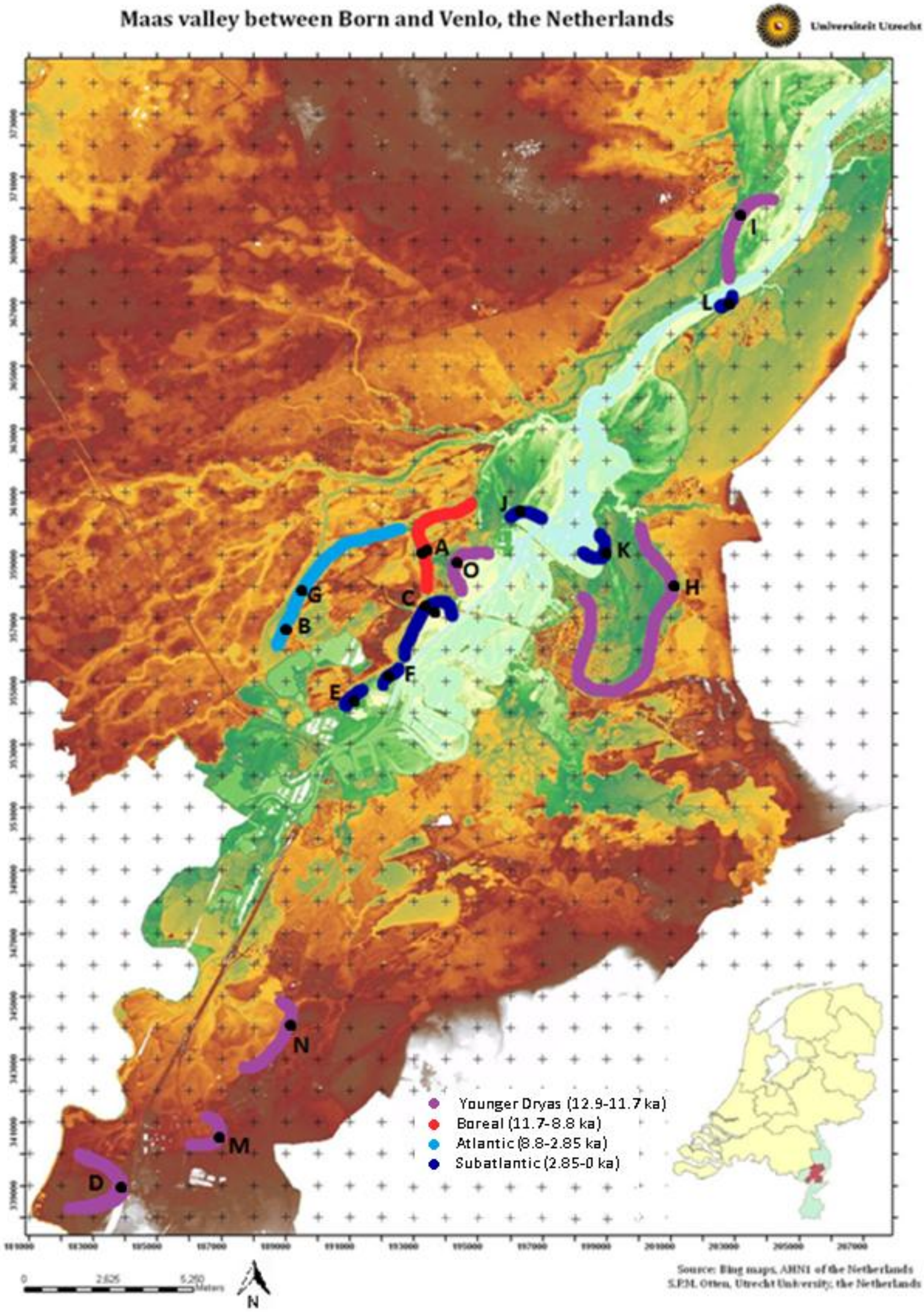

Figure 30. Locations of the used pollen diagrams. The start of infill is indicated with colors; purple indicates Younger Dryas, red indicates Boreal, light blue indicates Atlantic and dark blue indicates Subatlantic.

5.2 Local vegetation development and hydrology

In this paragraph the local vegetation development and hydrology of the four different sites from this study are discussed and compared with other vegetation reconstructions from the research region (figure 30).

5.2.1 Dukkelaar

Zone 1 can be correlated with the Younger Dryas from 12.9-11.7 ka. Vegetation is still open during this cold period. The high percentages of Ericales together with high values in *Pinus* and *Betula* are probably related with pollen zone 3b. The high percentages of aquatic species and algues like *Potamogeton, Nymphaea* and Zygnematacae indicate open water. The sedimentation changed from humic sand towards a clay layer, which probably can be related with a decrease in river activity. At the end of the Younger Dryas humic sands were deposited again. The presence of humic sand may origin from small vegetated sand bars which eroded and were deposited downstream. The presence of species that are usually not present in this period like *Alnus*, *Corylus*, *Quercus* and *Acer campestre* is caused by erosion from elsewhere in the Maas catchment. In particularly the palaeochannels Korbusch (M) and Kingbeekdal (N) this fluvial in-wash occurred. These palaeochannels were probably used during high discharges of the Maas only.

Zone 2 can be related to the Preboreal in which *Betula* values slowly increase and *Pinus* percentages remain low. The high percentages of aquatic species like *Nymphaea*, *Myriophyllum verticillatum* and *Pediastrum* indicate a situation of open water. The lithology changes gradually from humic sand towards clayey peat. The presence of *Alnus*, *Corylus* and *Quercus* can be explained by fluvial in-wash. The pollen diagram of Korbusch shows the same dominant *Pinus* values. The dotted line indicates the end of the Friesland phase, a period of higher temperatures compared with the Younger Dryas. In this diagram the Rammelbeek phase is not recognizable. The Rammelbeek phase is well visible in the pollen diagrams of Korbusch and Kingbeekdal, this was probably a local drought. The sudden rise of the *Pinus* is interpreted as the start of the Late Preboreal. Due to the dominant *Pinus* values (75% of the total pollen sum) the increasing percentages of upland herbs are not clearly visible from the pollen diagram. In this latest phase of the Preboreal, aquatic species first increase and then soon decrease. This is possible the result of deeper water, so the aquatics move towards the channel borders, in this short period the peat becomes more clastic. This small increase is followed by a decrease of aquatics and is also shown in the pollen diagram Korbusch. The pollen diagram of Kingbeekdal does not show these changes.

In zone 3 (Boreal), thermophilous tree species start to occur, first *Corylus* and followed by *Quercus* and *Ulmus*. The same pattern is visible in the Kingbeekdal, in Korbusch *Corylus* start to occur together with *Quercus* and *Fraxinus.* Aquatics like *Filipendula* and *Nymphaea* show an increase in percentages which indicate an open water situation. The lithology shows some thin clay layers which interrupt the clayey peat deposition, these are probably caused by small floodings. The pollen monsters from the Preboreal-Boreal transition are oxidized and poorly preserved, indicating periods of low groundwater level.

In zone 4 *Alnus* expanded rapidly together with *Corylus*, *Quercus*, *Ulmus* and *Tilia*. *Acer campestre* pollen started to occur, but the percentages are still very low. The total pollen sum remains low and aquatic species almost disappear, only some wetland taxa; Equisetum and *Typha angustifolia*, remained. During this period peat was again deposited in some thin, more clayey intervals. The depositional trend of thermophilous trees is also visible in the pollen diagram of Kingbeekdal.

Other palaeochannels of which the infill started during the Younger Dryas are Haelen (O), Boukoul (H) and Hout Baarlo (I). In the paleaochannel Haelen *Pinus* does not dominate the pollen diagram, while *Betula* does. During the Younger Dryas, Poaceae values are high followed by an expansion of *Betula* and *Populus* in the Friesland Phase. The Rammelbeek Phase is reflected in the high Poaceae percentages and a decrease in *Betula*. The Late Preboreal is characterized by an increase in Betula and *Populus*, followed by an increase in *Pinus* and *Humulus lupulus*. At the end of the Preboreal,

values of pine are slightly higher than the birch percentages. The start of the Boreal is characterized by the immigration of *Corylus* later followed by *Quercus* and *Ulmus*.
On the eastern site of the present day Maas, palaeochannel Boukoul is located. During the Younger Dryas the pollen diagram shows high percentages of *Salix*, *Pinus* and *Empetrum*. Vegetation is still open and different upland herbs dominate the landscape. During the Preboreal *Betula* increased while pine trees decreased. Upland herbs started to decrease, at the end of the Preboreal *Pinus* peaks while *Betula* decreases. The start of the Boreal is indicated by *Corylus*, followed by *Quercus* and *Ulmus*. Further in the Boreal *Pinus* remains present in relative high percentages.
More upstream of Roermond the palaeochannel Hout, Baarlo is located in the Maas valley. This pollen diagram starts during the Younger Dryas. Small percentages of *Juniperus*, *Salix*, *Rosaceae spec.*, *Helianthemum* and *Hedera helix* are present. *Betula* dominates over *Pinus*. During the Friesland Phase in the Preboreal *Betula* increased and *Pinus* percentages remained at the same level, wetland herbs and aquatics increased. In the Rammelbeek Phase, Poaceae percentages raised and forest decrease suddenly. During the Late Preboreal first *Betula* shows high percentages, followed by high values of *Pinus*. Upland herbs, wetland herbs and aquatics decreased. In the Boreal *Pinus* slowly decreased and *Corylus*, *Quercus* and *Ulmus* started to occur. Forest dominated the landscape in which *Salix* also show high percentages. During the Atlantic thermophilous trees like *Tilia*, *Salix*, *Corylus*, *Quercus* and *Alnus* start to dominate the forests, Upland herbs and Poaceae remain low.

In these pollen diagrams the vegetation succession is more clear due to the absence of the high *Pinus* percentages which were present in the Dukkelaar pollen diagram. In all the diagrams expect for Dukkelaar and Boukoul the different phases of the Preboreal are clearly recognizable. In the pollen diagrams of Dukkelaar and Boukoul, the Rammelbeek phase is not recognizable.

5.2.2 Houterhof

At the Houterhof site, the palaeochannel started to fill in during the Late Boreal, zone 3 in the synthesis figure. The pollen sample near the base is from a humic, sandy layer deposited during the Late Boreal. The vegetation consists of thermophilous trees like *Corylus, Quercus, Tilia* and *Ulmus*. *Potamogeton, Nymphaea* and *Myrophyllum* are present in low percentages which indicate an open water environment.
During the Atlantic, zone 4, the percentages of thermophilous trees further increased and also *Alnus* and *Fraxinus* are present. Forest seems to become more open and *Calluna* and upland herbs increase. *Potamogeton* is still present, other water species vanished. During the Atlantic highly organic peat was deposited which was oxidized the first 8 centimetres from the top of the core.

The palaeochannels Haelen (O) is located nearby the Houterhof site. The pollen diagram of this location covers a period from the Younger Dryas towards the Boreal. During the Boreal, *Pinus* values are 10% higher compared with *Betula* percentages. *Corylus, Ulmus* and *Quercus* start to appear in small percentages and woodlands started to develop with hazel, oak, elm and pine. During the Boreal peat was deposited (Bos et al., 2007). This sequence is comparable with the pollen diagrams of Houterhof.

5.2.3 Katerhof

The infill of the palaeochannel Katerhof started during the Atlantic, zone 4. *Pinus* values decreased during the Atlantic, *Salix* and *Betula* values remained very low. The base of the lithology is sandy, from which no pollen samples have been taken. During the Atlantic the lithology changes from sand towards sandy gyttja and, somewhat later, towards peat with plant remains. Especially in the earlier part of the Atlantic, forests of *Tilia, Ulmus, Corylus* and *Quercus* were dominant. Somewhat later in the Atlantic *Alnus* increased rapidly from 10% towards percentages of 45%. Percentages of upland herbs and Ericales are negligible. *Nymphaea* is present during the Early Atlantic.
During the Subboreal, zone 5, Fagus started to occur and upland herbs like Compositae, *Artemisia*, Rumex, *Lythrum* and *Rhamnus frangula* started to increase. *Tilia* and *Ulmus* almost disappeared

while *Fraxinus* increased. Aquatic conditions switched towards the presence of *Potamogeton* and *Typha angustifolia* with the lithological change from sandy gyttja towards peat. This indicates a change from stagnant water to flowing anoxic conditions.

The palaeochannel Apenbroek is located in the same gully as Katerhof. Tree pollen from *Alnus, Corylus, Betula, Fraxinus, Tilia, Ulmus* and *Pinus* dominate this pollen quick scan. The presence of *Alnus* and the absence of *Fagus* indicates that the material from which this sample has been taken is deposited during the Late Atlantic. The sandy layer at the base of the channel is probably the base of the channel, the thin loamy layer on top indicates a phase in which fluvial activity decreased.
Palaeochannels nearby the Katerhof and Apenbroek palaeochannel are all older. This channel has probably been reactivated during a flooding event of the Maas river or might have been used by the nearby stream 'Haelensche beek'.

5.2.4 Casquettenhof

The infill of the palaeochannel Casquettenhof started in the Subboreal, zone 5. The Subboreal is sub-divided into the Iron Age, Ancient Romand period, Middle Ages and New Age. During the Iron Age gyttja was deposited with a carbonate content of 10%. Forest were still dominant containing *Tilia, Fraxinus, Alnus, Corylus, Fagus, Quercu*s and *Ulmus*. Upland herbs like *Artemisia*, Compositae, Caryophyllaceae, Poaceae, Rumex and *Sinapis type* were only present in low percentages. During the Iron Age aquatic species like *Potamogeton, Callitriche* and *Nymphaea* were present indicating open water conditions, while wetland taxa like *Filipendula* and *Typha angustifolia* were also present.
During the Ancient Roman period upland herbs increased rapidly, species like; Plantago, Poaceae, *Trigolium*, Umbelliferae, Ranunculus, *Viscum, Lotus* and *Polemonium* indicate a grassland situation. The presence of Cannabaceae and Cerealia shows that human activity already occurred. Trees percentages decreased and *Tilia* and *Fraxinus* totally disappeared, *Alnus* and *Quercus* dominated. The presence of *Menyanthes trifoliata* shows the infill of the palaeochannel and the change towards more shallow water conditions. The disappearance of the aquatics indicates that the environment became drier. Wetland taxa were still present, so the moisture content was still high.
At the transition between the Ancient Roman time and the Middle Ages, a very high *Alnus* peak is visible while other tree species show a decrease. At this transition zone the gyttja becames more organic and the calcium content suddenly increased. At the beginning of the transition first *Betula* show high percentages followed by an increase in Salix percentages. Cerealia, Plantago and other upland herbs decreased, probably due to a decrease in human activity.
From the transition towards the Middle Ages, forest decreased and upland herbs increased rapidly. In the Middle Ages especially peat could be deposited, with one humic clayey interval of 50 centimetres. During the Middle Ages all thermophilous trees decreased towards percentages of 5-10%. Upland herbs that grow especially on tilled soil increased rapidly. This was probably the result of an increased agricultural activity. Aquatics like *Nymphaea, Lemna* and *Menyanthes trifoliata* are still present indicating shallow water conditions. Wetland taxa like *Filipendula, Typha angustifolia, Equisetum, Lythrum* and *Iris pseudacorus* increased, so soil conditions were still moist.

The palaeochannels with the same age as Casquettenhof are; Schietclub (E), Pannenhof (F), Buggenum (J), Asselt (K) and 'de Weerd, Reuver' (L). Schietclub and Pannenhof are two locations where pollen quick scans of two different palaeochannels downstream of Casquettenhof were obtained.

The residual channels Schietclub and Pannenhof are investigated previously by RAAP (Heunks, 2000). In the figure below different archaeological sites are shown. On these sites different traces of the Iron Age are found.

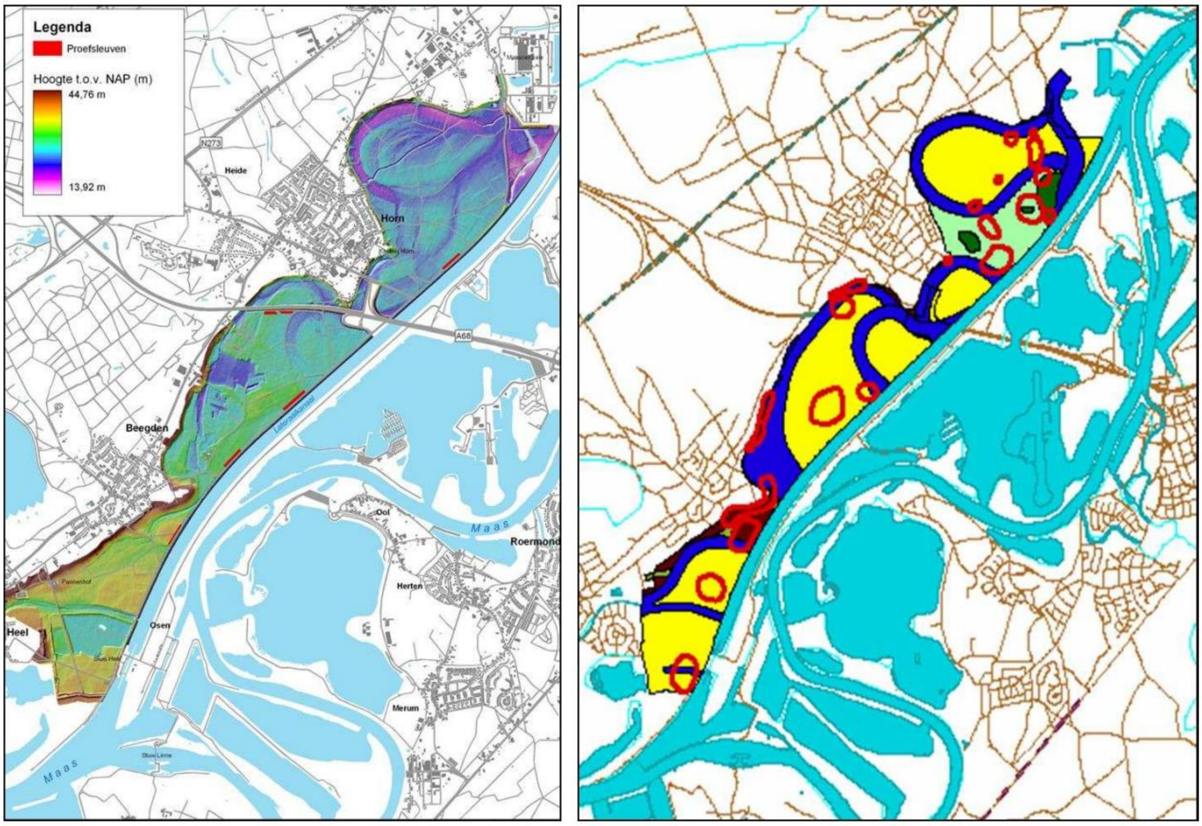

Figure 31. Geomorphology, channels and archaeological sites in Lateraalkanaal West (Heunks, 2000).

During the Bronze Age the Maas migrated towards the West which formed the terrace edge of Heel, Beegden and Horn. During the Iron Age het Maas shifted his river course back towards the East which preserved this part of the floodplain. No archaeological finds are known from the Roman Times and the Middle Ages, probably this area was uninhabitable due to the high flood risk. Overbank material was deposited on the floodplain and filled in the residual channels (Heunks, 2000). The pollen quick scans of Schietclub and Pannenhof indicate that the infill of both channels started during the Iron Age, which supports the outcome of above research.

The infill of the palaeochannels Buggenum, Asselt and de Weerd, Reuver occurred during the Subatlantic. These palaeochannels are all located upstream of Casquettenhof in the straight and narrow Holocene floodplain. Residual channel Buggenum started to fill in during the Iron Age indicated by the presence of *Carpinus* and *Fagus*. At the transition towards the Ancient Roman period, forests decreased rapidly and Cereals and agricultural weeds increased. The infill of palaeochannel Asselt started in the Late Middle Ages, which can be concluded based on the presence of *Centaureas Cyanus* and *Juglans*. In the pollen spectrum of residual channel de Weerd, Reuver, *Fagopyrum* is already present, an indicator for the Late Middle ages.
Other palaeochannels nearby like Houterhof, Katerhof and Haelen all show an earlier time of infill than Casquettenhof. This was expected because these locations are further away from the present day Maas and positioned on a somewhat higher level.

5.3 Discussion: differences with previous studies

The results from this study shows some differences with previous studies on terrace stratigraphy, climate, and vegetation changes. During the period of interest, the river Maas predominantly incised, in combination with climate changes and the subsequent changes in river pattern, this resulted in the formation of a series of terraces (Berendsen et al., 1995; Kasse et al., 2007; Van den Berg, 1996; Van den Broek and Maarleveld, 1963). Individual age determinations of these terraces come from studies of terrace deposits between Venlo and Nijmegen. On the highest elevations in this area the Overloon

terrace is located, a terrace that was formed during the Late Pleniglacial. In the research area, upstream of Venlo, two palaeochannels; Katerhof and Houterhof were selected because their location in this Late Pleniglacial terrace. The outcome of the pollen diagrams is, however, much younger than expected.
These same results were found in palaeochannel Dukkelaar, this infill started during the Younger Dryas according to the visible pollen zones in the pollen diagram. Before the sampling of the core, Dukkelaar was interpreted as an Allerød meander due to the location in the Maas valley and the peaty lithology of the channel fill. The age of Casquettenhof was expected to be older and about the same as for palaeochannel Haelen. The differences in age were very large; Haelen was correlated with the Younger Dryas while the infill of Casquettenhof started only during the Iron Age in the Subatlantic.

These deviations between expectations and results can be explained by local differences between the research areas and the areas downstream of Venlo which are given below with some explanations.

- In the research area some palaeochannels correspond with a Late Younger Dryas age. These were probably abandoned by a chute cutoff. This indicates that the river pattern in the research area might nog have changed towards a braided pattern. This is probably caused by the nearby higher elevations, so the river did not have enough space to develop a full braided pattern. This is further indicated by the pollen results from the palaeochannels Dukkelaar, Kingbeekdal, Korbusch, Boukoul and Hout, Baarlo. None of the investigated residual channels in the research area showed an infill older than the Younger Dryas. As these were all interpreted as Allerød meanders, this part of the Maas probably also had a meandering river pattern during the Younger Dryas. Other rivers like the Mark river in the Netherlands and the Warta river in Poland also showed a meandering pattern during the Younger Dryas (Vandenberghe et al., 1984, 1987).
- Katerhof looked like a braided river system within the Late Pleniglacial terrace, while the infill can be dated to Atlantic and Subboreal. This may have been caused by the re-use of the channel when the river Maas incised and earlier deposits might have been flushed out. The same explanation can be given for the palaeochannels Houterhof and Casquettenhof. Beside the river Maas, this could be done by the Haelensche Beek which flows through a part of the palaeochannels Katerhof and Houterhof or by the Maas.

The research area is located in the transition zone between the gravel Maas system upstream of Susteren and the sandy Maas system downstream of Venlo. Probably the Maas upstream of Born could only have a meandering pattern because of the high elevations next to the river Maas and the limited space for the river to shift. Downstream of Venlo the Maas could easily adjust its pattern to the climate changes because the floodplain was very wide. In this area these adjustments were probably better preserved because the Maas valley was broad and could easily incise. During the Holocene the floodplain that was used was relatively narrow and straight edged (Huisink, 1997). In the research area this floodplain is probably used since the Younger Dryas, which may have caused the disappearance of older infill. Another reason may be the different tectonic faults that cross the research area, these probably play a major role in the development of river patterns and the deposition of sediments.

In the research area, the vegetation development through the different geological periods seems to correlate with the vegetation sequence upstream of Venlo. Only the Pinus dominated pollen diagrams found in palaeochannel ‘Dukkelaar’ cannot be distinguished further upstream. Because these pine trees grew on higher elevations, high percentages are found nearby. That explains why Pinus is dominant in the Dukkelaar pollen diagram and not anymore downstream.

6. Conclusions

Based on the present study, the following research questions could be answered:

Are Lateglacial and Early Holocene residual channel fills of the Maas between Susteren and Venlo comparable with respect to architecture, timing, and lithology to those further downstream and how can differences be explained?

Residual channel fills of the Maas between Susteren and Venlo are very different from palaeochannels downstream. Overall the channel pattern and the time of infill of the channel do not correlate with palaeochannels downstream, while the lithology and the vegetation development does correlate with the time of infill. Spatial differences in channel pattern are likely to have been caused by differences in the local conditions like; tectonic faults, transition zone between the gravel Maas and the sandy Maas and differences in elevation. The answer of the major research question is further explained by the answers to the following sub-questions.

What are the differences in infill between the investigated residual channels between Susteren and Venlo? How can we explain these differences in lithology and timing?

The pollen diagrams of the investigated channels; Dukkelaar, Houterhof, Katerhof and Casquettenhof, do not correlate in time and appear to contain a different time interval. Overall the investigated channel show a delay in infill, the infills are all younger than expected. 14C dating should confirm whether the correlations made in the pollen diagrams are correct.

The differences in lithology and timing of the fills in this region can be explained by the geographical location with respect to the present day Maas and the tectonic faults that are present. The palaeochannels Katerhof and Houterhof are probably re-used by the Maas or the Haelensche Beek, which removed older deposits. Casquettenhof is located nearby the present day course of the Maas river, probably this investigated residual channel is used till the Roman Ages. During the Medieval the Maas river shifted more to the East. Dukkelaar was abandoned during the Younger Dryas, so the Maas shifted during the Younger Dryas towards the East.

Can we correlate the terrace stratigraphy between Susteren and Venlo with earlier published stratigraphic, past climate and vegetation changes? When they don't seem to correlate, how can we explain the deviation?

In the research area the terrace stratigraphy does not correlate with the found infill in the residual channels. Earlier published terrace stratigraphies of the area upstream of Venlo show that the pollen diagrams correlate with the terraces. This deviation can be explained by local differences, like the tectonic faults that crosses the research area, these probably play a major role in the development of river patterns and the deposition of sediments. Furthermore, the research area is located in the transition zone between the gravel Maas system upstream of Susteren and the sandy Maas system downstream of Venlo. Upstream of Susteren the Maas river could only have a meandering pattern because of the high elevations on the sites of the Maas and the limited space for the river to shift. Downstream of Venlo the Maas could easily adjust his pattern to the climate changes because the floodplain was very wide. This transition from a meandering pattern upstream of Susteren to a braided pattern downstream of Venlo probably needed some time to develop. This was probably facilitated by the nearby higher elevations, so the river had simply not enough space to develop a full braided pattern. Further research between Susteren and Venlo should resolve these problems.

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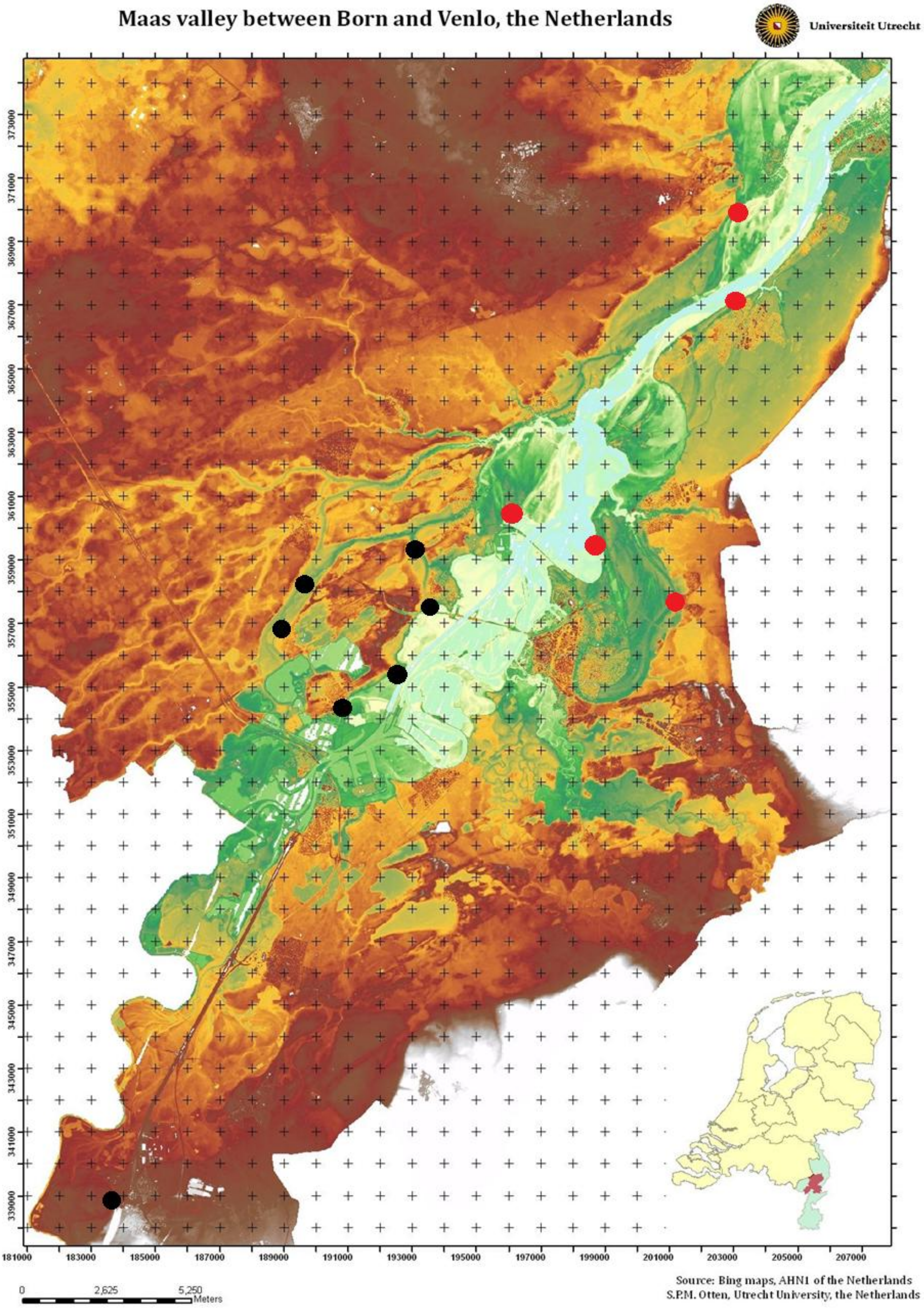
Appendix I. Research area and boring locations

Black dots indicate the research and boring locations of this research. Red dots indicate the research locations of the VU Amsterdam.



Appendix II. Bore hole descriptions

Boorstaten Dukkelaar
Boorstaten Houterhof
Boorstaten Katerhof
Boorstaten Casquettenhof
Boorstaten Pannenhof
Boorstaten Schietclub Beegden
Boorstaten Apenbroek

Legend bore hole descriptions

Structuur:

Ks1	Klei, zwak siltig
Ks2	Klei, matig siltig
Ks3	Klei, sterk siltig
Ks4	Klei, uiterst siltig
Kzx	Klei, zandig
Lz1	Leem, zwak zandig
Lz3	Leem, sterk zandig
Zs1	Zand, zwak siltig
Zs2	Zand, matig siltig
Zs3	Zand, sterk siltig
Zs4	Zand, uiterst siltig
Zkx	Zand, kleiig
Gs	Grind, siltig
Gz1	Grind, zwak zandig
Gz2	Grind, matig zandig
Gz3	Grind, sterk zandig
Gz4	Grind, uiterst zandig
g1	zwak grindig (<5%)
g2	matig grindig (<15%)
g3	sterk grindig (<30%)
Vm	Veen, mineraalarm
Vk1	Veen, zwak kleiig
Vk2	Veen, sterk kleiig
Vk3	Klei, venig
Vz1	Veen, zwak zandig
Vz2	Veen, sterk zandig
h1	zwak humeus
h2	matig humeus
h3	sterk humeus

Plantenresten:

R	Riet
H	Hout
W	Wortels
Z	Zegge
Sph	Sphagnum

Boundaries:

\1	sharp (<5mm)
\2	abrupt (5-25mm)
\3	clear (25-60mm)
\4	gradual (60-130mm)
\5	diffuse (>130mm)
EB	Einde Boring

Kolom (lithology)

Klei
Leem
Zand
Grind
Gyttja
Veen

Roundness:

a1	very angular
a2	angular
a3	subangular
a4	subrounded
a5	rounded
a6	well rounded

Sorting:

VWS	very well sorted
WS	well sorted
MS	moderately sorted
PS	poorly sorted
VPS	very poorly sorted

CaCO3:

1	niet carbonaathoudend
2	zwak carbonaathoudend
3	zsterk carbonaathoudend

Interpretatie

CL	Channel lag
AL	Active layer
PB	Pointbar
FP	Floodplain
CFl	Channel fill lacustrine
Cfo	Channel fill organic
CFc	Channel fill clastic
GA	Gradual abandonment
XX	verstoord

Dukkelaar

From West to East:

Datum:	28-9-2012	Naam:	Suzan	Opnamenummer	051

Coord.:	(x) unknown	(y) unknown	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z) 31.2	m +NAP	**GWS:** niet gezien	bosje	point bar	Dukkelaar

Opmerkingen: aan de rand van het bosje en de maisakker

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
35	/3	Zs1		w ‖	105-150	ws					10yr 6/3		O	1			
60	/4	Zk		w ‖							10yr 6/3		O	1	ijzerconcretie		
120	/4	Zk		w ‖							10yr 6/6		O	1			
140	/4	Zs2			105-150	ws		3%		2cm	10yr 6/2		O	1	grindlaagje van 120-130		
190	/3	Zs1			420-600	ms					10yr 6/2		O	1			
210	/3	Zk		plr.	75-105	ws					10yr 6/4		O	1	leemlaagje Lz3 203-205		
250	/4	Zs1			210-300	ws					10yr 5/3		O	1			
300	/2	Zs1			300-420	ms					10yr 4/4		O	1	vanaf 2.70m kiezelbijmeniging van 1,5cm		
310	/2	Lz3									10yr 4/6		O	1			
375	/3	Zs1			300-420	ws					10yr 6/2		O	1	vanaf 2.65 grinderige bijmenging		
405		Zs1			420-600	ps		10%		2,5cm	10yr 4/2		OR	1			
4.05m einde boring, grind gevoeld niet opgeboord.																	

Datum:	28-9-2012	Naam:	Suzan	Opnamenummer	050

Coord.:	(x) 183583	(y) 338649	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z) 30.5	m +NAP	GWS: 2.70m	Bosje	Restgeul?	Dukkelaar

Opmerkingen: epe is 31 meter.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
10	/4	Kz2	h3	w ‖							10yr 3/2		O	1			
12	/4	Kz3		w ‖							10yr 6/4		O	1			
85	/3	Ks3	h3	w ‖							10yr 2/2		O	2			
100	/4	Kz1	h3	w ‖							10yr 2/2		O	2			
150	/2	Ks2	h3	w ‖							10yr 2/2		O	3			
185	/3	Kz2									10yr 5/3		O	3			
200	/2	Kz3		plr							10yr 5/1		O	3+	ijzerconcreties		
230	/3	Zs1			420-600	ps					10yr 4/3		O	3	met lemige brokjes		
253	/2	Zs1			420-600	ps					10yr 5/2		O	3			
270		Lz3						1%		2mm	N 5/1		OR	3			
2.70 einde boring, grind gevoeld niet opgeboord.																	

Datum: 20/5/2012 **Naam:** Janssens **Opnamenummer** BM-030

Coord.:	(x) 183609	(y) 338648	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**
Hoogte:	(z)	~31 m +NAP	**GWS:**	bosje	restgeul/pointbar??	Dukkelaar, Julianakanaal, Born

Opmerkingen: geheel klastisch, maar erg kleiig. Te kleiig voor pointbar. Toch nog wat boringen erbij? Alle boringen in dit profiel gemarkeerd. LOCATIE: bij boomstam

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
25	2	Vm									1,7/1	brok	O	1			
78	3	Zk3	1		75-105						5Y 4/4	los	O	2	opgebracht? Denk het niet		
95	3	Kzx									7/8-7/1	brok	OR	1	Fe-vl+		
120	3	Ks4									5/3	brok	OR	1	Fe-vl		
135	3	Kzx									5/3	los	OR	2	Fe-vl-		
143	3	Zs1			210-300	ps	a3				5/3	m.vast	OR	2	Fe-vl-		
183	3	Ks4									5/3	m.vast	OR	2	heel licht zandig / Fe-vl / Mn-C		
233	3	Kzx									5/3	m.vast	OR	3	zandlaagje op 210		
235	3	Zs1			420-600	ps	a3				4/4	m.vast	OR	3			
250	3	Kz1									4/3	m.vast	OR	3	fijngrindig zandje		
262	3	Zg3			600-850	vps	a5	40	0,5cm	1cm	4/4	m.vast	OR	3			
270	3	Ks3									1,7/1	slap	R	3	sulfides		
305	3	Zs1/Ks4			105-150			1		0,5cm	2/1		R	3	afwisseling zand/klei 50%-50%		
338	3	Zs2			150-300						3/1		R	3			
370	EB	Ks2									3/1		R	3	met zandlensjes		
EB ivm grindigheid (grindige klei)																	

Datum: 24/5/2012 **Naam:** Janssens/deWit **Opnamenummer** BM-042

Coord.:	(x) 183621	(y) 338639	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**
Hoogte:	(z)	~31 m +NAP	**GWS:**	bos	restgeul	Dukkerlaar, Julianakanaal, Born

Opmerkingen: restgeulpovulling ondieper dan in boring BM-041

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
90	4	Vm		w							1,7/1	brok	O	1	veraard / grote houtwortels		cfo
140	3	Vm		w,r,z-							1,7/1	brok	O	1	5cm Vk1 op 100cm-mv		cfo
172	3	Vm		r,z							1,7/1	m.vast	R	1			cfo
185	3	Vk1		r,z							2/1	m.vast	R	1			cfo
212	3	Vm		r,z-							1,7/1	m.vast	R	1			cfo
228	3	Vm		r,z							1,7/1	m.vast	R	1	plr hor.		cfo
240	2	Ks2	h2	plr							3/1	m.vast	R	1	zandlam./ zandlaagje 235-237 (150-210)		cfc
254	3	Kz1	h1	plr							5/2	m.vast	R	1			cfc
261	2	Zk1		plr-	210-420	ps	a3	1		0,3mm	4/1	m.vast	R	2			ga
275	EB	Kz2		plr-							5/1	m.vast	R	2			ga
EB ivm		Grind niet opgeboord															bed

Datum:	20/5/2012	Naam:	Janssens	Opnamenummer	BM-028

Coord.:	(x) 183635	(y) 338634	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	~31 m +NAP	GWS: 140	bosjes	restgeul	Dukkelaar, Julianakanaal, Born

Opmerkingen: Zeer geschikt voor analyse. Boring BM-041 is nog dieper.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
100	4	Vm									1,7/1	brok	O	1	veraard		cfo
130	3	Vm									1,7/1	brok	OR	2-			cfo
150	3	Vm		z							1,7/1	m.slap	R	1			cfo
190	2	Vm		r							1,7/1	m.slap	R	1			cfo
193	3	Vk2		z							3/1	m.slap	R	1			cfo
210	3	Vm		z							1,7/1	m.slap	R	1			cfo
240	3	Vk1									3/1	m.slap	R	1			cfo
258	4	Vk3									2/1	m.slap	R	1			cfo
272	3	Zk1	h3		300-420	ms	a3				2/1	m.slap	R	1			ga
297	4	Ks2	h3	plr (z,r)							2/1	m.slap	R	1			ga
310	3	Kzx	h3								4/1	m.slap	R	1			ga
320	2	Zkx	h3		300-420			1		1cm	1,7/1	m.slap	R	1			ga
335	EB	Gz	h3					60	1cm	2cm	1,7/1		R	1			bed

Datum:	24/5/2012	Naam:	Janssens/de Wit	Opnamenummer	BM-041

Coord.:	(x) 183643	(y) 338627	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	~31 m +NAP	GWS:	bos	restgeul	Dukkelaar, Julianakanaal, Born

Opmerkingen: Diepste punt van de geul. Kern geprobeerd te steken met brede guts, niet gelukt (gescheurd in lengterichting). --> Piston corer nodig. OVERIG: boring geprobeerd in pointbar op akker te zetten, maar grind direct aan het oppervlak. Boren niet mogelijk.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
120	4	Vm		w							1,7/1	brok	O	1	veraard veen. Kiezel op 1,85 (D:4cm)		cfo
183	2	Vm		z-							2/3	m.vast	R	1			cfo
205	3	Ks2	h2	plr+ (z-)							4/2	m.vast	R	1	afwisseling klei/veen		cfc
230	4	Vm		w, z-							3/3	m.vast	R	1			cfo
243	4	Vm		w, r							2/2	m.vast	R	1			cfo
275	3	Vm		w, z-							2/2	m.vast	R	1			cfo
312	3	Vm		w, r, z-							2/2	m.vast	R	1	houtwortels / kleilaag 1cm op 2,80		cfo
325	4	Ks2	h3	z-							3/1	m.vast	R	1			cfc
335	1	Ks2	h2	plr=							4/1	m.vast	R	1	gelamineerd / plr horziontaal (lacustrien)		cfc
338	2	Zs2	h0		150-210	ms	a3				4/1	m.vast	R	1			ga
339	2	Ks2	h1	plr--							3/1	m.vast	R	1			ga
340	EB	Gz3			210-300	ps	a4	50		0,5cm	10Y 5/1		R	1	iets kleiig		bed

Datum: 20/5/2012		Naam: Janssens		Opnamenummer	BM-029
Coord.: (x) 183653 (y) 338621	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:	
Hoogte: (z) ~31 m +NAP	GWS:	bosje	restgeul	Dukkelaar, Julianakanaal, Born	

Opmerkingen:

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
40	1	Vm									1,7/1	brok	O	1	veraard		cfo
50	2	GY									7/2	m.slap	O	3	sideriet / Fe-vl-		cfo
70	2	Vm		h,w							1,7/1	m.slap	R	1	Bosveen		cfo
124	1	Vk1									4/1	m.slap	R	1			cfo
135	1	houtwortel									8/6	m.slap	R	1			cfo
166	2	Vk1+		z,w							4/1	slap	R	1	zandlaagje, grindje 0,5 cm		cfo
185	3	Ks4		plr-							5Y 5/1	slap	R	1			cfc
220	3	Ks3		plr-							5Y 5/1	slap	R	2			cfc
230	3	Ks4+		plr							5Y 5/1	slap	R	2	fijnzandige bijmening		cfc
254	1	Kz1						1		0,3cm	5Y 5/1	slap	R	2	grindjes: 0,5 %		cfc
255	EB	Zs1			150-210			1		0,5cm	5Y 5/1	comp	R	2			bed
EB ivm grindjes																	

Houterhof

From west to east.

Datum: 20-9-2012		Naam: Suzan		Opnamenummer	021
Coord.: (x) 193090 (y) 359335	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:	
Hoogte: (z) 23,2 m +NAP	GWS: 2.40	Elsenbroek	Restgeul	Houterhof	

Opmerkingen: epe is 10meter. Vanaf het padje meteen de eerste boring ter hoogte van de els (na de eik).

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
5	/3	Zs1	h3	w ǁ	105-150	ms					10yr 2/3	brok	O	1			
10	/2	Zs1	h1	w	75-105	ps	a4				10yr 3/4	poeder	O	1	lemige brokjes		
25	/3	Zs1		w	150-210	ps	a4				10yr 4/4	poeder	O	1			
40	/4	Zs1		w	105-150	ms	a4				7.5yr 4/4	poeder	O	1	ijzerinspoeling, uitgedroogde leembrokjes		
55	/3	Zs1			150-210	ms	a4				10yr 4/4	poeder	O	1	lemige brokjes		
63	/2	Zs1			75-105	ws					10yr 5/3	poeder	O	1	lemige brokjes		
109	/4	Zs1	h1		75-105	ws					10yr 5/2	poeder	O	2	lemige brokjes		
130	/4	Zs1			75-105	ws					10yr 5/2		O	3	lemige brokjes		
160	/4	Zs1			75-105	ms					2,5y 5/2		O	1	veel lemige brokjes		
220	/3	Zs1			210-300	ws					2,5y 5/2		OR	1			
235	/3	Zs2			150-210	ws					2,5y 5/1		OR	2			
270	/3	Lz3		w, plr.							2,5y 4/1		OR v	2			
280	/3	Zs4			150-210	ms					5y 4/1		R	3			
295	/2	Lz3		w, plr.							5y 4/1		R	3	humeuze vlekjes		
310		Zs1			105-150	ws					5y 4/1		R	3			
3.10meter einde boring, zand gevoeld niet opgeboord.																	

Datum:	20-9-2012	Naam:	Suzan	Opnamenummer	022

Coord.:	(x) 193115	(y) 359322	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	21,9 m +NAP	GWS: 2.00m	elzenbroek	restgeul	Houterhof

Opmerkingen: epe is 16meter. Na 1e omgevallen boom op het padje, staat een tak in het boorgat.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
10	/3	Vk1	h3	w ‖							10yr 2/1		O	1	veraard		
17	/4	Zs1			75-105	ms					10yr 5/4		O	1			
40	/3	Zs1			105-150	ms					10yr 4/6		O	1	ijzervlekken, veel lemige brokjes (Lz3)		
90	/3	Lz3									10yr 4/4		O	1	bijmenging van Zs1 (105-150 ws)		
102	/2	Zs1			420-600	ps	a3				7.5yr 4/4		O	1	baksteen??		
110	/3	Vm		w++							7.5yr 4/3		OR	1	geheel doorworteld.		
165	/1	Vm									7.5yr 2/3		R	1			
210	/3	Zs1			105-150	ws					10yr 5/2		R	1			
250	/4	Zs1			300-420	ws	a3				10yr 4/1		R	1			
265	/4	Lz3		plr ++, w							10yr 4/1		R	1			
273		Zs1			420-600	ms	a4				10yr 4/1		R	1			
2.73meter einde boring, grof zand gevoeld niet opgeboord.																	

Datum:	21-9-2012	Naam:	Suzan en Wim	Opnamenummer	027

Coord.:	(x) nb	(y) nb	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	m +NAP	GWS: 1.50m	Elzenbroek	Restgeul	Houterhof

Opmerkingen: Snelle quickscan tussen boring 022 en 023.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
130	/3	Zs1	w ‖								oranje		O	1	puinige opvulling		
150	/2	Vm	w ‖								bruin		O	1	mosveen en zeggeveen		
200	/3	Vm									bruin naar grijsbrui		OR	1	potamageton zaadjes		
240	/2	Zs2			150-210	ws					grijs		R	1			
245		Zs1			300-420	ms					grijs		R	1			
2.45m einde boring zand gevoeld niet opgeboord																	

Datum:	20-9-2012	**Naam:**	Suzan	**Opnamenummer**	023

Coord.:	(x) 193130	(y) 359335	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**
Hoogte:	(z)	21,6 m +NAP	**GWS:** 1.60m	Elsenbroek	Restgeul	Houterhof

Opmerkingen: epe is 9meter. Bij omgevallen berk met elvenbankjes, boorgat bevat een tak.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
9	/4	Vk1	h3	w ǁ, plr++							10yr 3/1		O	1			
18	/3	Zs1	h1	w ǁ	75-105	ws					10yr 5/3		O	1	lemige brokjes		
110	/4	Zs1			105-150	ws					10yr 5/4		O	1	lemige brokjes		
135	/3	Lz2									10yr 5/6		O	1			
145	/2	Lz3									10yr 4/3		OR	1			
155	/3	Vm		w++							10yr 3/3		OR	1	geheel doorworteld (monster)		
214	/1	Vm		w ǁ							10yr 1.7/1		R	1	monster		
230	/4	Zs2	h3		75-105	ms					10yr 2/1		R	1			
270	/3	Zs1		Plr.	105-150	ws					10yr 4/1		R	1			
280		Zs1			210-300	ps					2,5y 3/1		R	1	lemige brokjes		
2.80meter einde boring, grof zand gevoeld niet opgeboord.																	

Datum:	20-9-2012	**Naam:**	Suzan	**Opnamenummer**	024

Coord.:	(x) 193140	(y) 359348	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**
Hoogte:	(z)	22,5 m +NAP	**GWS:** 2.30m	elsenbroek	restgeul	Houterhof

Opmerkingen: epe is 14meter. Boringen op een rij: afstand tussen 1e en 2e boring is 24meter, afstand 2e en 3e boring is 20.8meter, afstand 3e en 4e boring is 17.6meter.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
3	/2	Vk1		plr., w ǁ							10yr 3/1		O	1			
10	/3	Zs1			75-105	ws					10yr 4/3		O	1	lemige brokjes		
78	/4	Zs1			105-150	ms	a4				10yr 6/4		O	1	ijzervlekken en lemige brokjes		
103	/4	Zs1	h1	w ǁ	75-105	ws					10yr 4/2		O	1	lemige brokjes		
130	/3	Zs2			75-105	ws					10yr 5/3		O	1	ijzervlekken		
170	/4	Kz1						1%		2,5cm	10yr 5/1		O	2	ijzervlekken		
210	/2	Zk		plr., w ǁ	150-210	ms	a4				10yr 5/1		OR	2			
230	/2	Zs1			300-420	ms	a4				10yr 5/1		OR	2	humeuze vlekjes, lemige brokjes		
265	/3	Zs2		w++, plr.	850-1000	vps	a4	25%		2mm	2,5y 4/1		R	1	lemige, humeuze brokjes (monster)		
280	/2	Zs1			600-850	vps	a4	10%		3mm	2.5y 5/1		R	1			
300		Zs1			600-850	vps	a4	5%		2mm	2,5y 4/1		R	1			
3.00meter einde boring, grof zand gevoeld niet opgeboord.																	

Katerhof

From West to east.

Datum:	24-9-2012		**Naam:**	Suzan + Kees			**Opnamenummer**	033
Coord.:	(x) 188600	(y) 357131	**Bodem:**		**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**	
Hoogte:	(z) 27,2 m +NAP		**GWS:**	4.00m	Bos	Uit de restgeul	Verlengde Katerhof	

Opmerkingen: epe is 17meter. Deze boring is in het bos en ongeveer 2 meter hoger dan boring 032.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
5	/3	Zs1	h3	w ‖	105-150	ws					10yr 3/2		O	1			
8	/3	Zs1			105-150	ws					10yr 5/2		O	1			
20	/4	Zs1			75-105	ws					10yr 5/3		O	1			
50	/3	Zs1			75-105	ws					10yr 6/3		O	1			
110	/3	Zs1			75-105	ws		2%		2cm	10yr 7/4		O	1	op 70cm 2 grindjes. Beuningen grindlaag?		aeolisch?
140	/2	Zs1			75-105	ws		1%		2mm	10yr 8/2		O	1			
170	/3	Zs2			105-150	ws					10yr 7/6		O	1	roestvlekken		
185	/4	Zs1			75-105	ws					10yr 7/3		O	1			
230	/4	Zs2			105-150	ws		1%		1cm	10yr 7/6		O	1	naar onder toe 10yr 6/6. op 2.30m grindje.		
260	/4	Zs3		w	75-105	ws					10yr 6/3		O	1	lemige bandjes		fluvial aeoli
280	/3	Lz3		w, plr.							10yr 6/2		OR	1	sterk gevlekt.		
340	/4	Zs2			105-150	ws					10yr 6/6		OR	1			
355	/4	Lz3									10yr 6/6		OR	1			
400		Zs3			105-150	ws					10yr 6/6		OR	1			
4.00m einde boring Zs1 gevoeld niet opgeboord.																	

Datum:	24-9-2012		**Naam:**	Suzan en Kees			**Opnamenummer**	032
Coord.:	(x) 188619	(y) 357101	**Bodem:**		**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**	
Hoogte:	(z) 25,2 m +NAP		**GWS:**	1.40m	Lege akker	Uit restgeul	Verlengde Katerhof	

Opmerkingen: epe is 8meter. Tussen bosrand en hekje in.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
28	/4	Zs2	h2	w ‖	105-150	ws					10yr 4/2		O	1			
72	/3	Zs4	h2	w ‖	105-150	ws					10yr 3/2		O	1			
100	/4	Zs2	(h1)		105-150	ws					10yr 5/2		O	1	vlekkerig, humeus en ijzervlekken		
130	/3	Zs3	h1		105-150	ms					10yr 3/3		O	1	humeus laagje op 1.10m		
170	/3	Zs2			150-210	ws					2.5y 6/2		OR	1	ijzervlekjes. Afwisseling meer zand of meer s		
180	/3	Zs2		hout, plr.	150-210	ws					2.5y 6/2		OR	1	samengedreven of doorgroeid??		
185	/2	Lz3									5y 5/1		R	1			
205	/3	Zs1			210-300	ms					2.5y 6/2		R	1			
220	/2	Lz3									2.5y 6/2		R	1			
250	/4	Lz3									5GY 5/1		R	1			
265	/4	Zs2			105-150	ws					5GY 5/1		R	1			
300	/2	Lz3									5GY 5/1		R	1	met zandige laagjes.		
340		Zs1			105-150	ws					10yr 6/2		R	1			
3.40m einde boring zand gevoeld niet opgeboord.																	

Datum:	24-9-2012		**Naam:**	Suzan en Kees			**Opnamenummer**	031
Coord.:	(x) 188675	(y) 357064	**Bodem:**		**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**	
Hoogte:	(z) 25 m +NAP		**GWS:**	1.10m	Weiland	Restgeul	Verlengde Katerhof	

Opmerkingen: epe is 9meter. Deze boring is geplaatst aan de rand van het bosje (de hoek).

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
30	/3	Zs2	h2	w ‖, plr.	105-150	ws					10yr 4/2		O	1			
50	/3	Zs3			105-150	ws					10yr 5/3		O	1			
90	/3	Zs4			105-150	ws					10yr 5/8		O	1			
120	/4	Kz3									10yr 5/2		OR	1	roestvlekken		
135	/3	Lz2		plr.							2.5y 5/2		OR	1			
160	/2	Zs1			300-420	ps		5%		tot 1cm	2.5y 6/2		R	1	houtbrokjes		~holoceen beekdal
170		Zs1			105-150	ws					2.5y 5/3		R	1			
tot 2.00meter geboord in hard zand maar niet opgeboord.																	

Datum:	24-9-2012		**Naam:**	Suzan en Kees			**Opnamenummer**	029
Coord.:	(x) 188735	(y) 357030	**Bodem:**		**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**	
Hoogte:	(z) 24,2 m +NAP		**GWS:**	1.40m	Weiland	Restgeul	Verlengde Katerhof	

Opmerkingen: epe is 4meter. Deze boring vond plaats in het midden van het Koeienveld op het diepste stuk.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
20	/4	Lz3	h3	w ‖							10yr 3/2		O	1			beekdal/beekleem
43	/2	Zs4	h2		75-105	ws					10yr 3/3		O	1			beekzanden tot 2.65m
60	/2	Zs1		brokjes hout	210-300	ws					10yr 5/2		O	1	houtresten (los), humeuze stukjes		
80	/3	Lz3	h2								10yr 4/2		O	1	met zandige laagjes/zandnestjes (105-150 w		
130	/3	Zs1	h1	verspoeld hout, plr.	150-210	ws					10yr 5/2		OR	1	ijzervlekjes verspoeld hout, humeuze vlekjes		
140	/2	Zs1	h3	plr. ++	105-150	ws					10yr 2/1		OR	1	detrituslaagje		
195	/3	Zs1	h1		150-210	ms					10yr 4/1		R	1	houtige brokjes (enkel)		
230	/3	Zs1	h1		210-300	ms					10yr 4/1		R	1	houtige brokjes (enkel)		
265	/2	Zs1	h1		420-600	ms					10yr 6/2		R	1			~onderkant geul
280		Zs2			105-150	ws					10yr 5/1		R	1			
2.80m einde boring 2.80-3.40m zand gevoeld maar niet opgeboord.																	

Datum: 24-9-2012 **Naam:** Suzan en Kees **Opnamenummer** 030

Coord.: (x) 188759	(y) 357019	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**
Hoogte: (z) 24,5 m +NAP		**GWS:** 1.40	Weiland	Restgeul	Verlengde Katerhof

Opmerkingen: epe is 4meter. Deze boring was meer richting de boomgaard op.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
29	/3	Zs1	h2	w ‖	105-150	ws					10yr 4/2		O	1			
50	/4	Zs4			105-150	ws					10yr 5/2		O	1	ijzervlekken		
60	/3	Zs4			105-150	ws					5yr 4/4		O	1	ijzervlekken ++		
80	/4	Zs2			150-210	ws					10yr 5/2		O	1			
126	/2	Lz3	h3	w ‖, hout							10yr 3/1		OR	1			
150	/3	Zs2	h1	hout w?	210-300	ps		1%		1cm	10yr 5/2		OR	1	hout		
165	/2	Zs1	h2	hout	210-300	ps		5%		2cm	10yr 4/1		OR	1	hout, heel hard en zwart -> eik? Grind gevoe		
173	/3	Zs2			150-210	ms		1%		0,5cm	10y 6/1 (groenig gri		R	1			
182	/3	Lz1									10y 6/1		R	1	naar beneden toe meer zandig		
230	/2	Zs2			150-210	ws					10y 6/1		R	1	met lemige bandjes		
243	/3	Lz1									10y 6/1		R	1	bovenste stukje klein beetje organisch -> mo		
255		Zs2			150-210	ws					10y 6/1		R	1			
2.55m einde boring zand gevoeld niet opgeboord.																	

Datum: 24-9-2012 **Naam:** Suzan en Kees **Opnamenummer** 028

Coord.: (x) 188891	(y) 357000	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**
Hoogte: (z) 25,7 m +NAP		**GWS:** 2.80m	Boomgaard	Restgeul/eiland ertussen in	Verlengde Katerhof

Opmerkingen: epe is 7meter. Boring gedaan aan einde van de laan richting het koeienveld. Publicatie lezen van Schwan & van der Berg (of andersom) over Panheel.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
5	/3	Zs1	h1	w ‖	105-150	ws					10yr 4/1	poeder	O	2			
30	/4	Zs2	h1	w	150-210	ws		1%		2mm	10yr 4/2	poeder	O	2			
50	/3	Zs2			105-150	ms	a2	2%		tot 8mm	10yr 5/4		O	2	onderkant 2cm bijmenging grind		~onderkant geul?
80	/3	Zs1			105-150	ws					10yr 6/3		O	1	lemige brokjes		
90	/4	Zs1			150-210	ws					10yr 6/4		O	1	ijzervlekken		
105	/4	Zs1			105-150	ws					10yr 6/3		O	1			
110	/3	Zs1			210-300	ms					10yr 6/4		O	1			
130	/2	Zs1			210-300	ms		1%		1cm	10yr 5/6		O	1			~onderkant geul?
144	/4	Zs3			105-150	ws					10yr 5/6		O	1			
162	/2	Lz3		w							2.5y 6/1		O	1			
170	/3	Zs1			210-300	ps	a4	15%		1.5cm	10yr 5/4		O	1	Van der hame/berg artikel.		Beuningen grindlaag?
180	/3	Zs4			105-150	ws					10yr 7/3		OR	1			
300		Zs2			105-150	ms					10yr 6/2		OR	2			
3.00m einde boring zand gevoeld, niet opgeboord.																	

Datum:	19-9-2012	Naam:		Opnamenummer	020
Coord.: (x) 188871 (y) 356993	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:	
Hoogte: (z) 25,3 m +NAP	GWS: 2.10m	boomgaard	restgeul	Verlengde van Katerhof	

Opmerkingen: epe is 6meter. 1e rij vanaf sloot na open veld rechts.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
15	/3	Zs1	h1	w ǁ	105-150	ps					10yr 4/2	poeder	O	1			
90	/2	Zs1		w	75-105	ms					10yr 5/3	poeder	O	1			
110	/3	Zs1			150-210	vps	a4	15%		4mm	10yr 5/6		O	1			
126	/4	Zs1			105-150	ws					10yr 5/3		O	2			
147	/2	Zs1			150-210	ws					10yr 4/3		O	1	ijzervlekken		
173	/2	Lz2									10yr 5/1		O	2	ijzervlekken		
190	/4	Zs1			150-210	ws					10yr 6/3		OR	1			
220	/2	Zs1			105-150	ms	a3				10yr 6/3		OR	2			
240	/1	Lz2									10yr 5/1		OR	1			
245		Zs2			105-150	ws					7.5y 5/1		OR	1			
2.45meter einde boring zand gevoeld maar niet opgeboord.																	

Datum:	19-9-2012	Naam:	Suzan	Opnamenummer	019
Coord.: (x) 188907 (y) 356947	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:	
Hoogte: (z) 25,7 m +NAP	GWS: 2.30m	boomgaard	restgeul	Verlengde van Katerhof	

Opmerkingen: epe is 5meter. 3e bomenrij rechts van de driesprong waar de auto stond.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
10	/3	Zs1	h1	w ǁ	105-150	ws					10yr 6/2		O	1			
45	/4	Zs1			150-210	ws	a4				10yr 7/4		O	1			
100	/3	Zs1			105-150	ws					10yr 5/4		O	1	vlekkerig		
115	/4	Zs4			75-105	ws					10yr 5/4		O	1	ijzervlekken		
143	/2	Lz3									10yr 6/1		O	1	ijzervlekken		
155	/3	Zs1			150-210	ws					10yr 5/6		O	1	ijzervlekken		
175	/2	Zs2			105-150	ws					10yr 5/3		O	1			
190	/4	Zs4			105-150	ws					10yr 5/3		OR	2			
215	/3	Zs2			150-210	ws					10yr 5/4		OR	1	met lemige laagjes		
316	/2	Zs1			210-300	ws					10yr 4/4		OR	2	ijzervlekken		
337	/2	Lz2									10yr 5/4		OR	1	ijzervlekken		
347		Zs2			150-210	ws					10yr 4/1		OR	2	ijzervlekken		
3.47meter einde boring zand gevoeld, niet opgeboord.																	

Datum:	18-9-2012	**Naam:**	Suzan en Wim	**Opnamenummer**	012
Coord.: (x) 190261 (y) 360158	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**	
Hoogte: (z) m +NAP	**GWS:** 1.20m	akker rand	restgeul	Katerhof	

Opmerkingen: epe is 9meter. Achteraan het pad ter hoogte van de paardenweide. Monster genomen.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
8	/3	Zs1	h1	w ǁ	105-150	ws					10yr 4/3	brok	O	1			
34	/2	Zs3			75-105	ws					10yr 6/6		O	1	vlekkerig		
36	/3	Vz2		w							10yr 3/2		O	1	vlekkerig, veraard --> veel meer dan hierond		
76	/1	Vz2		w+							10yr 3/1		O	1	veraard, monster genomen.		
170	/3	Zs1			150-210	ws					10yr 5/1		OR	1			
183	/4	Zs4			150-210	ws					N 6/1		R	2			
195	/3	Zs2			105-150	ws					N 6/1		R	2			
205	/4	Zs4			105-150	ws					N 6/1		R	1			
216	/3	Lz3									N 6/1		R	1			
225	/3	Zs4		plr.	105-150						N 6/1		R	1			
230		Zs1		plr.	105-150						2.5y 5/2		R	1			
2.30meter einde boring vanwege zand en grondwater.																	

Datum:	17-9-2012	**Naam:**	Suzan en Marlies	**Opnamenummer**	010
Coord.: (x) 188935 (y) 356946	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**	
Hoogte: (z) m +NAP	**GWS:** 0.90 meter	weiland	restgeul	Katerhof	

Opmerkingen: epe is 4meter. Aan de andere kant van de afscheiding richting de beek. Monster --> zaadje

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
10	/3	Zs1	h2	w ǁ	150-210	ms					10yr 3/2	brok	O	1			
45	/3	Zs1	h1	w ǁ	105-150	ws					10yr 4/4	brok	O	1			
72	/3	Zs2		w	150-210	ws					10yr 5/4		OR	1			
90	/2	Zs1		w-	105-150	ws					2.5y 5/2		OR	1			
110	/2	Vz1			75-105	ws					10yr 1.7/1		OR	1			
125	/4	Zs1	h1	plr	150-210	ws					10yr 4/1		OR	1			
165	/2	Zs1	h3	plr	105-150	ws					10yr 4/1		OR	2	laatste 5cm Zs1		
190	/3	Vm		plr							10yr 1.7/1		OR	1	veraard		
195	/3	Gy									10yr 1.7/1		R	1			
230	/4	Vm		plr							2.5y 3/2		R	1	monster --> zaadje		
260	/3	Gy									10yr 1.7/1		R	2	zandig		
325		Zs1			150-210	ws					2.5y 5/1		R	1	gelaagd met Zk1 of Zs2		
3.25 einde boring, zand gevoeld niet opgeboord.																	

Datum:	21-9-2012	Naam:	Suzan en Wim	Opnamenummer	026

Coord.:	(x) 188939	(y) 356939	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	25,5 m +NAP	GWS: 1.20m	Weiland	Restgeul	Katerhof

Opmerkingen: epe is 5meter.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
25	/3	Zs1	h1	w ‖	105-150	ws					10yr 3/3		O	1			
45	/3	Zs1	h1		105-150	ws					10yr 4/2		O	1			
92	/2	Zs2			105-150	ws					10yr 5/2		O	1			
100	/2	Vk1									10yr 2/2		O	1			
115	/2	Vz3									7.5yr 3/2		OR	1			
125	/3	Vz1									7.5yr 3/1		R	1			
210	/3	Vz1									7.5yr 3/2		R	1			
255	/2	Vz1									7.5yr 3/1		R	1			
260		Zs4	h1								10yr 4/1		R	1			
2.60m einde boring zand gevoeld niet opgeboord																	

Datum:	17-9-2012	Naam:	Suzan en Marlies	Opnamenummer	009

Coord.:	(x) 188945	(y) 356941	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	m +NAP	GWS: 1.10meter	Weiland	restgeul	Katerhof

Opmerkingen: epe is 5meter. De boring vond plaats ter hoogte van 1paaltje vanaf de sloot en het 2e paaltje vanaf de hekscheiding. Deze man is altijd op vrijdag en maandag aanwezig (dus dan het liefste boren) liefst even bellen vooraf: 06-12239471 zodat d

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
25	/3	Zs1	h1	w ‖	105-150	ws					10yr 4/2	brok	O	1			
50	/3	Zs2			75-105	ps					10yr 5/4		O	2			
66	/2	Zs1			105-150	ws					10yr 5/3		O	1			
100	/3	Vz1									10yr 3/1		O	1			
113	/2	Zs1	h2		150-210	ws					2.5y 5/1		OR	2	gelaagd		
127	/4	Vm		bladresten, plr.							10yr 1.7/1		R	1			
185	/3	Gy		w							10yr 1.7/1		R	1			
215	/3	Zs1	h2		210-300	ws					10yr 3/3		R	2			
230		Gy			210-300	ws					10yr 2/2		R	2	verstoord in de boor: GY en Zs1 in de boor.		
2.30meter einde boring, zand gevoeld maar niet opgeboord.																	

Datum:	21-9-2012	Naam:	Suzan en Wim	Opnamenummer	025

Coord.:	(x) 188963	(y) 356926	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	25,9 m +NAP	GWS: 3.00m	Weiland	Restgeul rand	Katerhof

Opmerkingen: epe is 9meter. 6e paaltje vanaf de sloot in het verlengde van vorige boring.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
20	/4	Zs1	h1	w ‖	105-150	ws					10yr 4/2	brok	O	1			
44	/4	Zs1	h1	w	75-105	ws					10yr 4/3		O	1			
65	/3	Zs1		w	105-150	ms		1%		2mm	10yr 5/3		O	1			
84	/3	Zs2			150-210	ws					10yr 5/4		O	1	ijzervlekken		
110	/2	Zs2			150-210	ws					10yr 5/8		O	1	ijzervlekken ++		
140	/2	Zs4			75-105	ws					10yr 7/2		O	1			
150	/3	Zs1			105-150	ws					10yr 6/6		O	1			
205	/3	Zs1			150-210	ws					10yr 7/3		O	1			
207	/3	Zs1			210-300	ws					10yr 8/2		O	1			
270	/3	Zs1			150-210	mws					10yr 7/3		O	1	tussen 227 en 232 Zs1 (210-200)		
284	/2	Zs1			150-210	ms					10yr 6/4		OR	1	GZ 1400-2000 bijmenging		
290	/3	Lz3									5y 5/1		OR	1			
302		Zs1			210-300	ws					10yr 5/3		OR	1			
3.02meter einde boring																	

Casquettenhof

From East to West.

Datum:	26-9-2012	Naam:	Suzan en Kim	Opnamenummer	044

Coord.:	(x) 193427	(y) 357505	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	19.7 m +NAP	GWS: 1.50m	Weiland	Restgeul	Casquettenhof

Opmerkingen: epe is 6meter. Boring aan bosrand voor de greppel richting voetbalveld. gutsen tot 3.10m. gutsen tot 4.10m

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
50	/4	Kz3	h1	w ‖							10yr 5/3		O	1			dit lijkt ook een geulvulling 2x in een geul .
80	/3	Zs1	h1		105-150	ws		10%	1cm	3cm	10yr 5/3		O	1	lemige brokjes		
100	/4	Kz3									10yr 4/4		O	1			
130	/2	Kz3		plr.							10yr 4/2		OR	1			
145	/3	Vk3	h3								10yr 3/1		OR	1			
180	/2	Kz3		plr.							10yr 5/1		R	1	stugge klei, bodemvorming?		
190	/3	Vk3	h2->h	plr.							10yr 3/1		R	1			
250	/2	Kzs1/Vk1	h3	plr.							10yr 3/2		R	3	gyttjeus zeer compact, aan de top kleiig veer		
255	/3	Zs1			210-300	ws					10yr 5/1		R	1			
270	/4	Ks1	h2								10yr 3/2		R	1	gyttjeus		
310	/2	Ks3		aan bovenkant plr.							5B 6/1		R	1	compact, breekt laminerend kleiige geulvulli		
330	/4	Ks1	h2	hout							10yr 3/1		R	2			
340	/4	Ks1	h3	plr.							10yr 2/3		R	2			
350	/2	Ks1	h3	plr.							10yr 2/3		R	3	gyttjeus		
395	/3	Zs3		plr. ++	105-150	ws					10yr 4/2		R	3	dikke laminatie grof, humeuze klei		geulvulling zandje.
410		Lz1	h3								10yr 2/2		R	3	geen overdreven erosieve contacten.		
4.10m einde boring. Tot 4.30m geboord en grind gevoeld maar niks opgeboord.																	

Datum: 27-9-2012 **Naam:** Suzan, Wim en Kim **Opnamenummer** 046

Coord.:	(x) 193425	(y) 357492	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**
Hoogte:	(z) 18.7	m +NAP	**GWS:** 1.40m	Weiland	Restgeul	Casquettenhof

Opmerkingen: epe is 6meter. Tussen boring 044 en 045 in. 110-200, 200-290, 290-380, 380-470 en 470-560.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
60	/3	Kz3		w ‖							10yr 5/3		O	1	opgebracht		
80	/3	Zk			105-150	ws					10yr 4/4		O	1			
100	/2	Kz3									10yr 4/4		O	1			
120	/3	Kz1									10yr 4/1		OR	1	H2S		
135	/2	Vk1		plr. +							10yr 3/3		OR	1	H2S, siderietgyttja vanaf 1.30m --> CaCO3		
165	/4	Ks1		plr.							2.5y 4/1		R	1	zeer compact		
230	/4	Vm		hout ++							7.5yr 3/2		R	1			
325	/3	Ks1	h1	plr							10yr 4/1		R	2	met organisch laagje op 2.80m, gyttjeuze kle		
340	/4	Zs1			105-150	ws					10yr 5/1		R	3			
380	/4	Vz3		plr							10yr 4/2		R	3	zandige gyttja		
440	/3	Vz1		plr							5y 5/2		R	3	gyttjeus, siderietgyttja FexCaCO3		
490	/4	Zs2	h2		105-150	ws					10yr 5/1		R	3	Zwak gyttjeus met zandnesten eindigd met H		
555	/4	Ks1	h2								5y 4/2		R	3	humeuze laagjes, licht gyttjeus, zandpulsjes,		
560		Ks3	h2								2.5y 5/1		R	3			
5.60m einde boring, grind gevoeld niet opgeboord.																	

Datum: 27-9-2012 **Naam:** Suzan, Wim en Kim **Opnamenummer** 045

Coord.:	(x) 193441	(y) 357479	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**
Hoogte:	(z) 18.2	m +NAP	**GWS:** 1.40m	Weiland	Restgeul	Casquettenhof

Opmerkingen: epe is 7meter. Boring tussen 043 en 044 in (meer richting boring 043). 140-230, 230-320, 320-410, 410-545.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
5	/3	Kz3	h1	w ‖							10yr 4/3		O	1			
50	/4	Kz3		w ‖							10yr 5/3		O	1			
73	/2	Kz3						1%		5mm	10yr 4/4		O	1	mangaan en ijzerconcreties		
100	/2	Zs4	h2		105-150	ws					10yr 3/2		OR	1	kleiige bijmenging		
117	/3	Ks2									7.5y 4/1		OR	1	H2S		
160	/2	Vk1		zaadjes, w							7.5y 3/1		OR	1	H2S, kliig laagje op 148cm. 10yr 4/2 vanaf 14		
185	/3	Vk1									2.5y 5/4		R	3	siderietgyttja, meneanteszaadje, gelaagd		
200	/4	Vk1									10yr 4/3		R	2-			
250	/5	Ks1		blad, plr.							10yr 5/1		R	1	vanaf 2.30m bladresten in laminae. Vanaf 2.		
330	/4	Vk1		plr. ++							10yr 3/2		R	1	laminae met Ks1 rond 2.90m. Gyttjeus met v		
390	/4	Ks1	h2	plr. +							5G 1.7/1		R	3	meer kleiige gyttja. Laminae met meer h3		
410	/2	Kz1	h2	plr. -							10G 2/1		R	3	kleiige gyttja met schelpresten.		
545		Ks1	h2								7.5y 4/1		R	3-	organisch stofgehalte 8-10%. Organische lam		
5.45m einde boring, grind gevoeld maar niet opgeboord.																	Moerasgas

Datum: 26-9-2012		**Naam:** Suzan en Kim		**Opnamenummer**	043
Coord.: (x) 193454	(y) 357440	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**
Hoogte: (z) 17.6 m +NAP		**GWS:** 1.20m	Weiland	Restgeul	Casquettenhof

Opmerkingen: epe is 8meter. Deze boring vond plaats meer richting dhet bosje. Bij het gras dat over het hekje zit, ongeveer 10meter links van de eerste populieren (met het gezicht richting horn). 180-260, 260-350, 350-440, 440-480.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
10	/4	Kz3	h1	w ǁ							7.5yr 4/4		O	1	Op 10cm anthropogene steentjes 4,5cm gro		
48	/3	Ks3									2.5yr 3/3		O	1			
80	/2	Ks2									5yr 4/1		O	1	mangaan en ijzerconcreties		
90	/3	Vk3		plr.							10yr 3/1		OR	1	waterdriebladzaadjes etc.		
180	/2	Vk2		plr. +, w ǁ							5y 3/2		R	1	riet/zegge veen doorworteld.		
300	/4	Ks1		plr. -, houtstukjes							10yr 4/1		R	1	humeus gebande klei		
350	/3	Ks2	h1								grijs met donkergrij		R	1	laminae met bladresten. Floodlaminae. Orga		
400	/3	Vk3	h2	plr.							10yr 2/1		R	1	gyttjeus		
466	/3	Vk3	h2								10yr 2/1		R	3	naar beneden toe meer kleiig -> initial disco		
480		Zs1			105-150	ws					grijs		R	2	laminae met h2 Zs1.		
4.80m einde boring.																	

Datum: 27-9-2012		Naam: Suzan, Wim en Kim		Opnamenummer	047
Coord.: (x) 193459	(y) 357432	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte: (z) 19 m +NAP		GWS: 1.60m	Weiland	Restgeul	Casquettenhof

Opmerkingen: epe is 7meter. Boring gedaan aan andere kant van het slootje.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
10	/3	Kz3		w ǁ							10yr 3/2		O	1			
25	/4	Kz2		w ǁ							5yr 4/4		O	1	mangaan en ijzervlekken		
90	/2	Kz1									10yr 5/1		OR	1	ijzervlekken		
150	/4	Vk1		plr.							10yr 2/2		OR (\	1			
220	/4	Ks1	h1								10yr 4/1		R	1	gyttjeus		
255	/3	Vk1		riet							10yr 3/2		R	1			
335	/4	Ks1	h1								10yr 3/2		R	2	gyttjeus, betinuaslakjes		
375	/3	Kz1	h1								10yr 3/1		R	3	gyttjeus		
390	/2	Zs1			150-210	ws					10yr 5/1		R	3-	matjes verslagen platenresten, floodlaagjes		
400		Kz1	h3								10yr 3/1		R	3-	monster genomen		
4.00m einde boring, grind gevoeld niet opgeboord.																	

Datum: 27-9-2012 | Naam: Suzan, Wim en Kim | Opnamenummer **049**

Coord.: (x) 193469 (y) 357419	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte: (z) 19.2 m +NAP	GWS: 1.40m	Weiland	Restgeul	Casquettenhof

Opmerkingen: epe 7meter. Tussen boring 047 en 048 in. 140-230, 230-320.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
10	/3	Kz3	h1	w ‖							10yr 4/3		O	1			
110	/2	Ks3									10yr 5/1		OR	1	ijzer en mangaanvlekken		
140	/4	Vk1		plr							10yr 3/3		OR	1			
170	/4	Vk1		plr							2.5y 3/2		R	1	gyttjeus		
215	/3	Vz3		plr							2.5y 4/2		R	1	licht gyttjeus		
245	/2	Ks3									5y 4/1		R	1			
295	/2	Vk1		plr							2.5y 3/2		R	1	gyttjes, vanaf 2.80m Vz3 (meer zandig)		
300		Zs1			105-150	ws					10yr 4/1		R	1			
3.00m einde boring, tot 3.20m geboord zand gevoeld maar niet opgeboord.																	

Datum: 27-9-2012 | Naam: Suzan, Wim en Kim | Opnamenummer **048**

Coord.: (x) 193478 (y) 357397	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte: (z) 19.4 m +NAP	GWS: 1.80m	Weiland	Restgeul	Casquettenhof

Opmerkingen: epe is 8meter. Deze boring is gedaan op de binnenbocht rand (het hoogste stuk).

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
25	/3	Kz3	h1	w ‖							10yr 3/3		O	1			
110	/3	Kz2		w ‖							10yr 4/2		OR	1	mangaan en ijzervlekken		
120	/4	Lz3									10yr 4/6		OR	1			
160		Zs1		w ‖	105-150	ws					10yr 5/3		OR	1	lemige bandjes van max. 5cm van Lz3 op 2.3		
1.60m einde boring ivm zand onder grondwater																	

Pannenhof

From West to East.

Datum:	25-9-2012	Naam:	Suzan en Timme	Opnamenummer	036

Coord.:	(x) 191289	(y) 354721	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	m +NAP	GWS: 2.70m	Akker	Restgeul	Pannehof

Opmerkingen: epe is 8meter. Nog verder van de sloot ten opzichte van boring 036.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
15	/4	Zk		w ‖	105-150	ws					10yr 3/2		O	1			
50	/3	Kz3									10yr 5/2		O	1	ijzervlekken		
0.50m grind gevoeld niet opgeboord.																	

Datum:	25-9-2012	Naam:	Suzan en Timme	Opnamenummer	036

Coord.:	(x) 191299	(y) 354721	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	m +NAP	GWS: 2.70m	Akker	Restgeul	Pannehof

Opmerkingen: epe is 6meter. Nog verder van de sloot ten opzichte van boring 035. 5 meter verder, richting weg nog een boring gedaan maar daar zit je binnen 0,5meter op het grind.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
7	/4	Zk		w ‖	105-150	ws					10yr 3/2		O	1			
70	/3	Zk		w	105-150	ws					10yr 5/3		O	1			
95	/4	Zk			105-150	ws					5yr 4/3		O	1	ijzervlekken		
169	/3	Kz3									10yr 5/2		O	1	ijzervlekken		
240	/3	Kz2		plr.							10yr 4/2		O	1	ijzervlekken (worden minder)		
270		Kz2	h2	plr. ++, hout w?							10yr 3/2		O	1			
2.70m grind gevoeld niet opgeboord.																	

Datum:	25-9-2012	Naam:	Suzan en Timme	Opnamenummer	035

Coord.:	(x) 191290	(y) 354715	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	m +NAP	GWS: 2.50m	Akker	Restgeul	Pannehof

Opmerkingen: epe is 8meter. Vanaf het waterschapspaaltje 3.5paal naar rechts richting weg.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
35	/4	Zk	h1	w ‖	105-150	ws					10yr 3/3		O	1			
65	/3	Kz3									2.5yr 4/6		O	1			
66	/3	Kz3									10yr 6/1		O	1	ijzervlekken		
120	/2	Kz3									10yr 4/3		O	1			
160	/2	Zk			105-150	ws					10yr 5/2		O	1			
172	/3	Zs1			150-210	ws					10yr 6/3		O	1			
220	/4	Kz3									10yr 3/1		O	1			
235	/3	Kz3									2.5yr 3/4		OR	1			
260	/2	Kz2	h2								10yr 3/1		OR	1			
300	/2	Kz1	h1								7.5y 4/1		R	1			
305		Grind									10yr 3/1		R	1			
3.05m einde boring grind gevoeld niet opgeboord.																	

Datum:	25-9-2012	Naam:	Suzan en Timme	Opnamenummer	034

Coord.:	(x) 191306	(y) 354696	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	m +NAP	GWS: 1.20m	Akker	Restgeul	Pannehoef

Opmerkingen: epe is 5meter. Einde akker aan de slootkant.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
35	/4	Zk	h1	w ‖	105-150	ms					10yr 4/3		O	1			
72	/3	Kz3		w							10yr 5/8		O	1			
100	/4	Kz2									10yr 5/3		OR	1	ijzervlekken		
127	/2	Kz1		stukjes/brokjes hout							10yr 5/2		OR	1	houtskool onderin. Kleine steentjes die je do		
160	/3	Ks3	h2	plr. ++							10yr 4/1		R	1			
165	/3	Kz3	h1								10yr 4/1		R	1			
200	/2	Ks3	h2								10yr 4/1		R	1	eindigd met stukjes hout.		
210	/3	Kz1	h2	bladresten							10yr 4/1		R	1			
255	/2	Ks2	h2	plr. ++							10yr 4/1		R	1			
260		Ks2	h3	plr. ++							10yr 1.7/1		R	1	gyttjeus monster.		
2.60meter einde boring grind gevoeld niet opgeboord.																	

Schietclub Beegden

From West to East.

Datum: 26-9-2012		**Naam:** Suzan en Kim		**Opnamenummer**	041
Coord.: (x) 192432 (y) 355476	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**	
Hoogte: (z) 20.1 m +NAP	**GWS:** niet gezien	Weiland	Restgeul, eruit	Schietclub	

Opmerkingen: epe is 4meter. Maaiveld is ongeveer 50cm hoger dan bij boring 41 en uit de geul richting Beegden.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
60	/3	Zs2	h1	w ‖	105-150	ms		5%		4cm	10yr 5/4		O	1	basis grinden anthropogeen		
110	/4	Zk			210-300	ws					10yr 4/6		O	1	zandig		
180	/2	Zk			210-300	ws					7.5yr 4/4		O	1	zandige klei		
240	/2	Zs1			420-600	ws					10yr 5/8		O	1	richting basis dikke laminae 3mm met Kz3. L		
245	/2	Lz3									10yr 5/3		O	1			
270	/4	Zs1			300-420	ms	a4	5%		1mm	10yr 5/3		O	1	bandje lichter zand (10yr 6/6)		
280		Zs1			300-420	ms	a4	25%	2cm	5cm	10yr 5/3		O	1	brokjes leem.		
2.80m einde boring, grind gevoeld niet opgeboord.																	

Datum: 26-9-2012		**Naam:** Suzan en Kim		**Opnamenummer**	040
Coord.: (x) 192443 (y) 355455	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**	
Hoogte: (z) 19.9 m +NAP	**GWS:** 2.10m	Weiland	Restgeul	Schietclub	

Opmerkingen: epe is 11meter. 10 meter van boring 39 (meer richting Beegden). 1e x gegutst tot 2.90, 2e x gegutst tot 3.80 maar vanaf 3.50 was het eruit gevallen.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
30	/4	Zs1	h1	w ‖	105-150	ms					10yr 4/2		O	3			
62	/3	Zk		w	105-150	ms		1%		2mm	10yr 4/4		O	1			
110	/4	Kz3						1%		2cm	10yr 4/4		O	1	kleine mangaan en ijzerconcreties		
140	/4	Kz2									10yr 3/4		OR	1	kleine mangaan en ijzerconcreties		
200	/2	Kz3									10yr 5/3		OR	1			
230	/3	Ks2						1%		3,5cm	10yr 5/1		R	1	overwegend klei met een humeus interval		
260	/4	Ks2	h1	plr. -				1%		8mm	10yr 4/1		R	1			
310	/3	Kz1									N 5/1		R	1			
325	/4	Ks2	h1	plr							N5/1		R	1			
335	/2	Kz3									N 5/1		R	1			
345	/2	Zk	h2	plr							10yr 4/1		R	1	laminaties van zand beginnen op 3.40m		
350		Zs2						1%		2mm	10yr 5/2		R	1			
3.50m einde boring, grind gevoeld, niet opgeboord.																	

Datum:	25-9-2012	Naam:	Suzan en Timme	Opnamenummer	039

Coord.:	(x) 192446	(y) 355452	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z) 19.5	m +NAP	GWS: 3.00m	Weiland	Restgeul	Schietclub

Opmerkingen: epe is 11meter. Deze boring is net in het andere weiland richting Beegden op genomen. Monster genomen op 3.20meter.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
25	/4	Zs1	h1	w ‖	105-150	ms					10yr 4/2		O	1			
60	/3	Zk			105-150	ws					10yr 4/4		O	1			
120	/3	Kz3									10yr 3/2		O	1			
150	/3	Kz3									10yr 4/4		O	1	ijzervlekken		
210	/2	Kz3		w							10yr 5/2		O	1			
320		Kz2	h3	plr., w							10yr 2/2		O	1	houtstukjes heel organisch, monster genome		
3.20m einde boring, grind gevoeld niet opgeboord.																	

Datum:	25-9-2012	Naam:	Suzan en Timme	Opnamenummer	038

Coord.:	(x) 192452	(y) 355443	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z) 19.9	m +NAP	GWS: niet gezien	Weiland	Restgeul	Schietclub

Opmerkingen: epe is 5meter. Deze boring vond plaats aan de andere kant van het slootje richting Beegden. Tussen boring 037 en 038 nog een boring gedaan deze laat hetzelfde zien als boring 037.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
60	/3	Zk	h1	w ‖	105-150	ms					10yr 4/2	brok	O	1	onderste 20cm ijzervlekken		
80	/4	Kz3									10yr 5/3		O	1	ijzervlekken		
150	/3	Zk			105-150	ws					10yr 5/2		O	1	met laagjes van Kz3		
170	/3	Kz3									10yr 5/3		O	1			
240	/4	Kz3	h1	houtstukjes, w							10yr 4/2		O	1			
260		Kz3	h3	houtstukjes, plr. +							10yr 2/1		O	1	monster genomen +zaadje gevonden		
2.60m einde boring, grind gevoeld maar niet opgeboord.																	

Datum: 25-9-2012		**Naam:** Suzan en Timme			**Opnamenummer**	037
Coord.: (x) 192481	(y) 355450	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**	
Hoogte: (z) 20.1	m +NAP	**GWS:** niet gezien	Weiland	Restgeul	Schietclub	

Opmerkingen: epe 3meter. Tussen 2 bomen dan geultje meer richting bocht.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
10	/4	Zs1	h1	w ǁ	105-150	ms					10yr 3/2		O	1			
60	/3	Zs1		w ǁ	105-150	ws					10yr 3/3		O	1			
90	/3	Zk			105-150	ws					10yr 4/4		O	1			
120	/3	Kz3									10yr 4/2		O	1			
150	/2	Kz3									10yr 3/4		O	1			
220	/2	Kz3	h1	w							10yr 4/2		O	1			
230		Zs2			105-150	ps		20%		5cm	10yr 3/3		O	1			
2.30m einde boring grind gevoeld niet opgeboord.																	

Apenbroek

From West to East.

Datum: 19-9-2012		**Naam:** Suzan			**Opnamenummer**	017
Coord.: (x) 189945	(y) 358125	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**	
Hoogte: (z)	m +NAP	**GWS:** niet gezien	akker rand	buitenbocht restgeul	Apenbroek	

Opmerkingen: epe is 5meter. Bocht naar boederij/eigen weg.

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
15	/4	Zs1	h1		105-150	ms		2%		1cm	10yr 5/3		O	2	(grind is van weg)		
76	/3	Zs2	h1		105-150	ps		2%		1cm	10yr 5/6		O	1			
100	/4	Zs1		w	105-150	ws					10yr 6/3		O	1	laagjes van Zs2		
145	/3	Zs1			75-105	ws	a4				2.5y 6/2		O	2			
210	/4	Zs2			105-150	ws	a4				10yr 6/6		O	2	ijzervlekken		
240	/2	Zs1			105-150	ps					10yr 7/4		O	1			
285	/4	Zs1			105-150	ws					10yr 7/8		O	2	ijzervlekken		
300	/3	Zs1			105-150	ws					10yr 6/3		O	1			
320	/4	Zs2			75-105	ws					10yr 6/6		O	2	ijzervlekken		
335	/3	Lz3									10yr 6/2		O	1			
350		Zs1			150-210	ws					10yr 6/6		O	1			
3.50 meter einde boring																	

Datum:	19-9-2012	Naam:	Suzan	Opnamenummer	015

Coord.:	(x) 189933	(y) 358141	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	m +NAP	GWS: 1.20m	akker	restgeul	Apenbroek

Opmerkingen: epe is 5meter. 5 stappen van eerste boring.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
20	/4	Zs1	h2		75-105	ws					10yr 3/3		O	1			
73	/3	Zs1	h1		105-150	ws					10yr 4/2		O	1			
102	/3	Zs1			105-150	ws					10yr 5/6		O	2	vlekkerig		
122	/3	Zs1			105-150	ws					10yr 8/6		O	2			
160	/3	Zs1			105-150	ws					10yr 6/6		OR	1			
170	/4	Zs1	h1	w ǁ, plr.	150-210	ms		1%		3mm	10yr 4/2		OR	1	humeuze vlekjes		
210	/4	Zs1		Plr.	210-300	ps					10yr 5/4		R	1			
265	/2	Zs1	h1		150-210	ms		1%		3mm	10yr 4/1		R	1			
270		Zs1	h3	Plr.	210-300	ws					10yr 2/1		R	1			
2.70m einde boring vanwege zand onder grondwaterspiegel																	

Datum:	19-9-2012	Naam:	Suzan	Opnamenummer	016

Coord.:	(x) 189930	(y) 358139	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	m +NAP	GWS: 1.20	akker	restgeul	Apenbroek

Opmerkingen: epe is 7meter. 2,5 meter is tussen boring 005 en 015.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
20	/4	Zs1	h2	w ǁ	75-105	ws					10yr 3/2		O	3			
85	/3	Zs2	h1		75-105	ws					10yr 4/4		O	1	tussen 48 en 52cm een laagje schoon zand (		
145	/4	Zs1			150-210	ms					10yr 7/6		O	1	vlekkerig, ijzer inspoeling		
180	/2	Zs1	h1	w ǁ	210-300	ws					10yr 5/2		OR	1			
210	/3	Vm		w ǁ							10yr 7/1		OR	1	monster op 200meter. Doorworteld veraard		
240		Zs1	h2	w ǁ	105-150	ws					10yr 3/1		R	1			
2.40m einde boring zand gevoeld maar niet opgeboord																	

Datum:	14-9-2012	Naam:	Suzan en Marlies	Opnamenummer	005

Coord.:	(x) 189925	(y) 358139	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	m +NAP	GWS:	akker	restgeul	Apenbroek

Opmerkingen: epe is 5m. Plantenresten intact, bovenkant veen licht geoxideerd, onderkant meer gyttjeus.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
13	/3	Zs4			105-150	ms					10yr 2/3		O	1			
68	/1	Zs1			105-150	ws					10yr 4/2		O	1	ijzervlekjes		
110	/2	Zs1			105-150	ws					10yr 5/6		O	2			
123	/2	Zs1			105-150	ms					10yr 5/3		R	3			
159	/4	Vkm		w ‖							10yr 3/1		R	1	houtskool (hk), gyttjeus		
164	/2	Zs2	h3	w ‖	150-210	ws					10yr 1.7/1		R	1			
175		Zs2	h1		150-210	ws					10yr 3/2		R	2			
1.75meter einde boring ivm zand.																	

Datum:	14-9-2012	Naam:	Suzan en Marlies	Opnamenummer	006

Coord.:	(x) 189929	(y) 358129	Bodem:	Landgebruik:	Geomorfologische eenheid:	Toponiem:
Hoogte:	(z)	m +NAP	GWS:	akker	restgeul	Apenbroek

Opmerkingen: epe is 6meter. Aan de andere kant van het slootje ten opzichte van de paal.

Ondergrens		Text.	Org.	Plr.	Zand			Grind			Kleur	Struct.	OR	CaCo3	Bijzonderheden/Opmerkingen	Kolom	Interpr
Diepte	Type				M50	Sort.	Afr.	%	M50	GGD							
15	/3	Zs1	h2	w ‖	105-150	ws					10yr 4/2		O	2			
48	/4	Zs1	h1		105-150	ws					10yr 4/3		O	1	geoxideerde ijzervlekken		
70	/1	Zs1			150-210	ws					10yr 6/4		O	1	vlekkerig		
75	/2	Vkm									10yr 1.7/1		O	1			
85	/3	Zs1	h2	w	105-150	ws					10yr 2/2		O	2			
105	/3	Zs1	h1		105-150	ws					10yr 4/2		O	1			
120	/4	Zs2		plr.--	105-150	ms					2.5y 6/3		O	3			
170	/3	Zs1			210-300	ps		1%		2mm	2.5y 5/2		O	3			
200		Zs1			105-150	ws					2.5y 5/2		O	1			
2.00meter einde boring ivm zand.																	

Datum:	19-9-2012		**Naam:**	Suzan		**Opnamenummer**	018

Coord.:	(x) 189901	(y) 358163	**Bodem:**	**Landgebruik:**	**Geomorfologische eenheid:**	**Toponiem:**
Hoogte:	(z)	m +NAP	**GWS:** niet gezien	akker	binnenbocht restgeul	Apenbroek

Opmerkingen: epe is 5 meter. Ter hoogte van het hoogste deel van de akker (waar het stijgen stopt).

Ondergrens		**Text.**	**Org.**	**Plr.**	**Zand**			**Grind**			**Kleur**	**Struct.**	**OR**	**CaCo3**	**Bijzonderheden/Opmerkingen**	**Kolom**	**Interpr**
Diepte	**Type**				**M50**	**Sort.**	**Afr.**	**%**	**M50**	**GGD**							
25	/3	Zs1	h1		75-105	ws					10yr 4/3		O	1			
110	/2	Zs1			105-150	ws	a4				10yr 7/4		O	1			
130	/4	Zs2			105-150	ws					10yr 5/4		O	1			
145	/4	Lz3									10yr 6/1		O	1	ijzervlekken en met grof zand M50 1000-140		
155	/4	Zs2			105-150	ms					10yr 6/3		O	1	ijzervlekken		
180	/2	Zs1			150-210	ws					10yr 5/3		O	1	ijzervlekken		
205	/3	Zs1			420-600	ps	a4				10yr 7/4		O	1			
270	/3	Zs1			150-210	ms					10yr 5/4		O	1	humeuze vlekjes en humeus laagje op 2.20m		
290	/4	Lz3									10yr 5/6		O	1			
330	/3	Zs1			150-210	ws					10yr 5/6		O	1			
340	/4	Lz3									10yr 5/1		O	1			
350		Zs1			150-210	ms					10yr 5/6		O	1			
3.50meter einde boring.																	

Appendix III. Core photographs

Dukkelaar

Steek 1 – diepte: 255-333 cm –MV (alleen 255-300 beschreven en bemonsterd)

Beschrijving:

300-286	Grofdetritisch gyttja / Veen. Gereduceerd. Grote wortel op 302. 2,5Y 4/2
286-280	Kleiig veen. 1 dikke wortel op 284
280-274	Venige klei. Horizontaal gelaagd (kleilaagjes). 10YR 3/1 tot 10 YR 2/1
274-255	Organische grofdetritische gyttja met horizontaal georienteerde plantenresten. Niet verticaal doorworteld. 10 YR 2/2

Steek 3 – diepte: 300-350 cm –MV

Beschrijving:

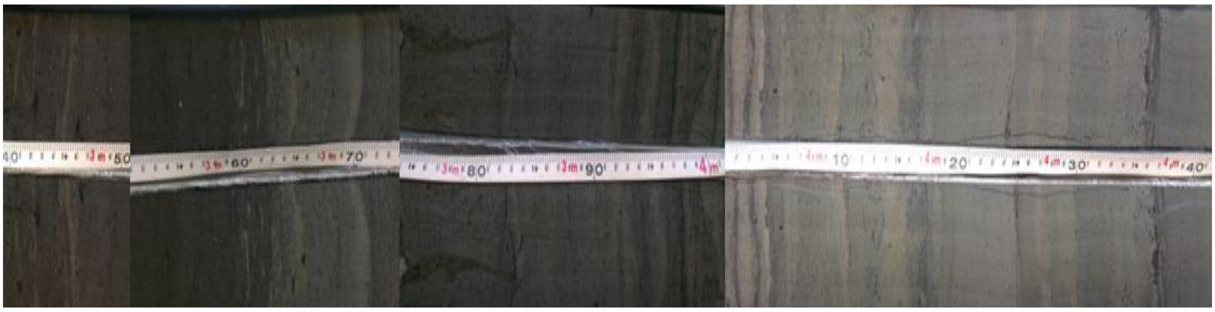
350-348.5	Grind, GGD ~2-3 cm. Matig tot goed afgerond. Kleiig. Zeer abrupte grens naar fijnkorrelige invulling. Kalkloos
348.5-348	(niet humeuze) grijze klei Ks2 (10YR 4/2). Bevat een lichtgekleurd kalkloos leembrokje (0,3cm)
348-343.5	Organische fijn detritische gyttja, misschien licht-kleiig (TGA). Bevat enkele plantenresten, horizontaal. Uiterst zwak sideriethoudend. 5Y 3/2
343.5-341	Zwak humeuze klei (Ks2) (onderste halve centimer schoon, niet humeus). Bevat enkele plantenresten. 10YR 3/1. Kalkloos
341-331	Gelamineerde humeuze gyttjeuze klei. Humeuze lagen (h2/h3) en schone lagen. Bevat fijndetritische en grofdetritische laagjes. Laminaties 0.1-1 cm dik. Veel plantenresten. Tussen 136-139.5 ook sideriethoudende organische gyttjeuze lagen (geen pure siderietlagen). Mooi enkel detrituslaagje op 141 5Y 3/2
331-318	Gelamineerde tot grlaagde fijn tot grofdetritische organische gyttja. Soms zeer zwak sideriethoudend. Zaandjes. Plantenresten horizontaal. 10YR 1.7/1 tot 5Y 3/2
318-300	Grofdetritische organische Gyttja tot veen. Niet doorworteld. Bruin, veel plantenresten nog herkenbaar (horizontaal) in smerende matrix. 10 YR 2/3

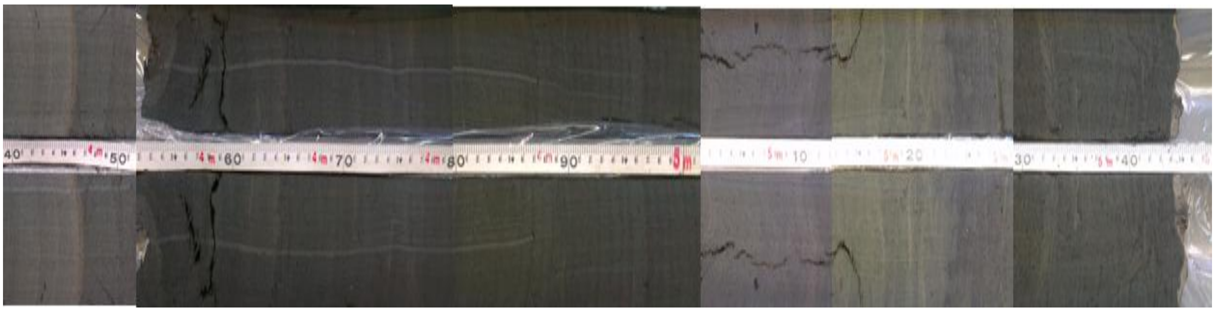
Houterhof I

Houterhof II

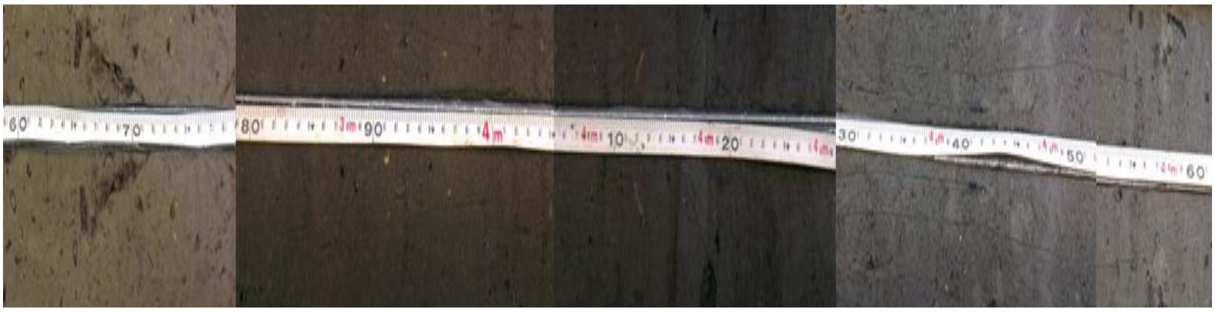
Katerhof

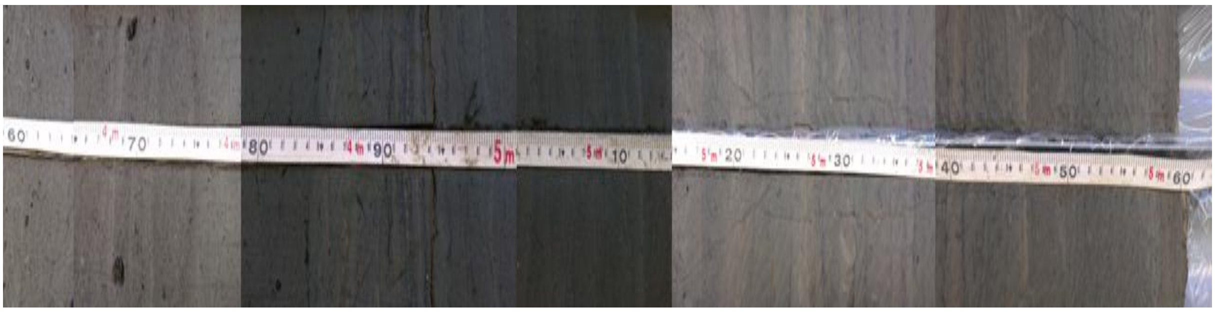
Casquettenhof I





Casquettenhof II





Appendix IV. Pollen counts

Dukkelaar

Depth						347	345	341	339	337	335	329	325	321	317	313	309	307	303	299	289	279	269	259	255	251	241	237	222	198
Pollen sample nr						DUK P1.1	DUK P1.2	DUK P1.3	DUK P3.25	DUK P1.4	DUK P3.26	DUK P1.5	DUK P3.27	DUK P1.6	DUK P3.28	DUK P1.7	DUK P3.29		DUK 1.8	DUK 2.35	DUK P2.36	DUK P2.37	DUK P2.38	DUK P2.39	DUK P2.40	DUK 86	DUK 87	DUK 88	DUK 90	DUK 91
LOI (%)						28,29341	27,76074	16,186557	21,57165	25,93985	26,49573	52,04082	63,28502	61,51762	72,32143	62,7907	66,41509	69,03915	62,61261	51,56863	57,25594	34,15842	66,09848	61,76471	63,13131	59,21569	50,18939	53,92157	50,86207	66,50485
Code	Name	Element	Units	Context	TaphonomGroup																									
	Betula				A	25	57	21	48	40	56	51	51	46	1	0	3	3	10	27	7	23	3	4	5	0	1	0	3	5
	Pinus				A	23	37	47	67	18	67	46	73	54	53	33	73	73	52	151	62	112	118	196	111	11	13	13	14	52
	Salix				A	5	0	12	1	0	1	4	6	8	3	1	7	7	9	14	2	3	2	3	1	2	1	0	1	3
	Abies				B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Alnus				B	0	0	7	12	13	5	3	2	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1
	Carpinus				B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Corylus				B	0	0	35	5	17	2	4	0	1	0	1	0	0	0	1	1	6	0	0	0	0	0	1	5	26
	Fagus				B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Fraxinus				B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nyssa				B	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Piceae				B	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Quercus				B	0	0	3	1	11	1	1	0	2	0	0	0	0	0	1	0	4	0	0	0	0	0	0	3	4
	Sambucus nigra				B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tilia				B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ulmus				B	0	0	0	0	1	0	1	0	0	0	0	2	2	0	0	0	3	1	0	3	1	0	0	0	7
	Acer campestre				B	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Artemisia				C	11	10	7	17	16	32	11	4	3	1	0	1	1	3	7	2	0	4	2	0	0	0	0	0	0
	Campanulaceae				C	0	0	0	1	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Compositae Tubuliflorae				C	3	5	0	2	2	2	2	3	3	2	0	0	0	0	1	1	0	3	3	1	0	0	2	0	10
	Caryophyllaceae				C	1	5	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Centaurea nigra				C	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Centaurea scabiosa				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chenopodiaceae				C	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Cirsium				C	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Compositae Liguliflorae				C	2	0	1	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Erodium				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Plantago				C	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Fabaceae				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Galium				C	5	9	4	5	13	1	0	2	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
	Hedera				C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Heliantunum				C	1	1	0	8	0	1	0	1	0	0	0	1	1	0	0	2	9	0	0	0	0	0	0	0	0
	Helleborus Viridis				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Heracleum				C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hippophae				C	0	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hornungia type				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Ilex				C	0	0	0	3	1	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
	Lythrum salicaria				C	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mentha				C	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Onobrychis				C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Polemonium				C	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Polygonum				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Primula				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ranuncalus				C	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	Rhamnus Frangula				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rosaceae				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rubiaceae				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rumex				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sanguisorba officinalis				C	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Saxifraga stellaris				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
	Sinapis type				C	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Talictrum				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Trifolium repens type				C	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
	Umbelliferae				C	7	11	6	3	3	10	2	13	10	0	0	1	1	0	1	0	1	0	0	1	0	0	0	0	0
	Vicia type				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Viola type				C	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Viscum				C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Calluna				D	0	0	1	6	2	5	2	0	0	0	0	0	0	0	1	0	5	0	0	0	0	0	0	0	0
	Empetrum				D	3	8	46	60	43	29	17	3	5	1	0	0	0	0	10	1	14	0	0	0	0	0	0	0	0
	Poaceae				E	63	38	27	21	52	35	72	44	59	6	12	14	14	17	25	4	25	14	5	10	0	2	8	1	15
	Cyperaceae				F	10	10	7	42	9	47	18	104	58	196	13	154	154	26	47	16	33	64	94	131	8	9	13	26	58
	Equisetum				G	100	87	23	19	10	34	21	5	10	2	2	4	4	8	16	1	9	5	5	8	1	0	0	0	1
	Filipendula				G	12	13	6	13	28	10	3	2	5	0	0	1	1	1	6	1	2	1	0	3	0	0	2	1	0
	Typa agustifolia / Sparganium				G	17	7	5	0	4	2	1	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Lemna				H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Menyanthes Trifoliata				H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Myriophyllum alt.				H	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Myriophyllum vert.				H	0	0	0	0	0	0	8	2	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0
	Nymphaea				H	0	0	4	20	0	12	2	7	5	4	0	3	3	0	3	4	7	5	1	0	0	0	0	2	1
	Nuphar lutea				H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Potomogeton				H	9	2	1	2	1	2	0	1	5	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0
	Hericlium				I	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Monolete spore glad				I	6	4	3	4	10	5	9	8	17	3	3	7	7	21	71	9	35	19	56	36	2	3	5	0	14
	Thelypteris palustris				I	0	0	0	0	0	0	0	0	4	0	0	2	2	0	9	11	83	28	22	40	1	1	1	3	1
	Monolete spore grof				I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0
	Trilete spore glad				I	0	2	29	20	26	19	5	1	4	0	0	0	0	3	1	1	10	0	0	0	1	1	0	0	2
	Trilete spore stekel				I	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Botryococcus				J	0	0	0	35	0	16	1	45	0	44	5	28	28	22	35	24	16	24	11	17	0	7	6	10	21
	Pediastrum				J	1	6	2	1	2	8	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tilletia				J	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Zygnematacae				J	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Type 8				J	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0
	Type 52				J	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Type 143				J	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Type 200				J	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Indet corroded				J	3	4	1	5	7	2	3	0	5	0	0	0	0	1	6	0	1	0	1	1	1	0	1	0	1
SUM(A)	Trees and shrubs		percent		P	53	94	80	116	58	124	101	130	108	57	34	83	83	71	192	71	138	123	203	117	13	15	13	18	60
SUM(B)	Thermofilous trees		percent			1	1	45	20	42	8	9	3	4	0	1	2	2	0	3	1	14	1	0	3	1	0	1	8	38
SUM(A,B)	Trees and shrubs (all)		percent			54	95	125	136	100	132	110	133	112	57	35	85	85	71	195	72	152	124	203	120	14	15	14	26	98
SUM (AB)	Trees and shrubs, excl		percent			54	95	118	124	87	127	107	131	111	57	35	85	85	71	194	72	151	124	203	120	14	15	14	26	97
SUM(C)	Dry herbs		percent		P	33	45	21	42	38	51	20	28	18	5	1	3	3	3	17	6	12	9	6	2	0	0	2	0	15
SUM (C)	Upland herbs excluding		percent			26	34	15	39	35	41	18	15	8	5	1	2	2	3	16	6	11	9	6	1	0	0	2	0	15
SUM(D)	Ericales		percent		P	3	8	47	66	45	34	19	3	5	1	0	0	0	0	11	1	19	0	0	0	0	0	0	0	0
SUM(E)	Grasses		percent		P	63	38	27	21	52	35	72	44	59	6	12	14	14	17	25	4	25	14	5	10	0	2	8	1	15
SUM(F)	Cypergrasses		percent			10	10	7	42	9	47	18	104	58	196	13	154	154	26	47	16	33	64	94	131	8	9	13	26	58
SUM(G)	Riparians		percent			129	107	34	32	42	46	25	7	17	2	2	5	5	9	23	2	11	6	5	11	1	0	2	1	1
SUM(H)	Aquatics		percent			9	2	5	22	1	15	10	10	10	4	0	4	4	0	5	5	7	5	3	0	0	0	0	2	1
SUM(I)	Ferns and Mosses		percent			6	6	32	25	36	24	14	9	25	3	3	9	9	24	81	22	131	47	78	76	4	5	6	3	17
SUM(J)	Algue and Indet		percent			6	10	3	42	9	26	7	45	11	44	5	28	28	23	42	24	18	25	13	18	1	7	7	10	23
SSUM(P)	Pollensum					152	185	175	245	193	244	212	205	190	69	47	100	99	91	245	82	194	146	214	129	13	17	23	19	90

Depth	343,5	333	331	327	323	319	315	311	305	301	297	295	293	291	287	285	283	281	277	275	273	271	265	263	261	257	253	249	247	245	243	239	235	234	232	230	228	226	224	220	219	217	200	196
LOI (%)	14,13043	25,33589	54,97238	53,16804	60,05587	63,20346	68,09816	69,62366	70,44335	66,06498	56,81818	54,92228	62,00717	66,08696	51,27119	36,20438	49,73913	35,05155	16,19718	45,53073	64,38923	62,73764	62,23242	53,82263	63,57309	62,8433	62,39316	60,0823	55,8952	55,76923	60,76923	53,31126	41,96242	56,52174	18,95044	34,32432	47,31544	70,70707	65,04854	48,91304	32,85714	51,74216	39,47368	71,09827

Houterhof I

Depth							170	168	166	164	162	160	158	156	154	152	150	148	171	144	142	140	138	136
Pollen sample nr								82					83					84					85	
LOI (%)							2,928258	1,850534	2,470265	3,0769231	3,2815199	14,16185	78,205128	91,93548	88,42105	94,4	97,34513	95,48872	84,51613	80,21583	79,67914	80,67227	72,90323	27,68031
Code	**Name**	**Element**	**Units**	**Context**	**Taphonomy**	**Group**																		
	Betula					A		7					7					10					16	
	Pinus					A		200					37					10					7	
	Salix					A		83					10					2					26	
	Alnus					B		0					66					82					81	
	Corylus					B		24					87					56					64	
	Fraxinus					B		0					1					12					10	
	Quercus					B		0					57					18					27	
	Tilia					B		0					18					15					13	
	Ulmus					B		0					15					9					2	
	Rumex					C		0					0					1					1	
	Artemisia					C		5					0					0					1	
	Compositae Tubuliflorae					C		0					0					0					1	
	Caryophyllaceae					C		0					0					0					1	
	Cirsium					C		1					0					0					0	
	Compositae Liguliflorae					C		0					0					0					1	
	Hedera					C		0					0					1					0	
	Ranuncalus					C		0					20					14					15	
	Umbellifereae					C		1					2					0					2	
	Calluna					D		0					0					0					4	
	Poaceae					E		3					4					6					10	
	Cyperaceae					F		7					96					31					58	
	Typa Agustifolia / Sparganium					G		3					3					0					6	
	Nymphea					H		0					0					0					0	
	Potomogeton					H		10					9					3					4	
	Monolete spore glad					I		6					91					75					32	
	Monolete spore grof					I		0					0					1					0	
	Trilete spore glad					I		0					0					2					16	
	Tilletia					J		0					0					0					4	
	Unknown/indeterminable					J		10					23					20					12	
SUM(A)	Trees and shrubs		percent					290					54					22					49	
SUM(B)	Thermofilous trees		percent					24					244					192					197	
SUM(A,B)	Trees and shrubs (all)		percent					314					298					214					246	
SUM (AB)	Trees and shrubs, excl		percent			P		314					232					132					165	
SUM(C)	Dry herbs		percent					7					22					16					22	
SUM (C)	Upland herbs excludin		percent			P		6					20					16					20	
SUM(D)	Empetrum		percent			P		0					0					0					4	
SUM(E)	Grasses		percent					3					4					6					10	
SUM(F)	Cypergrasses		percent					7					96					31					58	
SUM(G)	Riparians		percent					3					3					0					6	
SUM(H)	Aquatics		percent					10					9					3					4	
SUM(I)	Ferns and Mosses		percent					6					91					78					48	
SUM(J)	Algue and Indet		percent					10					23					20					16	
SSUM(P)	Pollensum							320					252					148					189	

Houterhof II

Depth							180	178	176	174	172	170	168	166	164	162	160	158	156	154	152	150
Pollen sample nr								79					80					81				
LOI (%)							4,5391385	7,0175439	12,33363	31,68142	80,1105	84,6473	82,67974	90,96386	87,82288	93,98496	91,28205	88,75	89,57055	76,59574	80,15873	61,55914
Code	**Name**	**Element**	**Units**	**Context**	**Taphonomy**	**Group**																
	Betula					A	9						4					6				
	Pinus					A	90						32					9				
	Salix					A	45						21					2				
	Alnus					B	3						90					106				
	Corylus					B	170						56					27				
	Fraxinus					B	0						0					3				
	Quercus					B	3						45					36				
	Tilia					B	1						27					13				
	Ulmus					B	1						16					8				
	Compositae Tubuliflorae					C	4						0					0				
	Hedera					C	0						1					0				
	Ranunculus					C	1						5					7				
	Umbelliferae					C	0						2					0				
	Valeriana					C	1						0					0				
	Lycopodium					C	0						1					0				
	Calluna					D	1						0					0				
	Poaceae					E	3						2					5				
	Cyperaceae					F	7						50					16				
	Typa agustifolia / Sparganium					G	0						3					2				
	Myriophyllum					H	1						0					0				
	Nymphaea					H	1						0					0				
	Potamogeton					H	0						2					1				
	Monolete spore glad					I	7						31					17				
	Monolete spore grof					I	0						0					1				
	Trilete spore					I	0						0					1				
	Tilletia					J	0						1					1				
	Indate corroded					J	16						19					14				
SUM(A)	Trees and shrubs		percent				144						57					17				
SUM(B)	Thermofilous trees		percent				178						234					193				
SUM(A,B)	Trees and shrubs (all)		percent				322						291					210				
SUM (AB)	Trees and shrubs, excluding		percent			P	319						201					104				
SUM(C)	Dry herbs		percent				6						9					7				
SUM (C)	Upland herbs excluding umb		percent			P	6						7					7				
SUM(D)	Empetrum		percent			P	1						0					0				
SUM(E)	Grasses		percent				3						2					5				
SUM(F)	Cypergrasses		percent				7						50					16				
SUM(G)	Riparians		percent				0						3					2				
SUM(H)	Aquatics		percent				2						2					1				
SUM(I)	Ferns and Mosses		percent				7						31					19				
SUM(J)	Algue and Indet		percent				16						20					15				
SSUM(P)	Pollensum						326						208					111				

Katerhof

Depth							238	236	226	218	208	200	198	188	178	168	158	156	146
Pollen sample nr							38	39	40	41	42	102	43	44	45	46	47	48	49
LOI (%)							3,7815126	2,5684932	11,852378	22,95597	27,31591	54,86726	48,71795	68,04734	68	51,77866	53,7037	64,41558	88,96104
Code	**Name**	**Element**	**Units**	**Context**	**Taphonom**	**Group**													
	Betula					A	0	6	0	5	5	27	10	12	18	7	11	15	15
	Pinus					A	121	44	12	31	10	7	4	11	9	11	9	7	5
	Salix					A	1	0	0	0	0	11	0	0	25	22	26	18	2
	Alnus					B	7	22	11	17	21	147	71	128	134	73	73	65	39
	Corylus					B	104	80	47	47	31	56	19	27	29	58	38	16	12
	Fagus					B	0	0	0	0	0	1	0	0	0	1	24	18	6
	Fraxinus					B	1	1	0	4	15	4	6	7	5	6	13	19	29
	Quercus					B	12	42	58	82	94	68	94	51	170	60	49	23	13
	Sambucus nigra					B	0	0	0	0	0	0	0	0	0	0	1	0	0
	Tilia					B	115	125	69	123	32	15	19	26	17	4	6	3	0
	Ulmus					B	0	6	5	8	5	2	12	11	4	2	1	2	1
	Rumex					C	0	0	0	0	0	2	0	0	0	1	6	4	13
	Acer campestre					C	0	0	0	0	0	0	0	0	1	0	2	0	0
	Artemisia					C	1	0	0	0	0	3	0	0	0	0	4	6	0
	Compositae Tubuliflorae					C	0	0	0	0	0	0	0	0	0	0	2	6	1
	Caryophyllaceae					C	0	0	0	0	0	0	0	0	1	3	2	2	1
	Chenopodiaceae					C	0	0	0	0	0	0	0	0	0	1	1	1	2
	Cirsium					C	0	1	0	1	0	0	0	0	1	0	1	0	0
	Compositae Liguliflorae					C	1	0	0	1	1	0	0	0	0	1	2	3	2
	Galium					C	0	0	0	0	0	0	0	0	0	0	0	1	0
	Hedera					C	0	0	0	0	0	3	1	5	7	9	2	4	1
	Lytrum					C	0	0	0	0	0	0	0	0	0	0	1	1	0
	Primula					C	0	0	0	0	0	0	0	0	2	0	0	0	0
	Rhamnus frangula					C	0	0	0	0	0	0	0	0	0	0	0	1	0
	Ranunculus					C	0	0	0	0	0	44	0	2	1	43	38	29	28
	Rosaceae					C	0	0	0	0	0	0	0	0	1	0	0	0	0
	Rubiaceae					C	0	0	0	0	0	0	0	0	0	2	0	1	0
	Umbelliferae					C	0	0	0	0	0	0	1	0	6	4	1	2	2
	Viscum					C	1	0	1	0	0	0	0	0	0	0	0	0	0
	Calluna					D	2	7	0	0	0	3	0	0	0	2	1	1	9
	Poaceae					E	1	7	6	8	5	21	12	5	10	4	21	12	19
	Cyperaceae					F	4	50	18	20	12	28	13	27	31	41	36	30	33
	Typa agustifolia / Sparganium					G	0	0	0	0	0	1	4	2	1	1	1	5	24
	Nymphaea					H	2	2	0	4	1	0	1	2	0	0	0	0	0
	Potamogeton					H	0	0	0	0	0	13	2	1	2	22	21	15	6
	Monolete spore glad					I	16	5	4	8	9	4	9	9	6	7	4	6	7
	Monolete spore grof					I	4	3	0	1	0	1	0	1	1	12	2	1	1
	Trilete spore glad					I	0	0	0	0	0	2	0	1	2	7	13	5	6
	Tilletia					J	0	0	0	0	0	0	0	0	0	0	1	1	6
	Unknown/indeterminable					J	45	49	37	55	53	7	29	56	23	19	6	14	7
SUM(A)	Trees and shrubs		percent				122	50	12	36	15	45	14	23	52	40	46	40	22
SUM(B)	Thermofilous trees		percent				239	276	190	281	198	293	221	250	359	204	205	146	100
SUM(A,B)	Trees and shrubs (all)		percent				361	326	202	317	213	338	235	273	411	244	251	186	122
SUM (AB)	Trees and shrubs, excl		percent			P	354	304	191	300	192	191	164	145	277	171	178	121	83
SUM(C)	Dry herbs		percent				3	1	1	2	1	52	2	7	20	64	62	61	50
SUM (C)	Upland herbs excludin		percent			P	3	1	1	2	1	52	1	7	14	60	61	59	48
SUM(D)	Empetrum		percent				2	7	0	0	0	3	0	0	0	2	1	1	9
SUM(E)	Grasses		percent				1	7	6	8	5	21	12	5	10	4	21	12	19
SUM(F)	Cypergrasses		percent				4	50	18	20	12	28	13	27	31	41	36	30	33
SUM(G)	Riparians		percent				0	0	0	0	0	1	4	2	1	1	1	5	24
SUM(H)	Aquatics		percent				2	2	0	4	1	13	3	3	2	22	21	15	6
SUM(I)	Ferns and Mosses		percent				20	8	4	9	9	7	9	11	9	26	19	12	14
SUM(J)	Algue and Indet		percent				45	49	37	55	53	7	29	56	23	19	7	15	13
SSUM(P)	Pollensum						359	305	192	302	193	243	165	152	291	231	239	180	131

Depth	240	234	232	230	228	224	222	216	214	212	210	206	204	202	196	190	186	184	182	180	176	174	172	170	166	164	162	160	154	152	150	148	144	142	140
LOI (%)	2,0874751	11,171367	10,621242	12,626832	11,584158	11,91088	26,35659	18,22358	18,31239	38,64542	23,24455	35,05535	32,12851	53,0303	24,93036	82,11382	72,91667	71,36752	78,26087	72,03791	69,18239	68,99225	66,84783	53,37243	61,15288	52,58126	31,7757	48,55491	83,66337	82,89474	92,85714	91,95402	81,39535	10,10204	8,399546

Casquettenhof I

	Depth						545	543	541	539	537	535	533	532	530	528	526	524	522	520	518	516	514	512	510	508	506	504	502	500	498	496	494	492	490	488	487	485	483	481	479	477	475	473	471	469	468	466	465	464	462	460	458	456	455	454	453	451	449	447	446	444	442	440	438	436	434	432	430	428	427	425
	Pollen sample nr							1											3										5		7											9												11								13										
	LOI (%)						8,219178	8,990148	9,971237	10,67031	10,92832	10,15385	10,65217	10,92715	11,48545	8,910891	9,825034	11,3253	11,19843	9,464286	10,25641	10,38319	11,43216	10,05362	11,20996	9,265442	8,791209	9,77131	10,21672	11,11111	11,00746	10,50657	11,37124	12,0743	12,29947	10,65292	11,07994	10,6422	10,77844	11,82266	11,71032	9,560524	9,295775	10,36168	10,4811	11,9863	10,57692	11,70213	12,79762	9,29309	9,665428	9,680968	15,72872	10,31073	8,87372	11,47327	9,541985	10,1029	9,725686	8,487805	8,247423	8,675799	9,199319	10,14975	14,03829	8,435137	8,534531	9,266409	6,900452	6,57277	8,626198	8,980583
	CaCO3 (%)							1,29					1,34						2,35					2,09		1,59			3		2,56							2,32				1,71						3,04						2,79		3,84						2,7						2,11				
Code	Name	Element	Units	Context	Taphonomy	Group																																																																		
	Betula					A		6											6										19		10											8												7								3										
	Pinus					A		1											6										1		3											2												1								4										
	Salix					A		3											8										4		7											1												2								2										
	Abies					B		1											0										0		0											0												0								0										
	Alnus					B		27											38										64		47											46												51								45										
	Carpinus					B		0											0										0		2											0												0								0										
	Corylus					B		11											10										15		15											15												21								18										
	Fagus					B		13											11										9		11											14												13								10										
	Fraxinus					B		0											0										1		2											2												0								0										
	Quercus					B		17											30										46		32											29												35								43										
	Sambucus nigra					B		0											0										1		0											0												0								0										
	Tilia					B		3											2										0		1											0												2								0										
	Ulmus					B		1											0										1		1											2												2								2										
	Acer campestre					B		0											0										0		0											0												0								1										
	Artemisia					C		1											6										5		2											0												4								2										
	Compositae Tubuliflorae					C		3											5										1		5											1												3								4										
	Caryophyllaceae					C		0											0										1		1											0												0								0										
	Centaurea nigra					C		0											1										0		0											0												0								0										
	Centaurea cyanus					C		0											0										0		0											0												0								0										
	Centaurea scabiosa					C		0											0										1		1											0												0								0										
	Chenopodiaceae					C		1											0										0		4											0												1								3										
	Cirsium					C		0											0										0		0											0												0								0										
	Compositae Liguliflorae					C		2											6										4		4											5												5								7										
	Erodium					C		0											0										0		0											0												0								0										
	Plantago					C		2											2										10		8											6												4								1										
	Fabaceae					C		0											1										3		3											6												0								3										
	Galium					C		0											0										0		0											0												0								0										
	Hedera					C		0											0										0		0											0												0								0										
	Helleborus viridis					C		0											0										0		0											0												0								0										
	Hornungia type					C		0											0										1		0											0												1								4										
	Lytrum					C		0											0										0		0											0												1								0										
	Mentha					C		2											0										0		0											0												0								0										
	Polygonum					C		1											1										1		0											0												0								0										
	Primula					C		0											0										0		0											0												0								0										
	Ranuncalus					C		6											3										3		4											2												0								0										
	Rhamnus frangula					C		0											0										1		0											0												0								0										
	Rosaceae					C		0											0										0		0											0												0								0										
	Rubiaceae					C		0											0										0		0											0												0								0										
	Rumex					C		4											13										8		6											14												7								5										
	Sinapis type					C		3											15										5		4											2												3								3										
	Thalictrum					C		0											1										1		1											1												0								0										
	Umbellifereae					C		4											8										5		2											0												1								7										
	Viscum					C		0											0										0		0											0												0								0										
	Calluna					D		3											5										5		1											2												4								2										
	Cerealia					E		0											0										0		5											0												1								0										
	Poaceae					E		38											53										50		82											26												53								41										
	Cyperaceae					F		2											4										4		7											6												7								3										
	Equisetum					G		0											2										3		5											1												0								4										
	Filipendula					G		4											4										4		4											4												4								5										
	Iris pseudacorus					G		0											0										0		0											0												0								0										
	Typa agustifolia / Sparganium					G		4											0										3		5											0												0								2										
	Lemna					H		0											0										0		0											0												0								0										
	Menyanthes trifoliata					H		0											0										0		0											0												0								0										
	Myriophyllum					H		0											0										0		2											1												0								1										
	Nymphaea					H		0											0										0		0											0												0								0										
	Potomogeton					H		1											3										3		1											1												3								1										
	Monolete spore glad					I		2											2										3		4											8												17								10										
	Thelypteris palustris					I		0											0										0		0											0												0								0										
	Monolete spore grof					I		0											1										1		0											0												0								0										
	Trilete spore glad					I		3											2										2		5											3												1								6										
	Botryococcus					J		0											0										0		0											0												0								0										
	Pediastrum					J		0											2										10		7											1												4								1										
	Tilletia					J		1											0										0		0											0												0								0										
	Type 52					J		0											0										0		0											0												0								0										
	Type 143					J		0											0										0		1											0												0								0										
	Indet					J		2											3										2		15											3												3								4										
SUM(A)	Trees and shrubs		percent					10											20										24		20											11												10								9										
SUM(B)	Thermofilous trees		percent					73											91										137		111											108												124								119										
SUM(A,B)	Trees and shrubs (all)		percent					83											111										161		131											119												134								128										
SUM (AB)	Trees and shrubs, excluding Alnus		percent			P		56											73										97		84											73												83								83										
SUM(C)	Dry herbs		percent					29											62										50		45											37												30								39										
SUM (C)	Upland herbs excluding umbelliferae		percent			P		25											54										45		43											37												29								32										
SUM(D)	Empetrum		percent			P		3											5										5		1											2												4								2										
SUM(E)	Grasses		percent					38											53										50		87											26												54								41										
SUM(F)	Cypergrasses		percent					2											4										4		7											6												7								3										
SUM(G)	Riparians		percent					8											6										10		14											5												4								11										
SUM(H)	Aquatics		percent					1											3										3		3											2												3								2										
SUM(I)	Ferns and Mosses		percent					5											5										6		9											11												18								16										
SUM(J)	Algue and Indet		percent					3											5										12		23											4												7								5										
SSUM(P)	Pollensum							84											132										147		128											112												116								117										

Casquettenhof II

	560	558	556	554	552	550	548	546	545	543	541	539	537	535	534	532	531	529
Depth	560	558	556	554	552	550	548	546	545	543	541	539	537	535	534	532	531	529
Pollen sample nr		50																
LOI (%)	8,154506	5,050505	7,244502	6,985573	7,86802	8,272059	7,314286	9,407666	9,180328	8,298755	10,20408	10,63536	10,11494	11,76471	8,870968	9,818182	4,574132	5,528455
CaCO3 (%)		10,95693					8,958039						10,16865					

	527	525	523	521	519	517	515	513	511	510	508	506	504	502	500	498	497	495	493	491	490	488	487	486	484	482
Depth	527	525	523	521	519	517	515	513	511	510	508	506	504	502	500	498	497	495	493	491	490	488	487	486	484	482
LOI (%)	4,972376	6,593407	6,73788	6,791339	6,2749	7,461024	7,446809	7,099391	8,394161	7,938389	10,26549	9,730669	11,0303	10,64815	10,58824	9,52381	10,1569	10,48689	13,7931	16,26667	11,42454	16,48936	13,39869	7,100592	9,144893	9,487952
CaCO3 (%)	8,51755					4,715523		4,646068					6,079027						4,307949							5,050073

	480	478	476	474	472	471	470	468	467	465	463	461	459	457	456	454	452	450	448	446	444	442	440	438	436
Depth	480	478	476	474	472	471	470	468	467	465	463	461	459	457	456	454	452	450	448	446	444	442	440	438	436
LOI (%)	10,33557	11,51439	9,055877	6,401766	7,659574	5,063291	9,777778	6,505576	4,988124	5,179283	4,137283	4,805793	4,552716	6,455266	4,712893	4,804046	3,94913	4,196816	6,875	9,962169	11,9195	12,43184	12,04819	11,42654	11,53552
CaCO3 (%)					5,334443						4,134653						3,416001					6,692407			

Code	Name	Element	Units	Context	Taphonom	Group	558	548	537	527	517	504	482	463	442
	Betula					A	5	3	3	2		4	4	5	6
	Pinus					A	9	1	3	5	6	6	1	3	3
	Salix					A	1	0	2	1	1	5	6	27	6
	Abies					B	0							1	
	Alnus					B	96	110	100	92	97	48	54	76	76
	Carpinus					B	0								
	Corylus					B	24	53	57	49	66	22	22	37	17
	Fagus					B	37	17	25	7	9	8	14	8	11
	Fraxinus					B	0	1	4	3	4	1	5	4	6
	Quercus					B	10	5	19	8	12	36	42	68	36
	Sambucus nigra					B	0	0							
	Tilia					B	12	6	10	17	14	10	7	7	6
	Ulmus					B	4	4	1		1	1		2	
	Acer campestre					B	0	0						3	
	Artemisia					C	3	7	1	2	7	4	5	1	3
	Compositae Tubuliflorae					C	1	1	2	1	1		1	2	1
	Cannabaceae					C									
	Caryophyllaceae					C	1	5	5	2	2		1		
	Centaurea nigra					C	0	0							
	Chenopodiaceae					C	3	0	1			1		1	
	Cirsium					C	0	0							
	Compositae Liguliflorae					C	2	2			1		2	3	1
	Erodium					C	0	0							
	Galium					C								1	
	Plantago					C	0	0				1	2	6	4
	Fabaceae					C	0	0							
	Hedera					C	0	0							
	Helleborus Viridis					C	0	0							
	Hornungia type					C	0	0							
	Lotus					C									
	Lythrum					C	1	0							
	Mentha					C	0	0							
	Polemonium					C	2	0							
	Polygonum persicaria type					C	2	0							
	Polygonum aviculare type					C				1					
	Primula					C	0	0							
	Prunella					C									
	Ranunculus					C	45	29	48	36	38	5		2	
	Rhamnus cathartica					C									
	Rosaceae					C	0	0							
	Rubiaceae					C	0	0							
	Viscum					C								1	
	Rumex					C	7	1	8	4	3	1	4	2	2
	Sinapis type					C	3	3	2		1		1	2	
	Thalictrum					C	0	0			1	3		2	
	Trifolium					C						1			
	Umbelliferae					C	1	0	1			1	2	2	1
	Viscum					C	0	0							
	Calluna					D	0	0			1		1	1	3
	Cerealia					E	0	0							
	Poaceae					E	13	16	34	24	21	23	31	18	11
	Cyperaceae					F	5	5	10	5	6	7	6	3	6
	Equisetum					G	2	0	2			1			
	Filipendula					G	1	4				5	2	3	4
	Iris Pseudacorus					G	0	0							
	Sagittaria					G								1	1
	Typa agustifolia / Sparganium					G	0	3	3	3	13		3	2	
	Callitriche					H			4						
	Menyanthes trifoliata					H	0	0							
	Myriophyllum vert.					H	0	0						1	
	Nymphaea					H	2	0				3	1		1
	Potomogeton					H	1	4	6	4	5	3	1		2
	Monolete spore glad					I	7	20	15	12	16	9	21	15	11
	Thelypteris palustris					I	0	0							
	Monolete spore grof					I	1	7	1	4					
	Trilete spore glad					I	7	3	3	1		3	5	1	4
	Trilete spore grof					I				1					
	Botryococcus					J	0	0							
	Glomus type					J									
	Pediastrum					J	0	0					2	2	1
	Tilletia					J	1	0		1	3			2	1
	Type 52					J	0	0							
	Type 143					J	0	0	1			1			
	Indet					J	1	8	2	10	7	1	1	3	
SUM(A)	Trees and shrubs		percent				15	4	8	8	7	15	11	35	15
SUM(B)	Thermofilous trees		percent				183	196	216	176	203	126	144	206	152
SUM(A,B)	Trees and shrubs (all)		percent				198	200	224	184	210	141	155	241	167
SUM (AB)	Trees and shrubs, excl		percent			P	102	90	124	92	113	93	101	165	91
SUM(C)	Dry herbs		percent				71	48	68	46	54	17	18	25	12
SUM (C)	Upland herbs excluding		percent			P	70	48	67	46	54	16	16	23	11
SUM(D)	Ericales		percent			P	0	0	0	0	1	0	1	1	3
SUM(E)	Grasses		percent				13	16	34	24	21	23	31	18	11
SUM(F)	Cypergrasses		percent				5	5	10	5	6	7	6	3	6
SUM(G)	Riparians		percent				3	7	5	3	13	6	5	6	5
SUM(H)	Aquatics		percent				3	4	10	4	5	6	2	1	3
SUM(I)	Ferns and Mosses		percent				15	30	19	18	16	12	26	16	15
SUM(J)	Algue and Indet		percent				2	8	3	11	10	2	3	7	2
SSUM(P)	Pollensum						172	138	191	138	168	109	118	189	105

Pannenhof

Depth							255
Pollen sample nr							108
Code	**Name**	**Element**	**Units**	**Context**	**Taphonom**	**Group**	
	Betula					A	1,454545
	Pinus					A	0,727273
	Salix					A	1,454545
	Alnus					B	6,909091
	Corylus					B	10,18182
	Fagus					B	5,818182
	Fraxinus					B	2,909091
	Quercus					B	2,181818
	Sambucus nigra					B	1,090909
	Ulmus					B	0,363636
	Rumex					C	5,454545
	Artemisia					C	4,363636
	Compositae Tubuliflore					C	1,090909
	Caryophyllaceae					C	2,181818
	Cirsium					C	0,727273
	Compositae Liguliflorae					C	1,454545
	Hedera					C	0,727273
	Lysimachia Vulgaris					C	1,090909
	Ranuncalus					C	4
	Sinapis type					C	3,636364
	Talictrum					C	0,363636
	Umbellifereae					C	2,909091
	Valeriana					C	0,363636
	Calluna					D	1,090909
	Poaceae					E	37,45455
	Cyperaceae					F	2,181818
	Equisetum					G	20,36364
	Filipendula					G	0,363636
	Typa Agustifolia / Sparganium					G	10,90909
	Myriophyllum					H	0,727273
	Nymphea					H	4,727273
	Potomogeton					H	4,363636
	Monolete spore glad					I	4,727273
	Trilete spore glad					I	0,363636
	Pediastrum					J	0,363636
	Tilletia					J	0,363636
	Unknown/indeterminable					J	2,545455
SUM(A)	Trees and shrubs		percent			P	3,636364
SUM(B)	Thermofilous trees		percent			P	29,45455
SUM(C)	Dry herbs		percent			P	28,36364
SUM(C,D)	Upland herbs		percent				29,45455
SUM(D)	Empetrum		percent			P	1,090909
SUM(E)	Grasses		percent			P	37,45455
SUM(F)	Cypergrasses		percent				2,181818
SUM(G)	Riparians		percent				31,63636
SUM(H)	Aquatics		percent				9,818182
SUM(I)	Ferns and Mosses		percent				5,090909
SUM(J)	Algue and Indet		percent				3,272727
SSUM(P)	Pollensum						275

Schietclub Beegden

Depth							320	270
Pollen sample nr							110	109
Code	**Name**	**Element**	**Units**	**Context**	**Taphonom**	**Group**		
	Betula					A	3	2
	Pinus					A	6	1
	Salix					A	2	0
	Alnus					B	56	117
	Corylus					B	18	19
	Fagus					B	9	2
	Fraxinus					B	3	1
	Quercus					B	35	9
	Tilia					B	6	0
	Ulmus					B	1	0
	Rumex					C	10	0
	Acer Campestre					C	2	0
	Artemisia					C	4	0
	Compositae Tubuliflorae					C	14	0
	Caryophyllaceae					C	4	1
	Chenopodiaceae					C	3	1
	Compositae Liguliflorae					C	5	0
	Hedera					C	2	0
	Ranuncalus					C	5	8
	Sinapis type					C	10	0
	Umbellifereae					C	4	0
	Calluna					D	1	0
	Poaceae					E	66	12
	Cyperaceae					F	8	1
	Equisetum					G	7	0
	Filipendula					G	2	0
	Typa Agustifolia / Sparganium					G	21	3
	Nymphea					H	2	0
	Potomogeton					H	5	2
	Monolete spore glad					I	10	8
	Trilete spore glad					I	2	0
	Type 143					J	1	0
	Unknown/indeterminable					J	10	1
SUM(A)	Trees and shrubs		percent				11	3
SUM(B)	Thermofilous trees		percent				128	148
SUM(A,B)	Trees and shrubs (all)		percent				139	151
SUM (AB)	Trees and shrubs, excl		percent			P	83	34
SUM(C)	Dry herbs		percent				63	10
SUM (C)	Upland herbs excludin		percent			P	59	10
SUM(D)	Ericales		percent			P	1	0
SUM(E)	Grasses		percent				66	12
SUM(F)	Cypergrasses		percent				8	1
SUM(G)	Riparians		percent				30	3
SUM(H)	Aquatics		percent				7	2
SUM(I)	Ferns and Mosses		percent				12	8
SUM(J)	Algue and Indet		percent				11	1
SSUM(P)	Pollensum						143	44

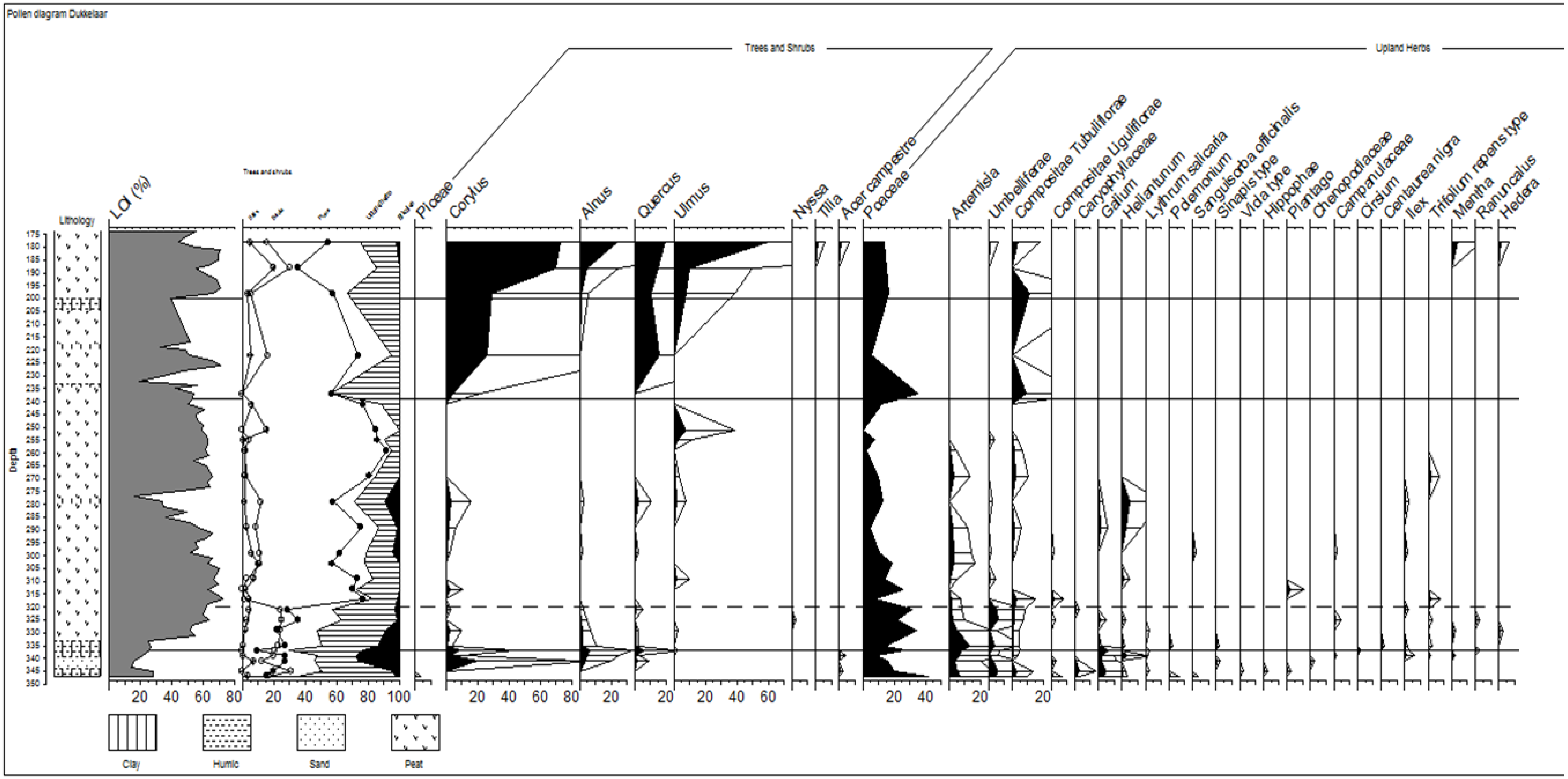
Apenbroek

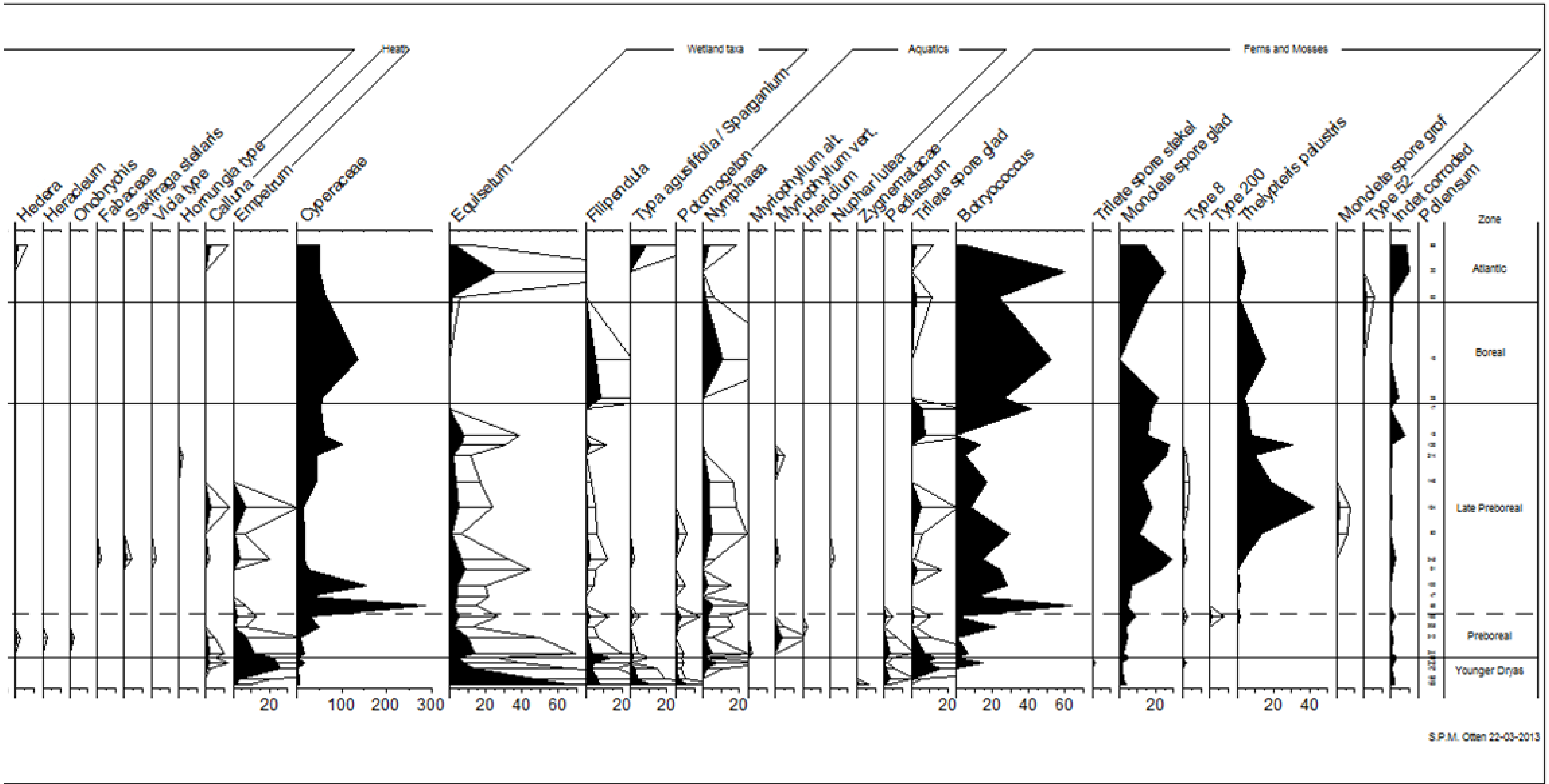
Depth							200
Pollen sample nr							104
Code	**Name**	**Element**	**Units**	**Context**	**Taphonom**	**Group**	
	Betula					A	56
	Pinus					A	3
	Salix					A	9
	Alnus					B	41
	Corylus					B	45
	Fraxinus					B	1
	Quercus					B	23
	Tilia					B	5
	Ulmus					B	2
	Artemisia					C	1
	Chenopodiaceae					C	3
	Compositae Liguliflorae					C	1
	Hedera					C	1
	Ranuncalus					C	14
	Umbelliferae					C	3
	Calluna					D	7
	Poaceae					E	26
	Cyperaceae					F	14
	Typa agustifolia / Sparganium					G	4
	Nymphea					H	1
	Potamogeton					H	8
	Monolete spore glad					I	6
	Trilete spore glad					I	27
	Helicoon pluriseptatum					J	1
	Tilletia					J	2
	Unknown/indeterminable					J	13
SUM(A)	Trees and shrubs		percent				68
SUM(B)	Thermofilous trees		percent				117
SUM(A,B)	Trees and shrubs (all)		percent				185
SUM (AB)	Trees and shrubs, excl		percent			P	144
SUM(C)	Dry herbs		percent				23
SUM (C)	Upland herbs excludin		percent			P	20
SUM(D)	Ericales		percent			P	7
SUM(E)	Grasses		percent				26
SUM(F)	Cypergrasses		percent				14
SUM(G)	Riparians		percent				4
SUM(H)	Aquatics		percent				9
SUM(I)	Ferns and Mosses		percent				33
SUM(J)	Algue and Indet		percent				16
SSUM(P)	Pollensum						171

Appendix V. Extended pollen diagrams

Below the extended pollen diagrams of Dukkelaar, Katerhof and Casquettenhof are shown. The extended versions of the Houterhof pollen diagrams are already shown in the report.

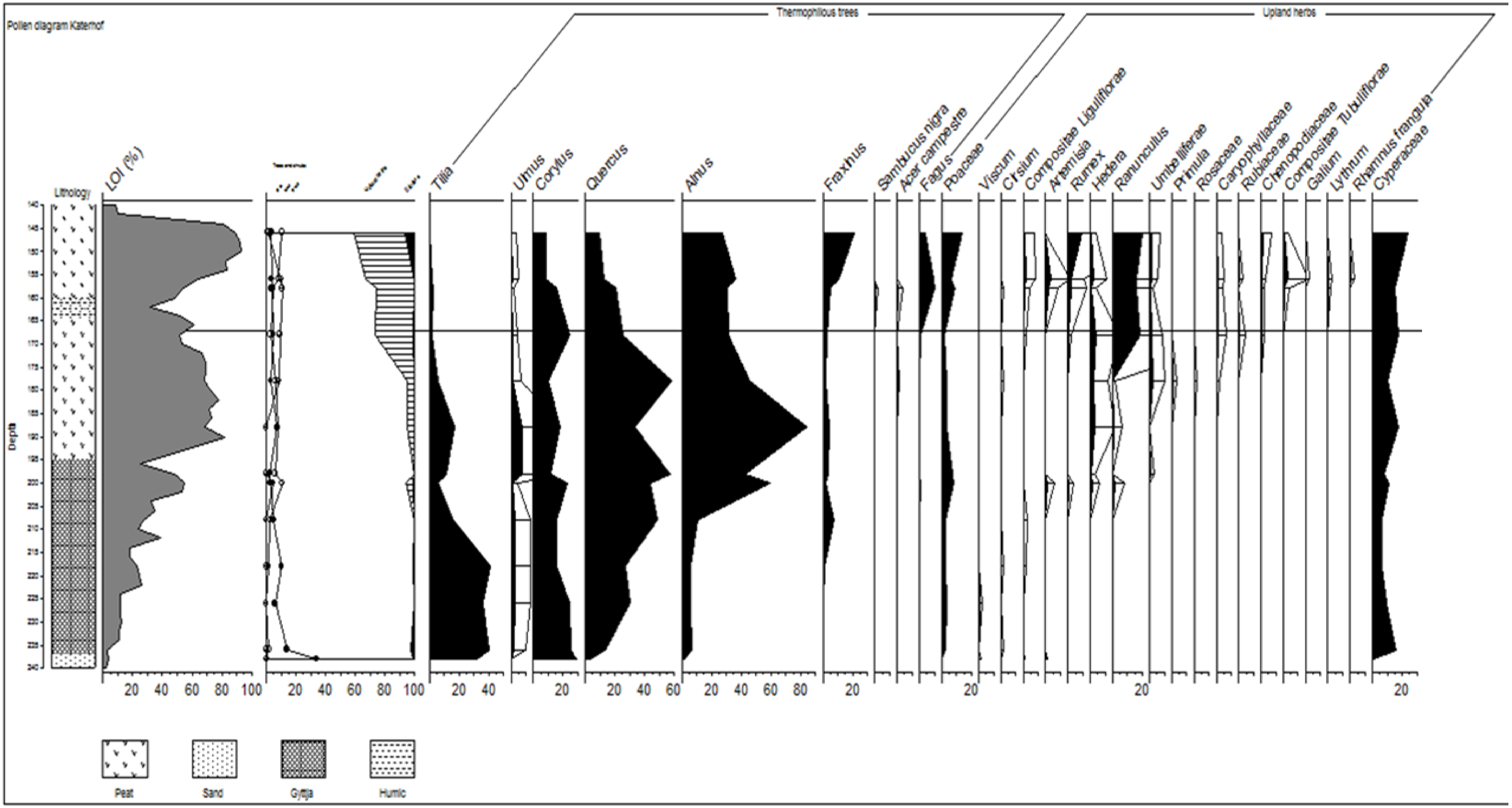
Dukkelaar



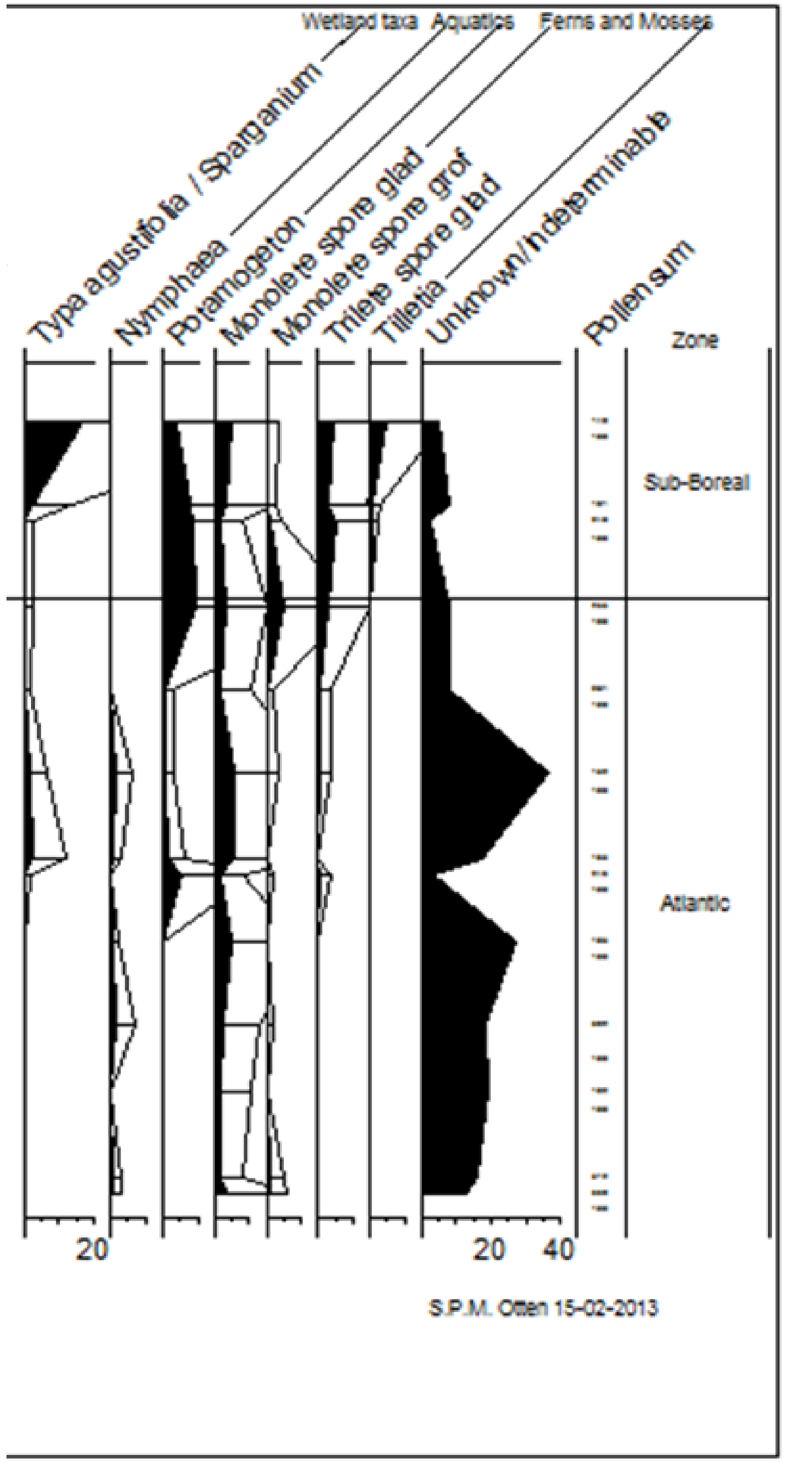


Heath
Wetland taxa
Aquatics
Ferns and Mosses
Hedera
Heracleum
Onobrychis
Fabaceae
Saxifraga stellaris
Vicia type
Hornungia type
Calluna
Empetrum
Cyperaceae
Equisetum
Filipendula
Typa agustifolia / Sparganium
Potamogeton
Nymphaea
Myriophyllum alt.
Myriophyllum vert.
Hericium
Nuphar lutea
Zygnemataceae
Pediastrum
Trilete spore glad
Botryococcus
Trilete spore stekel
Monolete spore glad
Type 8
Type 200
Thelypteris palustris
Monolete spore grof
Type 52
Indet corroded
Pollensum
Zone
Atlantic
Boreal
Late Preboreal
Preboreal
Younger Dryas
20
100 200 300
20 40 60
20
20
20
20
20 40 60
20
20 40
S.P.M. Otten 22-03-2013

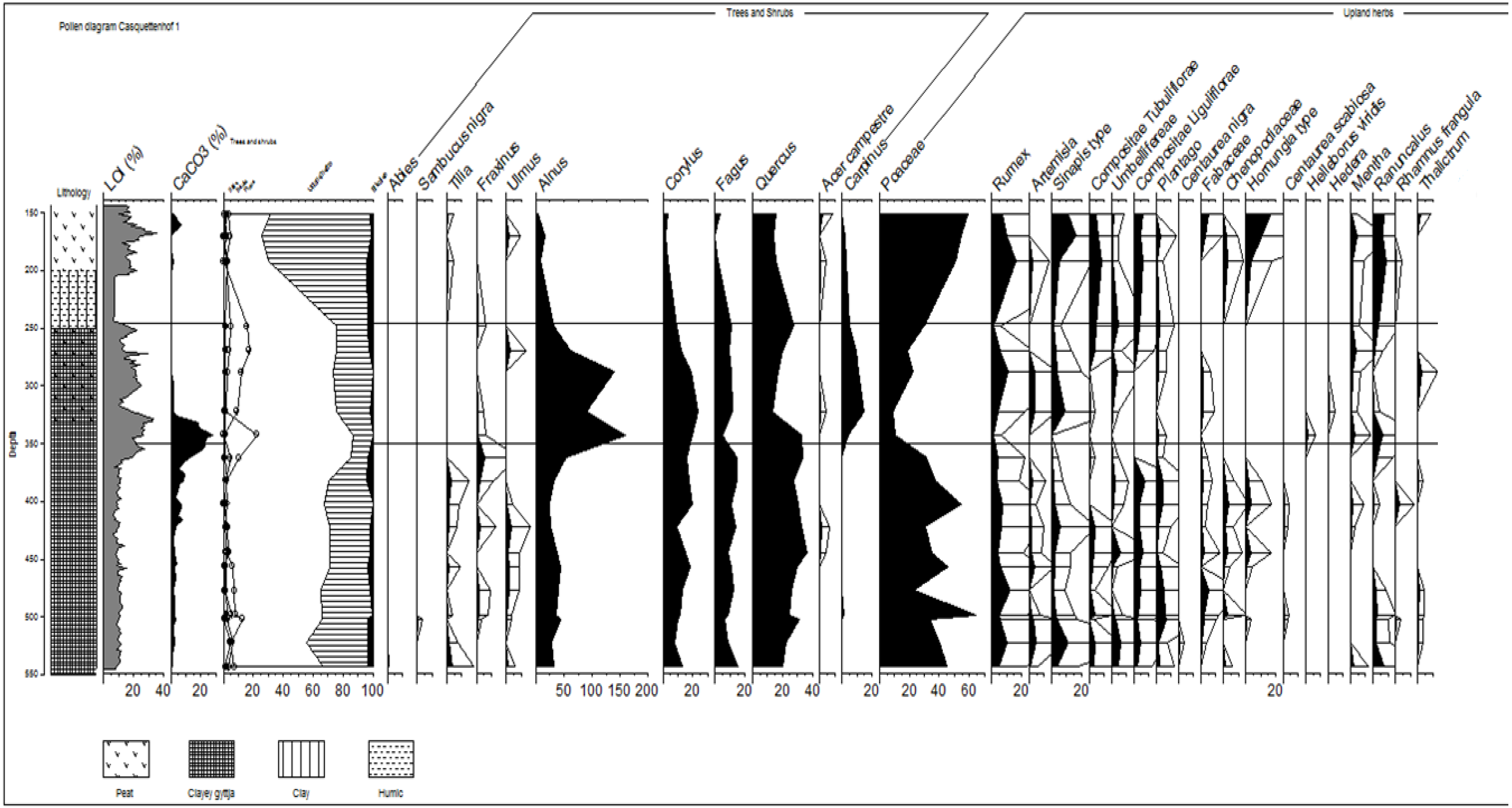
Katerhof

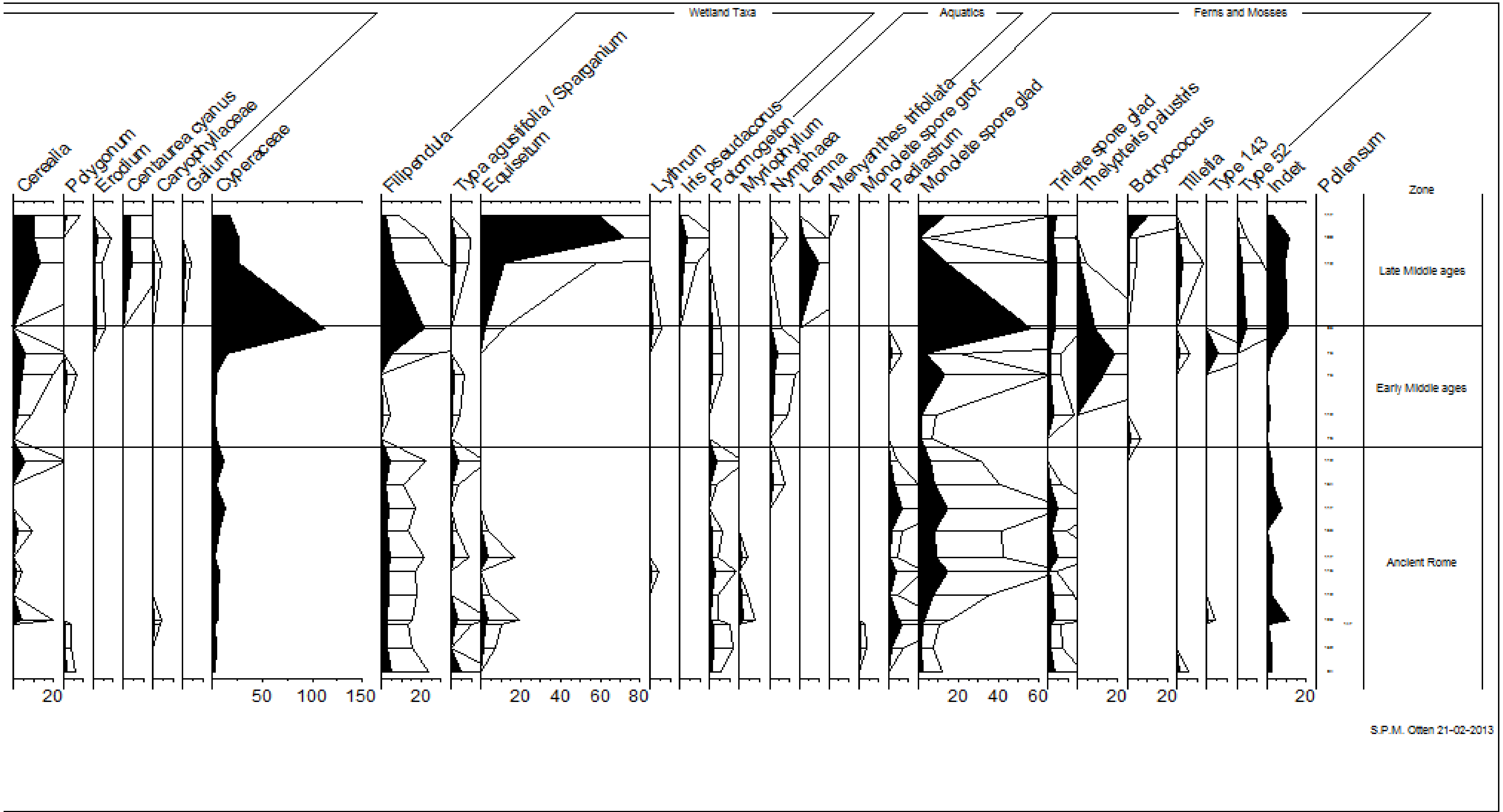


Pollen diagram Katerhof
Thermophilous trees
Upland herbs
Lithology
LOI (%)
Tilia
Ulmus
Corylus
Quercus
Alnus
Fraxinus
Sambucus nigra
Acer campestre
Fagus
Poaceae
Viscum
Cirsium
Compositae Liguliflorae
Artemisia
Rumex
Hedera
Ranunculus
Umbelliferae
Primula
Rosaceae
Caryophyllaceae
Rubiaceae
Chenopodiaceae
Compositae Tubuliflorae
Galium
Lythrum
Rhamnus frangula
Cyperaceae
Depth
Peat
Sand
Gyttja
Humic


Wetland taxa
Aquatics
Ferns and Mosses
Typa agustifolia / Sparganium
Nymphaea
Potamogeton
Monolete spore glad
Monolete spore grof
Trilete spore glad
Tilletia
Unknown/indeterminable
Pollen sum
Zone
Sub-Boreal
Atlantic
20
20
40
S.P.M. Otten 15-02-2013

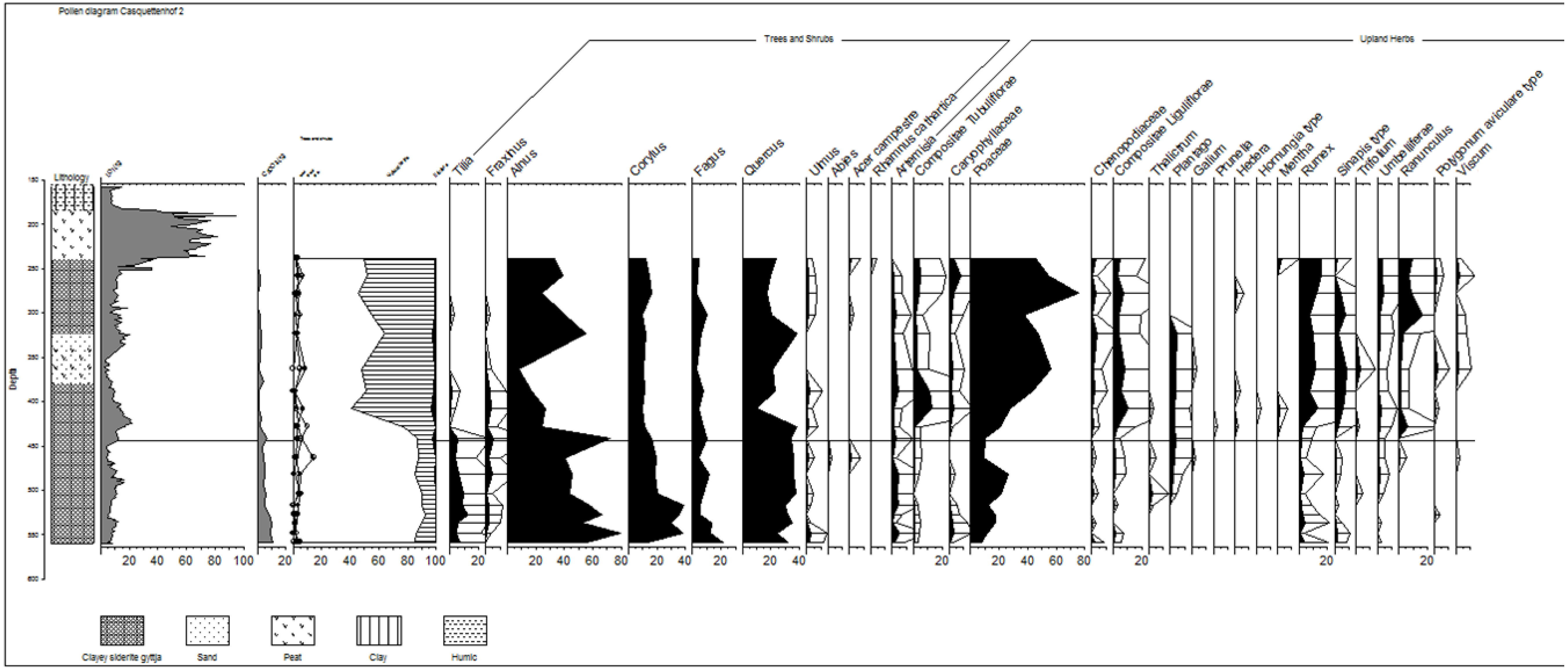
Casquettenhof I

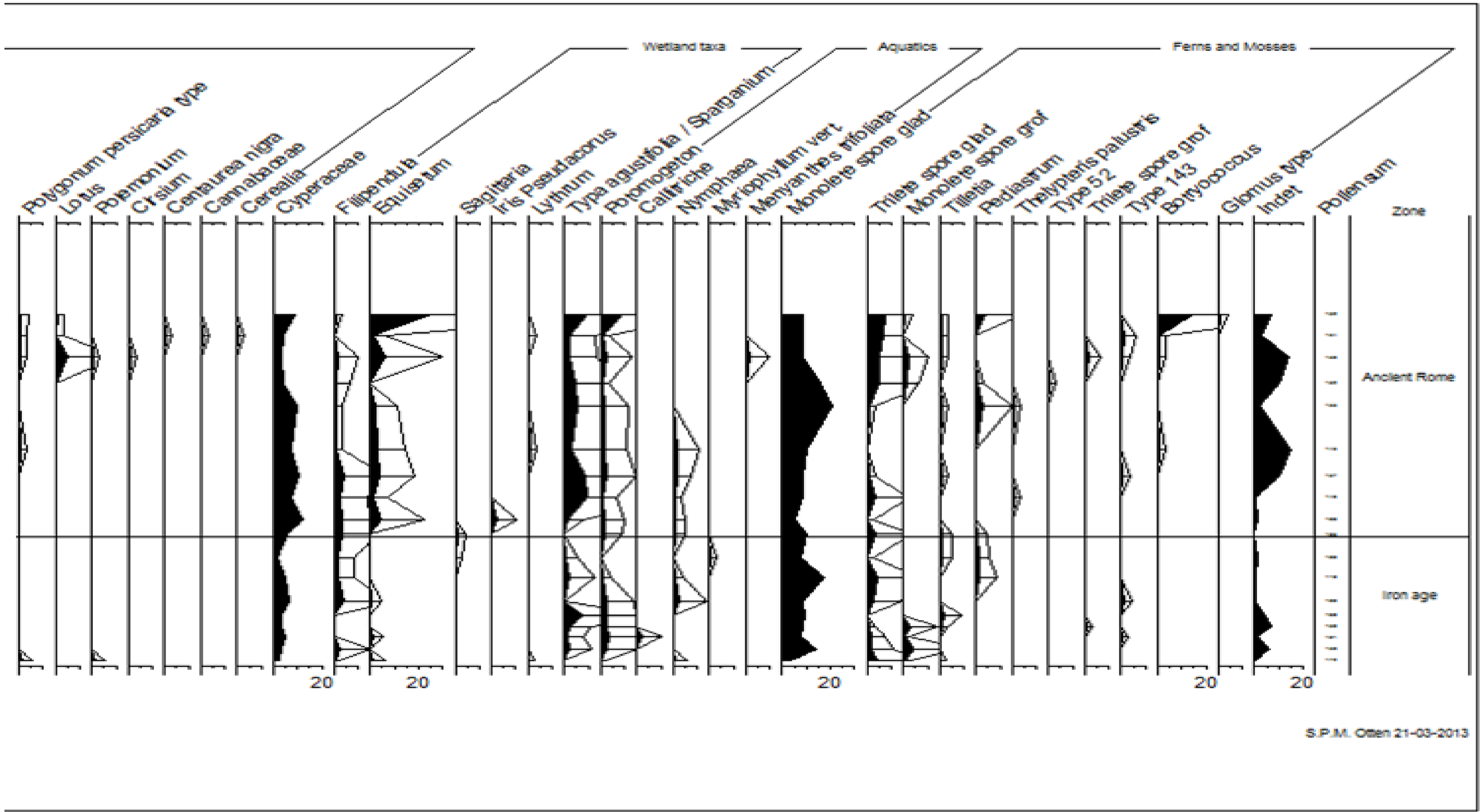




Wetland Taxa
Aquatics
Ferns and Mosses
Cerealia
Polygonum
Erodium
Centaurea cyanus
Caryophyllaceae
Galium
Cyperaceae
Filipendula
Typa agustifolia / Sparganium
Equisetum
Lythrum
Iris pseudacorus
Potomogeton
Myriophyllum
Nymphaea
Lemna
Menyanthes trifoliata
Monolete spore grof
Pediastrum
Monolete spore glad
Trilete spore glad
Thelypteris palustris
Botryococcus
Tilletia
Type 143
Type 52
Indet
Pollensum
Zone
Late Middle ages
Early Middle ages
Ancient Rome
20
50
100
150
20
20
40
60
80
20
40
60
20
20
20
S.P.M. Otten 21-02-2013

Casquettenhof II



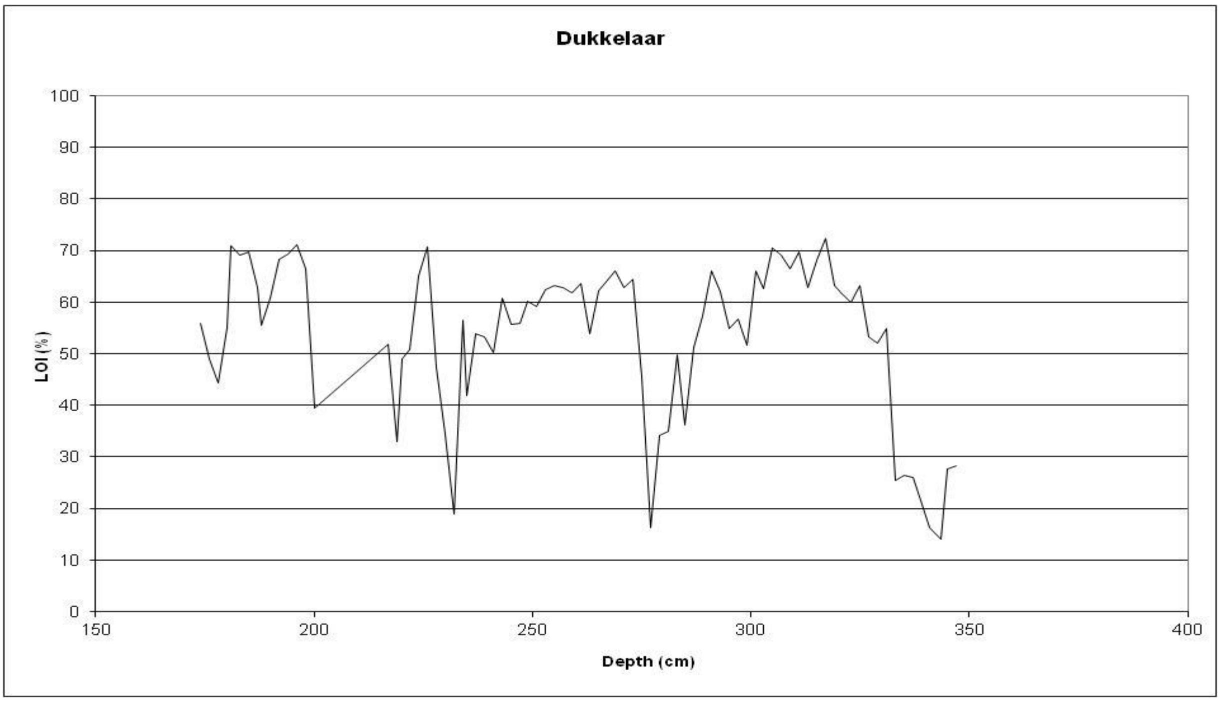


Wetland taxa
Aquatics
Ferns and Mosses
Polygonum persicaria type
Lotus
Polemonium
Cirsium
Centaurea nigra
Cannabaceae
Cerealia
Cyperaceae
Filipendula
Equisetum
Sagittaria
Iris Pseudacorus
Lythrum
Typa agustifolia / Sparganium
Potamogeton
Callitriche
Nymphaea
Myriophyllum vert.
Menyanthes trifoliata
Monolete spore glad
Trilete spore glad
Monolete spore grof
Tilletia
Pediastrum
Thelypteris palustris
Type 52
Trilete spore grof
Type 143
Botryococcus
Glomus type
Indet
Pollen sum
Zone
Ancient Rome
Iron age
20
20
20
20
20
S.P.M. Otten 21-03-2013

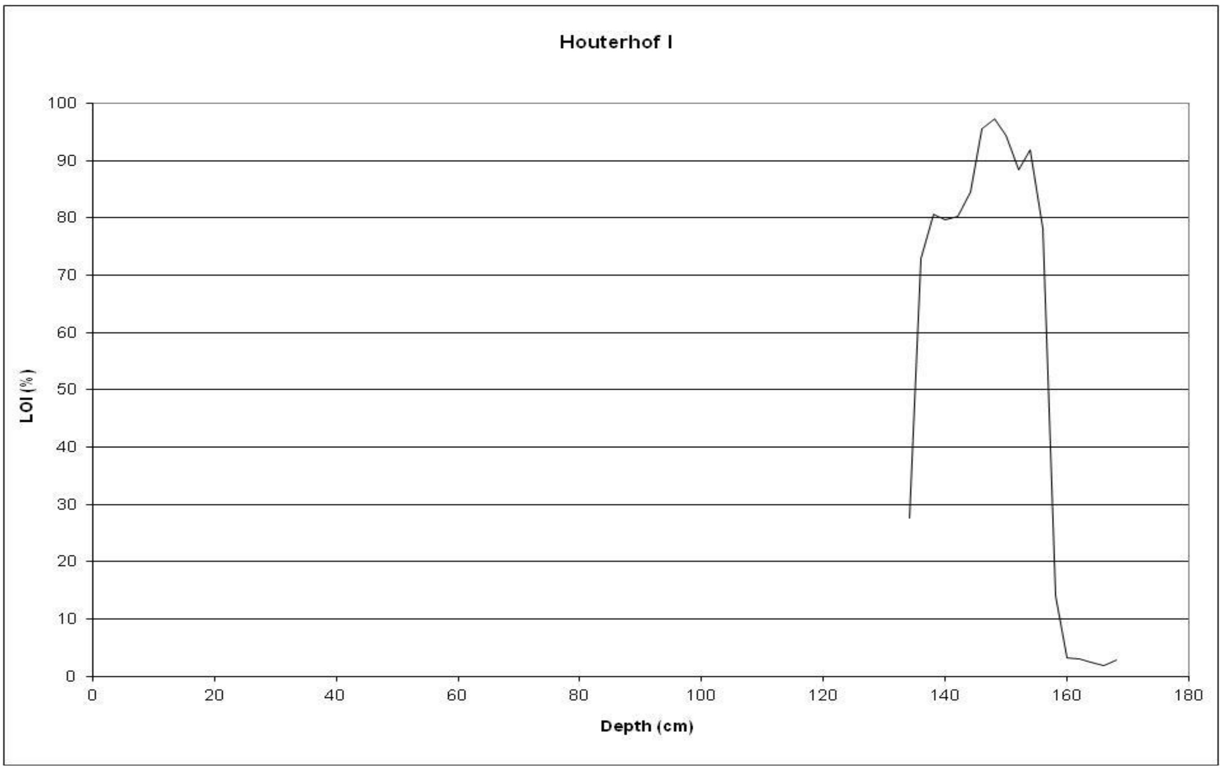
Appendix VI. Loss on Ignition and Calcium Carbonate content results

Below the LOI and calcium carbonate curves of Dukkelaar, Katerhof and Casquettenhof are shown.

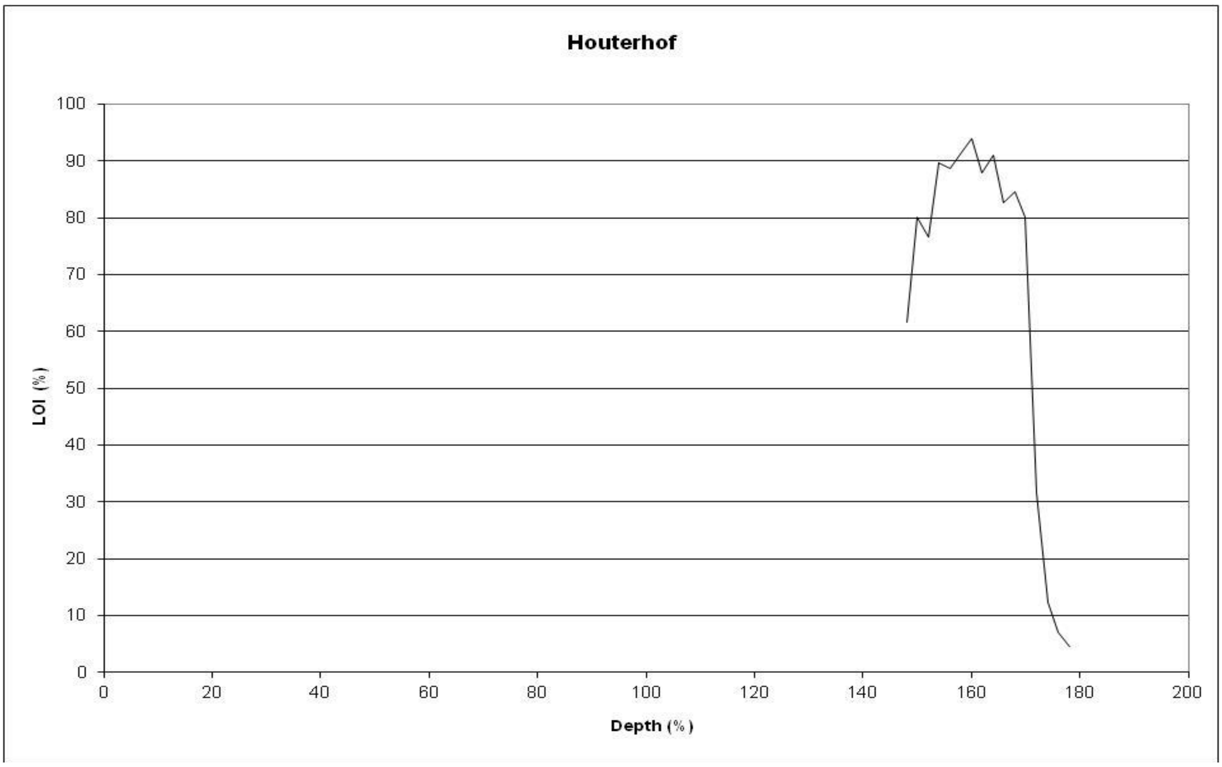
Dukkelaar



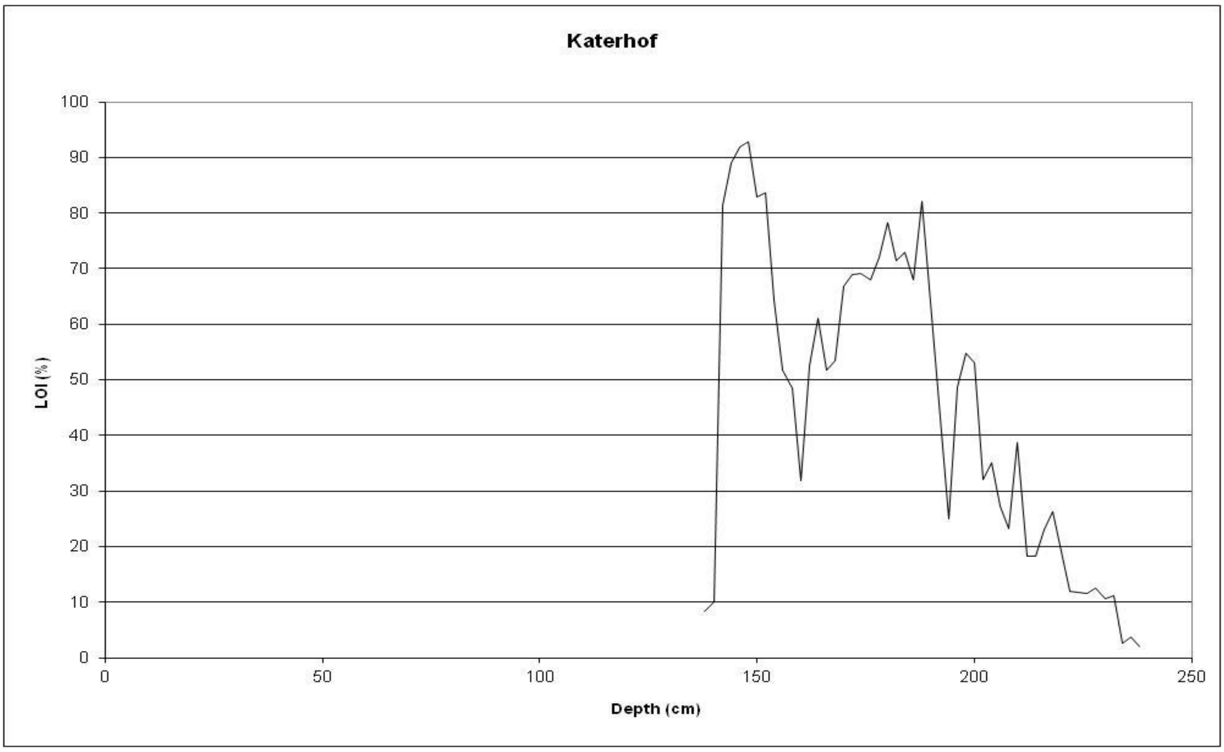
Houterhof I



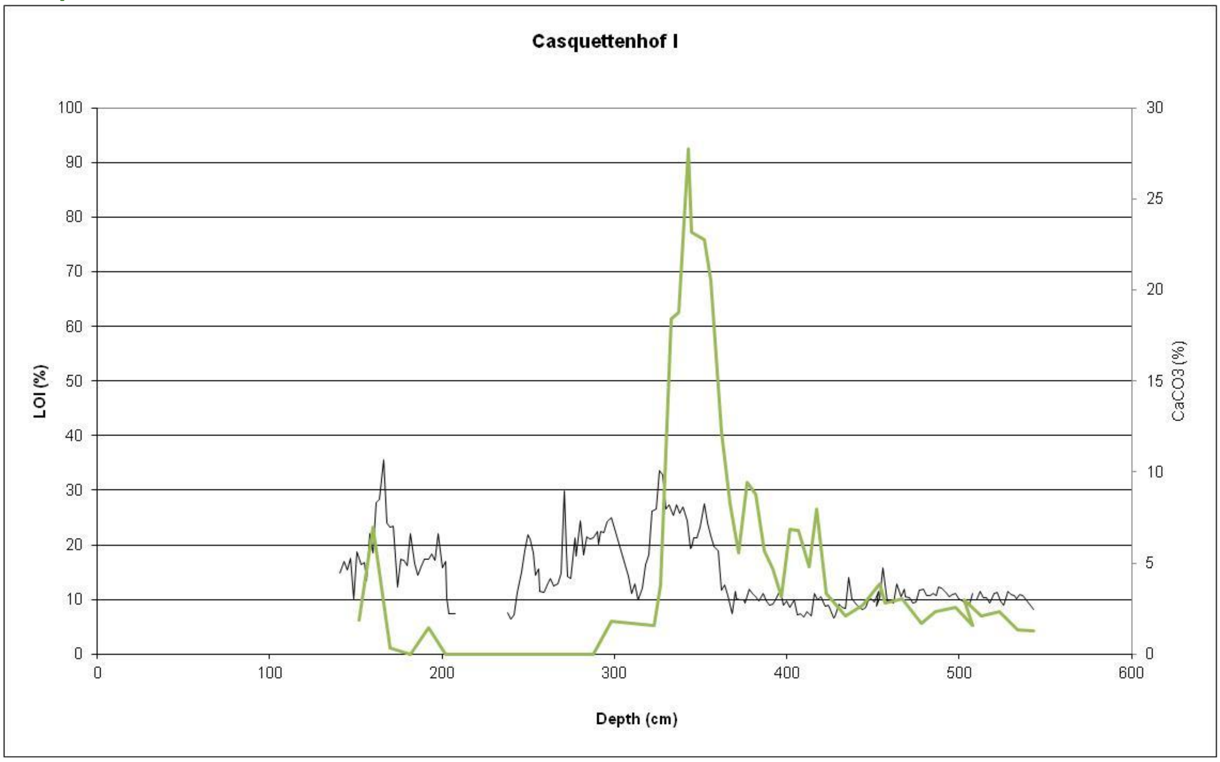
Houterhof II



Katerhof



Casquettenhof I



Casquettenhof II