

# Infill of Late Weichselian pingo remnants reveals rapid climate change



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## Introduction

In the Netherlands a high density of pingo remnants occurs (see poster A.S. Ruiter et al., Figure 3) and many have been described. However, no pingo remnants have been acknowledged in Germany in recent literature. In this study, various circular depressions in the northern Netherlands and northwestern Germany were investigated, among which 15 pingo remnants have been recognized (Figure 1a).

## Results

In order to estimate the timing of pingo collapse, pollen analysis has been performed on the deepest infill of several of the pingo remnants (Table 1). From two of the sites, Timmelteich (Figures 1b, 2) in Ost-Friesland and Emstekerfeld near Cloppenburg, Germany, cores were taken for further analysis.

Loss on Ignition (LOI) indicates the openness of the vegetation cover as a result of climate change. An age model was constructed based on the pollen composition, using the zone boundaries established by Hoek, 1997 (Figures 3, 4).

In the Late Weichselian/Early Holocene, LOI clearly reflects climate conditions: higher temperatures lead to denser vegetation and thus higher LOI values. However, during the Bølling interstadial (zone 1b) higher temperatures are not reflected by LOI and pollen assemblage.

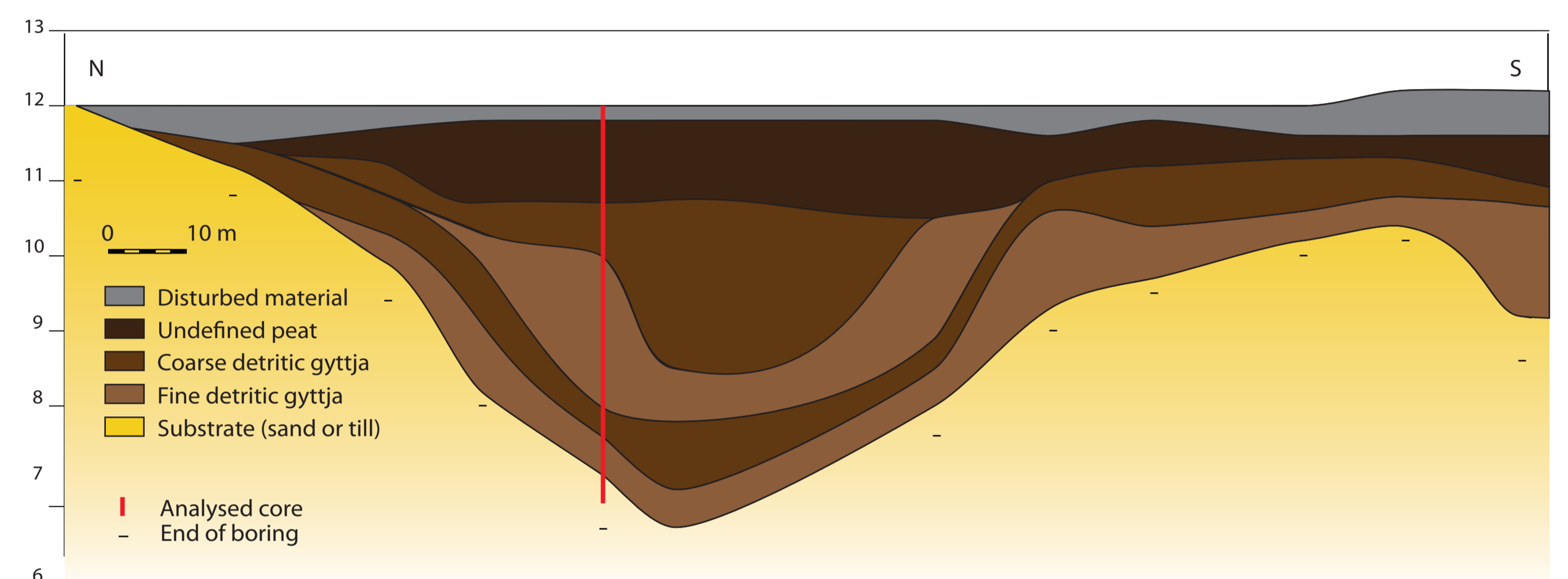
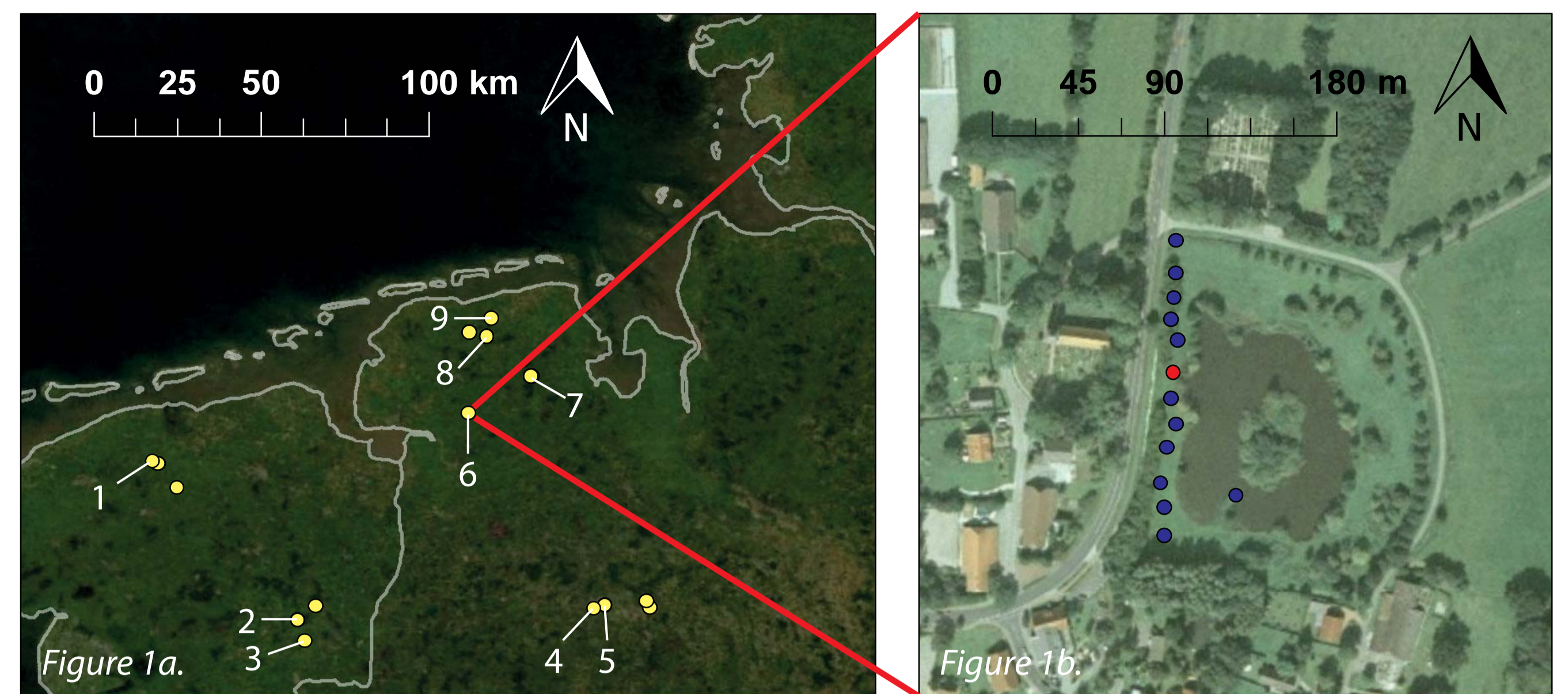


Figure 2. Cross section of the Timmelteich pingo remnant

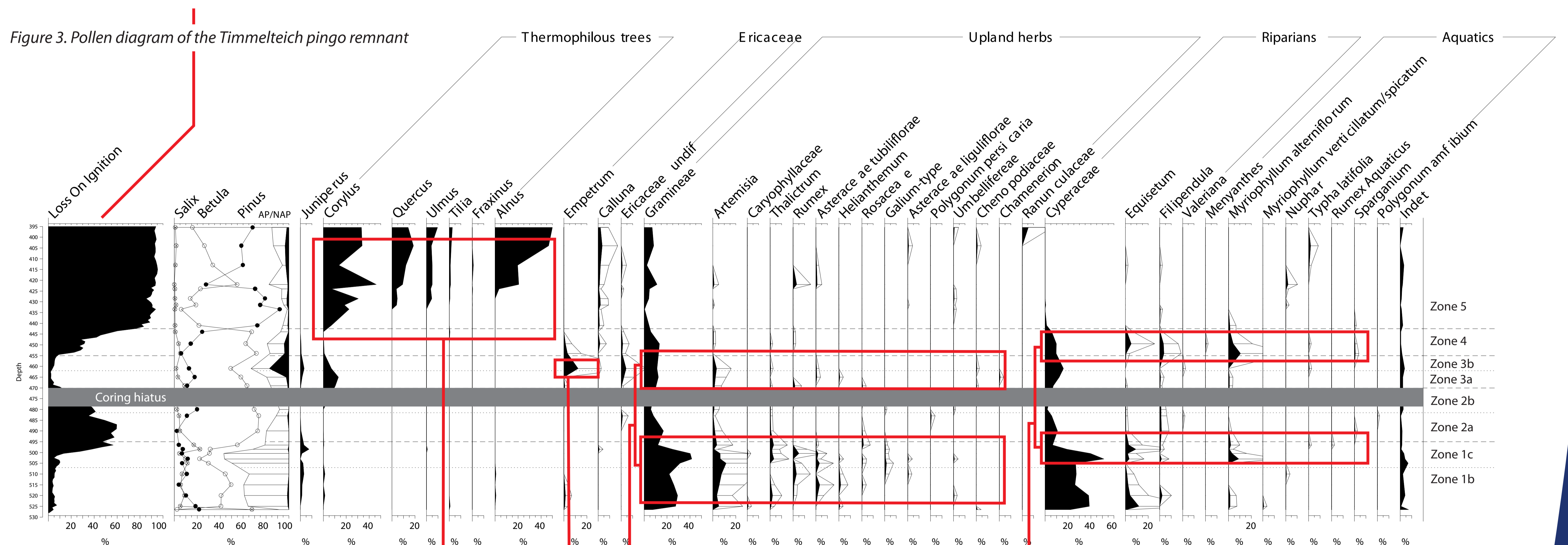


Figure 3. Pollen diagram of the Timmelteich pingo remnant

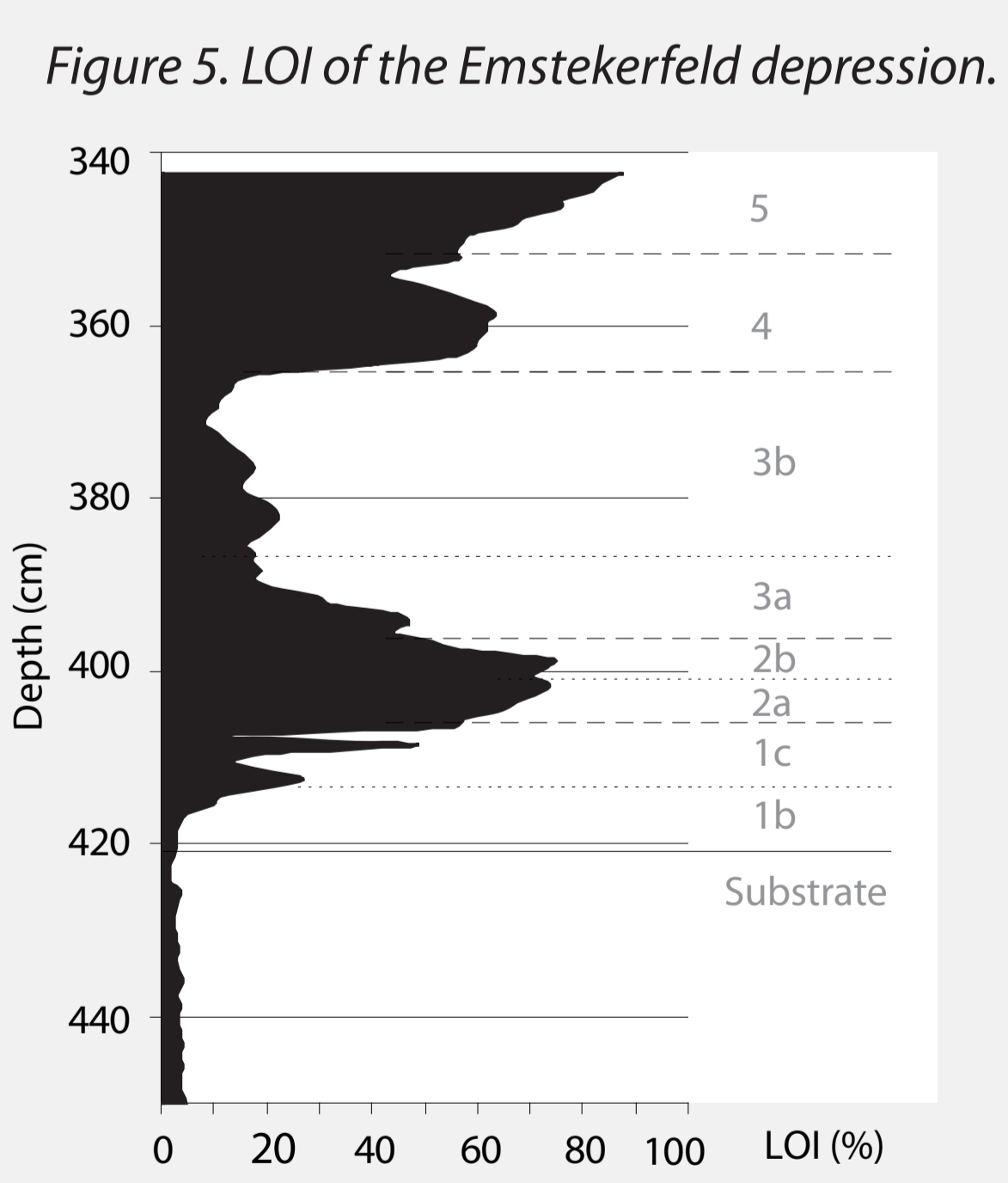


Figure 5. LOI of the Emstekerfeld depression.

A high percentage of herbs reflects an open landscape.

Higher values of Empetrum (Heather) indicate a period of active aeolian sedimentation.

Successive immigration of thermophilous trees indicate stable temperatures.

Wet conditions are implied by an increase in riparian and aquatic species.

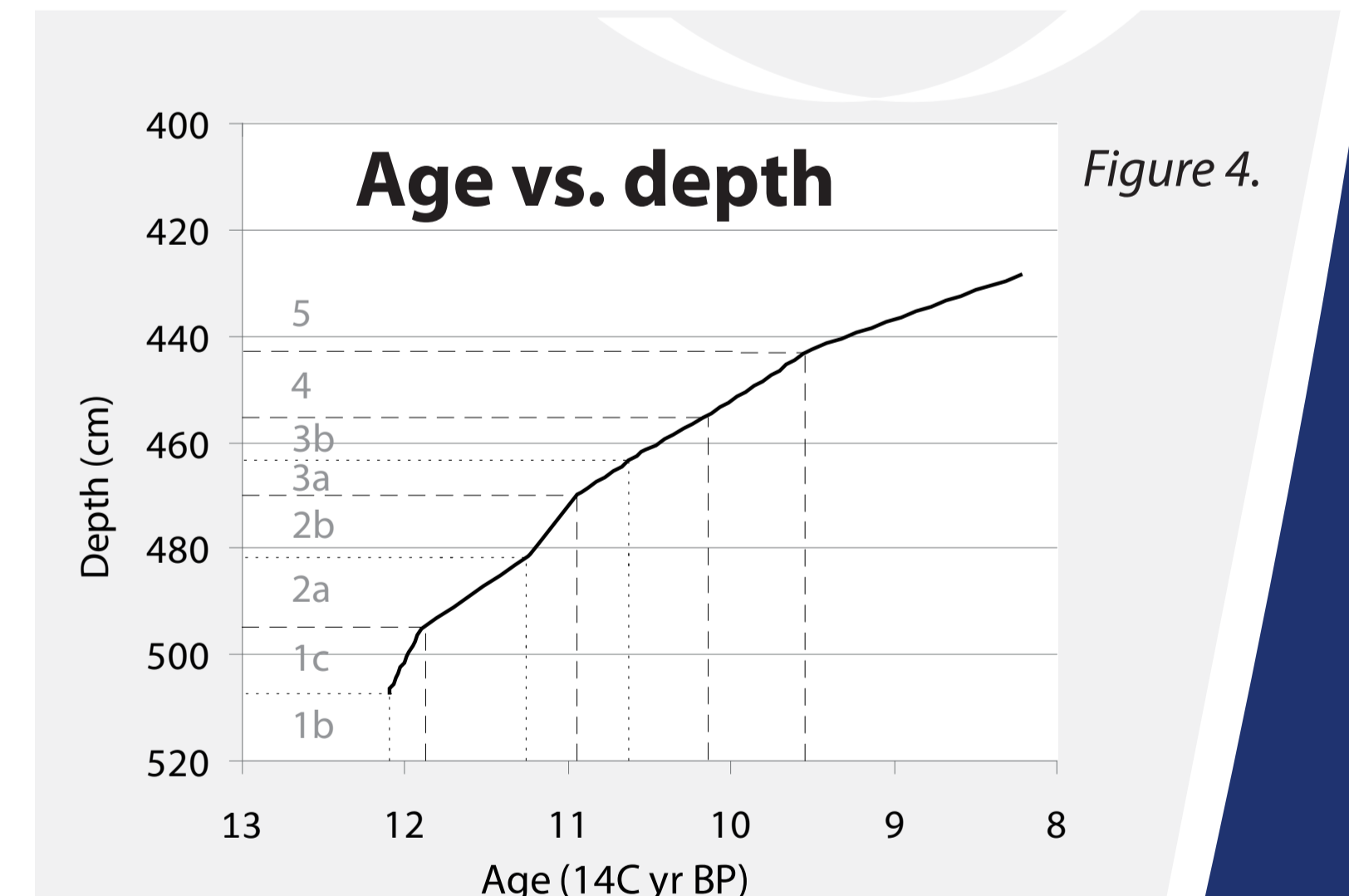


Figure 4. Age vs. depth

## Conclusions

The infill of the Timmelteich pingo remnant indicates several large shifts in climate. The earliest infill vegetation indicates that the depression started to fill in the Bølling interstadial, when temperatures were relatively high. However, LOI and pollen at this time show that landscape was open. Vegetation had not reached equilibrium with climate conditions. The onset and end of the Younger Dryas (zone 3) clearly show abrupt response to climate in both LOI and vegetation (Figure 3, 5). The Emstekerfeld depression infill reveals similar LOI values in response to climate change. Weichselian pingo remnants can be considered as valuable records for Late Weichselian and Early Holocene climate fluctuations.

Site	Depth (cm)	LOI (%)	Zone
1. Egypte	270	-	Zone 1c
2. Vlierendijk	465	3.56	PW/Zone 3
3. Sleenerstroom I	546	10.18	Zone 1b
4. Sevelte	483	40.61	Zone 2
5. Emstekerfeld	420	2.79	Zone 1b
6. Timmelteich	526	4.53	Zone 1b
7. Wrokmoor	508	1.74	PW
8. Brill	291	2.72	PW/Zone 1b
9. Mamburg	208	19.61	Zone 4

Table 1. Estimated age of the deepest infill of several pingo remnants. PW: Pleniglacial

## References

Hoek, W.Z. 1997. Paleogeography of Lateglacial Vegetations – Aspects of Lateglacial and Early Holocene vegetation, abiotic landscape, and climate in The Netherlands. Netherlands Geographical Studies 230, Utrecht.

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