Hunte 1 reloaded – combining ground penetrating radar, electrical resistivity tomography, corings and excavations at the Neolithic domestic site Hunte 1, Germany

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Abstract
With the help of geophysics an old excavation plan from the 1930ies and 1940ies could be relocalized. The interface between peat and sand can be traced over the whole area by GPR. Diffraction hyperbola in GPR data as well as excavation revealed piles and timbers. The Neolithic domestic site was much larger in extent and more complex than known before our research.

Keywords
archaeological prospection; corings; electrical resistivity tomography; ground penetrating radar; Neolithic domestic site

Introduction

The Hunte 1 site north of Lake Duemmer is one of the most important Neolithic archaeological sites in the North European Plain. This is mainly based on the excellent preservation conditions in the wetlands of the Duemmer Geest lowlands on the southern border of the Northwest German Lowlands in Lower Saxony, Germany.

Excavations conducted between 1938 and 1940 (Brozio and Heumüller 2022; Kossian 2007; Reinerth 1939) uncovered 24 building structures at the Hunte 1 site (Fig. 1a). These had been preserved in the form of piles, remains of wooden floor, clay lenses and fireplaces. Dendrochronological examinations of individual timbers from the buildings made it possible to date parts of the settlement to around 2820 BC. The 120 m × 75 m large settlement was surrounded by an oval-shaped palisade consisting mainly of alder stems, having been constructed, extended and maintained between 2837 BC and 2744 BC.

The aims of the combined fieldwork that was carried out in August 2022 as part of the Collaborative Research Centre 1266 "Scales of Transformation" using geophysical methods, corings and excavations were

1. to relocalize the excavation areas from the 1930s and 40s,
2. to verify the dimensions of the known settlement and to detect still possibly unknown areas of settlement activity, and
3. to investigate the geomorphology of the area in for a better understanding of the dynamics of landscape changes and their influence on the settlement.

The locations of geophysical measurements, corings and excavations have been marked in Fig. 1b.

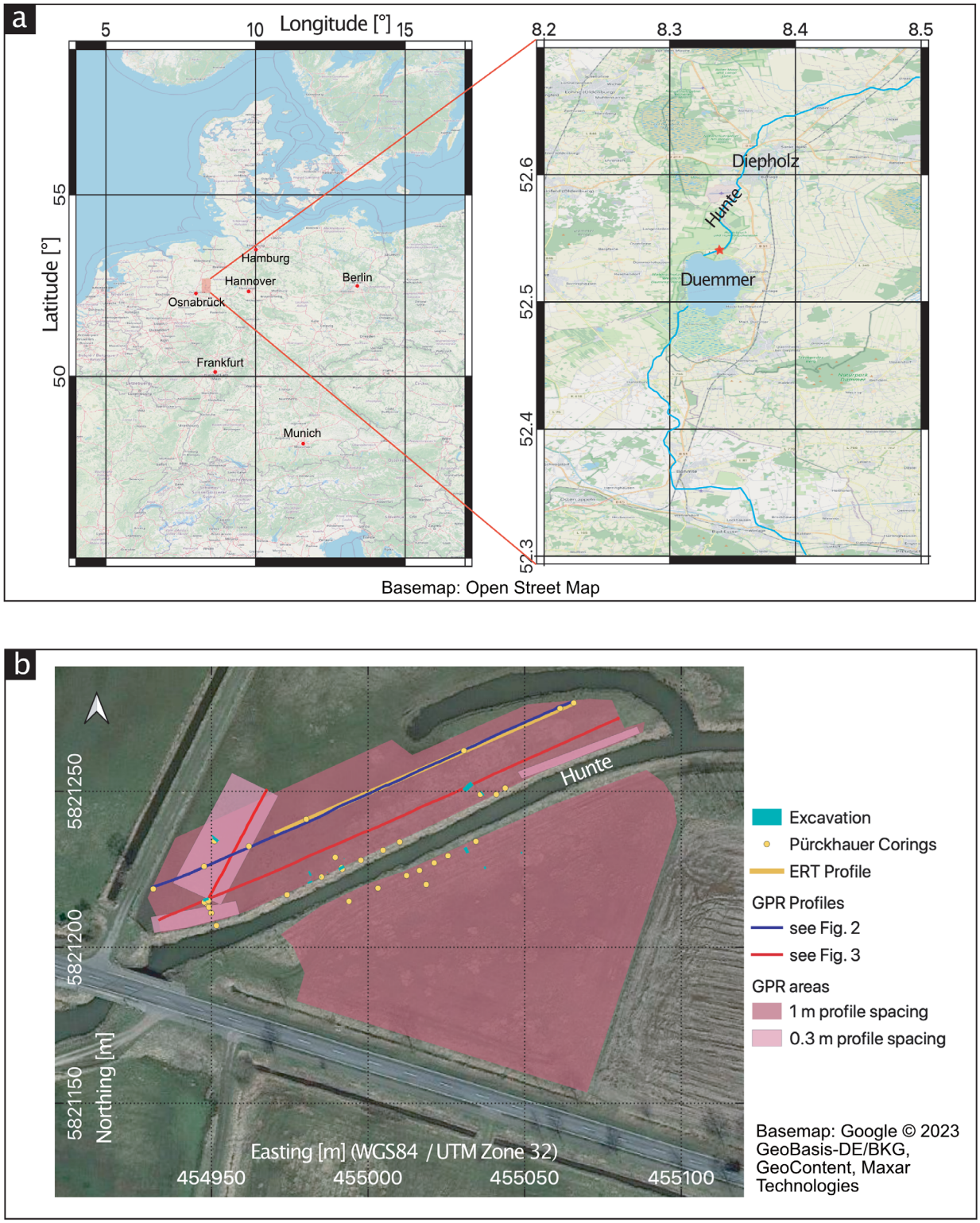

Fig. 1: Overview of the location of the Duemmer area in Germany (a) and the Hunte 1 site north of Lake Duemmer (b). b) Also shows the placement of the measurement areas, profiles, corings and excavations.

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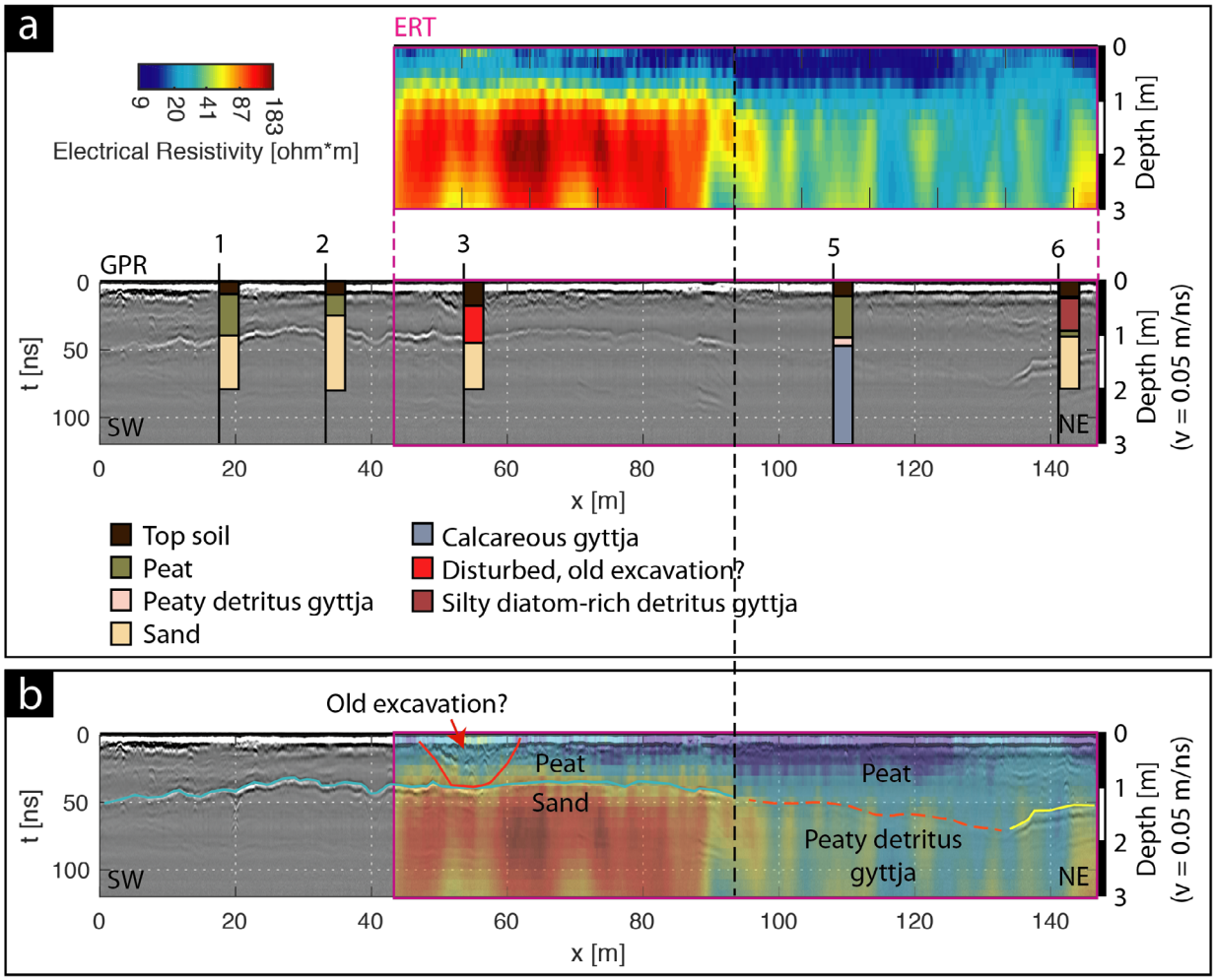

Fig. 2: Radargram P11 (location see Fig. 1) and ERT profile with corings (a). b) Shows the ERT model overlain on the radargram with a simplified interpretation based on the corings. The dashed black line shows the assumed transition between sand and lake marl in the bottom layer.

Materials and methods

Geophysics

Ground penetrating radar (GPR) measurements were conducted with a SIR4000 system (GSSI) and a 200 MHz antenna. Positioning was achieved with a RTK-DGPS in cm accuracy. On the complete site GPR profiles were measured with an average spacing of 1 m. After first interpretation of the results some smaller areas were measured again with 30 cm GPR profile spacing. The data were acquired over a time range of 180 ns and each GPR trace digitised with 1024 samples. Data processing was conducted using the program MultichannelGPR (Wunderlich 2021) and comprised DC amplitude removal, computation of a constant in-line trace spacing of 2 cm, time zero shift application, cutting of the time range to 120 ns, bandpass filtering to between 50 and 500 MHz, and application of a time gain.

In addition, Electrical Resistivity Tomography (ERT) measurements were conducted along one 103.5 m profile with an electrode spacing of 0.5 m. Data were collected in dipole-dipole, Schlumberger and Wenner alpha configuration. All configurations were inverted together with the program BERT (Boundless Electrical Resistivity Tomography, Günther et al. 2006).

Corings

Based on the geophysical results and available archaeological maps, several corings were conducted with a Pürckhauer corer of 22 mm diameter. The cores were described in the field and photos were taken for documentation.

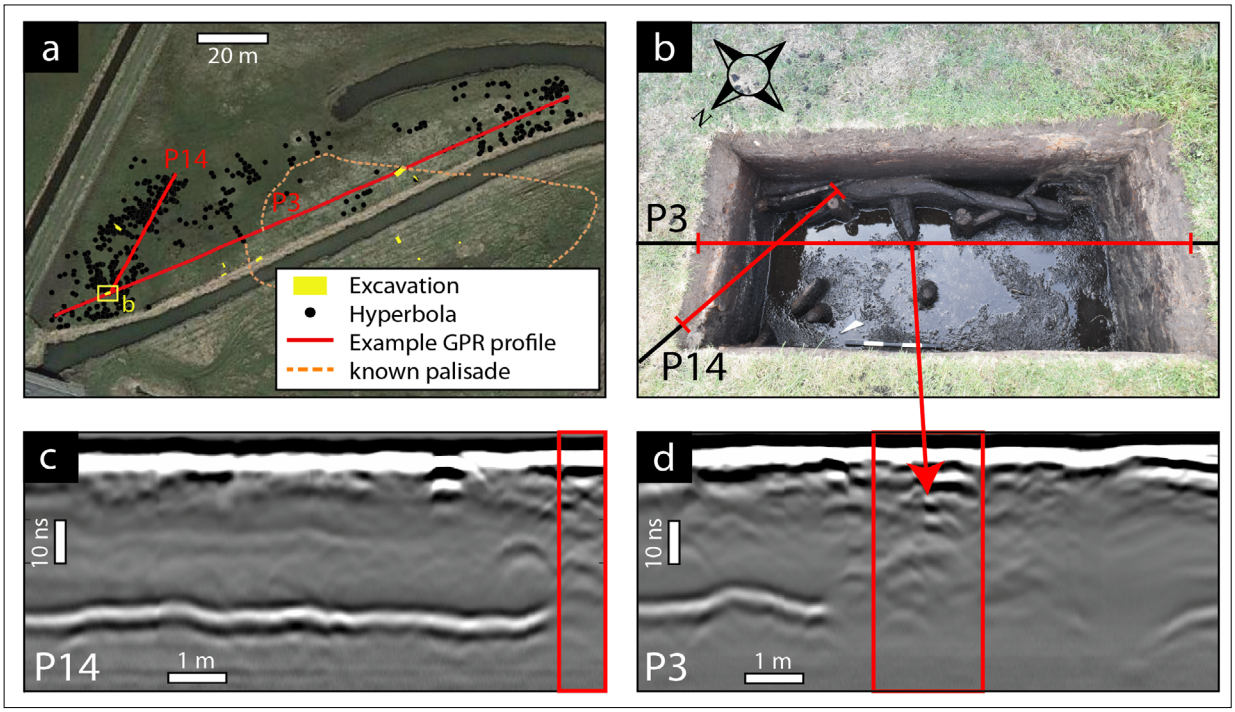

Fig. 3: Clearly visible hyperbolae were picked on all GPR profiles showing areas of high and low hyperbola density. The dashed line may represent the remains of the palisade examined by Reinerth (1939) (base map: Google © 2023 GeoBasis-DE/BKG, GeoContent, Maxar Technologies). (a) An excavation in the southwestern part of a cluster of hyperbolae revealed wooden piles and timbers (b) that can be directly connected to hyperbolae in two example radargrams (c and d) (photo: J.P. Brozio).

Excavation

The outlined questions and preliminary geophysical interpretations resulted in five excavation sections and several sondage trenches.

Results

The radargrams have a good signal-to-noise ratio in the uppermost 120 ns, which corresponds to approximately 3 m depth when using a propagation velocity of 5 cm/ns derived from hyperbola analysis. In almost all profiles a clear reflection can be traced over the area between approx. 40 to 80 ns (Fig. 2a). Correlation with the corings shows that this reflection is caused by the interface between the overlying peat and the underlying sand. On the example profile shown in Figure 2 this interface becomes hardly visible between x = 95 m and about 130 m distance. The ERT profile measured at the same location reveals lower electrical resistivities in this part both in the upper and lower layers. A coring in this area revealed lake marl at the bottom, instead of the sand layer found in the rest of the profile. Thus, the weakening of the reflection has two causes: higher attenuation due to lower resistivity and a weaker reflection coefficient of the interface. Strong chaotic reflections between approx. 50-60 m distance along the profile can possibly be attributed to an old excavation, as it could be confirmed by a coring.

In the southwestern part of the profile several diffraction hyperbolae can be seen. Picking these hyperbolae on all measured profiles reveals a higher density of hyperbolae in the southwestern part of the area north of the river Hunte (Fig. 3a). The geophysically identified hyperbola signatures were investigated in two areas by excavation sections. The detected causative features were wooden piles and timbers (Fig. 3b). These formed parts of a previously unknown, further palisade in the south-western and north-eastern part of the settlement area that had been excavated in the 1930s and 40s. Therefore, the settlement site actually is much larger than previously assumed.

Discussion and conclusion

With the help of GPR measurements the entire site could be covered relatively fast. This allowed for the targeted

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positioning of corings, and excavations that in turn helped in the understanding of the geophysical results. Tracing the layer interface between peat and sand (or lake marl) over the complete area revealed a depression in the northeastern corner, approximately correlating with the occurrence of the lake marl. This could relate to a former lake or river with the settlement located nearby on a sandy elevation. With the help of geophysical measurements the old excavation maps from the 1930s and 1940s could be relocalised and a former unknown prehistoric palisade and undisturbed settlement area were discovered in the southwest. Thus, the excavations in the 1930s and 1940s did not reveal the entire settlement, and we now know that the Neolithic domestic site was much larger in extent and more complex than known before our research. The dating, analysis and detailed evaluation of the data from both the survey and the excavations will be the next step in reconstructing the structure of the site and the past human-environment relationship in this area.

Acknowledgments

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References

Brozio JP, Heumüller M. Ein jungsteinzeitliches Dorf am Ufer der Hunte - der Siedlungsplatz Hunte 1. In: Klimscha F., Wiggering L. (ed): Die Erfindung der Götter. Die Steinzeit im Norden., Petersberg: Michael Imhof Verlag; 2022, p. 372–7. German.

Günther T, Rücker C, Spitzer K. Three-dimensional modelling and inversion of DC resistivity data incorporating topography – II. Inversion. Geophysical Journal International 2006;166:506–517, doi: 10.1111/j.1365-246X.2006.03011.x.

Kossian R. Hunte 1 : Ein mittel- bis spätneolithischer und frühbronzezeitlicher Siedlungsplatz am Dümmer, Ldkr. Diepholz (Niedersachsen). Die Ergebnisse der Ausgrabungen des Reichsamtes für Vorgeschichte in den Jahren 1938 bis 1940. Kerpen-Loogh: Welt und Erde; 2007. German.

Reinerth H. Ein Dorf der Großsteingräberleute. Die Ausgrabungen des Reichsamtes für Vorgeschichte am Dümmer. Germanenerbe 1939;4:226–42. German.

Wunderlich T. MultichannelGPR–A New MATLAB-Tool for the Processing of GPR Data. Archeosci. Rev. Archéométrie 2021;45:279–283. doi: 10.4000/archeosciences.10100