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Historiska

Stockholm University

ZBSA
Center for
Baltic and
Scandinavian
Archaeology

ARCHAEOLOGICAL RESEARCH LABORATORY
STOCKHOLM UNIVERSITY
2016

ISSN 1102-1195
ISBN 978-91-89338-20-3
Printed in Sweden by
Distributor: Archaeological Research Laboratory, Stockholm University,
Wallenberglaboratoriet, SE-106-91 Stockholm
Cover by: Sven Kalmring
Layout: Alexander Svedberg

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Geomagnetic Survey at Hedeby Hochburg

Andreas Viberg & Sven Kalmring

Introduction and Background

The hillfort of the Hochburg is situated on a longish and slender plateau of a ridge approximately 180 m north of the semi-circular rampart of the proto-town Hedeby (fig. 1). The actual ridge on which the hill-fort is situated is composed of post glacial clay, which gained its form by sedimentation when the two dead ice holes of the Busdorf valley and Haddebyer Noor melted away (Gripp 1940:52, 62–64). The once de-forested ridge at the inlet of the Haddebyer Noor offered a superb controlling view of the inner Schlei fjord. The plateau itself possesses a small earthen rampart, nowadays not more than 1.5 m high, that encloses an almost rectangular area of approximately 225 m in length and 45 to 70 m in breadth. The south-eastern part of the rampart was destroyed ear-ly on by the open-pit extraction of clay for brick-yards. One gate seems to be preserved at the eastern corner of the rampart. Facing a forework-like terrace at the north-eastern narrow side of the rampart, this section was additionally secured by a small ditch in front of the wall. Inside the rampart of the Hoch-burg, in a beech and oak tree forest, there are numer-ous flat burial mounds. A small additional group of mounds is situated north-east of the rampart, a little below the tip of the forework-like terrace, and one possible mound is located at the descent towards the Noor. The mounds are not uniform, but vary in height between 0.2 to 1.0 m and differ considerably

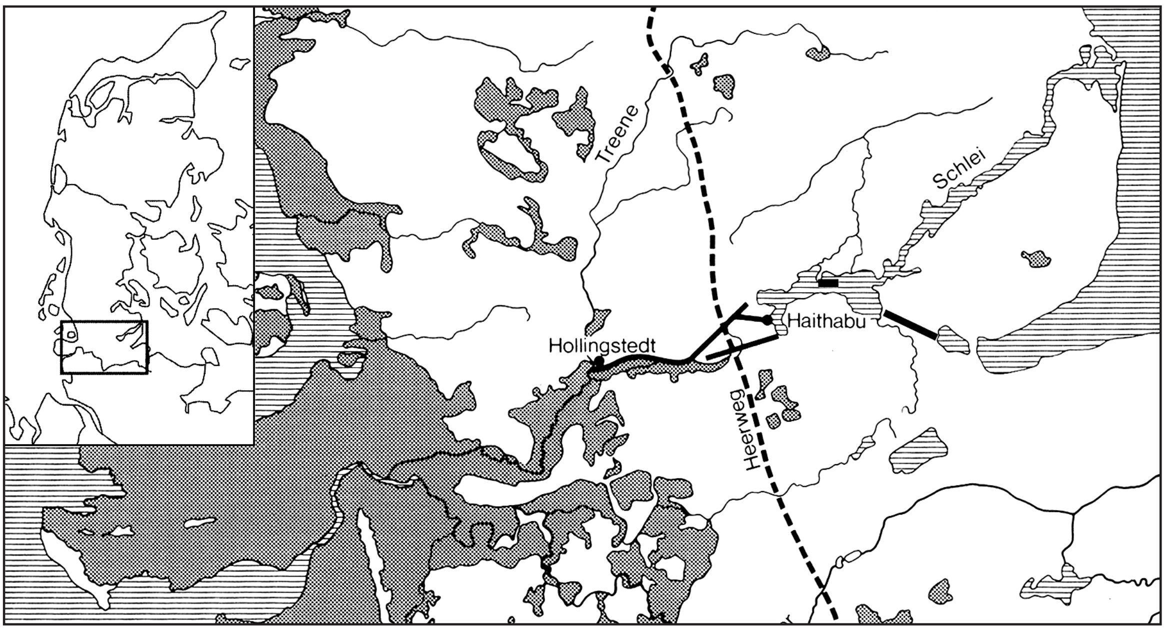

Fig. 1. Map showing the location of Hedeby (Ger. Haithabu) in present day Northern Germany (after Kalmring 2010:fig. 5).

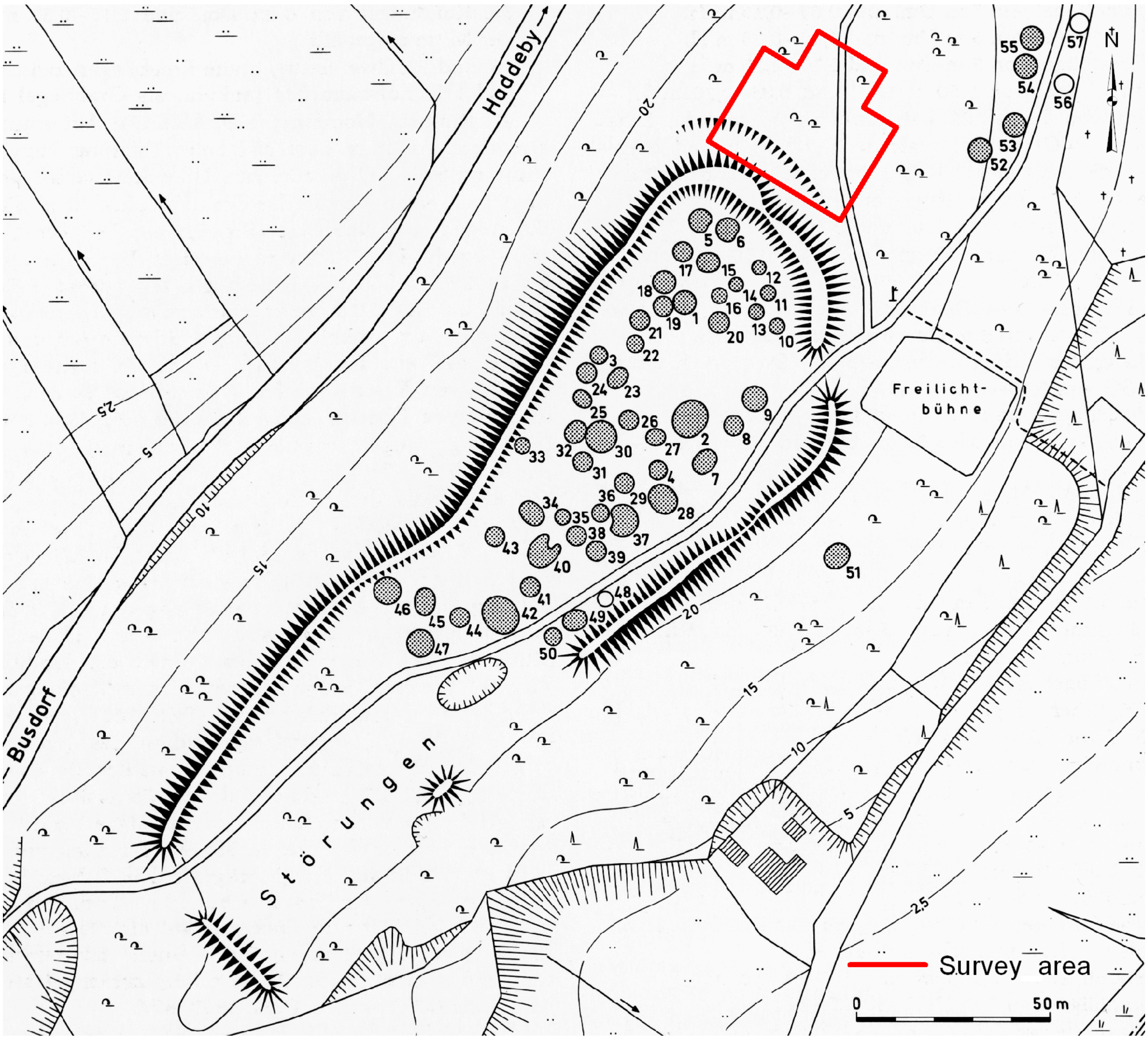

Fig. 2. Map showing the location of the magnetometer survey area in relationship to the known extension of the monument Hedeby Hochburg (after Loewe 1998:fig. 19 with additions).

in diameter. Because of their limited elevation, they sometimes are hard to discern from natural bumps inside the dense forest of the Hochburg. Therefore, the data of the exact number of graves sometimes varies greatly. In the publication on the archaeological survey of the administrative district of Schleswig (Loewe 1998:51–53) 57 mounds are listed. Ten graves had previously been excavated, but no datable material was ever recovered (cf. Holmquist & Kalmring 2012:7–8). According to Arents & Eisenschmidt (2010:286) the construction of the graves imply that they most likely originate from the 8th–9th century AD.

Hedeby Hochburg has always been the neglected cousin of Hedeby's archaeological research. However, a comprehensive academic discussion of the Hochburg does date back to the 16th century. The main lines of interpretation were a construction as the seat of a German margrave or as a refuge fort after the model of the hillfort Borg at Birka in Lake Mälaren (Kalmring & Holmquist 2010). While the historical classification was a matter of considerable debate, the actual archaeological evidence is still astonishingly sparse. Up to today, neither the rampart nor the burials have been dated with any certainty. This also implies that neither their chronological succession nor the hillfort's relationship to Hedeby is known. At this point, the survey of a Swedish-German excavation team began its work in June 2012. Apart from the main trench trough the rampart and an adjacent mound, the odd circumstance that the very tip of the plateau – the forework-like terrace – should have re-

Fig. 3. Magnetometer survey in progress at Hedeby Hochburg. The photograph is taken towards the south and depicts the northernmost part of the Hochburg rampart in the background. The Hochburg plateau is covered with large trees and in some areas very dense vegetation making geophysical surveys challenging (Photo: Antje Wendt 2012).

mained omitted from the fortification led to complementary geomagnetic surveys in that area (fig. 1–2).

Method

A magnetometer is a passive geophysical instrument that makes detailed measurements of the Earth's magnetic field. Since 1958, the method has successfully been used on archaeological sites worldwide (e.g. Aitken 1958; Becker & Fassbinder 1999a; 1999b; Kvamme 2008; Gaffney *et al.* 2012; Neubauer *et al.* 2013). The Earth's magnetic field is vital to archaeological magnetometer prospecting. This field can be locally distorted by buried archaeological remains, such as hearths, kilns, ditches and pits (Aspinall *et al.* 2008) which enable their detection with a magnetometer. The method has been used extensively within German archaeology since the 1950s (Clark 1996:19 and references therein), but has only been used sporadically for the detection of archaeological remains in Sweden until 2005 (Viberg 2012:87). Large-scale geophysical surveys have also successfully been carried out within the semi-circular rampart of the proto-town Hedeby, producing evidence of its spatial layout (e.g. Neubauer *et al.* 2003; Hilberg 2007).

The survey at Hedeby Hochburg was primarily carried out with the aim of detecting buried archaeological remains that might shed light on any activities carried out in the area in protohistoric times. We also hoped to find an explanation as to why the tip of the plateau is the only part not included in the defensive works of the hill fort (Kalmring & Holmquist 2012:64). The selected survey area would, by normal standards, not be considered suitable for geophysical surveys as the tip of the plateau is covered by very dense vegetation (*cf.* Holmquist & Kalmring 2012:7 fig.3). Dense vegetation and geophysical surveys in forested areas are time consuming and data collection in large enough areas or in rectangular grids is often

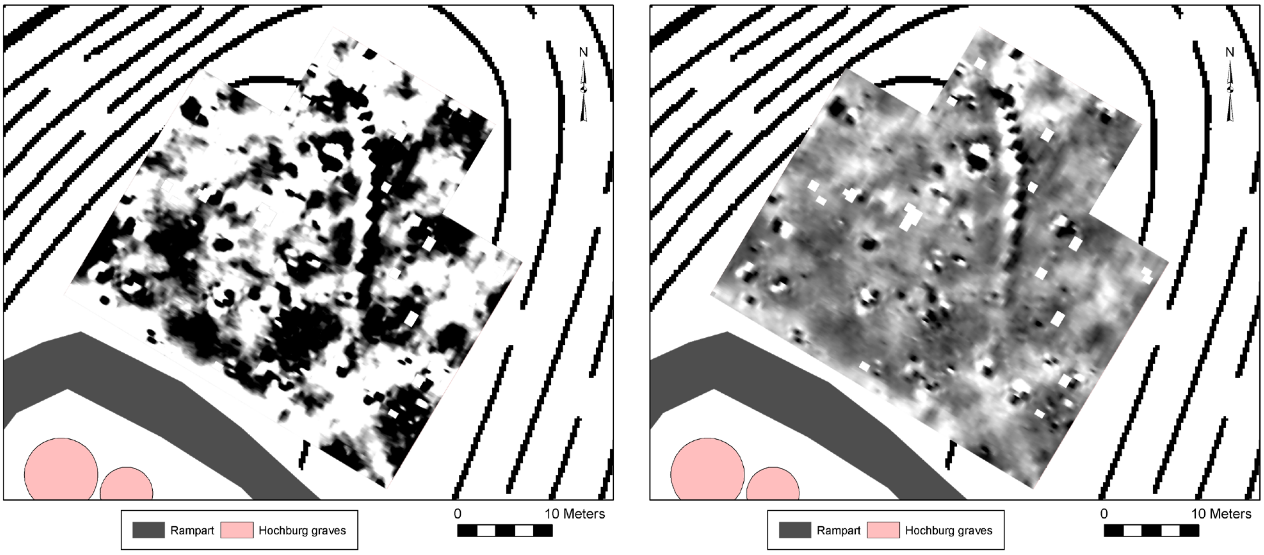

Fig. 4. Results from gradiometer measurements at Hedeby Hochburg. Grey scale: -1 nT white to +1 nT black (left). Grey scale: -4 nT white to +6 nT black (right).

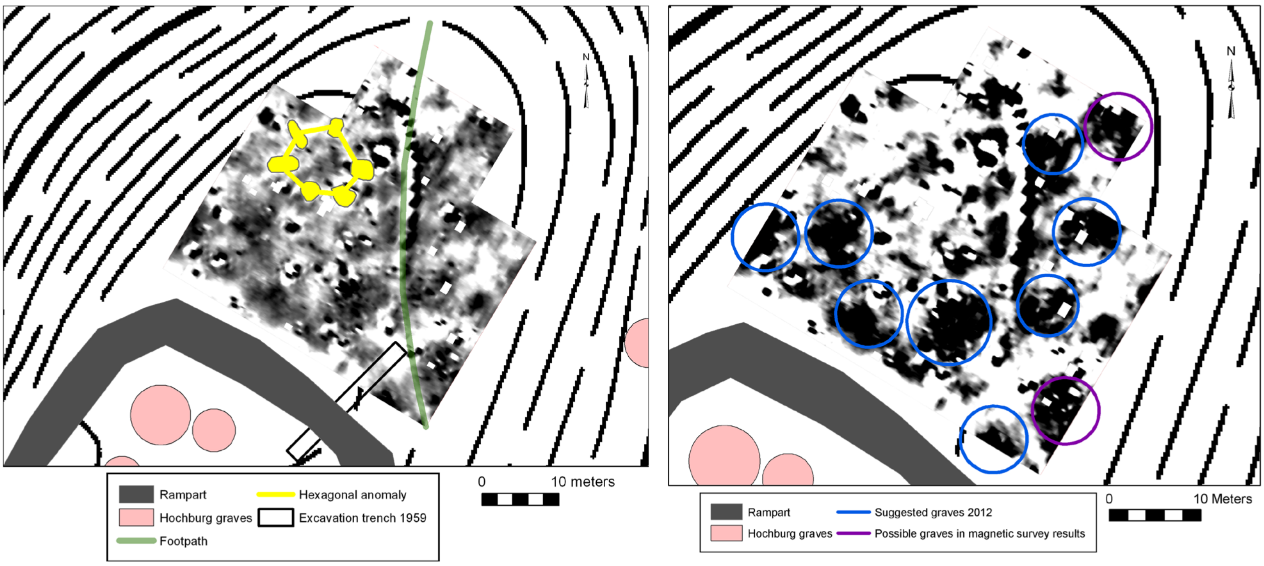

Fig. 5. Map showing the correlation between the strong magnetic anomaly and the footpath crossing the survey area, the probable location of the 1959 excavation trench and the ditch with nodular pits (left). Results from gradiometer measurements at Hedeby Hochburg and their correlation with recently discovered mounds at the site (blue). Possible additional mounds suggested by the magnetometer data are also presented (purple) (right).

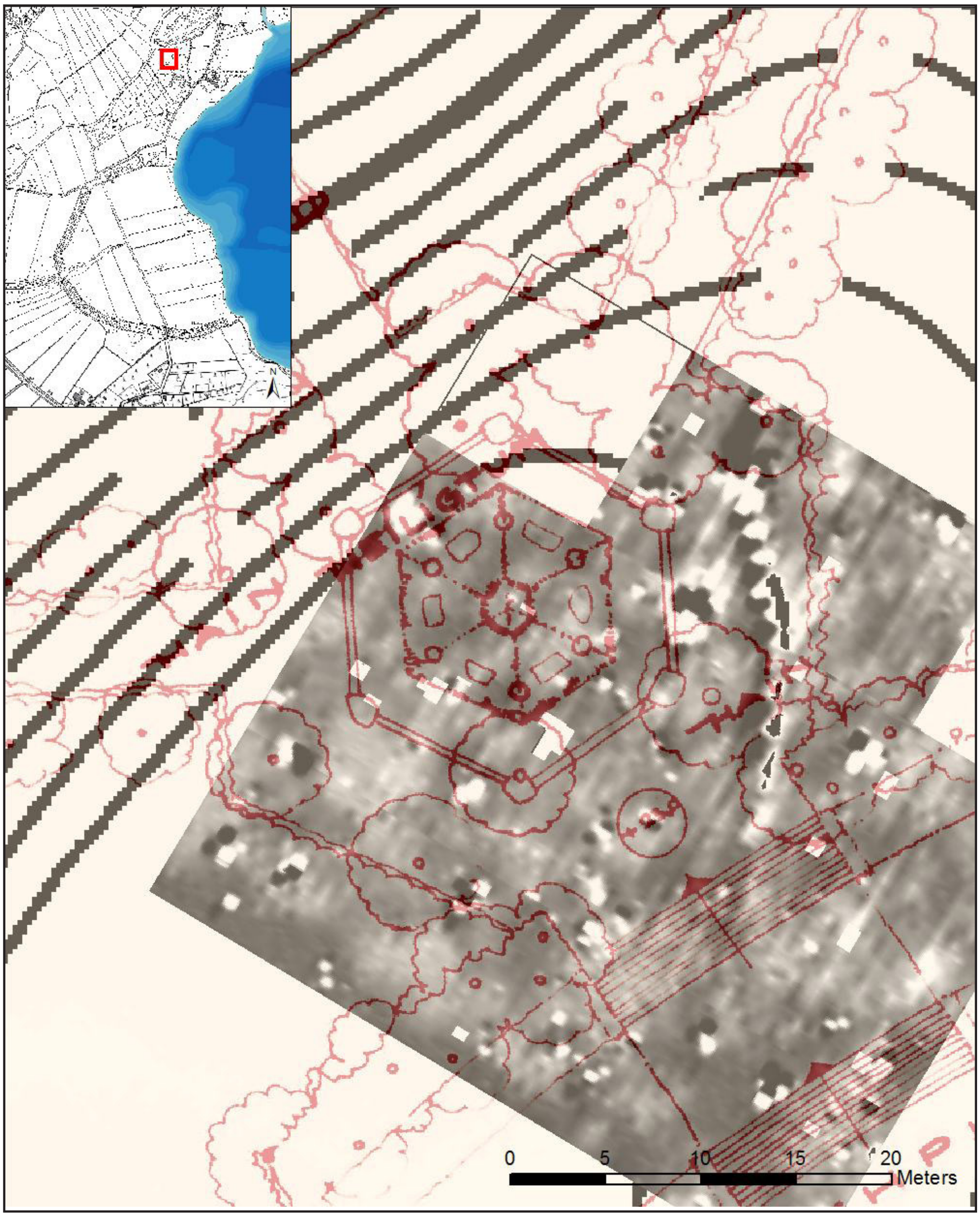

Fig. 6. Detail of the architectural drawing for the planned National Socialist thing assembly site with the co-called "sanctuary" surrounded by a groove (courtesy Ute Drews, Wikinger Museum Haithabu, Schleswig) superimposed on the hexagonal anomaly indicated by the magnetometer data (state archive Schleswig, div. 309,35.770). Note its position on the highest point on the very tip of the Hochburg-ridge.

difficult. As time and cost for geophysical surveys are intimately connected, surveys in forests are often not considered worthwhile as they would be too expensive and the quality of the collected data too poor. In Sweden, for example, where 53% of the total area is covered by forests (Statistiska Centralbyrån 2005), the use of geophysical methods would, according to such a standard, be unsuitable in more than half the country. An underlying purpose was therefore also to consider whether it could be worthwhile carrying out surveys in similar environments in Germany and abroad. Previous attempts to carry out geomagnetic measurements in densely forested areas in Sweden have unfortunately not produced convincing data and most surveys have not been carried out in large enough grids to provide any valuable information (e.g. George 2011).

During the surveys at Hedeby Hochburg, a single probe Foerster Ferex 4.032 fluxgate gradiometer was used measuring the vertical gradient of the Earth's magnetic field. The survey area measured 40x28m with an additional smaller extension of 20x11m to the north (fig. 2). The crossline sampling distance for the measurements was 0.5m and the inline sampling distance was 0.1m with data collected in zigzag formation. The post-survey data management and filtering was carried out using the software Data2Line by Foerster. The results are destaggered, corrected for Zero mean Traverse (ZMT) and the remaining stripy pattern, caused by heading errors, introduced as the survey was conducted in a densely forested area, were partly removed using a 2D-FFT filter. The magnetic results were subsequently interpreted and turned into georeferenced maps using the GIS ArcMap 9.3.

Results and Interpretation

The results from the geomagnetic measurements (fig. 4) show several areas of elevated magnetic susceptibility. These anomalies coincide with the location of additional mounds identified during the 2012 field campaign situated within the survey area (blue colour in fig. 5). These mounds are most ikely graves similar to those situated within the main fortification and below the tip of the terrace. Two additional areas of increased magnetic susceptibility might show the location of additional graves not visible above ground surface (purple colour in fig. 5). A strong linear bipolar anomaly is also visible in the middle of the survey area and partly seems to follow the foot path running through the area (fig. 5). However, as the bipolar anomaly and the foot path don't coincide completely, it is likely that the anomaly is caused by something other than this. The strength of the anomaly and its direction of magnetisation yet suggest that it could have a modern origin and as its curving very much follows the spurs' 26 metre contour line (see fig. 4 & 5). It therefore might be identified as the remnants of a former fence with iron cramps and wire. The slightly weakened magnetic susceptibility of the soils along the ditch in front of the rampart, in the southern part of the survey area, might be explained by the removal of magnetically enhanced topsoil from the area when constructing the rampart. For a discussion on the enhancement of magnetic susceptibility of top soil see, for example, Le Borgne (1955; 1960) and Aspinall *et al.* (2008). A likewise clear negative magnetic susceptibility can be noticed in the southern corner of the survey area starting off at the trail and leading up towards the rampart (fig. 4–5). With its rectangular shape and at a width of two meters it can be identified as Jankuhns' lost trench from 1959 (Jankuhn w/o year).

With a starting point at the gate of the hillfort, the distribution of the mounds on the terrace seems almost to be bifurcated, omitting an area towards the north. Here on its highest point, a somewhat circular anomaly can be observed that, as Jankuhn's excavation trenches or the moat, has a lower magnetic susceptibility than the surrounding soil matrix (fig. 4–5). Thus it can be assumed that the structure, of about eight metres in diameter, is a dug-down circular ditch. In addition the anomaly seems to be accompanied by six nodular pits measuring about two meters in diameter. It seems to coincidence with the hexagonal "sanctuary" of the planned National Socialist Thing assembly site from the mid-1930ies (state archive Schleswig, div. 309,35.770) of which one hitherto believed only the left wing of the open air theatre was realised before the plans where soon abandoned (fig.6; Haßmann & Jantzen 1994:15).

Discussion

It is interesting to note that the areas inside and outside the rampart are indeed very similar in terms of utilisation. Obviously the whole of the plateau was used as a burial ground and the currently registered 57 graves should, at least, be increased by the additional eight to ten graves discovered during the field campaign in 2012. Moreover it can be assumed that the present day spatial layout of the rampart most likely isn't its original course as this would leave the northernmost part of the Hochburg plateau undefended. This would imply that the present day north-easternmost part of the rampart has to be a later addition. The ^{14}C-dating from the from the 2012-main trench trough the rampart and an adjacent mound showed that that the burial mound dates as early as the second half of the 7th century while the multi-phased embankment itself was first raised in the course of the 9th century (Kalmring 2016).

The results furthermore show that geomagnetic measurement could be a useful tool even in a densely forested area, and the correlation between above ground visible mounds and the increased magnetic susceptibility, evident in the magnetic data, show that it may be used as a complement to other, more traditional archaeological field inventory methods. The data must, however, be collected in a rigorous manner with the aid of guide ropes and the surveyed grids need to be properly georeferenced using either a total station or an RTK-GPS. The sampling density also needs to be properly adapted to the sizes of the expected features in order to provide a proper resolution. It is also important to survey a large enough area in order to assess background levels and to avoid unnecessary interpretational errors (cf. e.g. Gaffney & Gater 2003:92)

Conclusion

Geomagnetic measurements at Hedeby Hochburg have provided evidence of burials on the apparently non-fortified part of the Hochburg plateau. As a result, the number of registered graves should be increased by at least eight to ten graves. Moreover the construction of the National Socialist Thing assembly site obviously had advanced further than previously assumed. The results also show that if proper time is devoted to the geophysical survey, meaningful results in areas not usually deemed suitable for such surveys might provide important information on subsurface features.

Acknowledgements

We would like to thank Charlotte Hedenstierna-Jonson, Laila Kitzler Åhfeldt, Joakim Schultzén, Lena Holmquist, Antje Wendt, Björn Rauchfuss, Martin Segschneider and Timo Ibsen for their kind support and assistance during field work.

Corresponding authors

Andreas Viberg
Archaeological Research Laboratory,
Department of Archaeology and Classical Studies
Stockholm, Sweden
andreas.viberg@arklab.su.se

Sven Kalmring
Centre for Baltic and Scandinavian Archaeology,
Schloss Gottorf
Schleswig, Germany
sven.kalmring@schloss-gottorf.de

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