Large-scale motorised prospection along the "SuedLink" route in Lower Franconia

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Abstract
Large-scale archaeological prospection has proven itself as an essential tool in advance of a linear infrastructure project. The non-destructive survey is a basis for infrastructural planning and the protection of archaeological sites. More than 410 ha of high-resolution motorized geomagnetics were surveyed within six weeks. Such infrastructure projects can also be seen as an opportunity for archaeological research.

Keywords
archaeological prospection; infrastructural project; magnetometry; neolithic settlement; SuedLink

Introduction

In these times of energy transition, major infrastructure projects are a major focus of interest, also for policymakers. The public pressure to realize these projects as quickly as possible while still aiming for an environmentally friendly solution is therefore enormous. Linear infrastructure projects are quiet challenging, because they have a predefined starting- and endpoint, and a long corridor in between. This corridor must be subjected to existing structures like roads and villages, the terrain and geological conditions. In addition to all these immovable/stationary elements, there are zones that can also influence the route, for example: nature reserves or those contaminated by ordnance and, last but not least, archaeologically relevant sites. The planning of such infrastructure projects is therefore a particular challenge. Previous approaches for linear infrastructure projects are shown by Hulin et al. (2018) and Bonsall et al. (2014).

A 1000 m wide corridor for the possible "SuedLink" route was already defined in advance by the Federal Network Agency, the project operator TransnetBW (+NU) provided appropriate corridor alternatives and thus a corridor some 100 km long was created across Lower Franconia. Due to its enormous length, this corridor included some already known archaeological sites. The GeoSphere Austria (former ZAMG) was contracted by ArcTron 3D to carry out preliminary archaeological investigations for one of the largest construction projects in Lower Franconia (Germany).

Challenges

Due to the aforementioned time pressure for the execution of the infrastructural project called "SuedLink" and the enormous length of the corridor to be prospected, the magnetic survey could only be carried out by using motorized measuring systems. However, the survey was made even more difficult by several factors and thus perfectly demonstrates the true challenge of such large-scale projects:

- Due to the different agricultural cultivation of neighboring fields, not all areas could be surveyed in the same campaign/season of the year.
- The rapid crop rotation currently practiced by the modern farmer created an additional significantly shortened time window.

Fig. 1: Motorized measuring device on a cold winter morning. Weather is a serious factor in daily measurement performance. In winter, the days are shorter, but as shown on frozen ground optical navigation is easier.

- Extremely wet weather from late autumn to spring made it impossible to survey.
- The very long, but narrow corridor sometimes collided with existing agricultural field boundaries, creating strange and complicated survey fields.
- Citizens' initiatives against the construction project and spontaneous bans on entering the land led to further delays.

Methods

For the magnetic surveys, motorized measuring systems with eight fluxgate sensors were used (Fig. 1 and Fig. 2). The probes were mounted on a six-meter-long, custom-built measuring cart at a spacing of 0.25 m. The measuring accuracy of the FEREX CON650 was 0.1 nanotesla (nT). The speed of the towing vehicle was adjusted in such a way that a maximum measurement distance of 0.1 m could be maintained. The positioning of the measurement systems was carried out using RTK GNNS with an average accuracy of 2 cm.

The data from the fluxgate sensors were converted to greyscale images with different clip-off values using the ArcheoSoft software developed at ZAMG (now GeoSphere Austria) (Sandici 2013). In the course of processing, the measurement data were subjected to the following algorithms: subgrid and line shifts, displacements, spikes, noise. In this way an uncorrected image of the raw data was generated and also, using image enhancement methods, several optimized images that form the basis of the archaeological interpretation. It was shown that here a value between minus 2 nT and plus 3 nT gave the ideal contrast between geological background and archaeological structures for interpretation and analysis.

Results

Within nine weeks, split in several measurement campaigns, a total area of 410 ha could be surveyed by magnetometry. The surveys revealed for the first time the existing archaeological structures in a unique clarity and spatial resolution. Based on the archaeological interpretation and spatial analysis, the sites can be assigned to several time periods. These range from the Neolithic through the Bronze and Iron Ages to the Middle Ages. However, the majority of the settlement sites found can be assigned to the Neolithic

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Fig. 2: Motorized measuring device in summer. The long-lasting daylight in summer makes it possible to work slightly longer each day if necessary. However, after the crops are harvested, the fields are quickly cultivated on the surface, which in turn can make the survey somewhat more difficult.

period and generated an invaluable basis for the non-destructive exploration of these large-scale settlements.

Through the spatial analysis of the prospected areas, it is now possible to propose a corridor that ensures the greatest possible protection of the archaeological structures.

Figure 3 shows such an example for a major Neolithic settlement within the planned corridor. Here the planners are either forced to move to the western part, or to find an overground solution for the planned infrastructure.

Discussion

The SuedLink project impressively demonstrates the benefits that non-destructive exploration can provide in advance of such large-scale infrastructure projects. Through the detailed archaeological analysis of the survey data, the actual construction corridor can be planned with high precision. In this way, sensitive archaeological areas can be avoided and our cultural heritage will be protected for our descendants.

Although large-scale construction projects are always associated with the destruction of parts of our cultural heritage, nowadays - with good planning - great efforts are made for preliminary investigations. This is the opportunity that might be of great value for archaeology. Because of the modern possibilities of high-resolution non-destructive archaeological prospection - in the course of these preliminary investigations - unique data sets are generated, which survey entire settlement areas/landscapes and thus are able to increase our knowledge significantly.

The non-destructive explorations, which were carried out in the course of the infrastructure project, show a unique overview of the archaeological site. While the archaeological excavations in the course of the actual construction activities will give an even more detailed view into the site, which allows not only an exact dating but also statements about its use and function.

Conclusion

A well-prepared survey campaign and analysis, adapted to the situation on site, shows the potential of large-scale archaeological/geophysical prospection, on the one hand as a planning tool for large infrastructural projects and on the other hand as valuable information for the exploration and preservation of our Cultural Heritage.

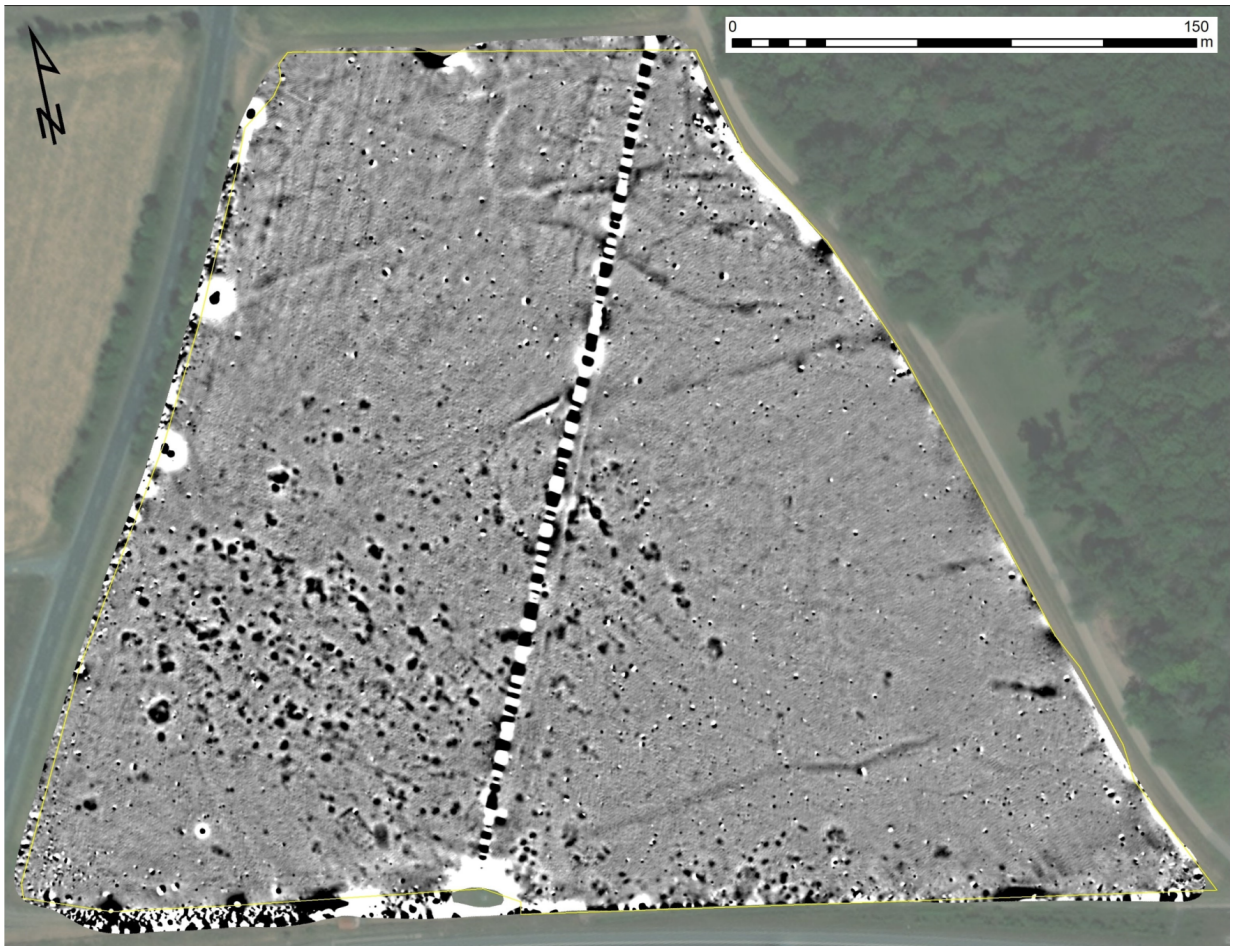

Fig 3: Magnetometry survey along the "SuedLink" corridor showing a major archaeological structure that forces the planning team to change the construction corridor. Clip off value -4nT/+6nT (base map: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community, 2022).

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