Hands-on Training: Sediment and soil description, paleo-ecological sampling and macroscopic peat description.

1. Introduction

The main goal of the training session on *Sediment and soil description, sampling for dating, palaeo-ecological & palaeo-environmental research, and macroscopic peat description* is to get some hands-on experience with these topics in an informal environment under guidance of specialists. For this purpose we provide a series of cores from Belgian estuarine contexts.

This information bundle is aimed to provide you with some working materials, provided by the trainers, and information on the coring locations to use during the workshop. It is by no means aimed to be a complete training handbook on these subjects.

The training will be given by:

Sedimentology:

- **Frieda Bogemans**: Geologist at the Geological Survey of Belgium, specialised in Quaternary Geology. More info: https://gsb.naturalsciences.be/personnel/frieda-bogemans/

Pedology:

- **Jari Hinsch Mikkelsen**: Soil scientist and director of the RAAKVLAK, the immovable heritage service of Bruges and surroundings, specialized in archaeo- and palaeopedology. More info: https://raakvlak.be/

Palaeoecology:

- **Annelies Storme**: Geologist & Palaeoecologist at GATE Archaeology/Ruben Willaert, specialized in micro-fossil palaeoecology of Quaternary environments and environmental archaeology. More info: https://www.researchgate.net/profile/Annelies-Storme
- **Coralie André**: Palaeoecologist & biologist at Ghent University. Specializing in the Holocene paleoecology and environmental archaeology of the Belgian coastal plain within the High tide, Low tide CRA project. More info: https://research.ugent.be/web/person/coralie-andre-0/nl
- **Luc Allemeersch**: Palaeoecologist at GATE Archaeology/Ruben Willaert, specialized in macro-fossil palaeoecology of Quaternary environments and environmental archaeology. More info: https://www.researchgate.net/scientific-contributions/Luc-Allemeersch-2042391019

Organisation:

GHENT UNIVERSITY PROSPECT HIGH TIDE LOW TIDE Geological Survey of Belgium RAAKVLAK Onroerend Erfgoed Brugge en Ommeland

2. Schedule for the day

The training, including a demonstration of mechanical coring by Geosonda, will happen in small groups according the schedule below.

Time	Group 1	Group 2	Group 3	Group 4
9.30-10h	Introduction			
10-10.30h	Jari	Frieda	Geosonda	break
10.30-11h	Frieda	Jari	break	Geosonda
11-11.30h	Annelies/Coralie	break	Jari	Frieda
11.30-12h	Luc	Annelies/Coralie	Frieda	Jari
12-12.30h	break	Luc	Annelies/Coralie	break
12.30-13h	Geosonda	break	Luc	Annelies/Coralie
13-13.30h	break	Geosonda	break	Luc
13.30-15h	Every group investigates a sequence			
15-16h	Every group shortly presents their results			

3. Forms & materials

Sediment description form

Name geologist: Date of description:

Assignment number: Project description:

Core number:

Executed at: Coring date:

Driller: Drilling firm:

Starting level: Drilling method:

Level first observation groundwater:

Pot/Liner Nr.	Depth (m)	Nature of the sediment layers	$CaCO_3$

Name geologist: Date of description:

Pot/Liner Nr.	Depth (m)	Nature of the sediment layers	$CaCO_3$

Pedological description & interpretation

The soil approach

Training session:
core description, sampling and interpreting
the soil approach

Brugge 18 January 2023

RAAKVLAK
Onroerend Erfgoed Brugge en Ommeland

RAAKVLAK

Syllabus

1. Field planning
2. Basic and optional field materials
3. Overview of hand augers and their soil suitability
4. The Munsell color chart
5. Use of field tests
6. Types of fieldwork
7. The auger borehole and preparation
8. Soil sampling

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1. Field planning

- *Quality data demands well prepared field planning*
- Appropriate clothing and footwear, consider your personal protective equipment
- Is the field equipment in order and complete? Is everything working correctly?
- Is the drilling equipment cleaned?
- Is there a first aid kit available in the car or on site?
- Are your electrical devices charged? Do you have extra batteries with you?
- Before leaving, look at the aerial photo of the site, where to park, how best to approach the fieldsite?
- What does the soil map say about the site itself and the wider surroundings of the site?
- Do I have the right augering equipment with me according to the expected textures/soils?
- In what geomorphological context should the fieldwork be conducted?
- Has the owner and/or land user been informed in advance?
- Have a printout of the site with you, with/without the locations of the observation points?

1. Field planning

- What type of fieldwork is prescribed (augering soil profiles...)?
- How much time is planned?
- How many augerings/profiles are to be studied?
- Can the average augering depth already be estimated?
- Are the soils easy to access or are there barriers in the landscape, such as wide ditches, train tracks, picket wires, an angry bull etc.?

2. Basic and optional field materials

Field should be matched to the type of survey, soil conditions, weather, etc. The following are some recommendations

Basic field material

- Shovel, possibly straight ground and sharpened to make soil profiles perfectly legible and to cut smaller roots
- Spade
- Trowel
- Folding gauge
  - When conducting an auger survey, bring at least two folding gauges
  - Know your auger equipment a combination drill head is 20cm, there is 50cm to bottom and 70cm to top of the coupling sleeve. The small knob is at 100cm and bottom of the handle at 120cm.
- Tape measure
- Munsell color chart
- Knife
- Diluted hydrochloric acid (10% HCl) in small dropper bottle
- Hydrogen peroxide (H_2O_2, 10%): In small dropper bottle.
- Plastic sheet e.g. black preferably matte and relatively thick to lay out the drill profile
- Compass

2. Basic and optional field materials

Optional field equipment

- Scraper
- Tape measure
- Umbrella/parasol
- Scissors
- Handlens
- Soft and hard brush
- Bucket

- Chalkboard/whiteboard/tablet.
- Writing equipment: pencil, pen, permanent marker, notebook, fill-in sheets, tablet, ...
- Towel: small, to clean your hands while working, especially before using the Munsell colour chart or between two texture measurements using the finger method

2. Basic and optional field materials

Packaging for soil samples

- Plastic bags for samples meant for soil laboratory analyses, for this no undisturbed sample is needed and samples can be stored in plastic bags. Sealable bags with a writing field are recommended
- Plastic boxes, the size, shape etc. depends on the purpose. For micromorphology a 250ml rectangular salad tray is perfect sized
- Sample tray: by using a tray when sampling for soil analysis, the entire sample can be taken at once and contamination can be easily removed before the sample is placed in the plastic bag
- Sample cards: a soil sample must always be accompanied by a sample card (cfr. code of good practice for the requirements related to sample cards)



3. Overview of hand augers and their soil suitability

Combi auger (Edelman auger) all-round augering head

The **sand auger** has wider blades than the combination auger

The **coarse sand auger** is even wider than the sand auger - head almost completely closed

Piston auger for waterlogged soils a piston sampler is the best choice

A **bailer auger** for sampling completely water-saturated sandy sediments

The **clay auger** offers less resistance in sticky soil materials

The **gravel auger** or stone auger, have two small solid cutting blades

The **riverside auger** is a special auger for soils mixed with fine gravel and for immature sediments. It also cuts through cemented layers

The **gouge auger** for unripe soils or drilling below the (ground) water level. Diameters of 20mm, 30mm, 40mm? and 50mm available

Gouge auger with beating head can be driven into the ground with a special hammer (with nylon head to absorb the impact)

3. Overview of hand augers and their soil suitability

++: suitable
+ moderately suitable
- not suitable

Soil Texture	Soil moisture	Auger head	Riverside	Gouge auger
Coarse sandy	Wet	Coarse sand	—	+
	Moist	Sand	+	++
	Dry	Coarse sand	—	—
Sandy	Wet	Sand	—	++
	Moist	Combi or sand	+	++
	Dry	Sand	—	—
Silty	Wet	Combi	—	++
	Moist	Combi	—	++
	Dry		++	—
Clayey	Wet	Clay	+	++
	Moist	Clay	+	++
	Dry		++	—
Stony	Wet	Gravel	+	—
	Moist	Gravel	+	—
	Dry		++	—
Peat	Wet	Clay	—	++
	Moist	Clay	—	++
	Dry		—	+
Frozen		Spade	—	—

3. Overview of hand augers and their soil suitability

A standard auger set could include the following items

- 2 handles (top pieces)
- 4 to 6 extension pieces
- 6 to 8 couplings sleeves
- 2 combination auger heads
- 1 stone auger head
- 1 gouge auger, diameter 30 mm, length 100 cm
- 2 pairs of gloves
- 1 carrying bag
- 1 spatula or knife
- 3 to 10 pieces of black sturdy plastic of about 120 by 140 cm
- (brush, cleaning cloth)

Recommended additions for river or polder sites

- 1 clay auger head
- 1 gouge auger, diameter 30 mm, length 100 cm
- 1 gouge auger, diameter 20 mm, length 100 cm

4. The Munsell color chart

- The Munsell color chart is part of the basic equipment
- Choose a laminated edition where dirt can be carefully washed away
- Be sure to choose an edition with the full gley color charts (Gley 1 and Gley 2).

The Munsell color code consists of three elements

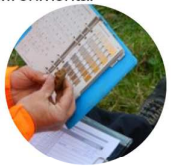
➢ the hue:
  - the pages follow each other according to the rainbow color, these are the individual hue values

➢ the value (brightness/luminosity)
  - The central vertical or y-axis possessing each leaf is the value, with black at the bottom (value = 0) and white at the top (value = 10); and

➢ the chroma (saturation/color intensity)
  The horizontal or x-axis is the chroma.

4. The Munsell color chart

- A series of special hues are added that are characteristic of soils located in reduced environmental conditions (swamps, mangroves, deltas, alluvial plains).
  - These are the "gley" colors that include more green, blue or purple hues



- Measurement of color is usually done in the field
- Important to note the moisture stage of the soil material dry, moist or wet

- **Note**
- Always determine the color of the same survey by one geologist, as there is a difference on how our brain and eyes assess a color
- Preferably the colors are determined without direct sunlight, create shadow by e.g. an umbrella
- Measuring color is more inaccurate just after sunrise and just before sunset, and in winter it is often too dark to determine color properly
- Take care of the color charts and especially make sure the color chips do not get dirty.

- In addition to the color code, color names are given for all color chips

5. Use of field tests

Fieldtest for the presence of carbonates

- Carbonates: calcium carbonate ($CaCO_3$); magnesium carbonate ($MgCO_3$).
  - Presence determined by few drops hydrochloric acid (10% HCl)
- If calcareous, bubbles will form due to the breakdown of the calcium and the formation of carbon dioxide (CO_2).
- If moisture and texture similar, the intensity chemical reaction guide to the carbonate concentration
- Regularly renew the product, cleaning the container thoroughly in the process
- In alluvial, fluvial or estuarine context, hydrochloric acid is always brought Likewise when investigating in loamy and urban contexts, hydrochloric acid is part of the standard equipment

Fieldtest for the presence of manganese oxide

- In the soil, small black spots typically 1-3 mm in diameter can sometimes be observed
- To verify whether manganese oxide or charcoal is present apply few drops of hydrogen peroxide
- If bubbles or even white smoke it is manganese oxide Charcoal is inert
- The hydrogen peroxide is used in a 10-12% dilution.
- Take good care to close the container tightly and to avoid getting the product on the skin or in the eyes

6. Types of fieldwork

Control augerings aim to answer simple questions based on a few borings (n<10).

Landscape survey aim to map an area in terms of soil and geomorphology

A landscape survey can be done in several ways Factors of importance are:

- The size order of the landscape survey, is it a small field or meadow, or is it a conglomeration of meadows, fields and natural areas?
- Is it a line tract or a coherent survey area?
- Is the natural landscape visible in the present-day landscape?
- Soil complexity.
- The historical and recent human impact on soil stratigraphy, topography and landscape geomorphology

6. Types of fieldwork

Types of landscape survey

The knowledge building survey

The transect survey with knowledge building

The transect survey with fixed distance

The survey according to a fixed grid (typical 50*50m)

Notice:

- ✓ If a augering indicates disturbance (windfall, moat, anthropogenic structures..) drill again 1 to 2 meters away etc. Still record the observation!
- ✓ Large-scale surveys where the senior earth scientist must manage multiple auger teams can only be conducted according to a fixed grid For smaller surveys, this method is not recommended precisely because of the lack of flexibility and adaptability

Archaeological borings

Exploratory archaeological drilling (10x10m or 10x12m grid); auger dia. 12 or 15cm (very clayey 10cm)

Evaluative archaeological borings (5x5m or 5x6m grid)

Test pits

Trial trenches

Excavations

7. The auger borehole and preparation

Types of landscape survey

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8. Soil sampling

Sampling strategy

- The sampling strategy is determined by the type of survey and the objective
- In soil surveys, mostly no sampling
  - Still bring sampling bags in case artifacts or special soil elements are to be samples

Sample position

- The composite sample: Multiple (typically 3-5) soil samples are collected per geological unit.
  - Stored separately (labeled as P12H2a, P12H2b, P12H2c, P12H2d etc), or
  - Sampled in one bag (labeled P12H2 for example)
- The weighted average sample: where the sample consists of material that proportionally represents the full thickness of the horizontal
- The central sample: a sample taken where the characteristics of the horizon are best developed

- Each type of sampling method has its advantages and disadvantages. The choice of method should be in function of the objective of sampling

8. Soil sampling

The amount of soil material

For soil chemical and physical laboratory analyses the amont depends on:

1) the number and type of analyses to be performed,

2) the type of soil (e.g. stony soils), and

3) the need to archive part of the sample

On samples with no or very little coarse material, the guideline is a minimum weight of 200 grams preferably 500 grams and 1 kg is recommended for important samples or for soil sample collection from heterogeneous horizons

Labeling soil sample

An example of a labeling code may look like the following:

- Project Code 2020W242
- Date 9/10/20
- Name geologist (if required:) NN
- Profile number P13
- Horizon number H6
- Sample depth 64-73 cm

8. Soil sampling

Sample collection for physical and chemical laboratory analyses

For laboratory analyses plastic bags are sufficient The preferred types are those with a locking zipper and with a special label for writing the sample code

Sample name for soil mesomorphology

Sample sampling for soil micromorphology

Kubiena box, size of 80 x 65 x 40 mm, made of aluminum (expensive) otherwise, plastic recipients!

'Metal stud': standard 50 mm wide and 40 mm deep

Sampling for determining the bulk density

Use metal rings with an exact volume of e.g. 100 cm

Usually sampled on horizontal sections, but also possible with an auger

Homogeneous horizon (e.g., a plow layer), 3 samples are sufficient;

Standard horizons (e.g. an E, and B or a C horizon), 5 samples are recommended; and for

Heterogeneous horizons (e.g., a Bt or a gravelly horizon) 8 samples are desired

!!! Always store samples in the shade

!!! Immediately after fieldwork dry the soils

Field Manual for describing of soils in archaeological resear in Flanders

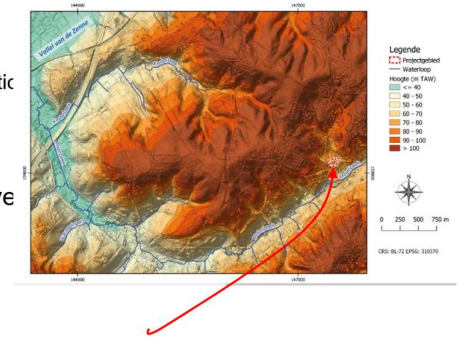
Authors
Jari Mikkelsen, Carole Ampe, Nathalie Cools, Yannick Devos, Stefaan Dondeyne, Katrien Oorts, Marnix Pieters & Roger Langohr

GENERAL INFORMATION ABOUT THE RESEAR(THE LOCATION/SITE

- Project code
- Internal project code
- Site location
- Type of survey
- Reference profile/auger number
- Identification excavation plan
- Identification number
- Date soil description/date of bore hole drilling
- Author(s) and organization
- X and Y coordinates
- Elevation
- Weather conditions
- Field data specific to an auger survey
  - The auger strategy
  - The auger distance
  - The orientation of the auger transects
  - The diameter of the borehole
  - The technique and type of auger

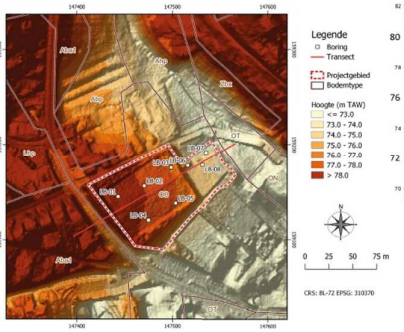
SOIL-FORMING FACTORS

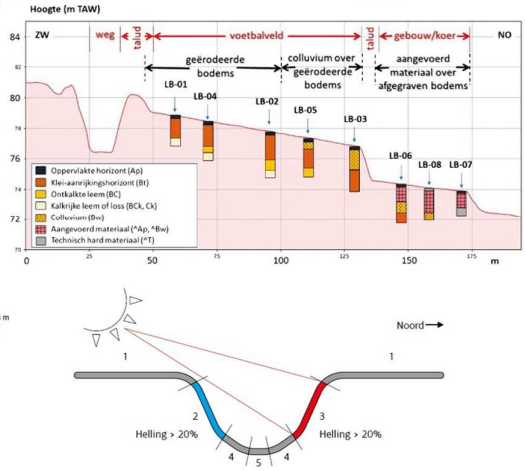
- Parent material
- Substrate
- Geomorphology
  - General relief
  - Slope position, slope shape and orientatic
- Soil hydrology
  - External water regime
  - Current water table
- Contemporary land use and land cove
  - Plant species (vegetation)
- Anthropogenic influence on the landscape (terrain observations)
- Erosion and sedimentation
  - Type
  - Activity



SOIL-FORMING FACTORS

- Geomorphology





SOIL-FORMING FACTORS

- Soil hydrology
  - External water regime
  - Current water table
- Contemporary land use and land cover
  - Plant species (vegetation)
- Anthropogenic influence on the landscape (terrain observations)
- Erosion and sedimentation
  - Type
  - Activity

TABEL 7 / De categorieën voor de periode van erosie/sedimentatie te omschrijven

Geen erosie in het Holoceen (bosbestanden)
Versnelde en natuurlijke erosie niet waargenomen
Periode van activiteit niet gekend
Actief in de prehistorie
Actief in de historische periode
Actief in een recent verleden (laatste 100 jaar ongeveer)
Tot op vandaag actief

- Vegetation (weakly/moderately/seriously disturbed)
- Deepplouging
- Plaggen
- Bed construction
- Levelling
- Raising
- Excavation (land clearing)
- Excavation (trenches)
- Drainage (e.g., via pipes or ditches)
- Soil compaction (treading, riding)
- Trenches from trafficking
- Soil sealing (road, old floor, asphalt...)
- Clearing (e.g., of forest or building)
- Forest exploitation
- Contamination (e.g., oil, construction waste)
- Archaeology (visible, e.g., burial mounds or dikes)
- Other (explain)

Human (examples)

Raised beds, agriculture, forest management

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Human (examples)

Levelling

Mining

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Human (examples)

Raised and spitted

Raised

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Human (examples)

Archaeology Motte van Werken

Archaeology Earthwall

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DESCRIPTION OF SOIL HORIZONS AND LAYERS

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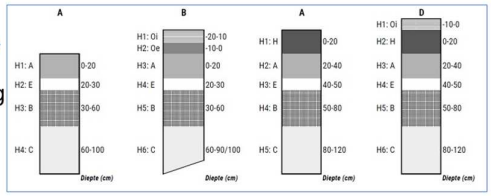
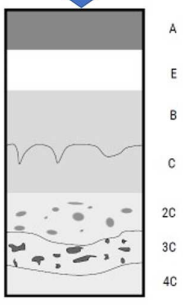
- Surface rocks
- Horizon boundary
  - The number of the horizon (geolog
  - The depth relative to ground level
  - Horizon boundary distinctness
  - Horizon topography
- Soil moisture
- Soil colour
- Mottling
  - Colour
  - Abundance
  - Contrast



DESCRIPTION OF SOIL HORIZONS AND LAYERS

RAAKVLAK

- Earth unit designation (horizon symbo
  - Main horizons and layers (master symb
  - Vertical subdivisions
  - Lithological discontinuity



Master horizons and layers

Symbol	Description
H	Organic horizon formed under long-term water-saturated conditions (peat). H horizons are further classified according to the degree of decomposition: Hi (fibric), virtually intact plant remains, He (mesic), partially decomposed, Ha (sapric), advanced stage of decomposition.
O	Organic horizon formed by accumulation of plant remains that have fallen to the soil surface, but not in water-saturated conditions. Oi: consists of no to little decomposed organic material, especially litter such as leaves/needles, twigs, woody materials. Oe: consists of moderately decomposed, mainly fragmented organic material whose original structure can still be recognized. Oa: consists of mainly highly decomposed organic material, humus; the original structure of the organic material is no longer recognizable.
A	Mineral horizon enriched with humified organic material, formed at or near the surface.
E	Mineral horizon from which clay and/or iron and/or aluminium have leached (eluviation); usually has a lighter colour and/or lighter texture than the upper and lower horizons.
B	Mineral horizon usually below an A or E horizon, in which soil processes have taken place; the original stratification or sediment structure (i.e. geological structure) has at least largely disappeared. The main soil processes in transforming a C-horizon into a B-horizon are: Colour development (browning), Structure development, Decalcification (leaching of carbonates), Clay formation due to weathering of primary soil minerals; Illuviation (enrichment) of iron, aluminium, clay, humus.
C	The parent material: an unconsolidated mineral layer, not or very little influenced by soil-forming processes, i.e. where geological structure dominates (properties characteristic of the H, O, A, E or B horizons are absent).
L	Limnic material: sediments deposited under water, consisting of both organic and mineral soil material. Limnic material was deposited, for example, by the deposition of organisms that lived in the water such as algae, diatoms, etc., or originates from underwater vegetation that was later worked by aquatic fauna. Sedimentary deposits of peat belong to this but not deposits consisting of in situ vegetation (use the H for this).
R	Little weathered, or unweathered, hard rock.
T	Technically hard materials such as asphalt, concrete, foundations, etc.

DESCRIPTION OF SOIL HORIZONS AND LAYERS

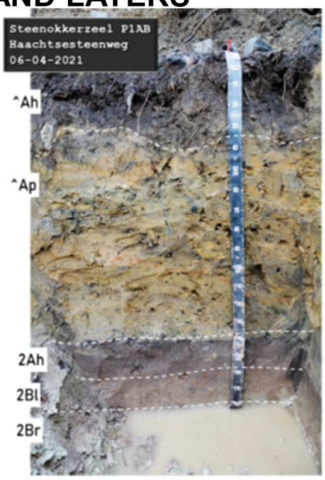
- Earth unit designation (horizon symbols)
  - Additional features of a horizon/layer (subordinate symbols

Symbol	Description	Use
a	Strongly decomposed organic material	H- en O-horizons
b	Buried horizon or layer	
β	A biologically highly active layer	Not for A-horizons
c	Concretions and/or nodules	
d	Compaction, root limiting	
e	Partially decomposed organic material	H- en O-horizons
g	Oxido-reduction mottles (Fe and/or Mn) caused by a temporarily stagnant water table	
h	Accumulation of organic matter	
i	Slightly decomposed organic material	H- en O-horizons
j	Accumulation of jarosite	
k	Accumulation of secondary carbonate	
l	Oxido-reduction mottles (Fe and/or Mn) caused by a fluctuating groundwater table	
m	Cemented horizon	Particular in Podzol B horizon
m	Marsh limnic, marl	L-horizon
p	Cultivated horizon (plough horizon...)	A-horizon (surface or buried)
q	Accumulation of silica	
r	Strong reduction (permanent groundwater table)	
s	Illuvial accumulation of sesquioxides	
t	Presence of clay illuviation	B-horizon
u	Presence of anthropogenic material	
w	Color and/or structure due to soil genesis	B-horizon
x	Fragipan characteristics	Btx
y	Accumulation of gypsum	
z	Accumulation of salts more soluble than gypsum	
zo	Zoogenic (of animal origin: meso or macrofauna)	Only H-, O- and A-horizons Use as prescript
noz	Non-zoogenic (no animal activity, but presence of fungi).	Only H-, O- en A-horizons Use as prescript
@	Traces of cryoturbation	
^	Anthropogenic (mechanically) supplied material	Use as prescript

DESCRIPTION OF SOIL HORIZONS AND LAYERS

- Anthropogenic (mechanically) supplied mater

Symbol	Description
^T	Technical hard material, supplied (e.g. tiles, concrete layer, glass, asphalt, ...)
^A	Surface horizons developed in anthropogenically supplied material
^Ah	Surface horizons developed in anthropogenically supplied material enriched with organic material
^Ab	Buried surface horizons of anthropogenically supplied mineral material
^Bw	Supplied mineral soil material. Colour or texture development ('w') is a feature adopted from the supplied material or may have formed in situ
^E	Supplied mineral material from an original eluvial horizon
^C	Mineral material in which no soil formation has occurred since anthropogenic deposition, i.e. in which there is not yet any new soil structure or colouration indicating that weathering has occurred
^Ch	Supplied mineral material rich in organic matter, in which no soil formation has occurred since the anthropogenic deposition
^Cu	Supplied mineral material dominated by waste from human settlements and/or industrial residues (slag heaps, dredge, clinker, ash, rubble, etc.)



DESCRIPTION OF SOIL HORIZONS AND LAYERS

- Anthropogenic (mechanically) supplied material

Symbol
^T
^A
^Ah
^Ab
^Bw
^E
^C
^Ch
^Cu

DESCRIPTION OF SOIL HORIZONS AND LAYERS

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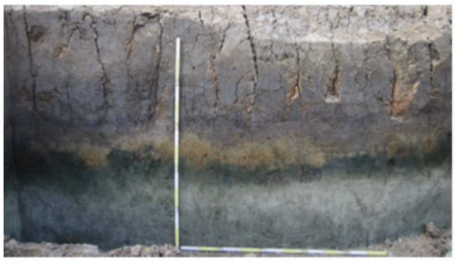
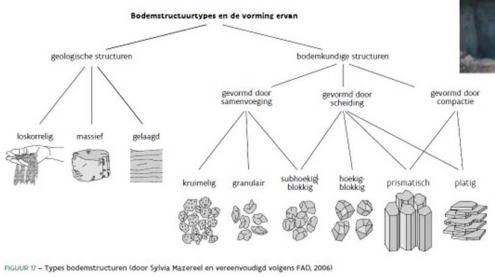
- Texture
  - Presence of clay coatings
- Coarse fragment
  - Type of fragment
  - Distribution/distribution of the coarse fraction in the profile
  - Cappingsand pendants

DESCRIPTION OF SOIL HORIZONS AND LAYERS

RAAKVLAK

- Soil structure
  - Types of soil structure
  - The dimensions
  - The degree of structure development
  - Composite structure





FIGUUR 17 – Types bodemstructuren (door Sylvia Mazereel en vereenvoudigd volgens FAO, 2006)

DESCRIPTION OF SOIL HORIZONS AND LAYERS

RAAKVLAK

- Cementation
- Compactness
- Living roots
  - Number

Root mat

Preferetial root growth

Treerooth

DESCRIPTION OF SOIL HORIZONS AND LAYERS

- Traces of animal activity
  - Type of animal activity
  - Concentration
  - Condition
  - Associated characteristics

Wildboar

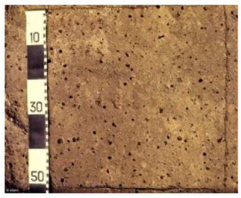
Mole

Rabbit

Cows

Fauna

Earthworms



Ants

Mols

Micro organisms

RAAKVLAK

Fauna

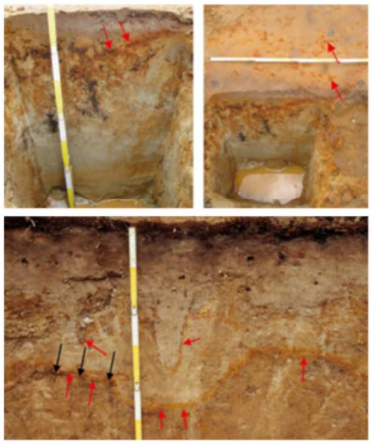
Dassenburcht (St.Trudo, Steenbrugge)

RAAKVLAK

DESCRIPTION OF SOIL HORIZONS AND LAYERS

RAAKVLAK

- Carbonate reaction with HCl
- Accumulations of iron and manganese



CLASSIFICATION AND REGISTRATION LEVEL OF THE SOIL PROFILE

RAAKVLAK

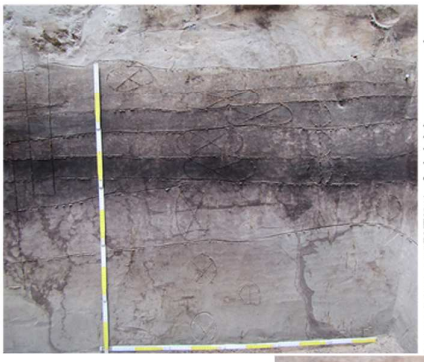
- Soil types according to the Belgian Soil Classification
- The drainage classes and soil moisture regime
- Profile development
- Brief soil description
- Record level (linking with Code of Good Practice)
- Special soil characteristics important for interpretation
- Photographic recordings

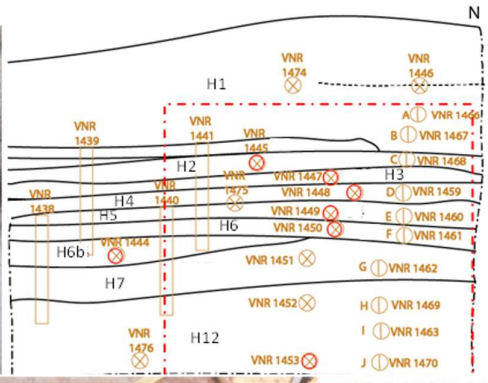
RAAKVLAK

CLASSIFICATION AND REGISTRATION LEVEL OF THE SOIL PROFILE

RAAKVLAK

- Photographic recordings





CLASSIFICATION A REGISTRATION LE OF THE SOIL PROF

RAAKVLAK

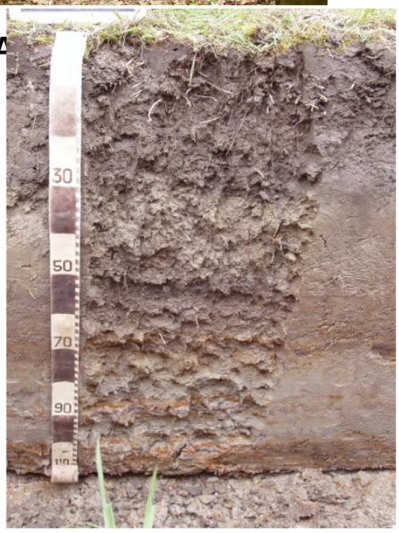
- Photographic recordings

CLASSIFICATION AND REGISTRATION LEVEL OF THE SOIL PROFILE

- Photographic recordings

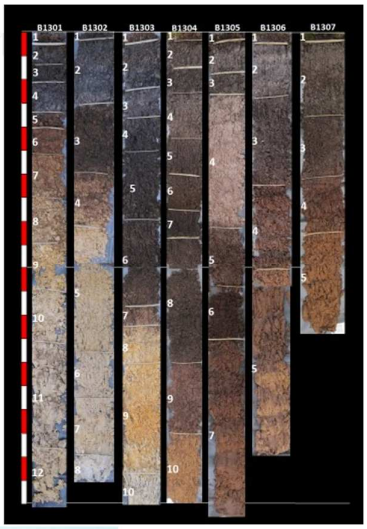
CLASSIFICATION AND REGISTRA LEVEL OF THE SOIL PROFILE

- Photographic recordings



CLASSIFICATION AND REGISTRAT LEVEL OF THE SOIL PROFILE

- Photographic recordings



Empty pedological description form

RAAKVLAK ID:		Datum:		Uitvoerders:		Boortype:		GWT:	
Topografie:				Vegetatie:		Opmerkingen:			

Boor Nr.	Hori. nr.	Horizont Symbool	Diepte	Grens	Kleur Kleur	Homo-geniteit	Vlekken Type	Kleur	Contrast	Frequentie	Textuur	Stratifi-catie	Kalk	Orga-nische fractie	Inclusies	Vocht	Staal	Opmerkingen
	1			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	2			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	3			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	4			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	5			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	6			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	7			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	8			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	1			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	2			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	3			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	4			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	5			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	6			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	7			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	8			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	1			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	2			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	3			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	4			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	5			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	6			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	7			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	
	8			A/D/G/D/X		HO/liHE/HE	OXI/RED		O/D/U	ZW/W/Va/Ve/ZV		J/N	J/N	G/W/Ve		D/V/N	J/N	

Grens	Abrupt	0-2cm	Kleur, homogeniteit:	Homogeen	Vlekken, type:	Oxido	Frequentie:	Zeer weinig	Organisch f.:	Geen	Vocht:	Droog
	Duidelijk	2-5cm		Licht heterogeen		Reductie		Weinig		Weinig		Vocht
	Geleideli	5-15cm		Heterogeen				Vaak		Veel		Nat
	Difffus	>15cm						Veel				
								Zeer veel				

Completed pedological description form example

RAAKVLAK: landschappelijk booronderzoek

ID: BR22PA, 2022F162 | Datum: 1/12 en 5/12 | Uitvoerders: Jari Mikkelsen, Femke Germonpré, Jurgen Vandewalle, Bjorn Verbeke

Boring	x-coordinaat	y-coordinaat	TAW	TAW (cm)	Horizont						Kleur	Vlekken			Textuur	Stratificatie	Kalk	Inclusies	Vocht	Opmerkingen per horizont	Interpretatie boring
					Nummer	Symbool	Diepte			Grens	Kleur	Type	Kleur	Frequentie							
							Top	Onderkant	TAW top												
B1	67651.792	214073.48	3.8099999	380.99999	H1	^Ah	0	14	381		doBR									dunne A-horizont, vermoedelijk aangevoerd	1e poging gestaakt op 60 cm, 2e poging gestaakt op mengeling van mortel en baksteen op 72 cm diepte. Sterk antropogeen verstoorde bodem.
					H2	Bu	14	38	367		GRBR	OXI	Ro								
					H3	Cu1	38	63	343	duidelijk	BLGR	OXI	Ro		klei						
					H4	Cu2	63	72	318									bakstee n mortel		boring gestaakt op baksteen	
B2	67672.5	214057.75	4.3200002	432.00002	H1	^Ah	0	13	432		doBR									dunne A-horizont, vermoedelijk aangevoerd	Natuurlijke sedimenten (getijdenlandschap, estuariene sedimenten) H8 restgeul, H7 stabilisatie met humusaccumulatie, nadien heractivatie van de geul: opnieuw zandafzettingen (H6). H5 duidt opnieuw op een stabilisatie, nadien neemt de stroomsnelheid toe: zandafzetting in H4 en H3. bodem vermoedelijk afgeknot en omgewoeld (H2) door antropogene invloed. H1 aangevoerd
					H2	^B	13	33	419		BRGR	OXI	Ro		zand+klei					meer kleiig, zonevreemd (aangevoerd), gemengd	
					H3	C1	33	63	399	scherp	liGR				grof zand				V	heel zuiver zand (zandplaat, afgezet onder sterke stroming?)	
					H4	C2	63	81	369		liBEGR				zand				V	iets meer beige	
					H5	C3	81	93	351		doGR				zand	ja			V	stratificatie met humusbandjes	
					H6	C4	93	110	339		doBEGR				zand				V	iets meer beige	
					H7	2A	110	131	322	scherp	doGRZW				klei				V	begraven A, andere lithologie	
					H8	2Cr	131	200	301		doBLGR				zandleem				N	sterk gereduceerd, iets grover materiaal	

Master horizons and layers

Symbol	Description
H	Organic horizon formed under long-term water-saturated conditions (peat). H horizons are further classified according to the degree of decomposition: Hi (fibric), virtually intact plant remains, He (mesic), partially decomposed, Ha (sapric), advanced stage of decomposition.
O	Organic horizon formed by accumulation of plant remains that have fallen to the soil surface, but not in water-saturated conditions. Oi: consists of no to little decomposed organic material, especially litter such as leaves/needles, twigs, woody materials. Oe: consists of moderately decomposed, mainly fragmented organic material whose original structure can still be recognized. Oa: consists of mainly highly decomposed organic material, humus; the original structure of the organic material is no longer recognizable.
A	Mineral horizon enriched with humified organic material, formed at or near the surface.
E	Mineral horizon from which clay and/or iron and/or aluminium have leached (eluviation); usually has a lighter colour and/or lighter texture than the upper and lower horizons.
B	Mineral horizon usually below an A or E horizon, in which soil processes have taken place; the original stratification or sediment structure (i.e. geological structure) has at least largely disappeared. The main soil processes in transforming a C-horizon into a B-horizon are: Colour development (browning), Structure development, Decalcification (leaching of carbonates), Clay formation due to weathering of primary soil minerals, Illuviation (enrichment) of iron, aluminium, clay, humus.
C	The parent material: an unconsolidated mineral layer, not or very little influenced by soil-forming processes, i.e. where geological structure dominates (properties characteristic of the H, O, A, E or B horizons are absent).
L	Limnic material: sediments deposited under water, consisting of both organic and mineral soil material. Limnic material was deposited, for example, by the deposition of organisms that lived in the water such as algae, diatoms, etc., or originates from underwater vegetation that was later worked by aquatic fauna. Sedimentary deposits of peat belong to this but not deposits consisting of in situ vegetation (use the H for this).
R	Little weathered, or unweathered, hard rock.
T	Technically hard materials such as asphalt, concrete, foundations, etc.

The subordinate horizon symbols:

Symbol	Description	Use
a	Strongly decomposed organic material	H- en O-horizons
b	Buried horizon or layer	
β	A biologically highly active layer	Not for A-horizons
c	Concretions and/or nodules	
d	Compaction, root limiting	
e	Partially decomposed organic material	H- en O-horizons
g	Oxido-reduction mottles (Fe and/or Mn) caused by a temporarily stagnant water table	
h	Accumulation of organic matter	
i	Slightly decomposed organic material	H- en O-horizons
j	Accumulation of jarosite	
k	Accumulation of secondary carbonate	
l	Oxido-reduction mottles (Fe and/or Mn) caused by a fluctuating groundwater table	
m	Cemented horizon	Particular in Podzol B horizon
m	Marsh limnic, marl	L-horizon
p	Cultivated horizon (plough horizon...)	A-horizon (surface or buried)
q	Accumulation of silica	
r	Strong reduction (permanent groundwater table)	
s	Illuvial accumulation of sesquioxides	
t	Presence of clay illuviation	B-horizon
u	Presence of anthropogenic material	
w	Color and/or structure due to soil genesis	B-horizon
x	Fragipan characteristics	Btx
y	Accumulation of gypsum	
z	Accumulation of salts more soluble than gypsum	
zo	Zoogenic (of animal origin: meso or macrofauna)	Only H-, O- and A-horizons Use as prescript
noz	Non-zoogenic (no animal activity, but presence of fungi).	Only H-, O- en A-horizons Use as prescript
@	Traces of cryoturbation	
^	Anthropogenic (mechanically) supplied material	Use as prescript

Symbol	Description
^T	Technical hard material, supplied (e.g. tiles, concrete layer, glass, asphalt, ...)
^A	Surface horizons developed in anthropogenically supplied material
^Ah	Surface horizons developed in anthropogenically supplied material enriched with organic material
^Ab	Buried surface horizons of anthropogenically supplied mineral material
^Bw	Supplied mineral soil material. Colour or texture development ('w') is a feature adopted from the supplied material or may have formed in situ
^E	Supplied mineral material from an original eluvial horizon
^C	Mineral material in which no soil formation has occurred since anthropogenic deposition, i.e. in which there is not yet any new soil structure or colouration indicating that weathering has occurred
^Ch	Supplied mineral material rich in organic matter, in which no soil formation has occurred since the anthropogenic deposition
^Cu	Supplied mineral material dominated by waste from human settlements and/or industrial residues (slag heaps, dredge, clinker, ash, rubble, etc.)

Sampling for dating, palaeo-ecological & palaeo-environmental research

Preparation of the core

→ Opening the sample
- Cut the liner (2 halves or lid)
  - Liners cutter
  - Multitool
  - Core splitter
- Split the sediment: with iron wire or fishing line

→ Cleaning the core (knife)

→ Taking pictures (camera or scanner)

→ Scanning with sensors
- Magnetic susceptibility
- Gamma ray density
- Spectrophotometer

Sampling strategy

→ Depending on research questions

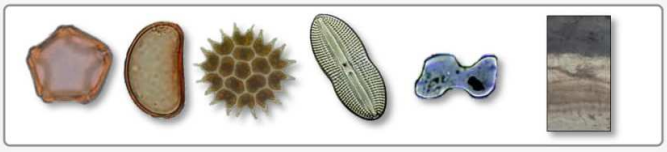
→ Possibilities of the sediment
- Non-organic clastic sediment → diatoms, charred remains, molluscs, OSL
- Organic-rich sediment → + pollen, waterlogged botanical macroremains, ^{14}C
- Soil → soil characteristics, micromorphology

! Be ware of oxidation

→ Sampling resolution
- High in slowly deposited layers (e.g. organic lake infill)
- Low in fast deposited layers (e.g. sandy channel infill)

Proxy	Sediment type	Purpose
Grain size	All sediment types	Palaeo-environmental reconstruction
Loss-on-ignition	All sediment types	Palaeo-environmental reconstruction
Pollen & spores	Organic-rich sediment, below GWT	Local & regional vegetation & palaeo-environmental reconstruction
Diatoms	(Acidic) sediments	Palaeo-environmental reconstruction
Phytoliths	(Acidic) sediments	Local vegetation reconstruction
Botanical macroremains	Organic-rich sediment, waterlogged only below GWT, charred also above GWT	Local vegetation & palaeo-environmental reconstruction
Molluscs	Alkaline sediment	Palaeo-environmental reconstruction
Micromorphology	Soils	Soil formation reconstruction
OSL dating	Clastic sediments	Dating
Radiocarbon dating	Botanical remains, animal remains, (bulk sediment)	Dating

Subsampling
- *First small samples* (if possible all at the same level, follow the stratigraphy)
  - Pollen + spores + NPPs
  - Diatoms + phytoliths
  - Sedimentology
    - grain size
    - Loss-on-ignition
- *Then bulk samples*
  - Botanical remains
  - Molluscs
  - Micromorphology
  - OSL (in dark room!)
  - ^{14}C



! Contamination

Storage: cool for organic remains

References on radiocarbon dating

Bayliss, A., and Marshall, P., 2022. Radiocarbon Dating and Chronological Modelling: Guidelines and Best Practice (Historic England, London). [https://historicengland.org.uk/images-books/publications/radiocarbon-dating-chronological-modelling/]

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Macroscopic peat description: Peat types in the coastal plain (B).

Trainer: Luc Allemeersch (allemeersch.luc@skynet.be; luc.allemeersch@rubenwillaert.be)

Which plant remains from the original vegetation can we still find ?

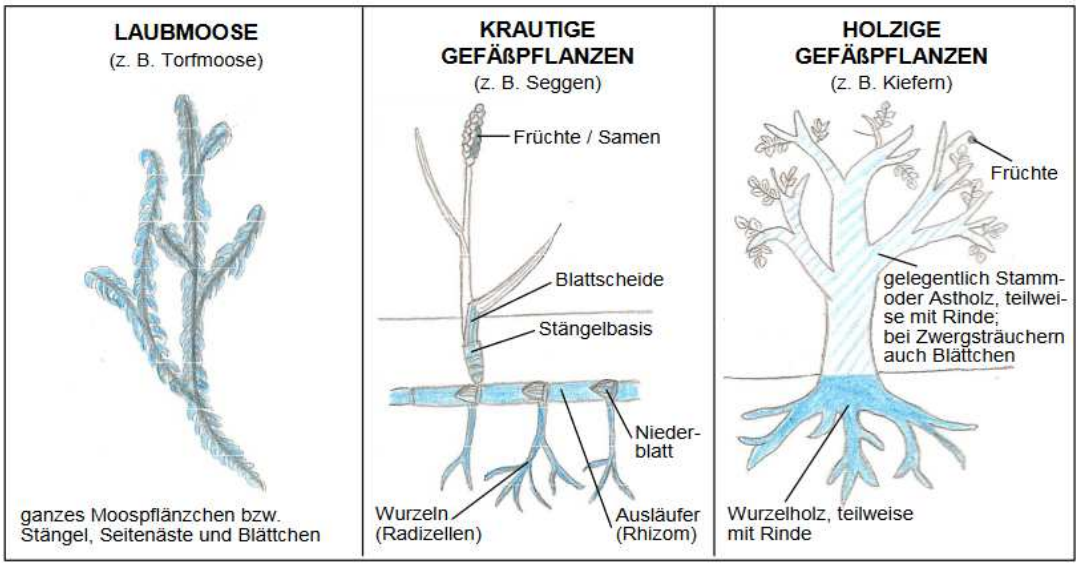

Fig. 1. Schematic overview of plant remains that are preserved in the peat; adapted from Meier-Uhlherr et al. (2015)

Within the peat (as substrate) only a limited part of the living peat will be preserved. The underground parts that are best preserved. Small, tough plant remains such as seeds are also part of this. Rather by chance, such as during a windfall, more above-ground parts can be well preserved. Figure 1 gives us a schematic overview of what is preserved in the peat.

Humification degree

Peat is always weathered to a greater or lesser extent. In many cases, the degree of humification is used to describe this. This indicates the extent to which the peat has been decomposed. The higher the degree of decomposition/humification the higher the number (from 1 to 10). The wetter the peat substrate is, the easier it is to handle. With very dried out peats it becomes difficult to squeeze water out of them. Below is a slightly modified scale (Overbeck, 1975) as proposed by von Post (1924).

Zersetzungsgrad von Post (D)

H1 *Vollstandig unzersetzter und Dy-freier Torf; beim Quetschen in der Faust geht farbloses, klares Wasser zwischen den Fingern ab.*

H2 *Beinahe völlig unzersetzter Torf; beim Quetschen fast klares, nur schwach gelbbraunes Wasser abgehend.*

H3 *Sehr schwach zersetzter oder schwach Dy-haltiger Torf: beim Quetschen deutlich trübes, braunes Wasser, aber keine Torfsubstanz zwischen den Fingern abgehend; Rückstand nicht breiartig.*

H4 *Schwach zersetzt oder etwas Dy-haltig, beim Quetschen stark trübes Wasser, aber noch keine Torfsubstanz abgehend. Rückstand etwas breiartig.*

H5 *Ziemlich zersetzter oder ziemlich Dy-haltiger Torf. Pflanzenstruktur noch deutlich aber etwas verschleiert. Beim Quetschen geht etwas Torfsubstanz aber hauptsachlich trübes, braunes Wasser ab; Rückstand stark breiartig.*

H6 *Ziemlich zersetzter oder ziemlich Dy-haltiger Torf, mit undeutlicher Pflanzenstruktur. Beim Quetschen geht bis 1/3 der Torfsubstanz ab; Rückstand stark breiartig, aber mit deutlich hervortretender Pflanzenstruktur als im ungequetschten Torf.*

H7 *Stark zersetzter oder Dy-haltiger Torf; Pflanzenstruktur noch ziemlich erkennbar; beim Quetschen geht etwa die Hälfte der Torfsubstanz ab.*

H8 *Sehr stark zersetzt oder stark Dy-haltig. Pflanzenstruktur sehr undeutlich. 2/3 der Substanz geht zwischen den Fingern ab; Rückstand hauptsachlich aus widerstandsfähigen Pflanzenmaterial, wie Wurzelfasern, Holz, u.a.*

H9 *Fast völlig zersetzt bzw. Fast ganz Dy-haltig. Beinahe ohne erkennbare Pflanzenstruktur, fast die ganze Torfmasse gleitet beim Quetschen zwischen den Fingern heraus.*

H10 *Völlig zersetzt oder ganz Dy-haltig. Ohne erkennbare Pflanzenstruktur; beim Quetschen gleitet die ganze Masse zwischen den Fingern ab.*

Humificatiegraad von Post (NL)

H1 Totaal niet verweerd veen, zonder fijne plantaardige brij. Bij het persen in de vuist vloeit er kleurloos, helder water tussen de vingers.

H2 Zo goed als niet verweerd veen. Bij het persen vloeit er licht geelbruin water weg.

H3 Zeer licht verweerd of zeer weinig fijne, plantaardige brij. Bij het persen vloeit er duidelijk troebel bruin water weg maar geen veensubstantie. Overblijfsel (in de vuist) niet brij-achtig (fijn, plantaardig).

H4 Licht verweerd of weinig fijne, plantaardige brij. Bij het persen vloeit er sterk troebel bruin water weg maar nog geen veensubstantie. Overblijfsel (in de vuist) iets brij-achtig (fijn, plantaardig).

H5 Tamelijk verweerd of nogal wat fijne, plantaardige brij. Plantenstructuur nog duidelijk, maar enigszins versluierd. Bij het persen vloeit er iets veensubstantie maar vooral troebel, bruin water weg. Overblijfsel (in de vuist) sterk brij-achtig (fijn, plantaardig).

H6 Tamelijk verweerd of nogal wat fijne, plantaardige brij. Plantenstructuur onduidelijk, Bij het persen vloeit 1/3 van de veensubstantie weg. Overblijfsel (in de vuist) sterk brij-achtig (fijn, plantaardig) maar met duidelijker aanwezige plantenstructuren als in het ongeperste veen.

H7 Sterk verweerd of veel fijne, plantaardige brij. Plantenstructuur nog tamelijk te herkennen. Bij het persen vloeit 1/2 van de veensubstantie weg.

H8 Zeer sterk verweerd of zeer veel fijne, plantaardige brij. Plantenstructuur zeer onduidelijk. Bij het persen vloeit 2/3 van de veensubstantie weg. Overblijfsel (in de vuist) bestaat vooral uit taai plantenmateriaal zoals wortelvezels, hout, enz.

H9 Bijna volledig verweerd of bijna volledig een fijne, plantaardige brij. Bijna geen herkenbare plantenstructuur. Bijna alle veen vloeit bij het persen tussen de vingers.

H10 Volledig verweerd of volledig een fijne, plantaardige brij. Geen herkenbare plantenstructuur. Alle veen vloeit bij het persen tussen de vingers.

Degree of humification von Post (EN)

H1 Completely undecomposed peat without fine organic matter; when squeezed in the fist, colourless, clear water comes off between the fingers.

H2 Almost completely undecomposed peat; when squeezed, almost clear, only faintly yellow-brown water comes off.

H3 Very weakly decomposed peat or peat with fine organic matter: clearly cloudy brown water when squeezed, but no peat substance coming off between the fingers; residue not slurry-like.

H4 Weakly decomposed or including some fine organic matter, water very turbid when squeezed, but no peat substance coming off yet. Residue somewhat slurry-like.

H5 Fairly decomposed peat or peat with fine organic matter. Plant structure still clear but somewhat obscured. When squeezed, some peat substance but mainly turbid, brown water comes off; residue strongly slurry-like.

H6 Fairly decomposed or fairly fine organic matter peat, with indistinct plant structure. When squeezed, up to 1/3 of the peat substance comes off; residue strongly slurry-like, but with plant structure more distinct than in unsqueezed peat.

H7 Heavily decomposed peat or peat with fine organic matter; plant structure still fairly recognizable; about half of the peat substance is removed during squeezing.

H8 Very decomposed or with fine organic matter. Plant structure very indistinct. 2/3 of the substance comes off between the fingers; residue mainly of resistant plant material, such as root fibers, wood, etc.

H9 Almost completely decomposed or almost completely with fine organic matter. Almost no discernible plant structure, almost all peat mass slips out when squeezed between fingers.

H10 Completely decomposed or with fine organic matter. Without recognizable plant structure; the entire mass slips between the fingers when squeezed.

In the strongly weathered peat types (H7 – H10) there are only a few recognizable remains that are well preserved. This is the case with most of our peat deposits from valley areas, as well as with the top of peat deposits which are also usually heavily weathered.

	1	2	3	4	5	6	7	8	9	10
Sphagnum[1] *sect. Cymbifolia*	+	+	+	+	+					
Eriophorum vaginatum[2] (leaf sheath)	+	+	+	+	+	+	+	+	+	
Calluna vulgaris[3]: branches with leafs	+	+	+	+	+	+	+	+		
Oxycoccus palustris[4]: leafs	+	+	+							
Betula[5] *pub./pen.*		-	+	+	+	+	+	+	-	
Alnus[6] *glutinosa*					-	+	+	+	+	
Phragmites[7] *australis* (rhizom)	-	+	+	+	+	+	+	-		
Menyanthes[8] *trifoliata* (seeds)	+	+	+	+	+	+	+			

Table 1: some remains, still recognizable within a certain degree of humification. This scheme contains only a few selected macro remains and is a selection taken from Caspers (2010).

Wood species coastal peat

Several types of wood are present in the coastal peat. The wood is not so easy to recognize. After all, it usually concerns wood from roots. Wood from the trunk or thicker branches may be present.

Quercus[9]: (*Q. peduncalata* and *Q. sessiliflora*) is a tree that does not occur in living peat. This trees can occur in alluvial forests, which can change into alder carr. Large trunks of fallen oaks are also present at peat deposits. In Belgium, they are regularly found on the west coast but not on the east coast.

Betula: (*B. pendula* and *B. pubescens*) is commonly found in the coastal peat. The wood can be recognized in the field. Many fruits and scales are found under the microscope.

Alnus glutinosa: is regularly found in the coastal peat. In the field, both the wood and the cone-like flowers (containing the fruits) can be recognized. Many fruits and cone-like flowers are found under the microscope.

Pinus[10] *sylvestris*: of this species both the wood and the cones can be found. Scots pine is said to occur on the edge of the ombrotrophic bog. We can see this edge/transition both in time and in space.

Taxus[11] *baccata*: does not currently occur in modern peat vegetations. Wood of this tree species has been found once in field descriptions on the east coast (Allemeersch, 1991). It has been found several times on the west coast.

[1] *Sphagnum*: veenmos, Torfmoos, sphaigne, peat moss
[2] *Eriophorum vaginatum*: éénarig wollegras, Schneiden-Wollgras, linaigrette vaginée, tussock cottongrass
[3] *Calluna vulgaris*: struikhei, Heidekraut, bruyère commune, heather
[4] *Oxycoccus palustris*: kleine veenbes, Gewöhnliche Moosbeere, Canneberge des marais, small cranberry
[5] *Betula pubescens/pendula*: zachte/ruwe berk, Moor-/Hänge-Birke, bouleau pubescent/verruqueux, moor/silver birch
[6] *Alnus glutinosa*: zwarte els, Schwarzerle, aulne noir, black alder.
[7] *Phragmites australis*: riet, Schilf, roseau, common reed
[8] *Menyanthes trifoliata*: waterdrieblad, Fieberklee, Trèfle d'eau, bogbean
[9] *Quercus*: eik, Eiche, chêne, oak
[10] *Pinus sylvestris*: grove den, Wald-kiefer, pin sylvestre, Scots pine
[11] *Taxus baccata*: taxus, Eibe, if, common yew

How to describe peat types from the Belgian coastal plain

For use in the field, we should rely on Meier-Uhlherr et al. (2015), mainly because of the many images and the complete descriptions. This corresponds to the **mire_substrates.com** (.https://e-docs.geo-leo.de/handle/11858/8054)

This manual does contain all the peat types in Germany. Within Germany there are (were) four regions with many peat bogs. For the coastal peat types of the southern North Sea, we can limit ourselves to one region; NW Germany. An overview of the peat (as substrate) for this region can be found in Casper (2010).

It is therefore best to use Casper (2010) for a description in the field. Some comments here:

• peat with *Cladium*[12] *mariscus* is absent. This can be recognized in the field and is present in the coastal peat. This is stated in Meier-Uhlherr et al. (2015) at 1.6 as Schneider Torf;

• in addition to other heather plants, leaves of common heather (*Erica*[13] *tetralix*) can also be found in field research;

• Casper (2010) merges *Vererdeter Torf* and *Vermulmter Torf* into *Amorpher Torf*.

[12] *Cladium mariscus*: galigaan, Binsen-Schneide, marisque, saw sedge
[13] *Erica tetralix*: gewone dophei, Glocken-Heide, bruyère quaternée, cross-leaved heath

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Vos P., Bazelmans J., van der Meulen M., Weerts H., 2018. Atlas van Nederland in het Holoceen. Landschap en bewoning vanaf de laatste ijstijd. *Uitgeverij Prometheus*. 96 p.

Detailed peat description form

	diepte in liner (cm)	hoogte (m TAW)	Botanische samenstelling	Code
Boring 707	285	-0,27		
			mosveen met Ericaceae-takjes (Betula-hout)	**Hnb**, Hhi
	300	-0,42		
			mosveen (veel verstoord materiaal in boring terechtgekomen)	**Hnb**
	310	-0,52		
			houtveen (Betula), snel overgaand in mosveen met Ericaceae	**Hulb**
	320	-0,62		
			sterk humeuze bodem, met enkele (Ericaceae-)takjes	Erica
	330	-0,72		
			humusrijk anorganisch materiaal	
	340	-0,82		
			humusrijk organisch materiaal, (gebleekt) zand	
	350	-0,92		
Boring 706	220	0,28		
			Eriophorum-veen, weinig Ericaceae-takjes.	**Hhe**
	230	0,18		
			Eriophorum-veen, beperkt mosveen met Ericaceae- takjes	**Hhe**, Hhi
	240	0,08		
			Eriophorum-veen	**Hhe**
	250	-0,02		
			mosveen, vooral *Polytrichum*, weinig *Eriophorum vaginatum*	**Hnb**
	260	-0,12		
			nog beetje *Betula*, mosveen met *Polytrichum* en *Aulacomnium*	**Hnb**
	270	-0,22		
			houtveen met *Betula* (schors en vrucht), met bruinmossen	**Hulb,** Hnb
	280	-0,32		
			houtveen (*Betula*) met *Carex* typ. *acuta*	**Hulb,** Hnr
	290	-0,42		
			houtveen (*Betula*)	**Hulb**
	300	-0,52		
			houtveen met *Carex*	Hnr
	310	-0,62		
			houtveen, sterk verweerd veen	
	320	-0,72		
			houtveen-zeggeveen, sterk verweerd	Hnr
	330	-0,82		
			houtveen, sterk verweerd veen	
	340	-0,92		
			houtveen (*Betula*), sterk verweerd veen	**Hulb**
	350	-1,02		
			sterk verweerd veen	
	360	-1,12		
			houtveen, sterk verweerd veen	
	370	-1,22		
			sterk verweerd veen met wat hout, verspreid zandkorrels	
	380	-1,32		
			houtveen, bijna alleen hout (*Alnus glutinosa*)	**Hnle**
	390	-1,42		
			houtveen, onderaan veel kwartskorrels	
	400	-1,52		

	diepte in liner (cm)	hoogte (m TAW)	Humificatie-graad
Boring 707	285	-0,27	
			6
	310	-0,52	
			4-5
	320	-0,62	
			7
	330	-0,72	
Boring 706	220	0,28	
			5
	240	0,08	
			5-6
	250	-0,02	
			3
	260	-0,12	
			4-5
	270	-0,22	
			6
	290	-0,42	
			6-7
	310	-0,62	
			7-8
	320	-0,72	
			7
	330	-0,82	
			7-8
	340	-0,92	
			8
	360	-1,12	
			7
	370	-1,22	
			7-8
	380	-1,32	
			5
	390	-1,42	
			7
	400	-1,52	

Figure 1: Dudzele-Zonnebloemweg: Detailed description with legend following mire-substrates.com

Macroscopic peat analysis: simplified peat description form

core	depth in liner	peat type, recognized plant remains	degree of decomposition
	-		
	-		
	-		
	-		
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	-		
	-		

4. Core info

Introduction

Various old and new core samples including Holocene tidal sediments and peats have been collected for the training session. Except for the Aardenburg core, these originate from the fossilized (tidal) floodplain of the river Scheldt between Antwerp and the Belgium-Netherlands border.

The coring methods employed to retrieve these samples include manual gouge augering and various mechanical coring methods such as Geoprobe direct push/hammer coring, Begemann direct push coring and roto sonic Sonic Sampdrill coring with Aqualock sampler. These coring techniques result in samples of differing quality as discussed in Hissel et al (2005) and Verhegge et al. (2016).

References

Hissel, M., Van Londen, H., Tiggelman, L., & van Deen, J. K. (2005). Een oog voor de archeoloog. Geotechniek, oktober 2005, 30-35.

Verhegge, J., Vanhecke, M., Van Den Wijngaert, M., & Crombé, P. (2016). Geotechniek & Archeologische prospectie: een overzicht van mechanische boor- en elektrische sondeer- technieken voor archeologie. Notae Praehistoricae, 36, 203-209.

Aardenburg: Diomedeweg

Driller: Dante de Ruijsscher

Drilling date: January 2023

Context:

Research question: Mapping the Roman landscape around Aardenburg

Geological map: (Late)Holocene Estuarine deposits > (Middle)Holocene peat deposit > Pleistocene (coversand) deposits

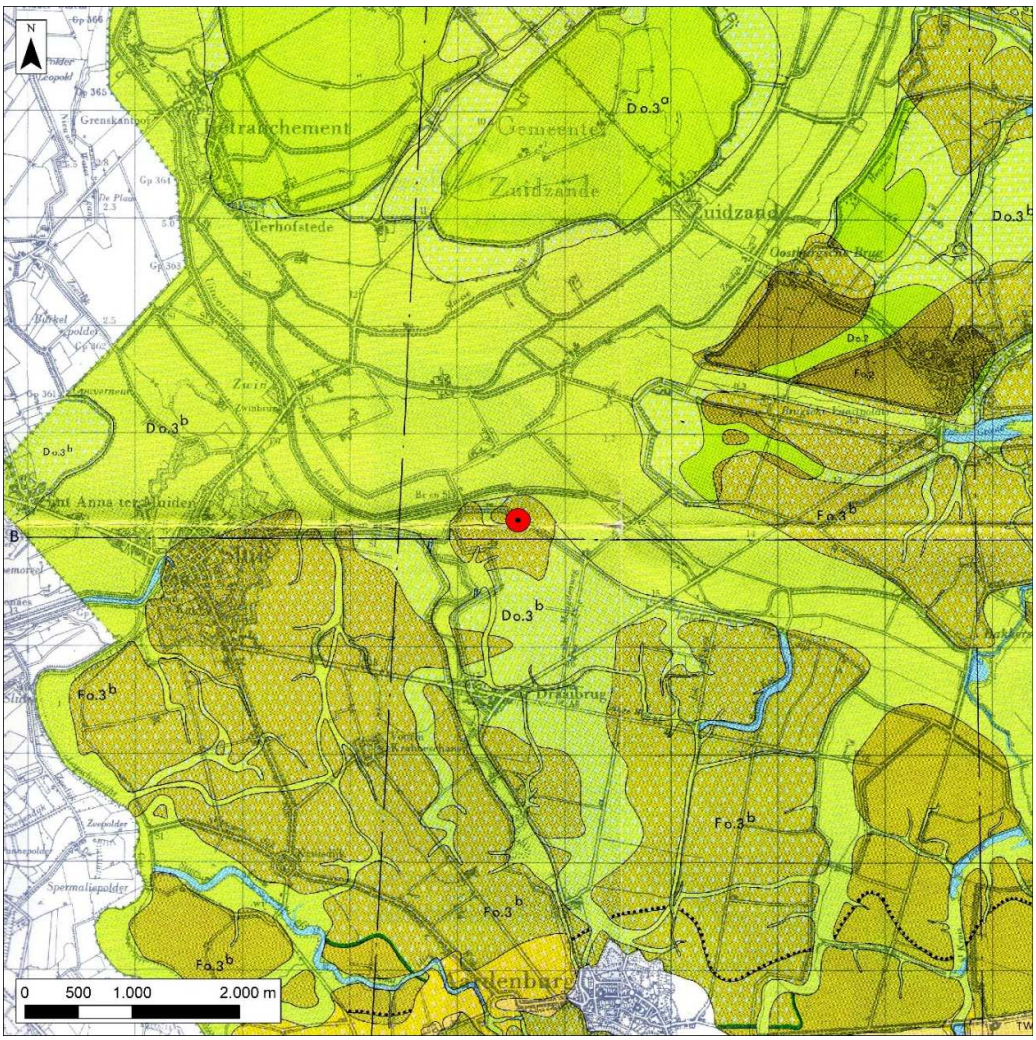
Soil map: *Nieuwlandgrond op overgangsgrond en/of poelklei*

Location: x= 84567.4 m, y= 223054.2 m, z= 3.53 m TAW (EPSG:31370)

Drilling method: manual gouge auger (60 mm), extruded into PVC tube

Sample depth: 1.2 m – 2.5 m

Further information: dante.deruijsscher@ugent.be



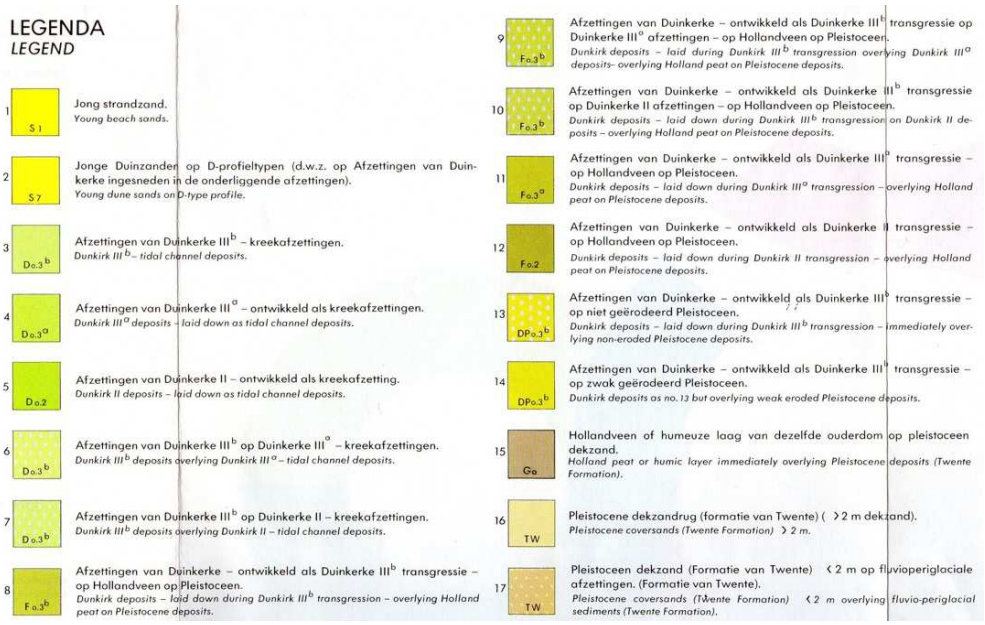
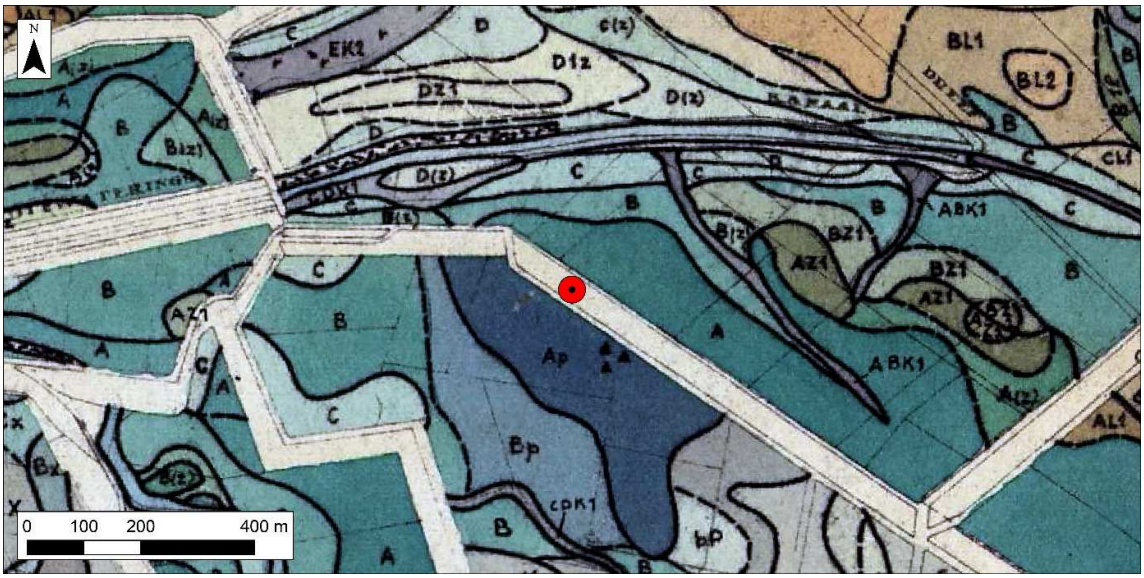


Figure 2 Core location on geological map of western Zeelandic Flanders (*Van Rummelen 1967).*



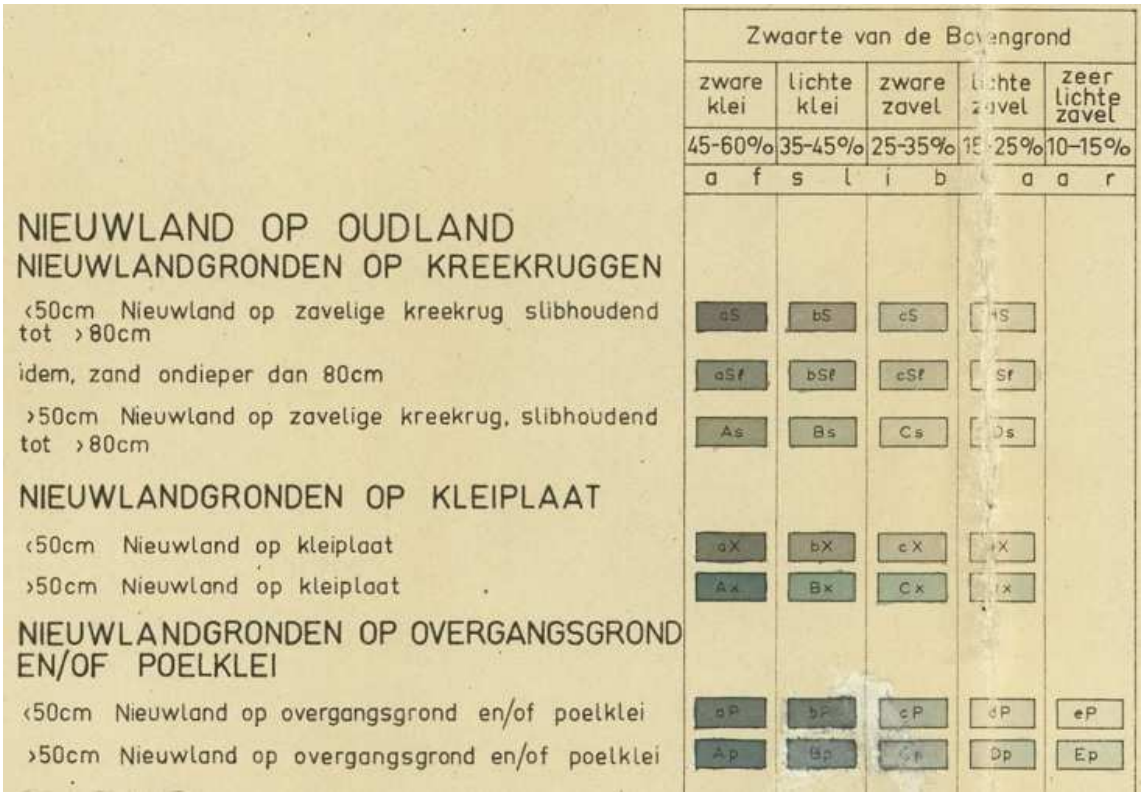


Figure 3 Core location on soil map of western Zeelandic Flanders (Ovaa 1957).

Beveren: Prosperpolder-Zuid

Core: BEG9 **Liners:** 5, 6, 7, 8

Driller: Fugro

Drilling date: July 2015

Context:

Research question: (pre-)historic landscape mapping using electromagnetic induction survey, cone penetration testing, coring and trial trenching in context of an archaeological evaluation

Quaternary geological map: Estuarine deposits consisting of a clayey-sandy complex on peat (<0.5 m), possibly with clastic intercalations on sandy acyclic braided river deposits, usually fine grained

Soil map: sUdp (Moderately gleyey heavy clay soil without profile development with sand at depth shallower than 75 cm)

Location: x= 139500.263 m, y= 223503.895 m, z= 3.638 m TAW (EPSG:31370)

Drilling method: Begemann core (66 mm), extruded into PVC tube

Sample depth: BEG9(5): 3.24 m-4.26 m; BEG9(6): 4.26 m-5.25 m; BEG9(7): 5.25 m-6.24 m; BEG9(8): 6.24 m-7.37 m

References

Bogemans, F., 1999. Quartairgeologische kaart [van België, Vlaams Gewest]: Essen - Kapellen, kaartblad 7 - 1. 1/50 000. Vlaamse Overheid, Dienst Natuurlijke Rijkdommen, Brussel. [https://www.vlaanderen.be/publicaties/quartairgeologische-kaart-kaartblad-1-7-essen-kapellen-met-toelichting]

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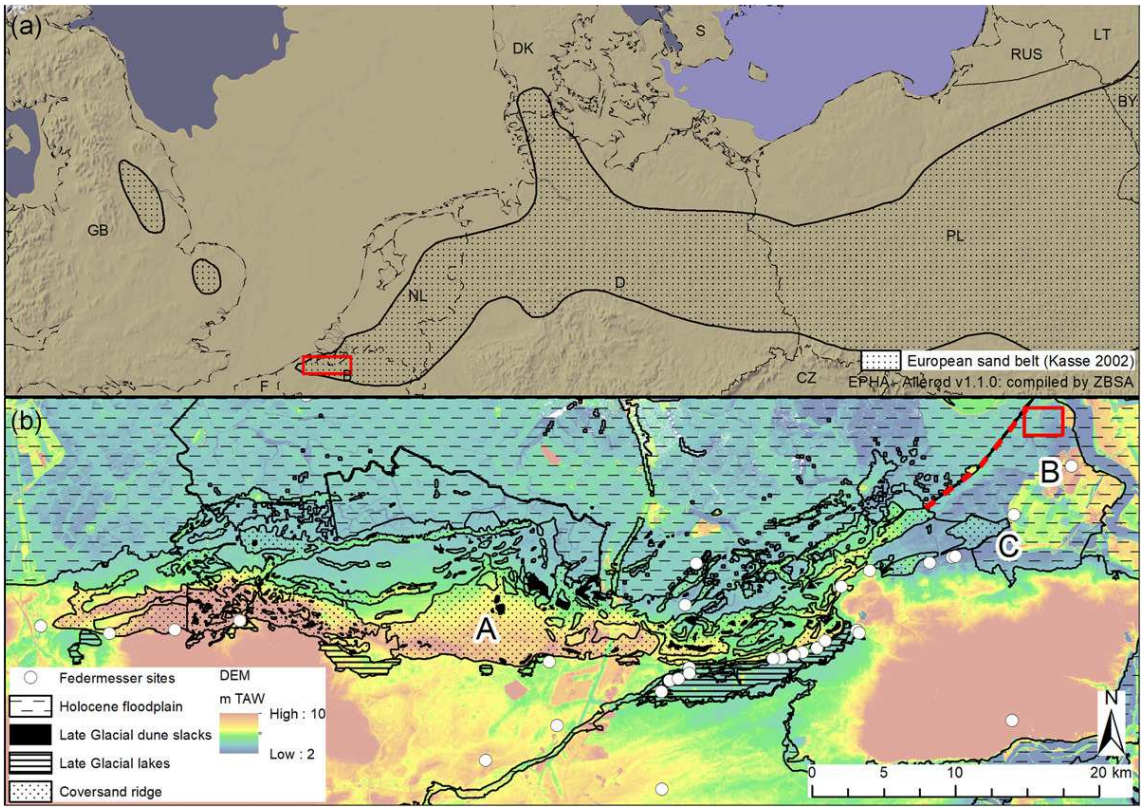

Figure 4 (a) Extension of the European coversand belt (adapted after Kasse, 2002), extent rectangle to Figure 1b, background: EPHA - European prehistoric and historic atlas- Allerød v1.1.0, compiled by ZBSA; (b) Late Glacial geomorphologic features and Holocene floodplains in NW Belgium-SW Netherlands (adapted from Heyse, 1979), location of known Final Paleolithic (Federmesser Gruppen) sites (adapted from Crombé & Robinson, 2017), extent rectangle to Figure 3, background: compilation of Digital Elevation Model Flanders version 2 (DHMVII; digital surface model; Agentschap Informatie, 2014) and General Elevation model of the Netherlands (AHNII; Rijkswaterstaat, 2014).

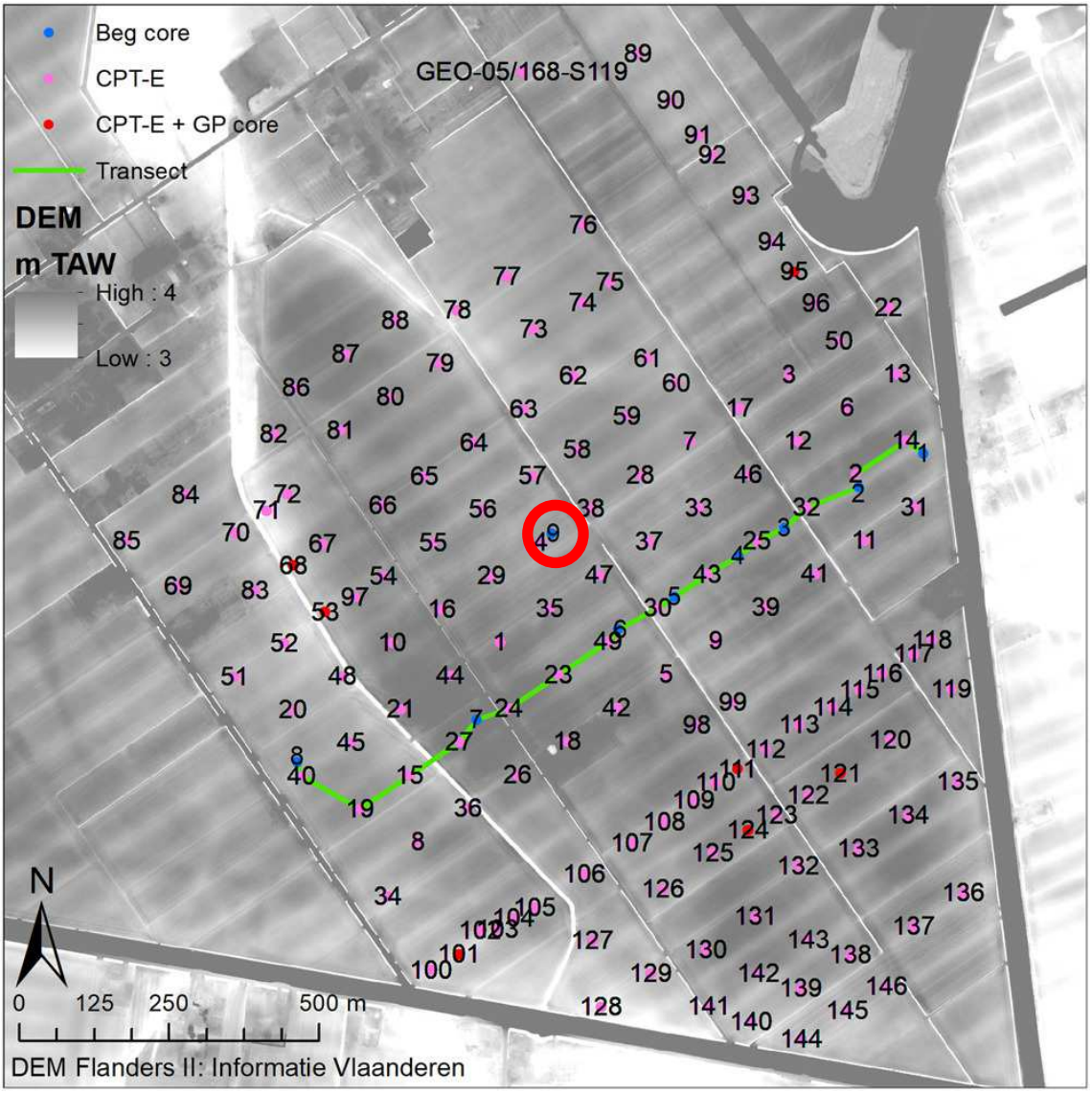

Figure 5 Locations and labels of the CPT-Es, CPT-Es validated by Geoprobe (GP) cores Begemann (Beg) cores. Background: Digital Elevation model of the site surface (DHMVII; Agentschap Informatie, 2014). CPT-E, electric cone penetration testing.

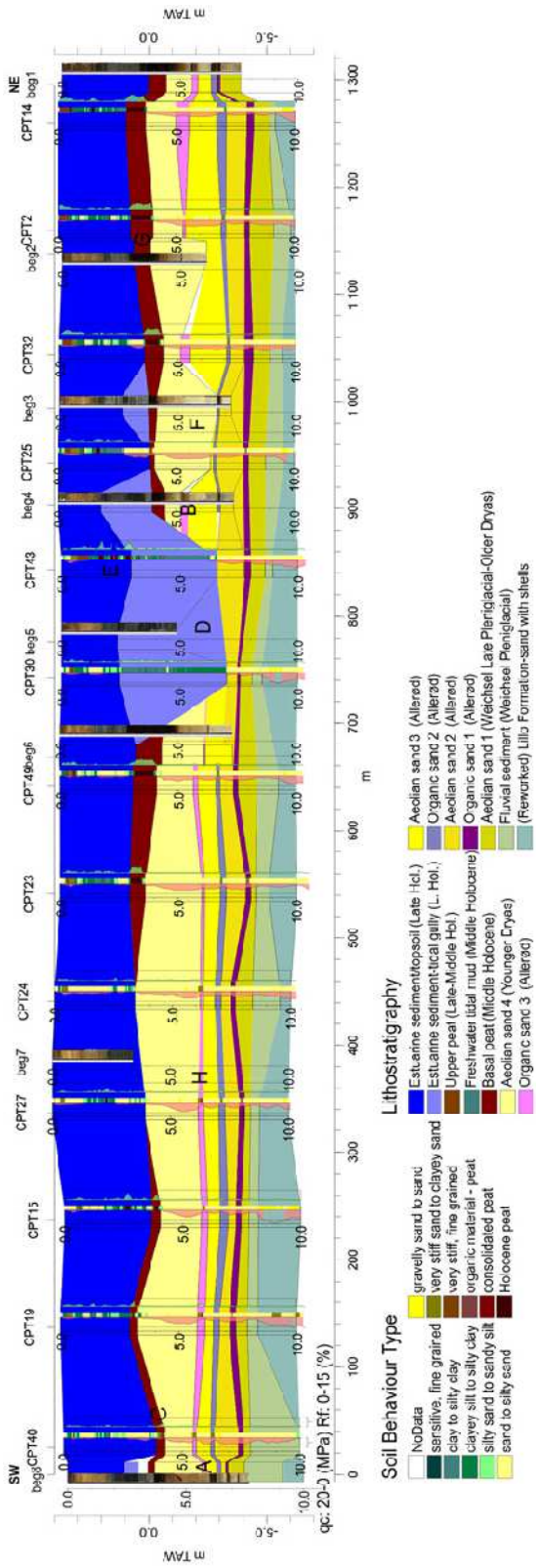

Figure 6 SW-NE transect of CPT-Es with SBT and lithostratigraphic interpretation as well as Begemann core scan images and lithostratigraphic interpretation. The location of this transect is indicated on Figure 3. CPT-E, electric cone penetration testing; SBT, soil behavior types.

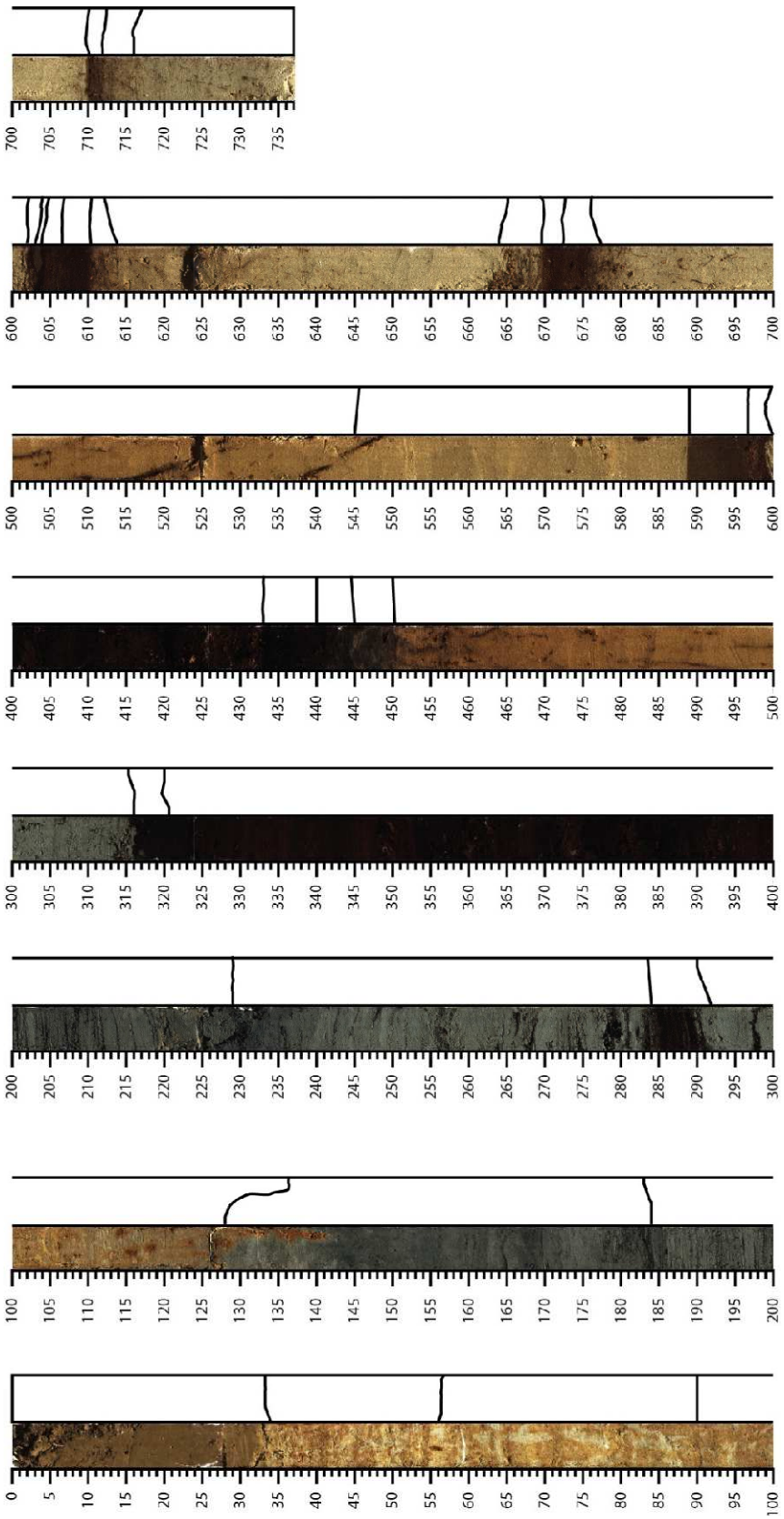

Figure 7 Corescan of BEG9.

Figure 8 BEG9 location on the Belgian soil map (Van Ranst & Sys 2000).

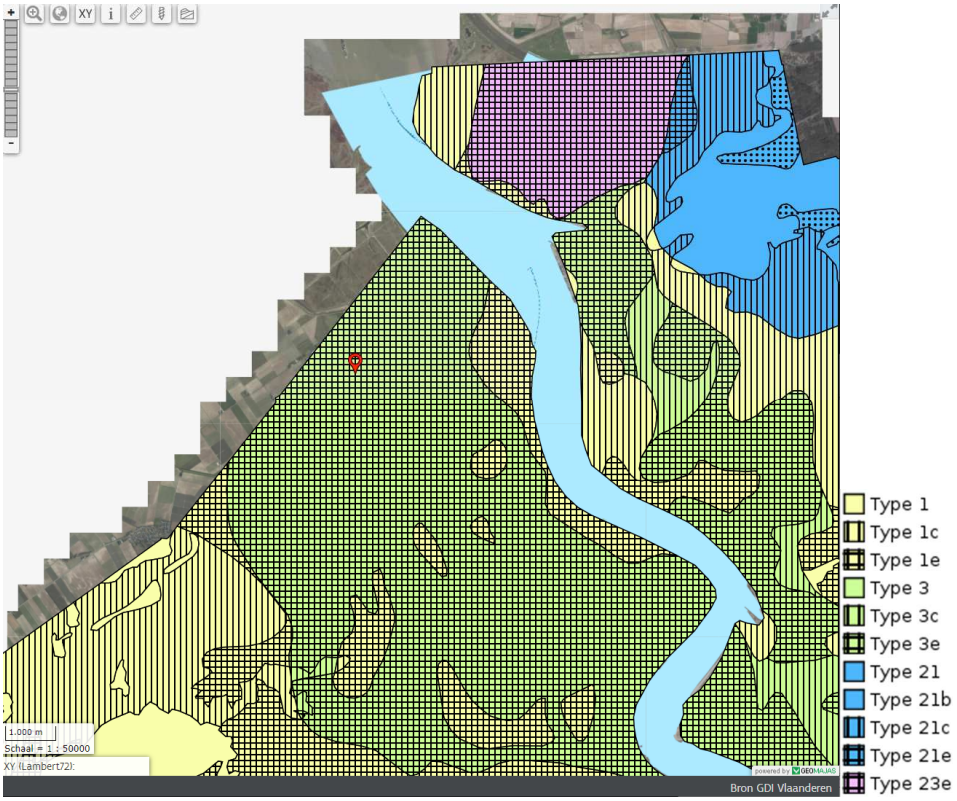

Figure 9 BEG9 location on the Quaternary geological profile type map (1/200.000) (More info: Bogemans 1999).

Stabroek: Opstalvallei

Core: B1264 (B938 extra) **Liners:** A: 100-250, 250-400; B: 120-300; C: 100-300

Driller: Geosonda

Drilling date: April 2017

Context:

Research question: (pre-)historic landscape mapping using coring and trial trenching in context of an archaeological evaluation. Discovery of an early Holocene river valley.

Quaternary geological map: Estuarine clayey-sandy complex on aeolian fine sand, sometimes loamy with possibly an alternating complex of sand- and loam layers at the base

Soil map: uPep (Wet light sandloam soil without profile development with clay at depth shallower than 75 cm)

Location: x= 147154.001 m, y= 225042.864 m, z= 2.755 m TAW (EPSG:31370)

Drilling method: Geoprobe direct push+hammering in plastic liners. Compacted.

Sample depth: A: 1.00 m-2.50 m, 2.50 m-4.00 m; B: 1.20 m-3.00; C: 1.00-3.00

References

Bogemans, F., 1999. Quartairgeologische kaart [van België, Vlaams Gewest]: Essen - Kapellen, kaartblad 7 - 1. 1/50 000. Vlaamse Overheid, Dienst Natuurlijke Rijkdommen, Brussel. [https://www.vlaanderen.be/publicaties/quartairgeologische-kaart-kaartblad-1-7-essen-kapellen-met-toelichting]

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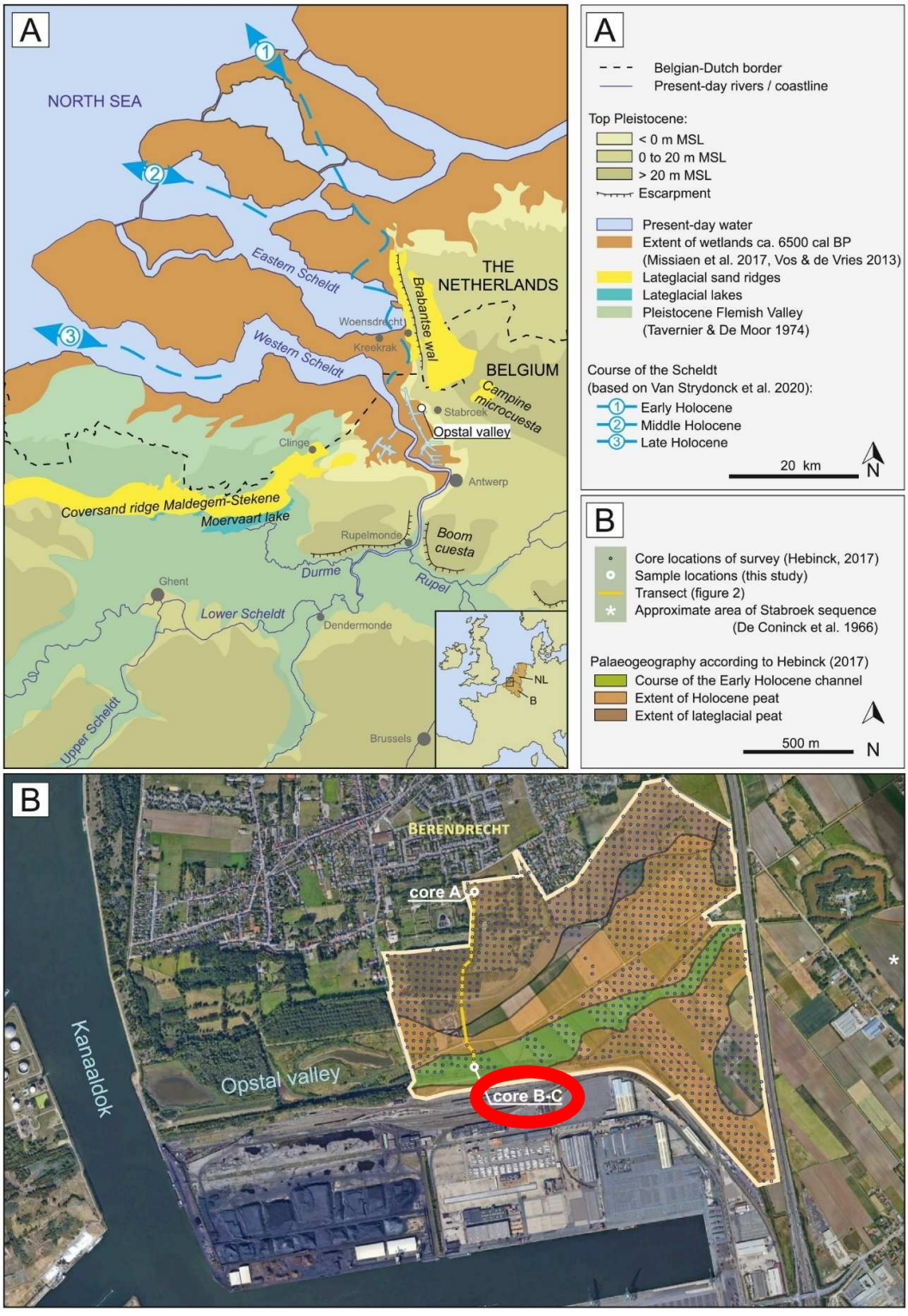

Figure 10 Location of the study area and the sampled cores. A: Regional setting: present-day geography with palaeogeographical elements and subsequent courses of the Scheldt; B: Core locations (core A: 51°20'32,8" N - 4°19'41,0" E; core B-C: 51°20'06,7" N - 4°19'41,4" E) and palaeogeographical units according to Hebinck (2017).

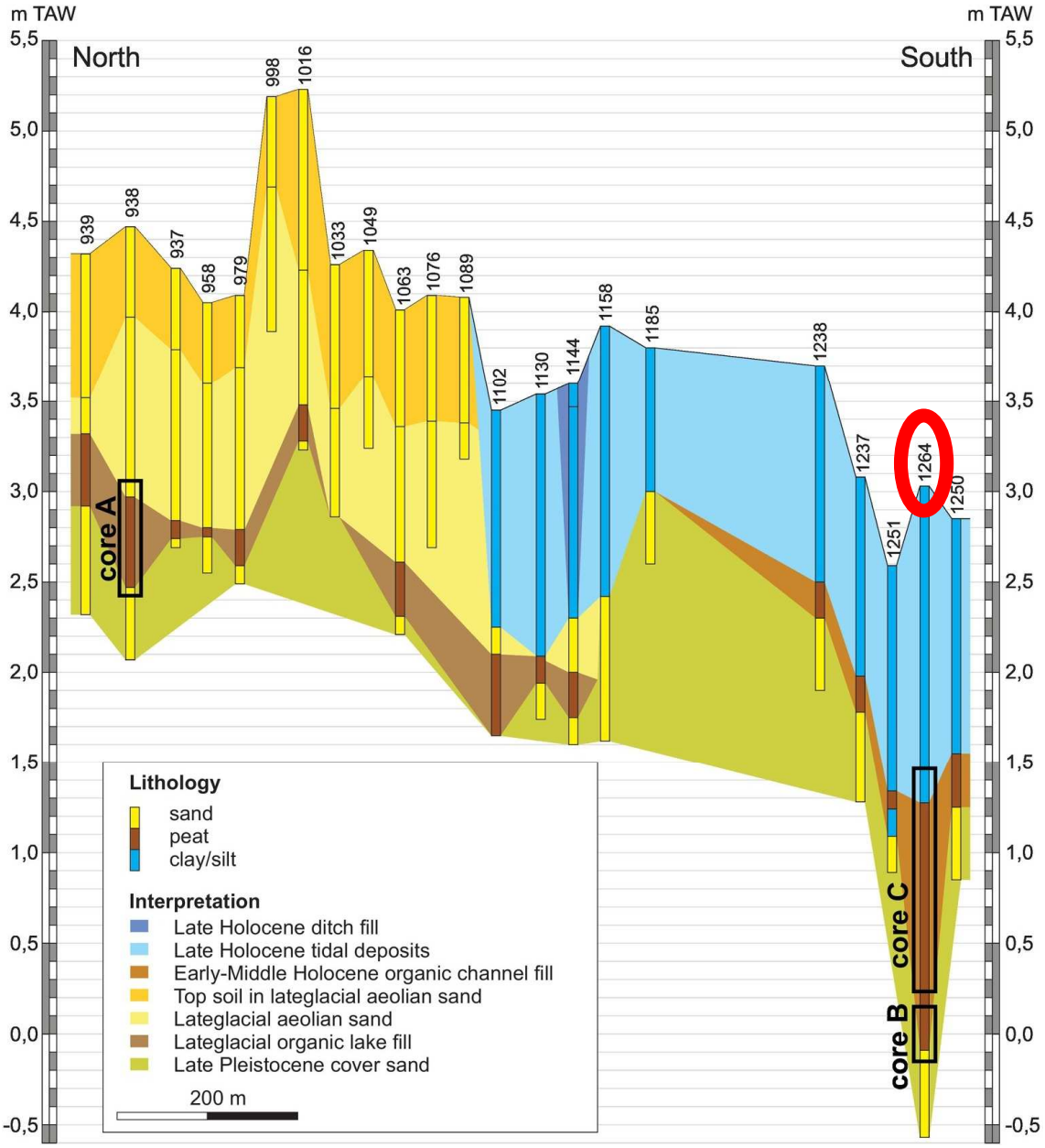

Figure 11 North–south transect through the study area (location: Fig. 1), based on core descriptions by Hebinck (2017). The studied core sections (A-C) are taken from core locations 938 and 1264. TAW = Belgian ordnance level, corresponding to 2.3 m below MSL.

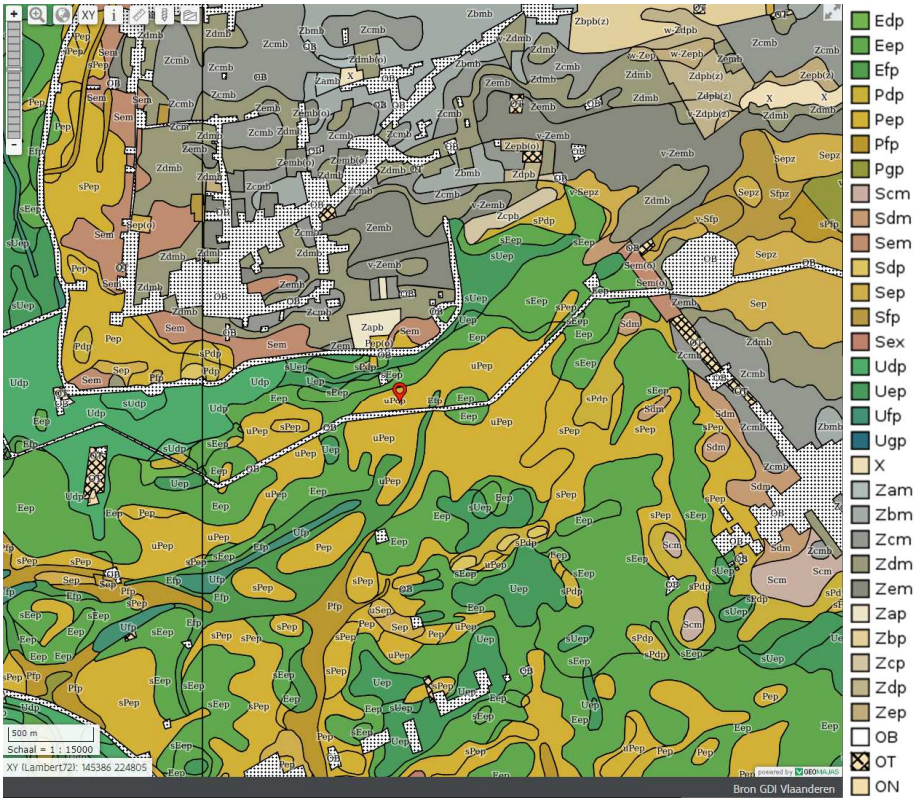

Figure 12 B1264 location on the Belgian soil map (Van Ranst & Sys 2000).

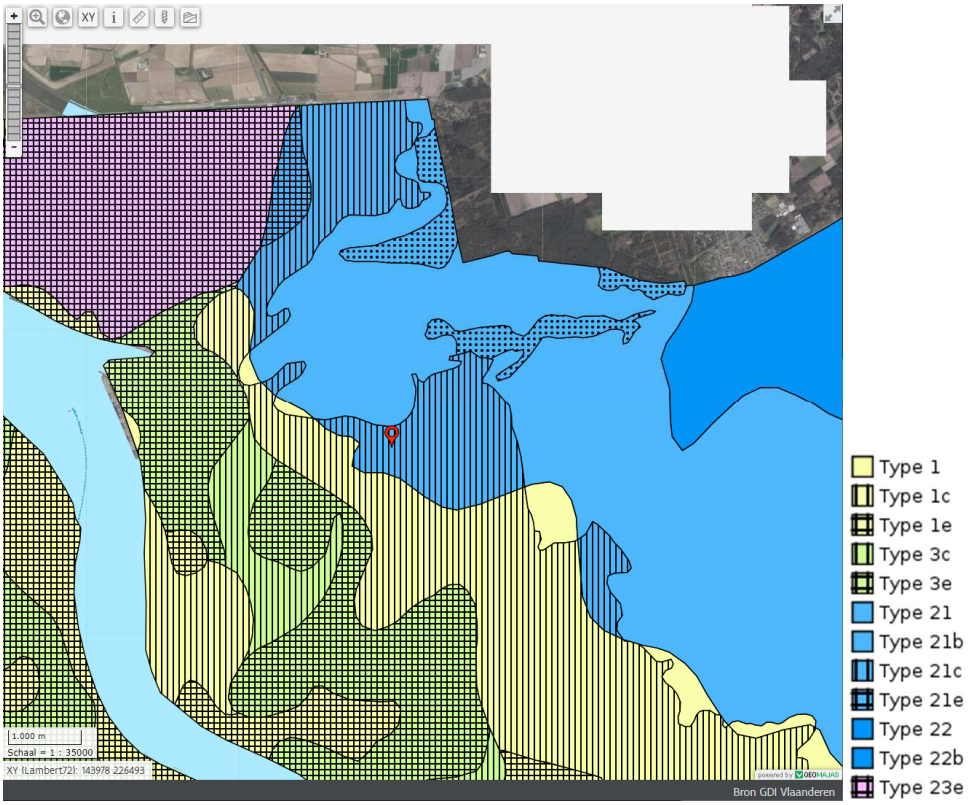

Figure 13 B1264 location on the Quaternary geological profile type map (1/200.000) (More info: Bogemans 1999).

Antwerpen-Regatta

Core: **Liners:**

Driller: Geosonda

Drilling date: December 2022

Context:

Research question: (pre-)historic landscape mapping using coring in context of an archaeological evaluation.

Quaternary geological map: filling/raising/excavation on Holocene marine clayey (close to border with sandy) facies on peaty facies on Weichselian sandy fluvio-periglacial facies.

Soil map: ON (raised soils)

Location (approximate): x= 149600m, y= 212000 (EPSG:31370)

Drilling method: Rotosonic Sonic Sampdrill with Aqualock sampler.

Sample depth:

References

Adams, R., Vermeire, S., De Moor, G., Jacobs, P., Louwye, S. & Polfliet, T., 2002. Toelichting bij de Quartairgeologische kaart [van België, Vlaams Gewest]: kaartblad 15, Antwerpen [1/50 000]. Vlaamse Overheid, Dienst Natuurlijke Rijkdommen, Brussel, 50

Smits, B.I. & Timmerman, R., 2010. Plangebed Regatta (Antwerpen-Linkeroever). Gemeente Antwerpen. Archeologisch vooronderzoek voor een paleolandschappelijke reconstructie. RAAPrapport 1988.

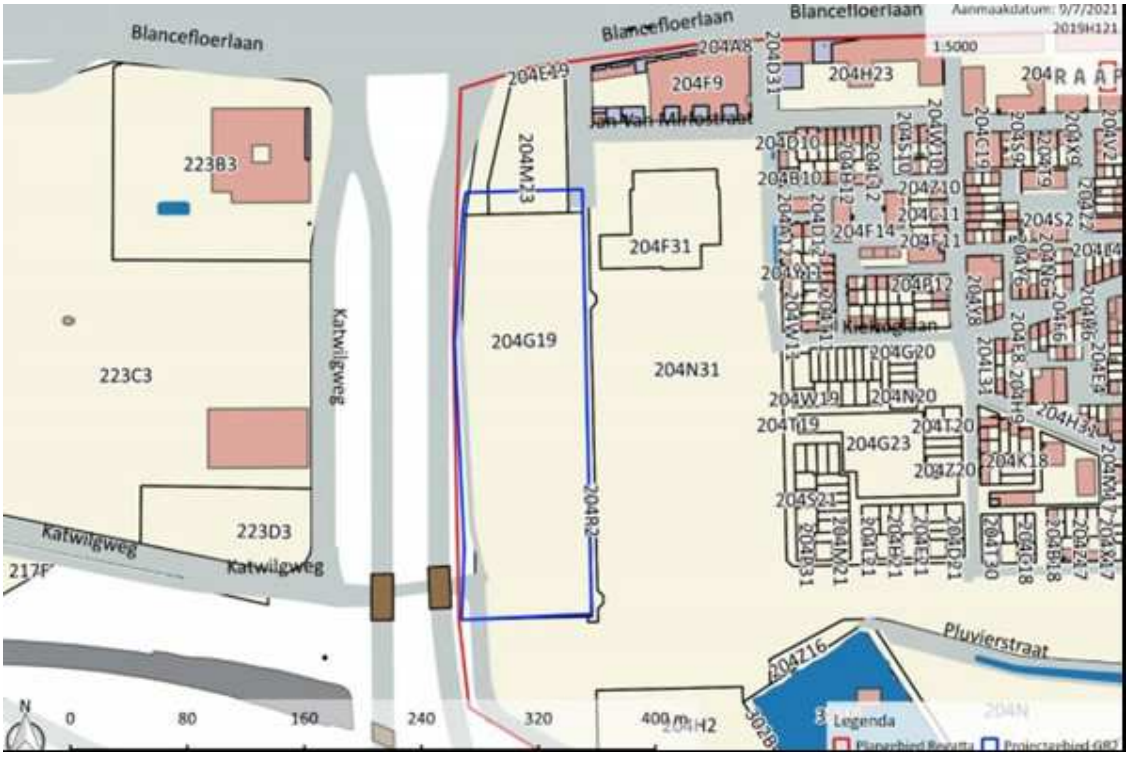

Figure 14 Location of the coring area (blue)

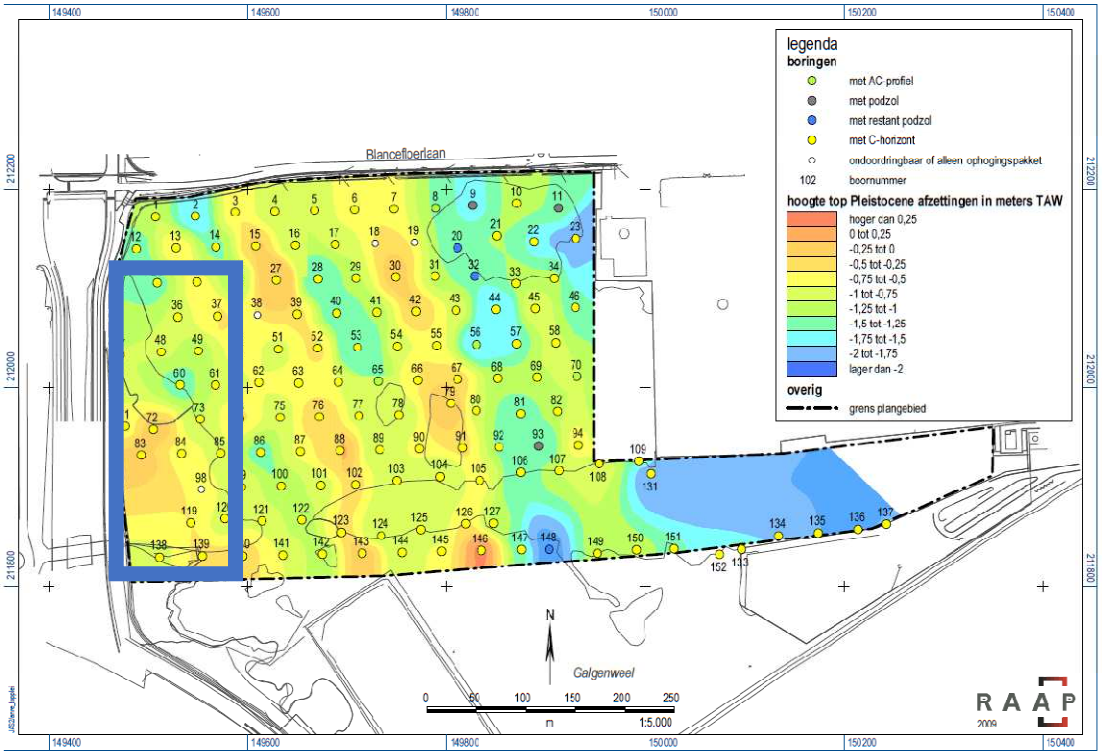

Figure 15 Top elevation of the Pleistocene deposits, coring location in blue rectangle (Smits & Timmerman 2010)

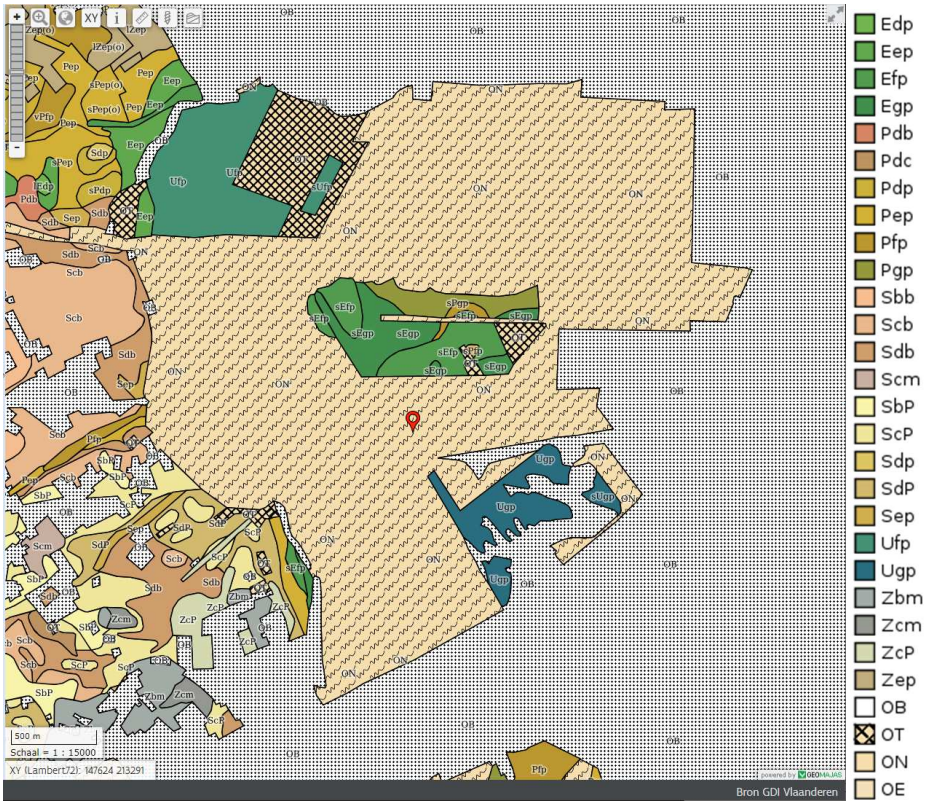

Figure 16 Coring location on the Belgian soil map (Van Ranst & Sys 2000).

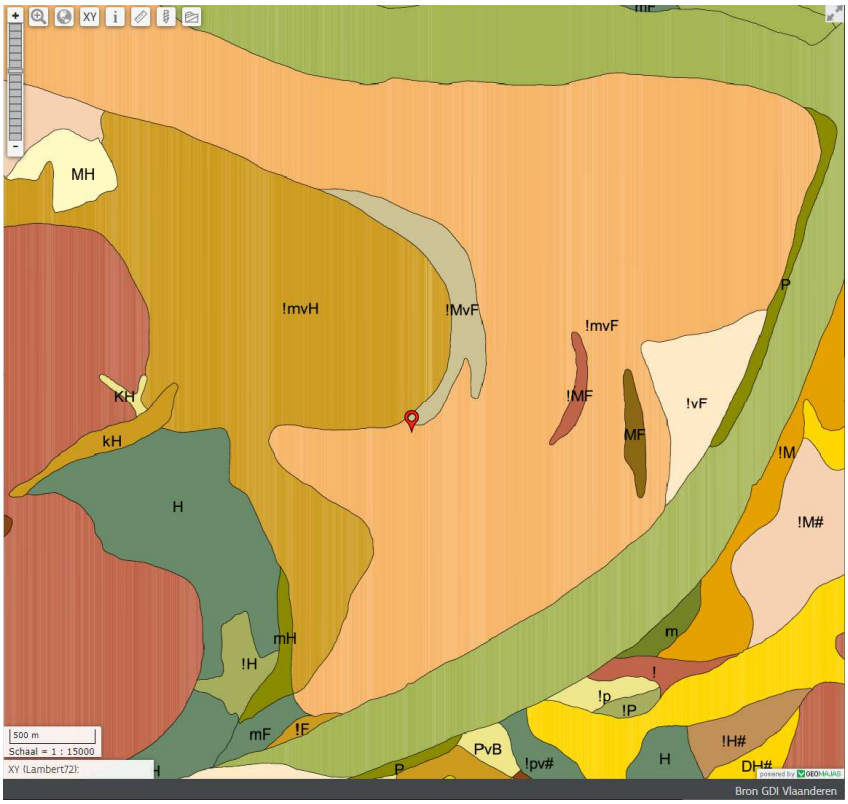

Figure 17 Coring location on the Quaternary geological profile type map (1/50.000) (Adams et al 2002).

Antwerpen-Scheldelaan

Core: B9, B10, B11, B12, B13 **Liners:**

Driller: Geosonda

Drilling date: December 2022

Context:

Research question: (pre-)historic landscape mapping using CPT-e and coring in context of an archaeological evaluation.

Quaternary geological map: Estuarine clayey-sandy complex (Type 1c). Estuarine clayey-sandy complex on aeolian deposits (sand to silt) on (usually fine) sandy, acyclic, braided river deposits (Type 3c). Estuarine clayey-sandy complex on peat with potentially clastic intercalations on aeolian deposits (sand to silt) on (usually fine) sandy, acyclic, braided river deposits (Type 3e).

Soil map: Udp (Moderately gleyey heavy clay soil without profile development, Pgp (Extremely wet light sandloam soil without profile development), PfP (Very wet light sandloam soil without profile development), sPep (Wet light sandloam soil without profile development with sand at depth shallower than 75 cm)

Location (approximate): x= 145250 m, y= 223250 (EPSG:31370)

Drilling method: Rotosonic Sonic Sampdrill with Aqualock sampler.

Sample depth:

References

Bogemans, F., 1999. Quartairgeologische kaart [van België, Vlaams Gewest]: Essen - Kapellen, kaartblad 7 - 1. 1/50 000. Vlaamse Overheid, Dienst Natuurlijke Rijkdommen, Brussel. [https://www.vlaanderen.be/publicaties/quartairgeologische-kaart-kaartblad-1-7-essen-kapellen-met-toelichting]

Aluwé, K.,Laloo, P., Cruz, F., Van Baelen, A., Noens, G. 2021, Archeologienota Verslag van Resultaten bureauonderzoek: 2020B137 Antwerpen Scheldelaan Ineos Olefins Belgium, Ghent Archaeological Team bv [https://loket.onroerenderfgoed.be/archeologie/notas/notas/19550/bijlagen/83316]

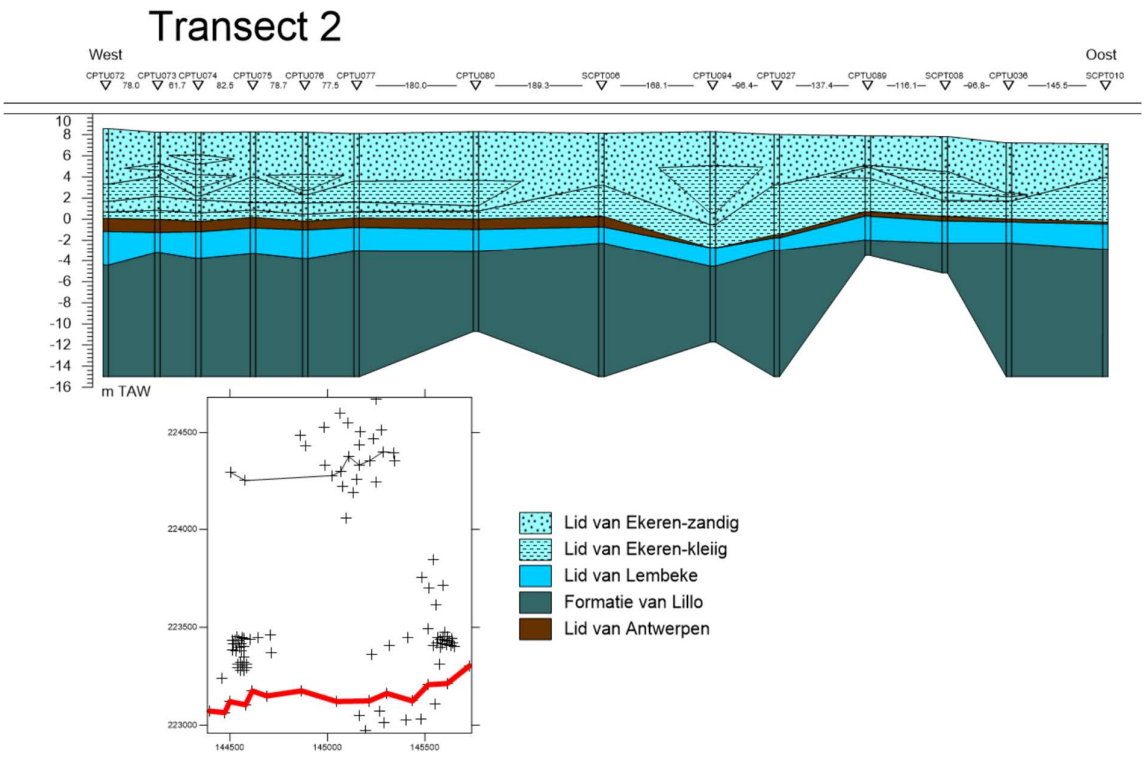

Figure 18 interpreted stratigraphy of a CPT-e transect at coring location (Aluwé et al 2021)

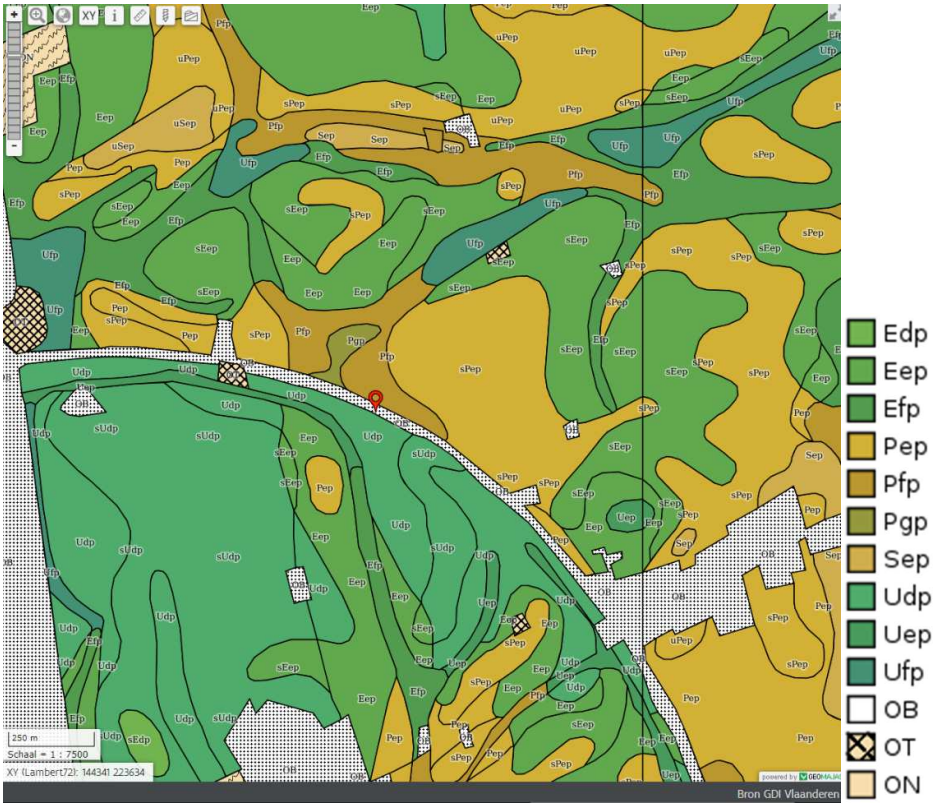

Figure 19 Coring location on the Belgian soil map (Van Ranst & Sys 2000).

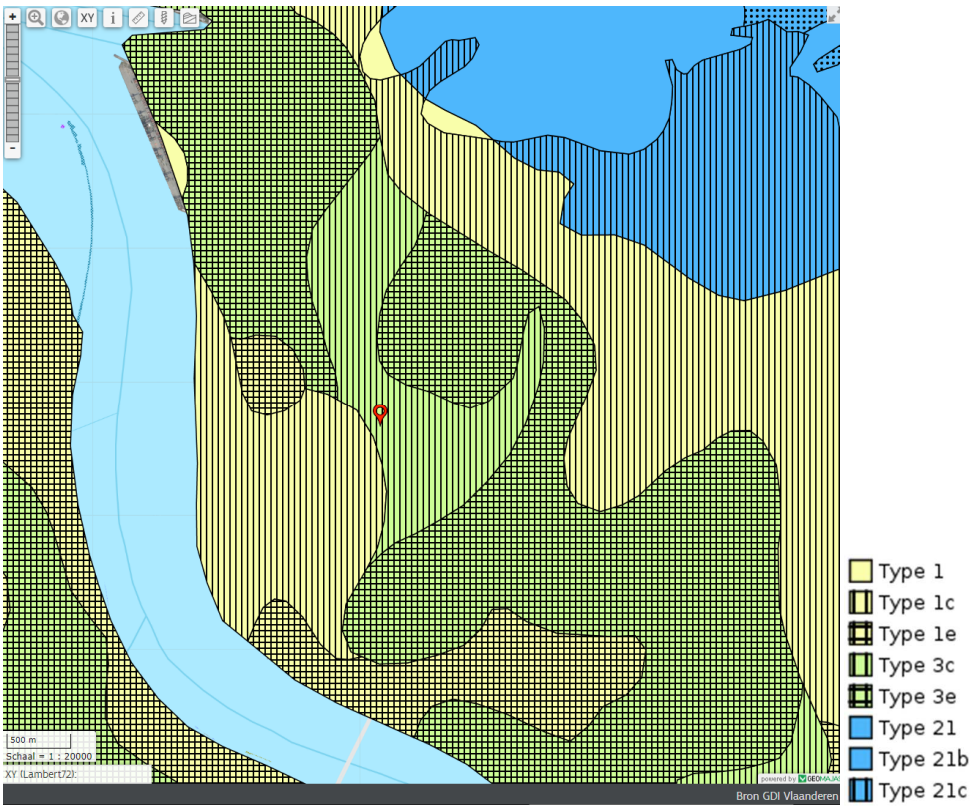

Figure 20 Coring location on the Quaternary geological profile type map (1/200.000) (More info: Bogemans 1999).

Antwerpen (Zandvliet)-Noordzeeterminal

Core: B11b **Liners:**

Driller: Geosonda

Drilling date: December 2022

Context:

Research question: Geotechnical investigation.

Quaternary geological map: Estuarine clayey-sandy complex on peat with possibly clastic intercalations on possibly sandy braided river deposits on estuarine mica containing and to a lesser extent glauconite containing sand, very fine to coarse with vegetation fragments, peat fragments and wood fragments (Type 23e).

Soil map: Pep (Wet light sandloam soil without profile development)

Location: x= 143612 m, y= 226763 (EPSG:31370)

Drilling method: Rotosonic Sonic Sampdrill with Aqualock sampler.

Sample depth (approximately): 12.50 m-16.50 m

References

Bogemans, F., 1999. Quartairgeologische kaart [van België, Vlaams Gewest]: Essen - Kapellen, kaartblad 7 - 1. 1/50 000. Vlaamse Overheid, Dienst Natuurlijke Rijkdommen, Brussel. [https://www.vlaanderen.be/publicaties/quartairgeologische-kaart-kaartblad-1-7-essen-kapellen-met-toelichting]

Figure 21 core photo

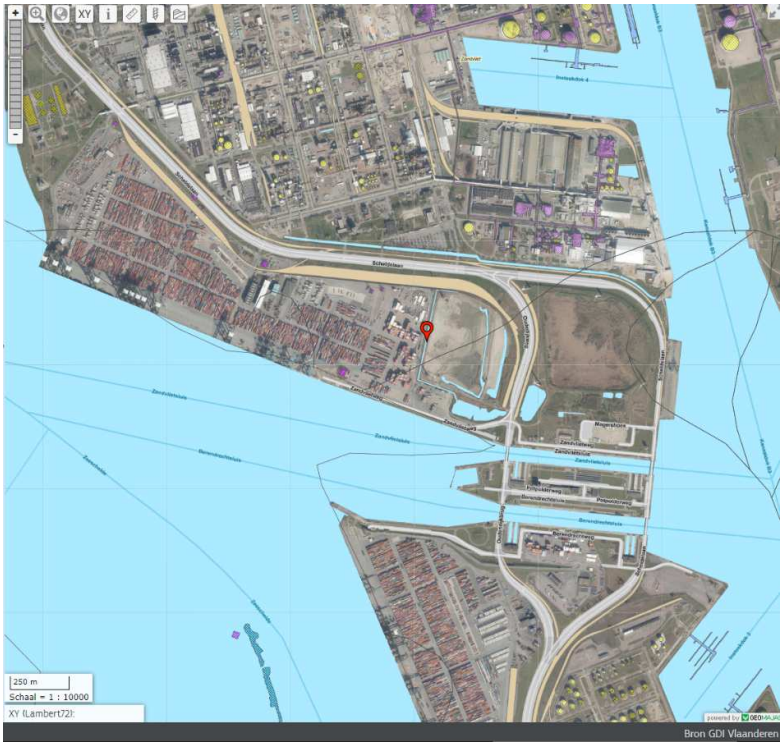

Figure 22 core location map

Figure 23 Coring location on the Belgian soil map (Van Ranst & Sys 2000).

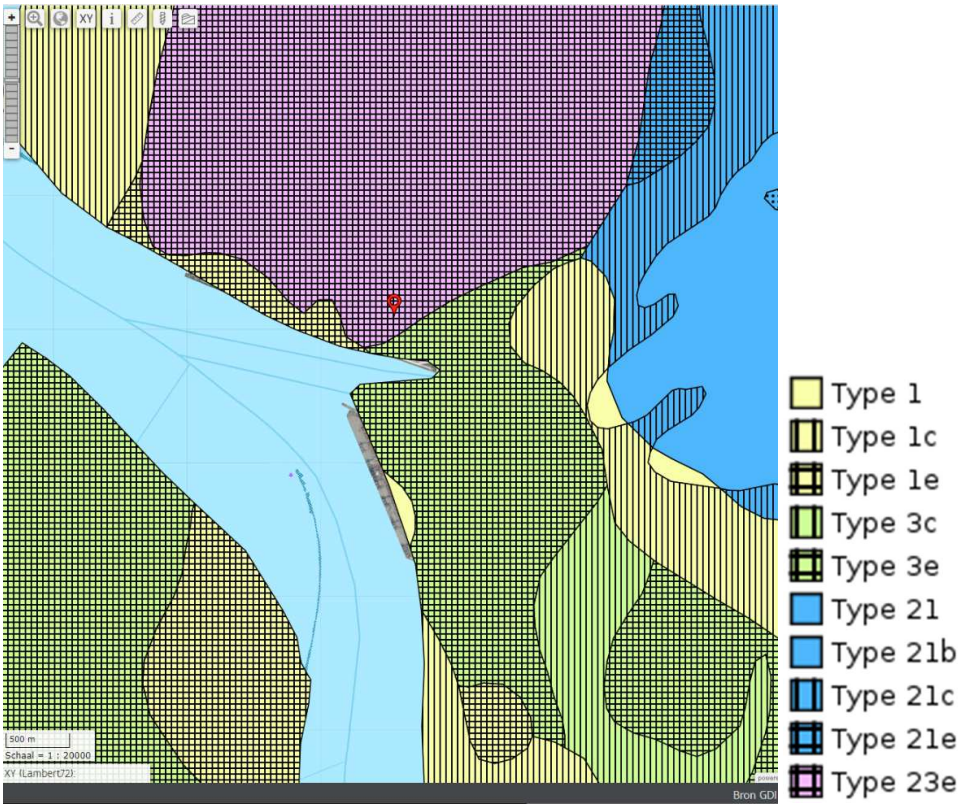

Figure 24 Coring location on the Quaternary geological profile type map (1/200.000) (More info: Bogemans 1999).