UFZ HELMHOLTZ Zentrum für Umweltforschung

Direct push-color sensing and geophysical mapping – a combined approach to investigate floodplain structures

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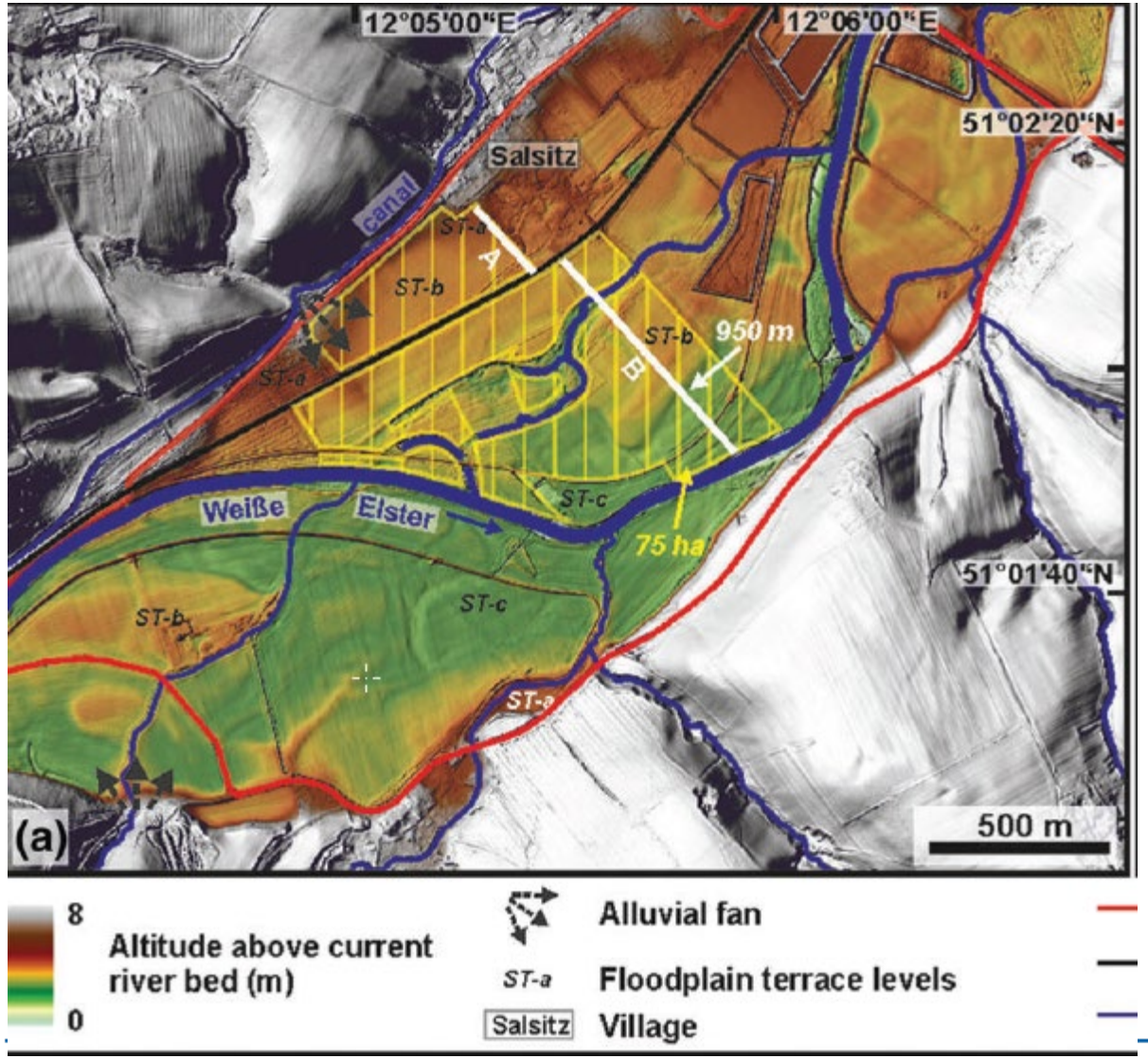
Motivation – mapping of floodplains

- most dynamic parts of the cultural landscape
- floodplains as hotspot of sensitive socioenvironmental changes and early human forcing mechanisms
- Paleo-environmental research – distinguish human and climatic impact on sedimentation in floodplains (renaturalization of floodplains)
- enhance understanding of storage of organic carbon, as changes in SOC depot are climate relevant

-> **test and development of approaches beyond coring at points and elevation models**

Imaging by geophysical methods – electromagnetic induction + resistivity tomography



Weisse Elster - fluvial river dynamics are characterized by repeated periods of fluvial erosion and re-deposition in different parts of the floodplain

Imaging by geophysical methods – Electromagnetic Induction + resistivity tomography

two-dimensional analyses along transect

Electrical Resistivity Tomography (ERT)

pre-screening for areas with fine- and coarse-grained sediments: allows to adapt coring density

↓

Parallel core drillings

buildup of well-resolved fluvial architecture along transect

↓

spatially resolved analyses of transect surroundings

Electromagnetic Induction (EMI)

spatial upscaling of main elements of fluvial architecture

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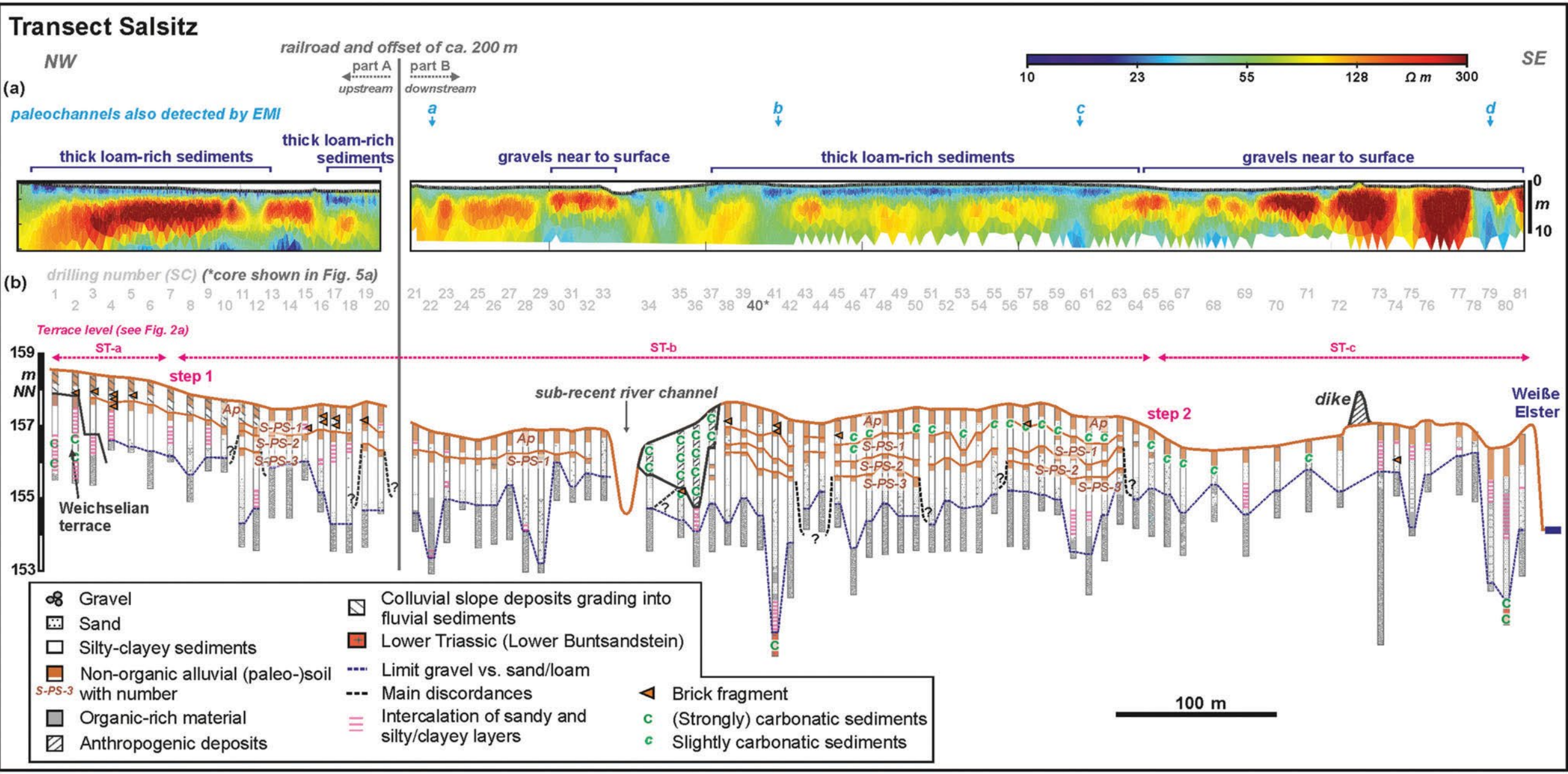
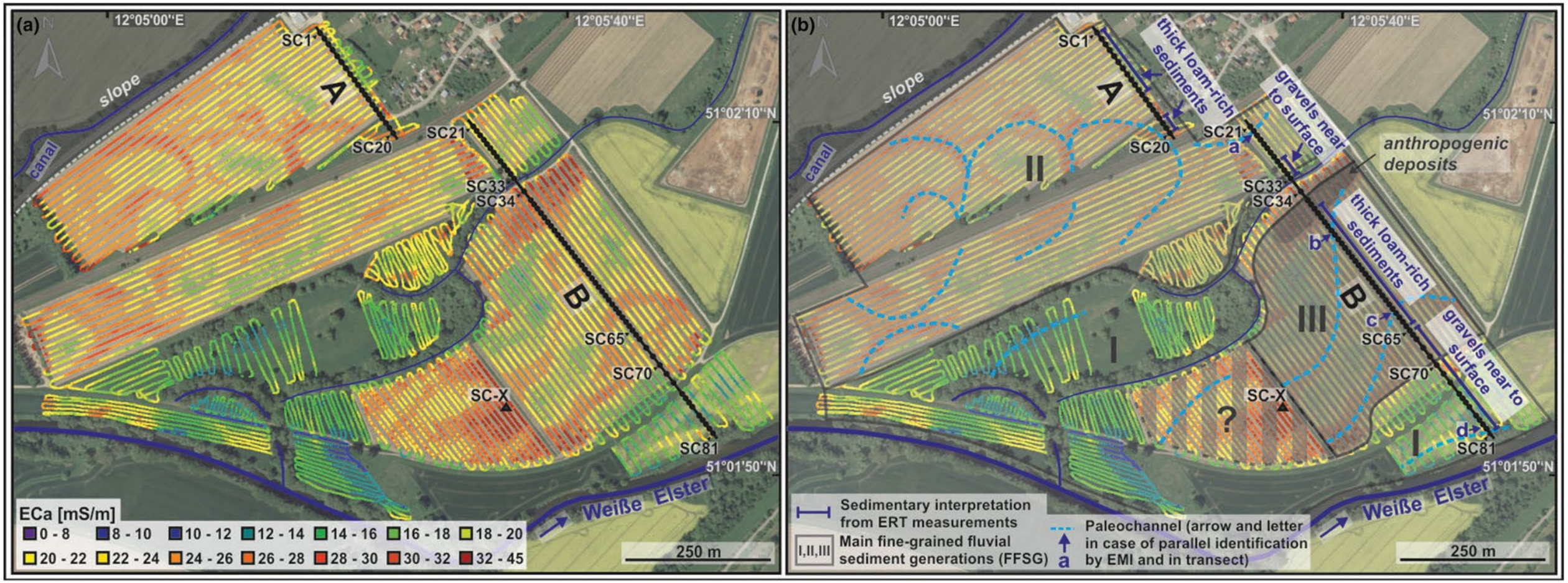
spatial upscaling of main elements of fluvial architecture


Transect Salsitz
NW
railroad and offset of ca. 200 m
part A
upstream
part B
downstream
SE
10
23
55
128
Ω m
300
(a)
paleochannels also detected by EMI
a
b
c
d
thick loam-rich sediments
thick loam-rich sediments
gravels near to surface
thick loam-rich sediments
gravels near to surface
0
m
10
(b)
drilling number (SC) (*core shown in Fig. 5a)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40* 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81
Terrace level (see Fig. 2a)
159
m
NN
157
155
153
ST-a
ST-b
ST-c
step 1
step 2
sub-recent river channel
dike
Weiße Elster
Ap
S-PS-1
S-PS-2
S-PS-3
Weichselian terrace
100 m
Gravel
Sand
Silty-clayey sediments
Non-organic alluvial (paleo-)soil with number
S-PS-3
Organic-rich material
Anthropogenic deposits
Colluvial slope deposits grading into fluvial sediments
Lower Triassic (Lower Buntsandstein)
Limit gravel vs. sand/loam
Main discordances
Intercalation of sandy and silty/clayey layers
Brick fragment
(Strongly) carbonatic sediments
Slightly carbonatic sediments

Imaging by geophysical methods – Electromagnetic Induction



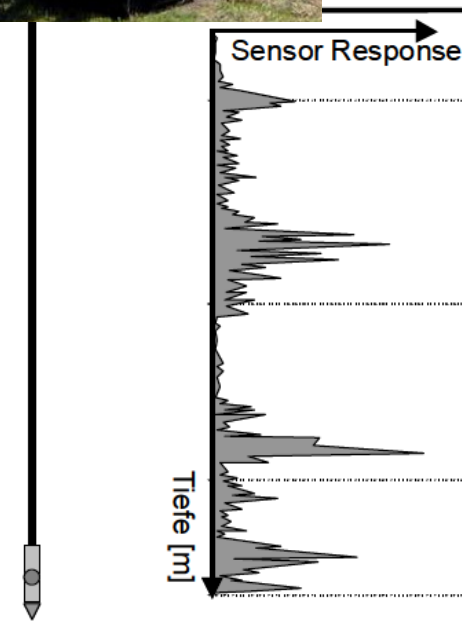
large-scale distribution of thick fine-grained silt-clay overbank deposits
paleochannel structures -> reconstruction of former channel patterns

Imaging by direct push technologies

in situ measurement of properties

while pushing/hammering sensors

into the ground



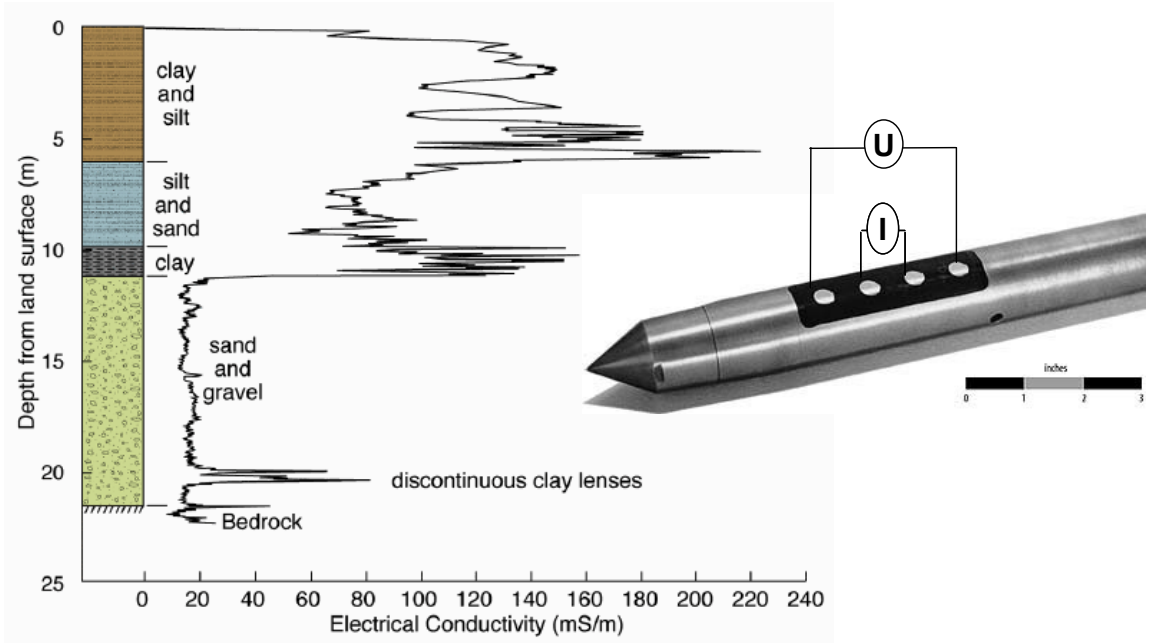
geotechnical properties

geophysical properties

hydraulic properties

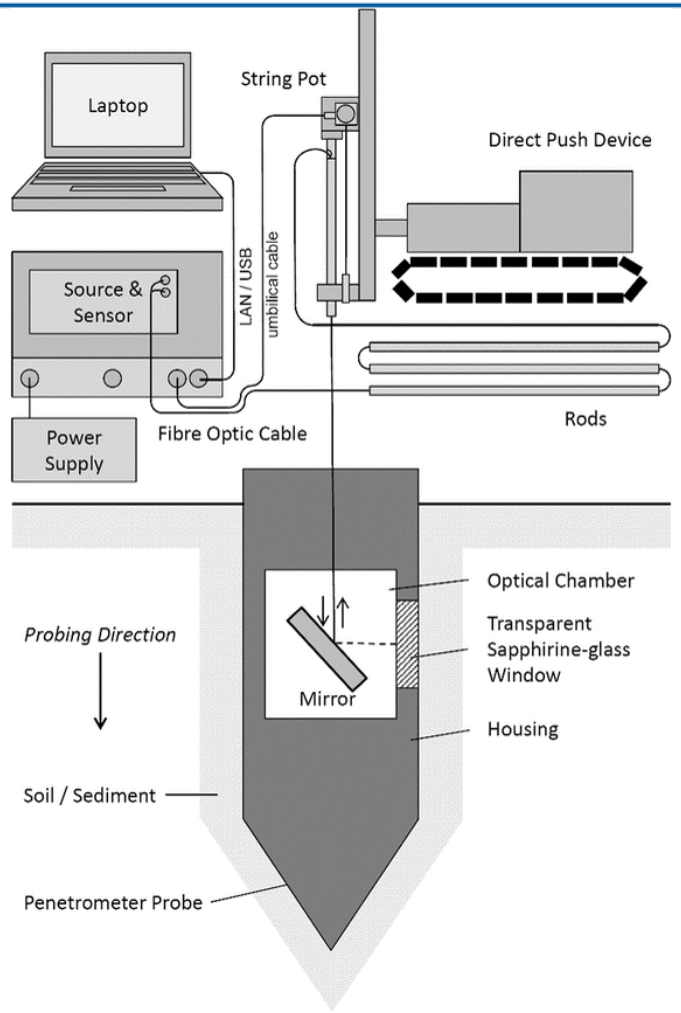
geochemical properties

(after Weiß, 2007)

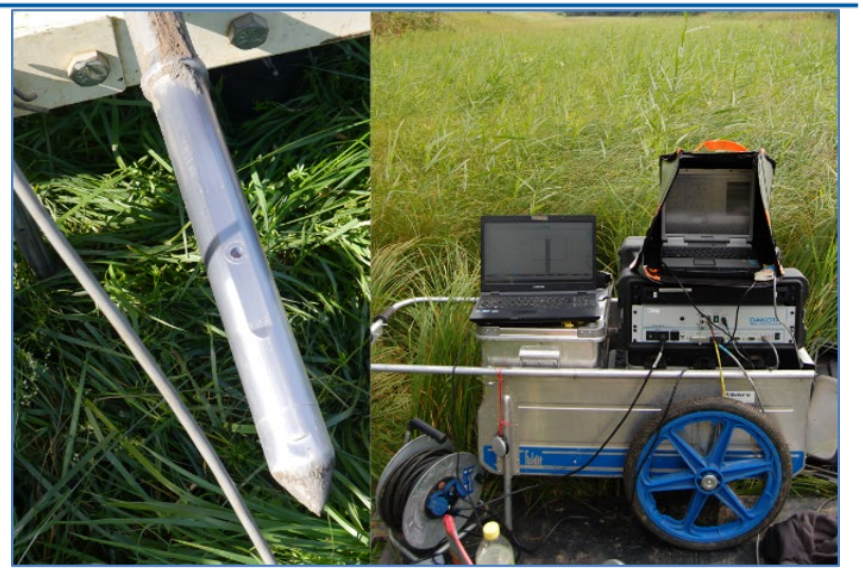


(Schulmeister, 2004)

Color logging tool



- Ø = 3.8 cm, v_{push}= 2 cm/s,
- integration time = 300 ms
- λ = 350 – 1000 nm
- color values in RGB, Munsell, XYZ
- optical + numerical interpretation
- resolution: < 1 cm

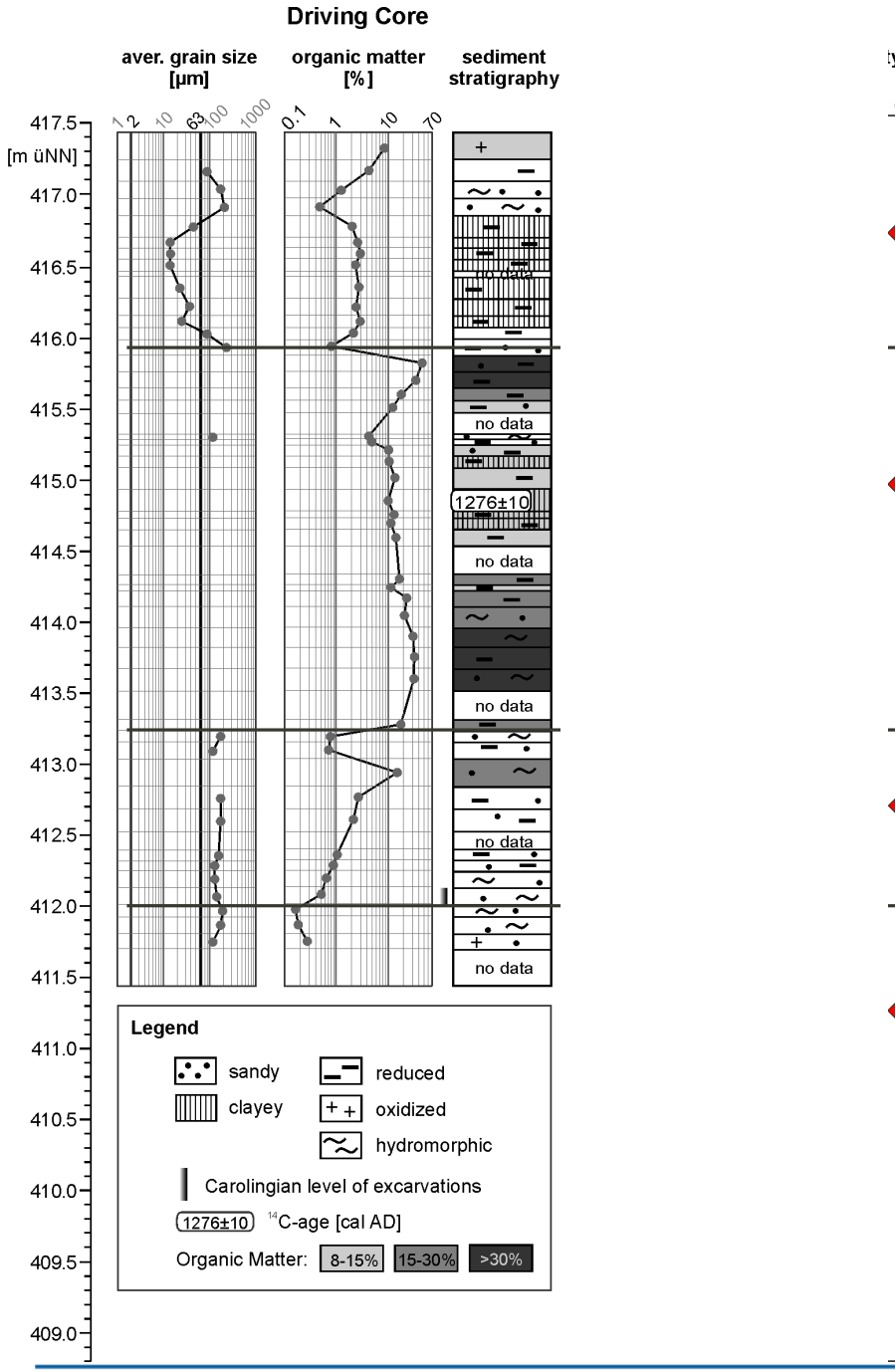


Environ Earth Sci (2016)75:957
DOI 10.1007/s12665-016-5515-7

THEMATIC ISSUE

Technique, analysis routines, and application of direct push-driven in situ color logging

Jörg Hausmann[1] · Peter Dietrich[1,2] · Thomas Vienken[1] · Ulrike Werban[1]



1) colluvial and limnic deposits

2) organic deposits

3) colluvium

4) pleistocene fluvial fills

Quaternary International 473 (2018) 21–36

Contents lists available at ScienceDirect

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Direct push sensing in wetland (geo)archaeology: High-resolution reconstruction of buried canal structures (*Fossa Carolina*, Germany)

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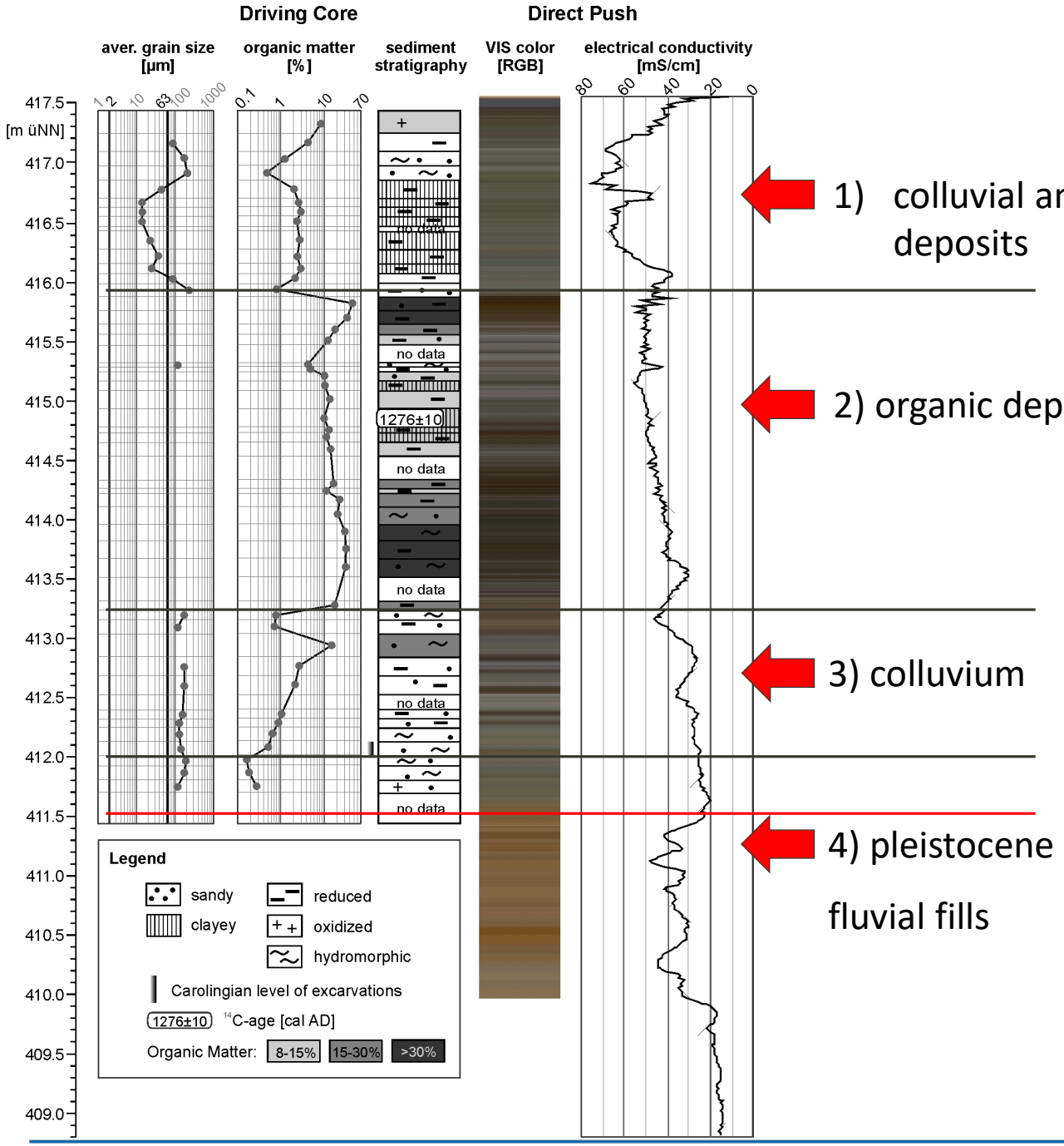

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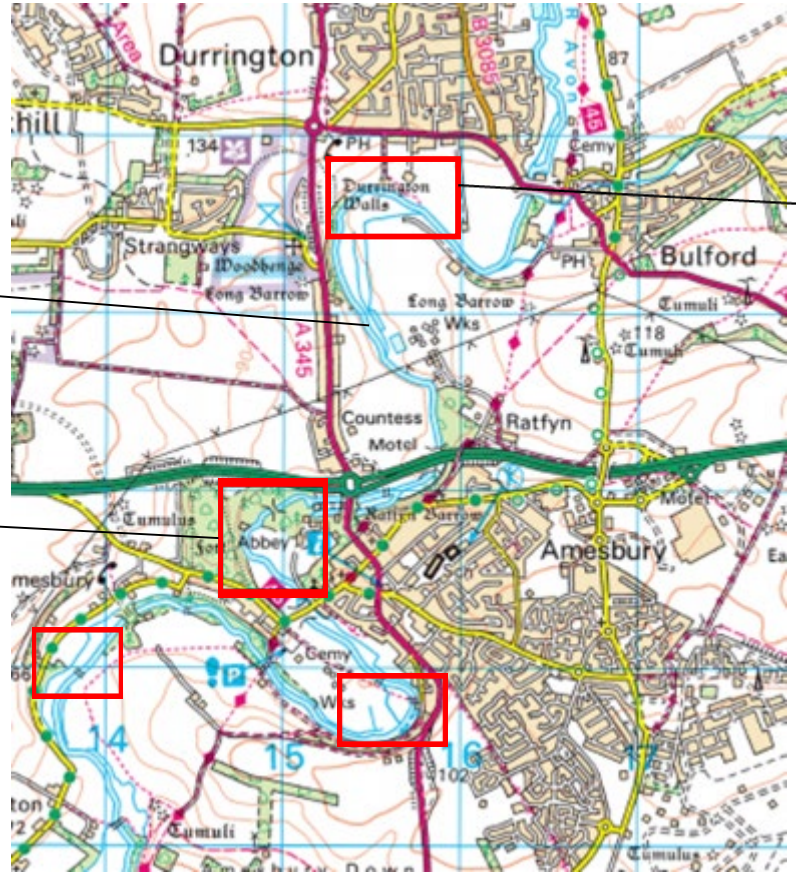
Stonehenge landscape – environmental conditions during mid-later Mesolitic

Potential of *SedaDNA* Application to Wetland Archaeology



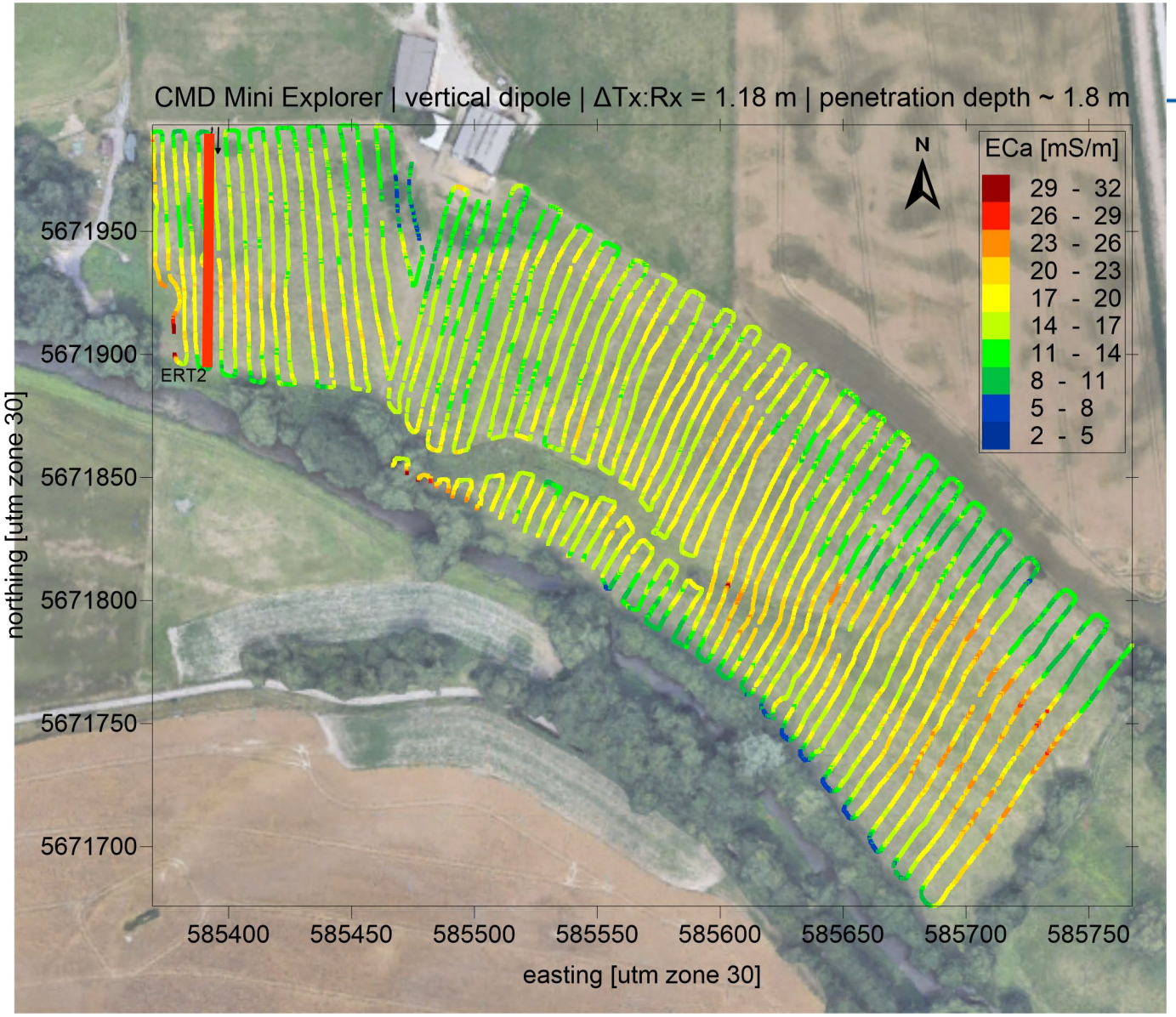
AHRC project- Buried Landscapes of the Avon Valley

- what was the scale of pre-Neolithic activity,
- how dynamic was the environment during the mid-later Mesolithic?

- Wetland contexts often preserve comparative environmental data (pollen, plant macros, wood) which help to evaluate the DNA data

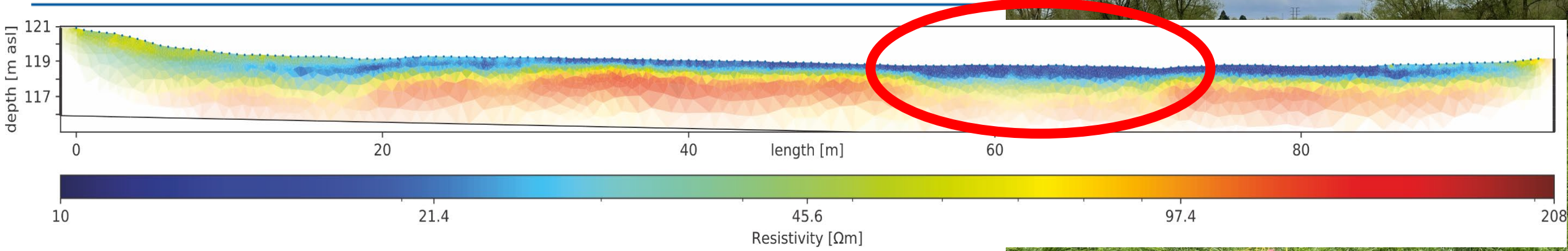
Geophysical invstigation

Geophysical investigations - EMI



indication of channel structures

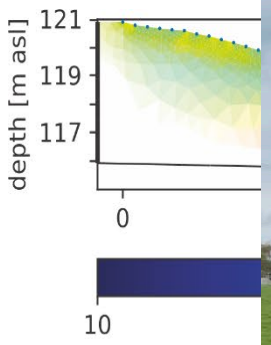
Geophysical investigations - ERT



clear indication of an palaeochannel

extension approx 20 m

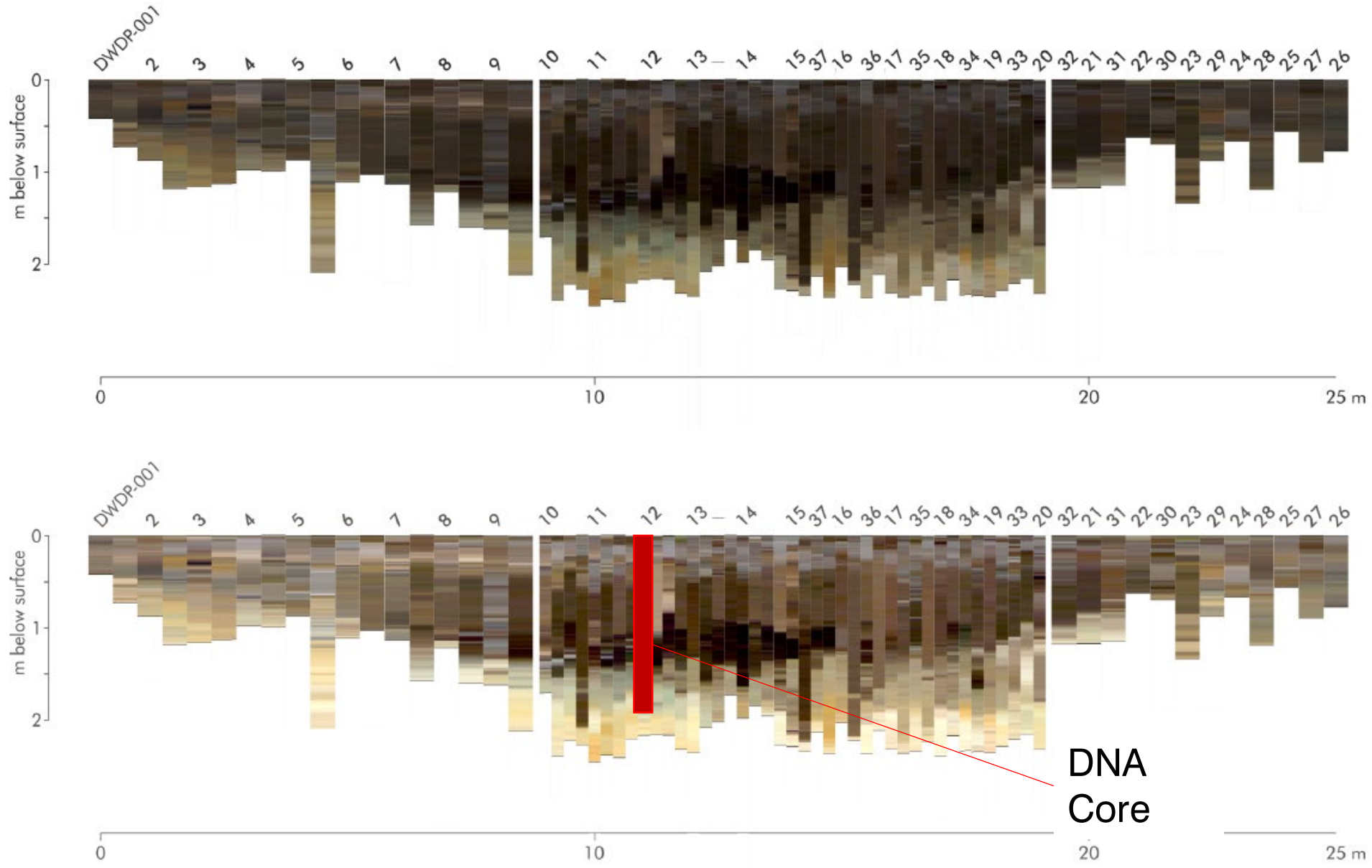
Geophysical investigations - ERT



clea

exte

direct push-sensing – color logging



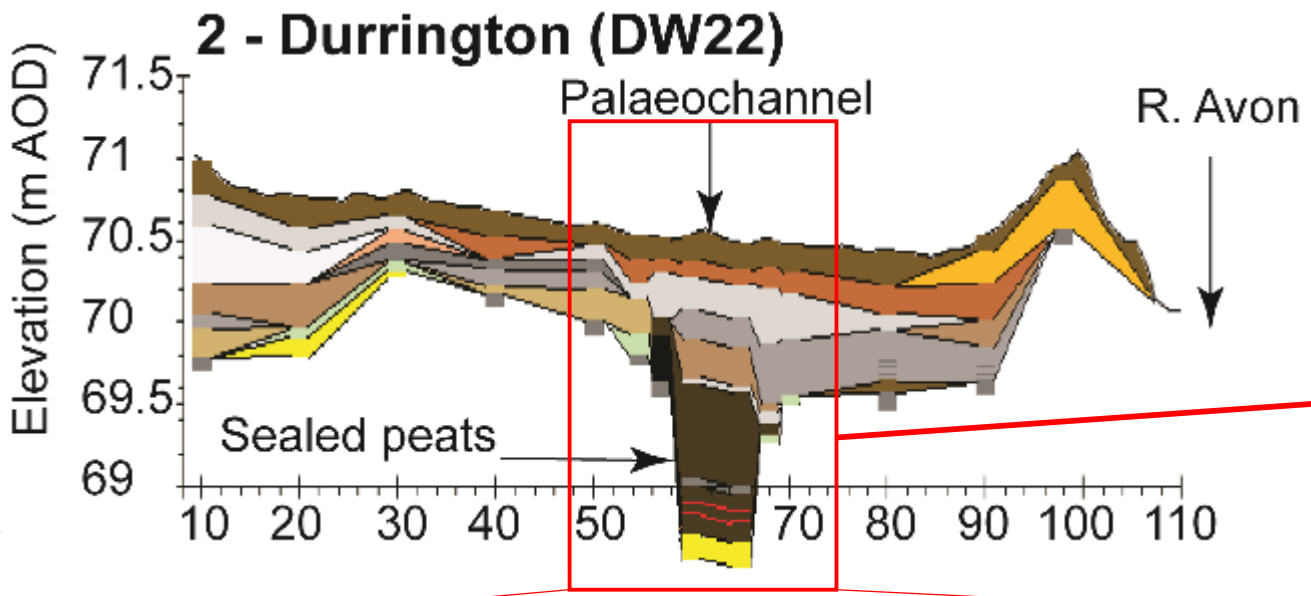
Δlog= 25 cm to 50 cm

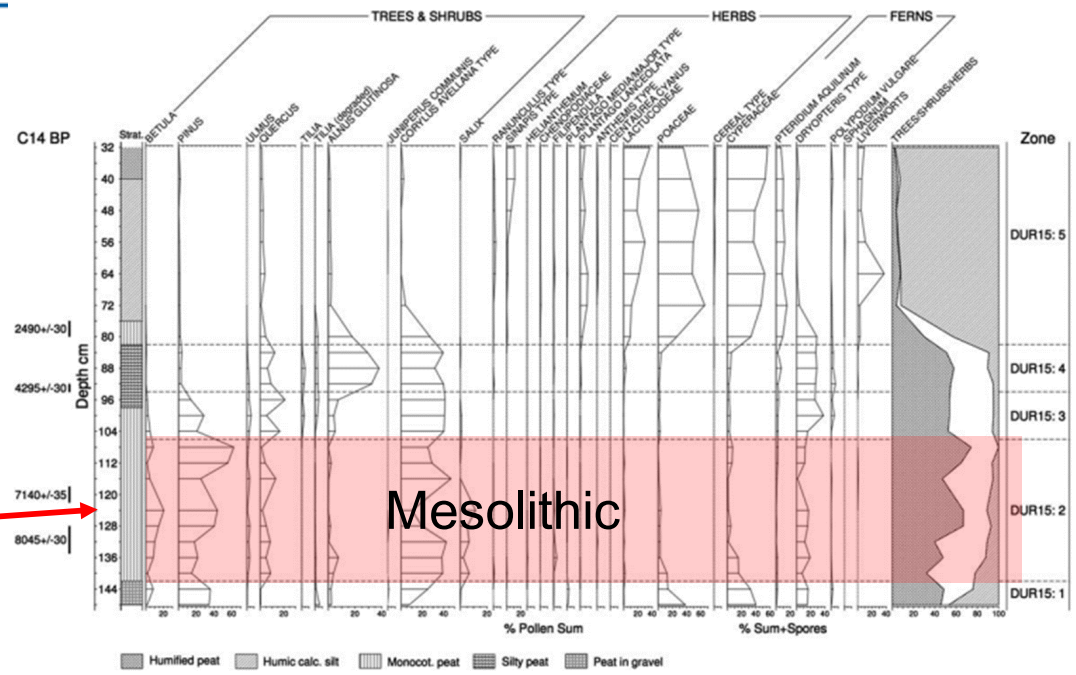
sealed peats in a paleochannel

Summary

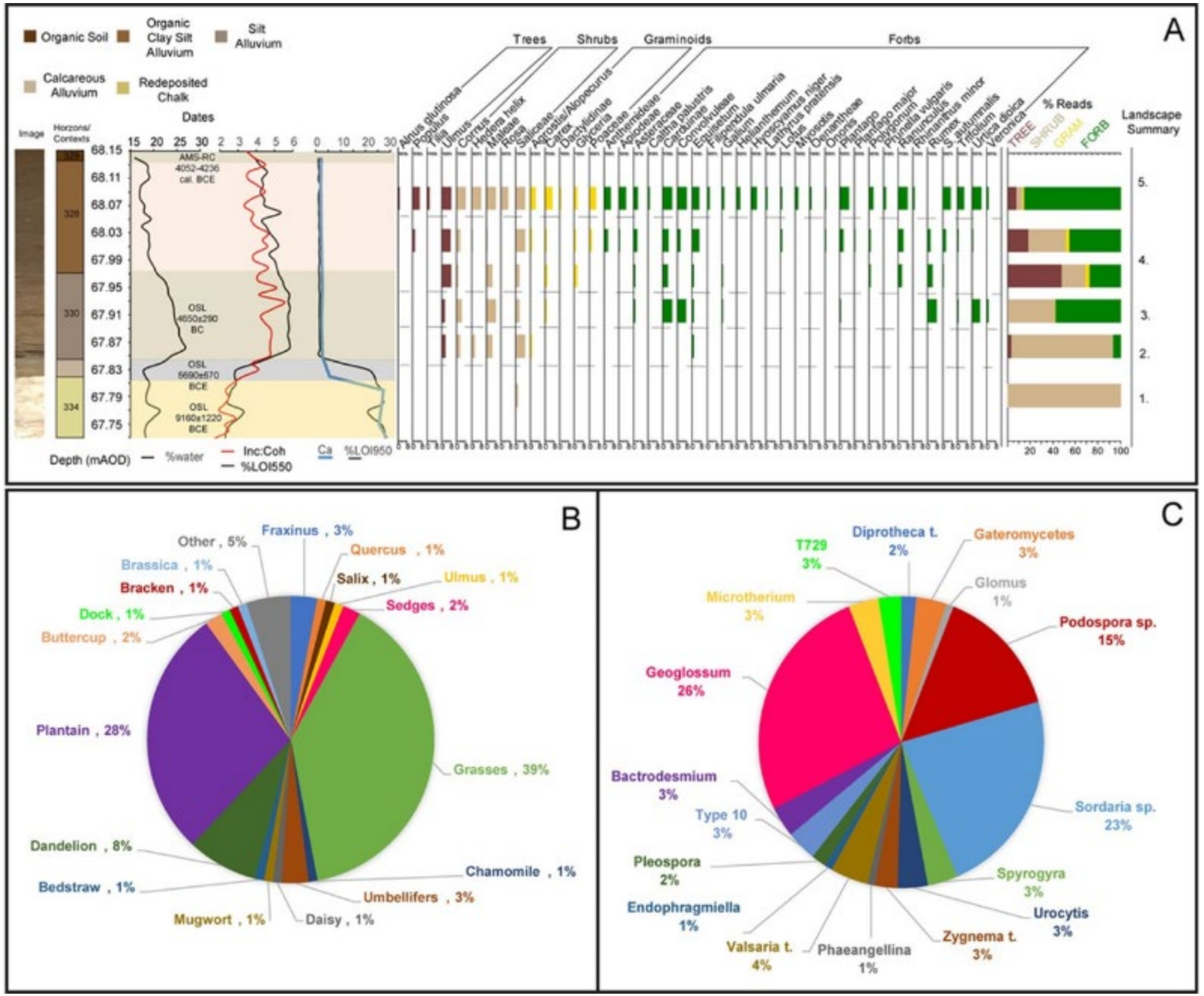
- ERT+EMI is a valuable combination for mapping floodplains
- direct push-technologies can support geoarchaeological investigations
- well suited for mapping of organic layers
- “depth true” mapping
- direct push is able bridge the gap in spatial resolution between core sampling and geophysics

Soil Moisture





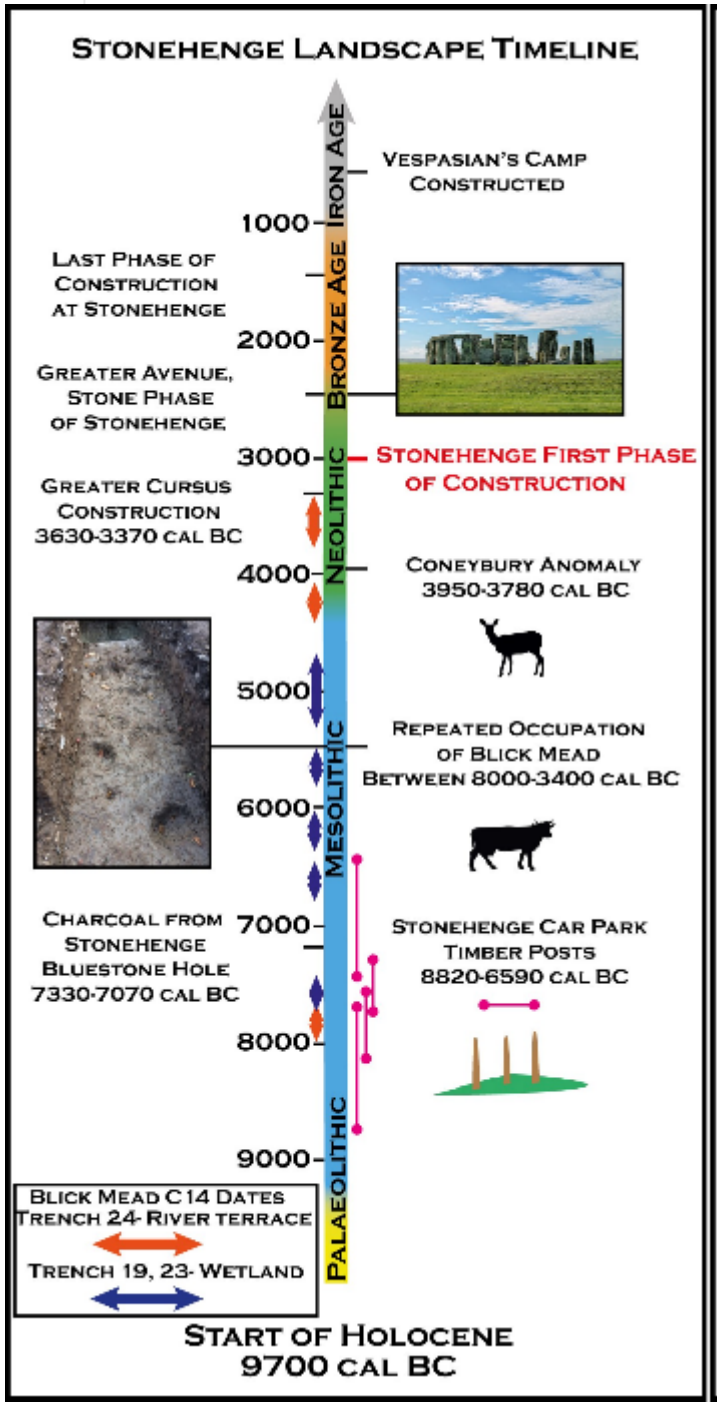
French *et al.* 2012

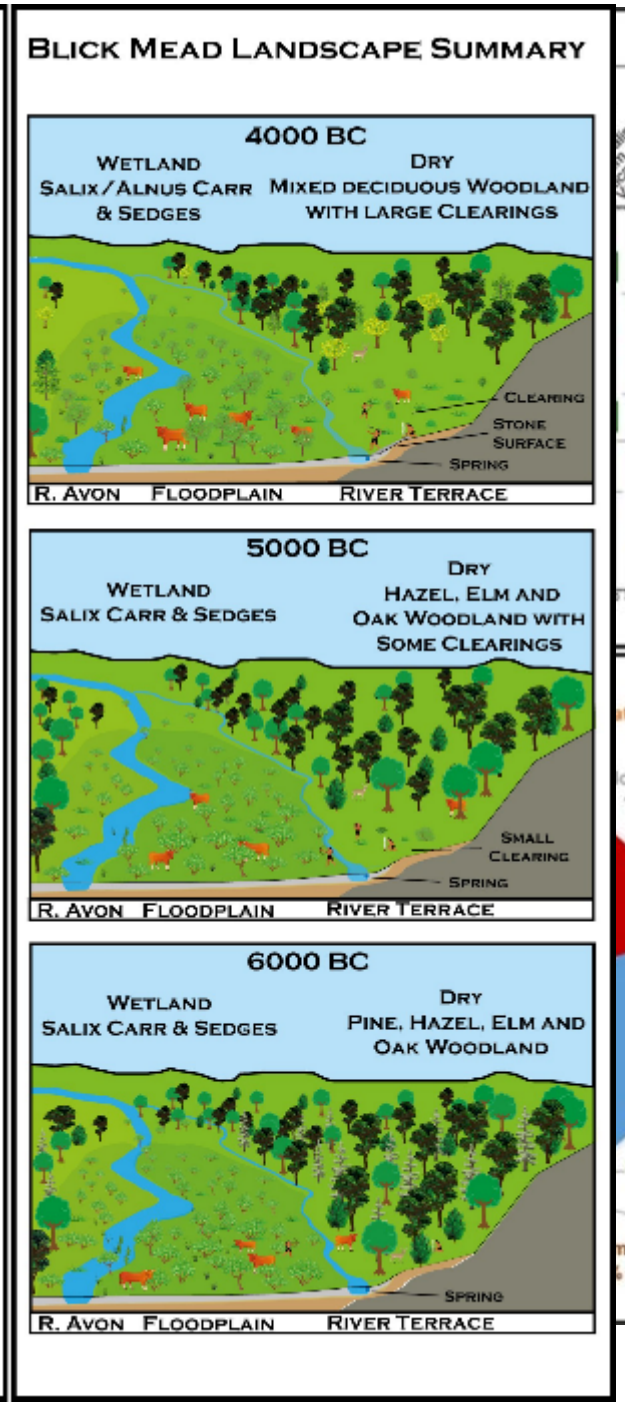


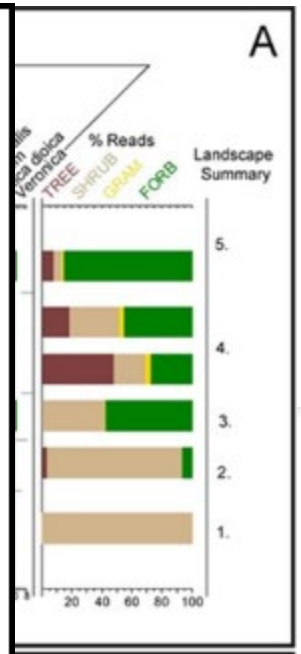
A SedaDNA, **B** Pollen, **C** Fungal spores

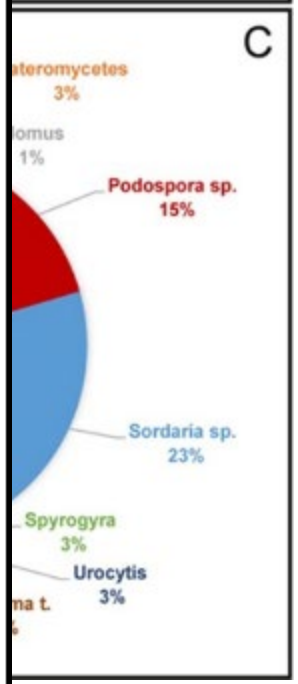
- Establishment of a floodplain meadow/clearing in the Late Mesolithic
- Associated with the hunting of aurochs and other grazing mammals
- Aligns with pollen and fungal spore evidence.

Hudson et al. 2022 Plos ONE.









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Hudson et al. 2022 Plos ONE.

geometry & stratigraphy

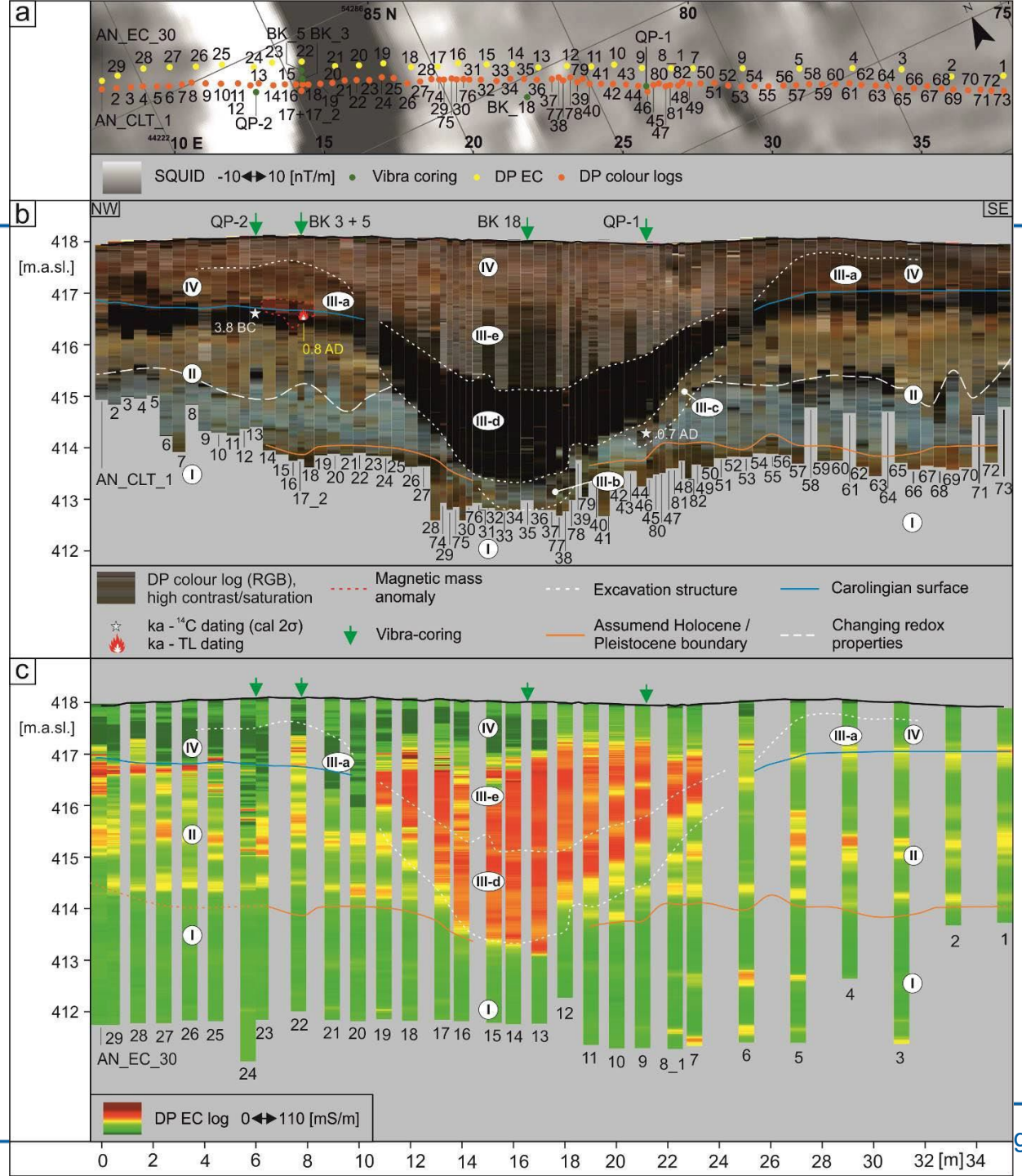
exact geometry of the channel and the former banks

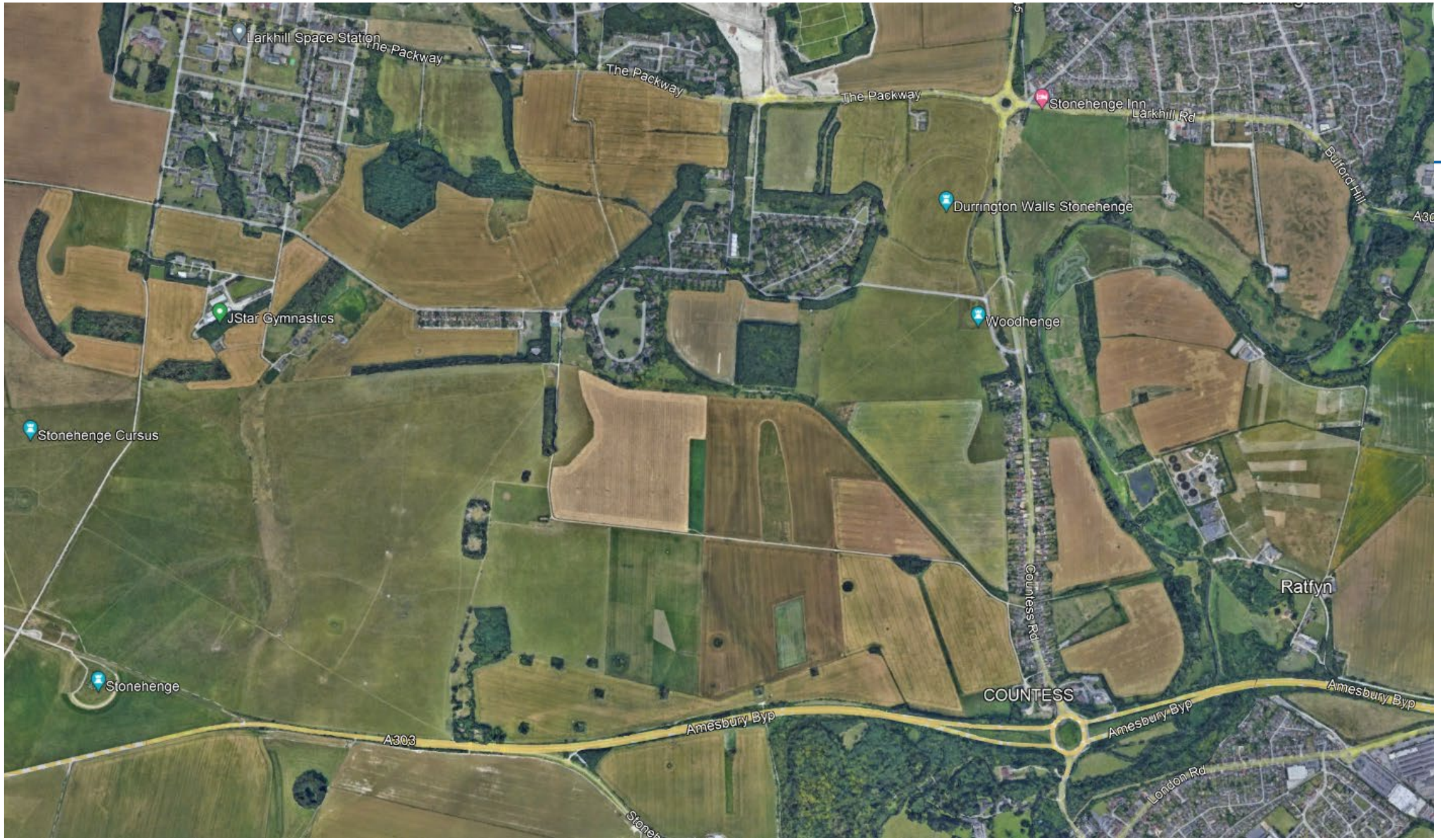
magnetic anomaly clearly localized below the excavation material

-> precise position within the stratigraphy

reductive-oxidative layering related to groundwater level

(Rabiger-Völlmer et al., 2021, Remote Sensing)




Larkhill Space Station
The Packway
The Packway
The Packway
Stonehenge Inn
Larkhill Rd
Durrington Walls Stonehenge
Woodhenge
JStar Gymnastics
Stonehenge Cursus
Stonehenge
A303
Amesbury Byp
Countess Rd
COUNTESS
Ratfyn
London Rd