Geographic and temporal trends in pingo remnants in the northern Netherlands and northwestern Germany

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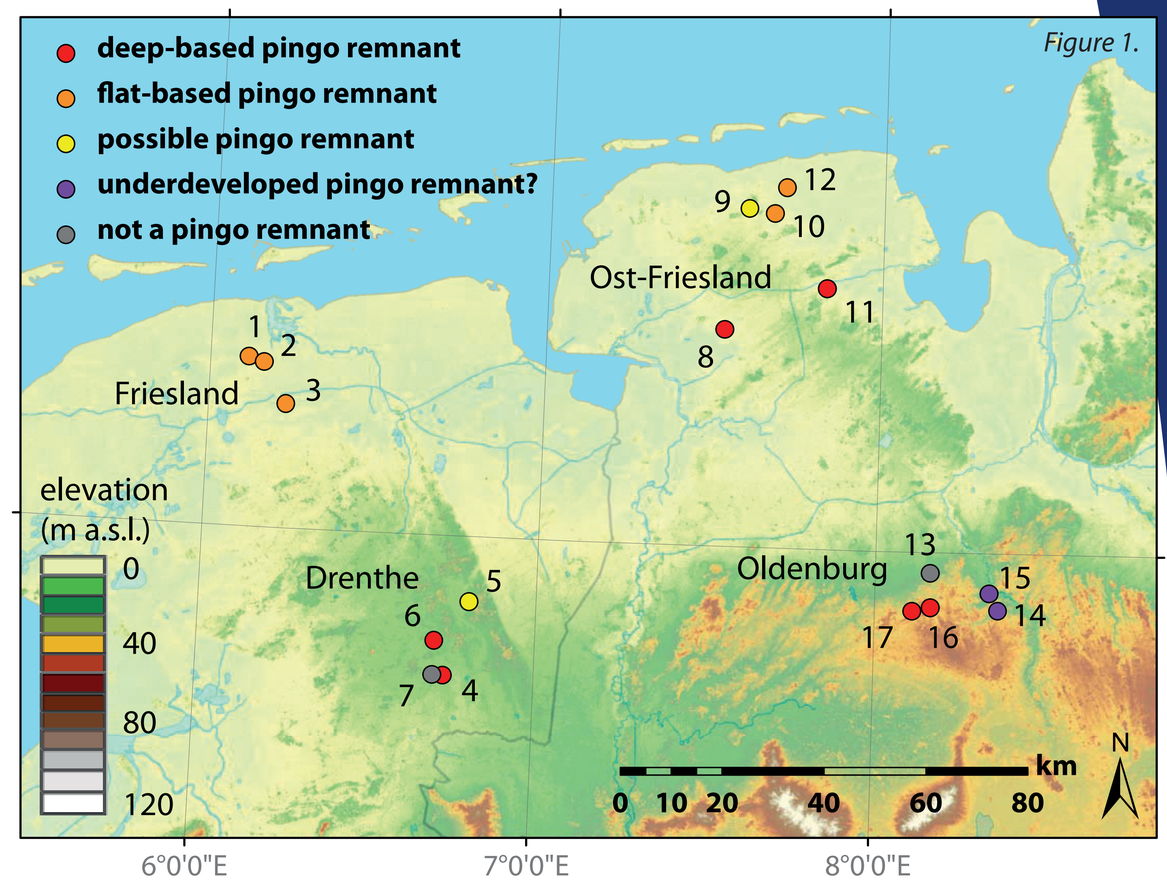
Introduction

Although pingo remnant depressions widely occur in the northern Netherlands, in north-west Germany these features have not often been described. For this study, 17 potential pingo remnants have been studied in four regions: Friesland and Drenthe in the Netherlands and Ost-Friesland and Oldenburg in Niedersachsen, Germany. Depression shape and infill were compared based on coring transects and samples of the deepest infill of the depressions, in order to evaluate geographical and temporal trends.

All four regions are located over glacial till plateaus overlain by coversands. These tills provided suitable hydrological conditions to form hydraulic-type pingos. Pingos most likely developed where seepage occurred through weaker spots in the permafrost and glacial tills.

There is a geographical trend in shape, where pingo remnant depressions in the north are relatively shallow. This may be due to the depth of the impermeable glacial till in this area.

Figure 1.



Once their collapse began, pingo remnant depressions filled in two ways: by aeolian sands and by organic material showing a hydroseral sequence (figure 2a and b). The infillings record Late Glacial climate change at a high resolution. Pollen zone boundaries (figure 3) were used to determine the age of the earliest infill.

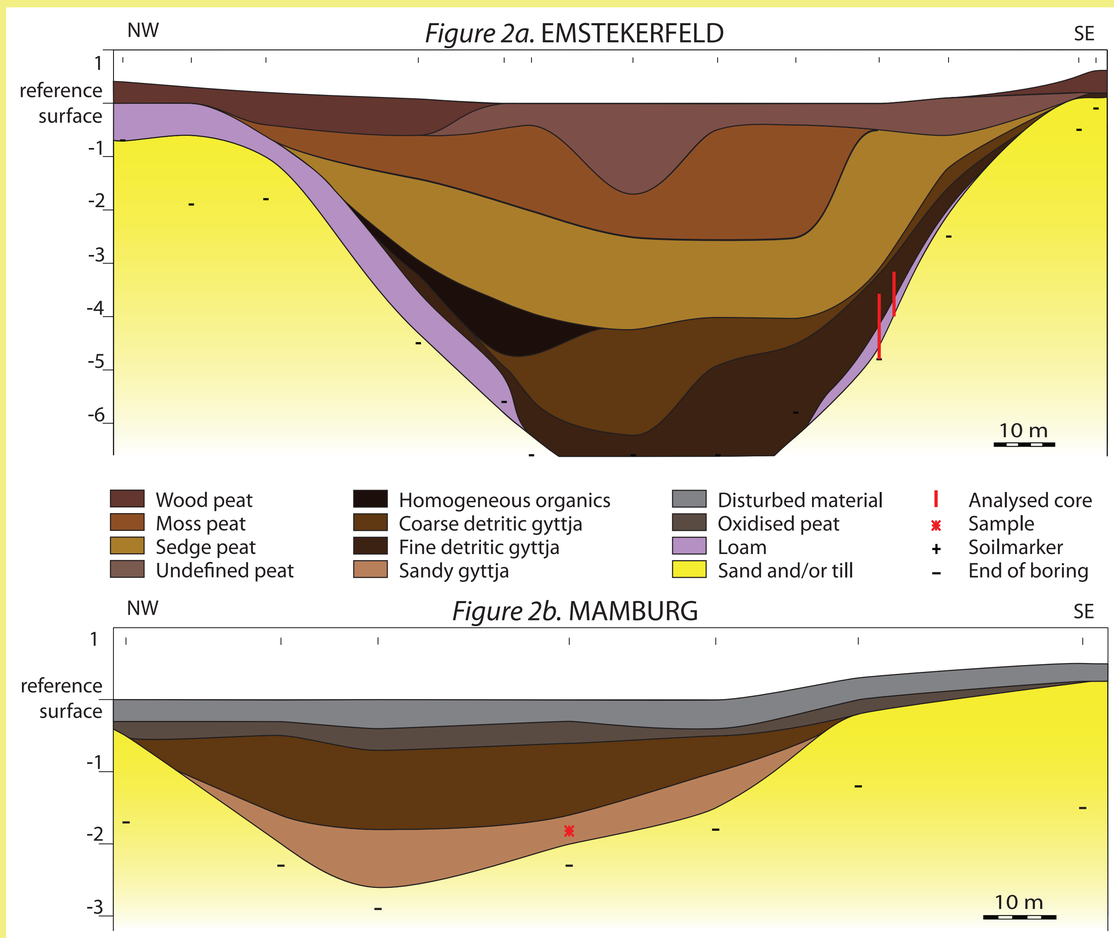


Figure 2. Typical deep-based (a) and flat-based (b) pingo remnant depressions, filled with a hydroseral sequence of organic material.

Loss on Ignition measurements on cores obtained from the centre of pingo remnants show a clear, reproducible signal reflecting the openness of the vegetation cover (figure 4). This signal sometimes is locally overprinted.

Figure 3.

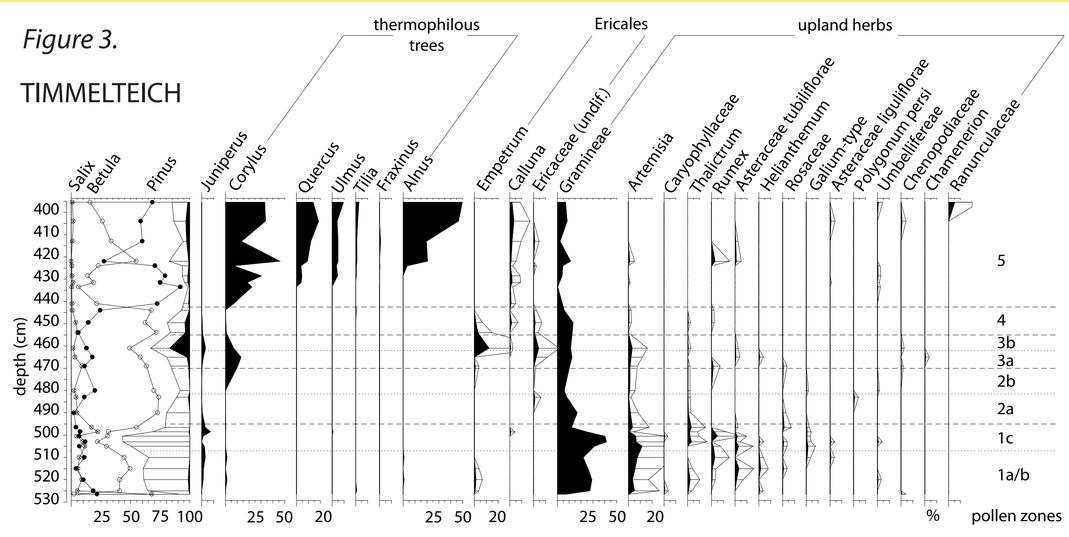
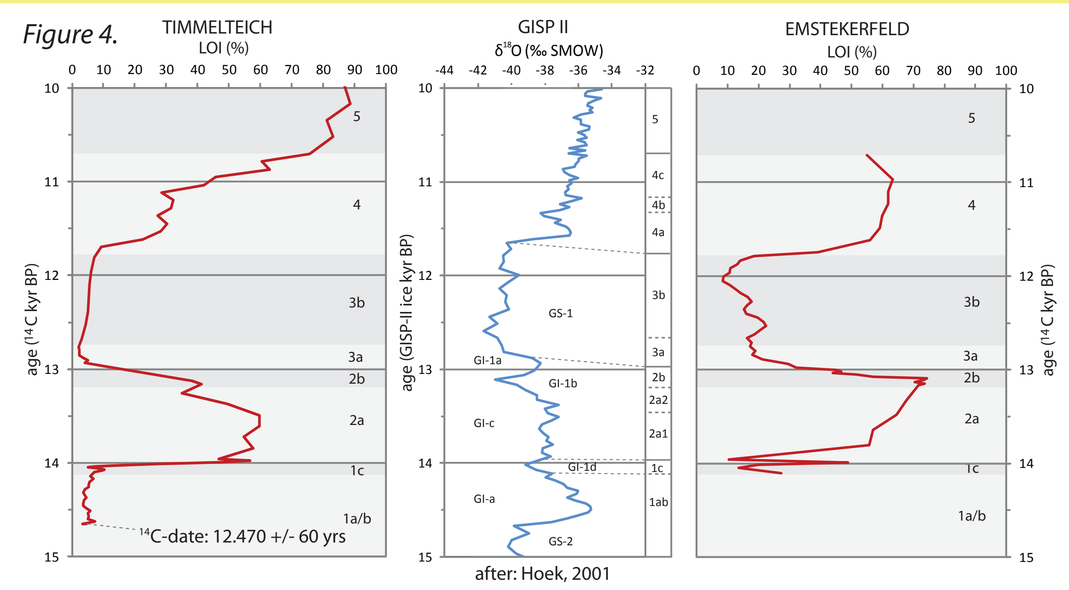


Figure 4.



research area	study site	dimensions diameter/depth (m)	pollen and lithology based (minimum) age	pingo remnant?
Friesland	1. Egypte	170 / 3.1	Earlier Dryas	yes
	2. Laarzenpad	150 / 2.5	pre-Younger Dryas	yes
	3. Opende	125 / 4.0	Bølling	yes
Drenthe	4. Sleenerstroom I	230 / 6.0	Bølling	yes
	5. Lammeer	230 / ?	-	possibly
	6. Vlierendijk	170 / 7.3	Pleniglacial	yes
	7. Sleenerstroom II	150 / 2.4	-	no
Ost-Friesland	8. Timmelteich	200 / 5.6	14.7 kyr cal BP	yes
	9. Westerschoo	200 / ?	-	possibly
	10. Brill	>80 / 3.4	Pleniglacial	yes
	11. Wrokmoor	140 / 5.5	Pleniglacial	yes
	12. Mamburg	130 / 2.9	Pleniglacial	yes
Oldenburg	13. Keller-Höhe	130 / ?	-	no
	14. Rennplatz	100 / 2.4	-	possibly
	15. Erlte	140 / 0.9	-	possibly
	16. Emstekerfeld	170 / 6.6	Bølling	yes
	17. Sevelte	150 / 4.9	Allerød, *Pinus* phase	yes

The age of the deepest infill ranges from (Late) Pleniglacial to Bølling/Allerød, implying that pingo decay occurred by both mechanical failure and climate-induced collapse.

Conclusions

1) The occurrence of pingo remnant depressions extends beyond the eastern border of the Netherlands.
2) The most northern clusters of pingos are relatively shallow, which can possibly be related to the depth of the glacial till in the substrate.
3) Pingos did not collapse isochronically. In the Pleniglacial, pingos collapsed by mechanical instability. Late Glacial collapse was caused by the warming climate.
4) Pingo remnant depressions containing an organic infill form unique (continuous) high-resolution records of the last glacial-interglacial climate transition.

Reference: Hoek, W.Z. (2001). Vegetation response to the 14.7 and 11.5 ka cal. BP climate transitions: is vegetation lagging climate? *Global and Planetary Change, Vol. 30, p. 103-115*