Archaeology at the Danube using non-invasive ground and aerial prospection methods to document prehistoric settlement traces at the Bisamberg near Vienna, Austria

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Abstract
To link prehistoric settlement activities with a modern mapping of existing monuments on the site, non-invasive aerial and terrestrial prospection methods are used. The LiDAR data catches the course of the presumed prehistoric rampart. The geomagnetic measurements display, among other things, the course of a 250 m long prehistoric ditch. Furthermore, ERT measurements reveal the rampart's inner construction.

Keywords
archaeological prospection; Bisamberg; LiDAR; prehistoric settlement traces

Introduction

The Bisamberg is an approximately 358 m high rise north of Vienna (Austria), with the southernmost foothills reaching into Vienna's 21st district. Together with the Leopoldsberg flanking the Danube across the river, the two hills form the Vienna Gate. Geologically, the Bisamberg is the north-easternmost extension of the Central Alps and is a continuation of the Flysch zone of the Wienerwald. Traces of settlements around and on the Bisamberg date from the Mesolithic around 8000 BC (Kmoch 1966; Neugebauer-Maresch 1993) to the Modern Era. Matthäus Much described a 3-4 m high prehistoric rampart enclosing the Elisabethhöhe, the highest plateau of the Bisamberg, as early as 1874. Prehistoric finds from the settlement were assigned to the Middle Bronze Age in the 1980s (Much 1874; Kaus 1986).

Objective of the study

In the course of the project "Archaeology at the Danube - Pilot Study Bisamberg" conducted by the Austrian Archaeological Institute (ÖAI) of the Austrian Academy of Sciences (ÖAW), a survey of the archaeological monuments on the Bisamberg was carried out using modern non-invasive aerial and terrestrial prospection methods (Fig. 1). Magnetometry yielded information about the current state of the archaeological monuments and prehistoric settlement activities. Electrical Resistivity Tomography (ERT) was used to gain insights into the structure of the rampart, which is still visible in the terrain. In addition, high-resolution LiDAR terrain surveys were carried out in order to better show the course of the rampart.

Topographical situation and challenges

Most of the survey area is designated for landscape conservation and serves mainly as a recreational area. The meadow south of the prehistoric enclosure is dominated by a south-facing slope and is used for agriculture. The steep slope made geomagnetic measurements difficult, which is why only the northern part of the area was measured so far. The conditions for geoelectric investigations

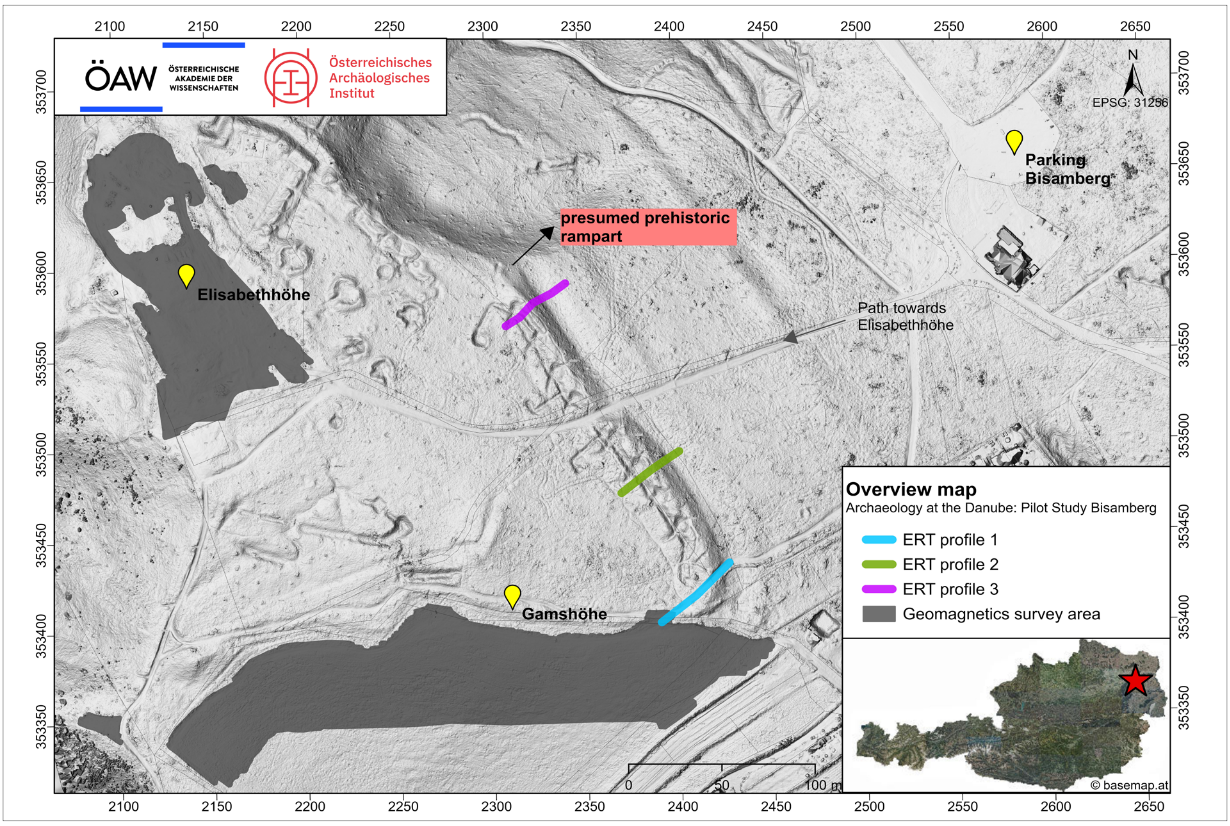

Fig. 1: Overview map of the geomagnetic survey area and the geoelectric profiles with background terrain model (copter-supported, vegetation-cleaned LiDAR data © ÖAW/ÖAI, Ch. Kurtze) (© ÖAW-ÖAI/F. Reiner).

also proved to be difficult, as the recurring remains of the (presumed prehistoric) rampart serve as a mountain bike trail and thus suffer recent deformations and modifications of the terrain relief. The area where the rampart is located carries dense vegetation in spring/summer, which is why the geoelectrical measurements as well as the LiDAR flights were mainly carried out before the growth season.

Survey methods

The geomagnetic measurements were carried out with a 5-channel fluxgate gradiometer system Magneto MXPDA from Sensys (survey width 1.0 - 2.0 m, sensor spacing 0.25 - 0.5 m, sampling rate 100 Hz). Total area surveyed was approx. 1 ha around the Elisabethhöhe and 1.6 ha south of the Gamshöhe. Due to the direct integration of an RTK-DGPS, georeferenced measurements of the survey area could be carried out. The data were georeferenced, managed and analyzed in ArcGIS Pro in form of digital greyscale images (-5/+5 nT).

Geoelectric measurements were conducted in cooperation with Cornelius Meyer Prospection (CMP) and the Central Institute for Meteorology and Geodynamics (ZAMG). A total of three profiles à 50 and 40 m length with an electrode spacing of 0.5 m could be laid out in order to gain information about the internal structure of the rampart (Fig. 1). A 4PLight multi-electrode resistivity meter from Lippmann Geophysical Measuring Instruments (LGM) was used for Profile 1 and the ABEM Terrameter LS2 multi-channel device for Profiles 2 + 3. The processing of the ERT data (Profiles 2 + 3) consisted of the removal of measurements with negative transfer resistances and those associated with contact resistances larger than 15 kOhm and was performed with python packages developed at the ZAMG. The inversions were performed with the open source software ResIPy using a smoothness-constraint regularization. All inversions converged to a RMS misfit of approximately 1. The result of the measurements is shown as a vertical section, which depicts a lithological and structural model of the subsurface down to depths of about 6 m below ground level by classifying the resistivity distribution.

KIEL-UP • DOI: https://doi.org/10.38072/978-3-928794-83-1/p45

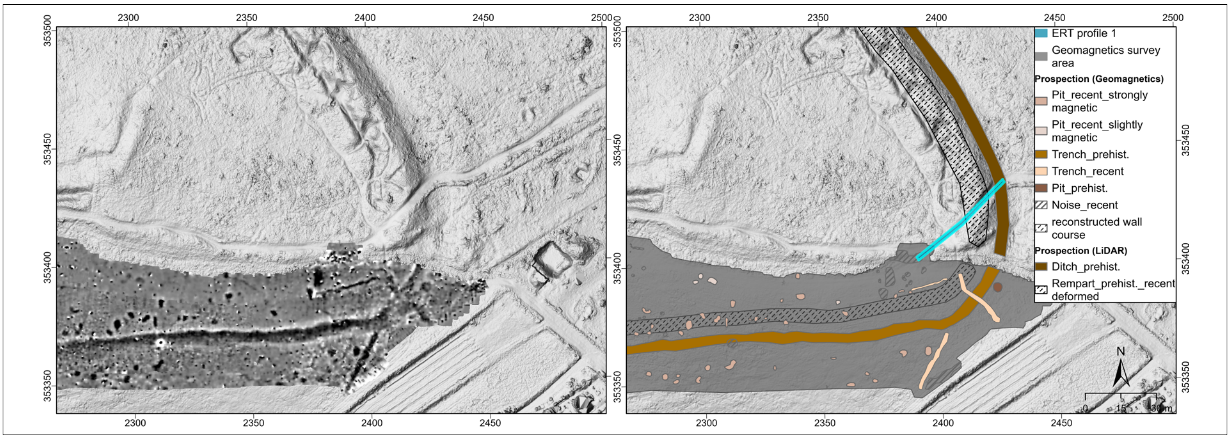

Fig. 2: Result of the magnetic measurements on the Gamshöhe (left) and archaeological interpretation (right) with background terrain model (© ÖAW-ÖAI/F. Reiner).

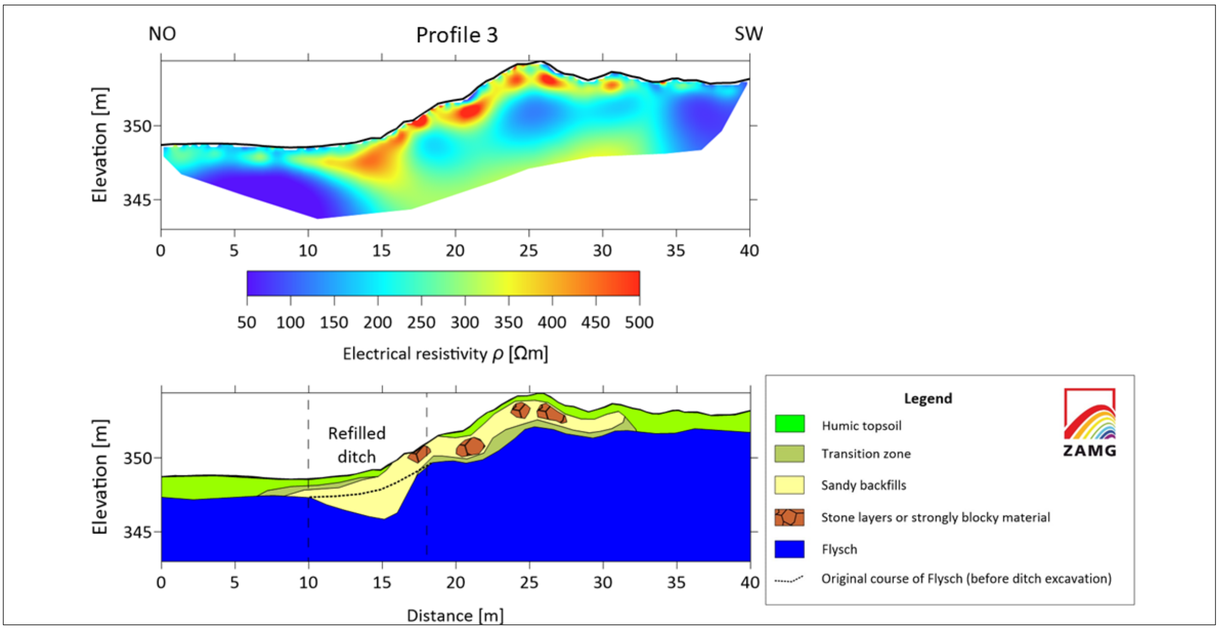

Fig. 3: Result of the 2D geoelectric inversion (top) and lithological and archaeological interpretation of the resistivity model (bottom) for Profile 3 north of the path towards Elisabethhöhe (© ZAMG/J. Gallistl).

The system used for the aerial survey consisted of the miniVUX-SYS mounted on the DJI Matrice 600 Pro, using the miniVUX-2UAV laser scanner and the APX-20 UAV IMU/GNNS.

Results of the survey

The course of a large ditch structure of about 250 m on the Gamshöhe was revealed by means of geomagnetics (Fig. 2). The greyscale image shows a massive ditch coming from the northeast and bending towards the west after about 30 m. The bend is only weakly visible and the ditch filling is slightly magnetic and inhomogeneous in the first 30 m. It is also interrupted after about 15 m by another small ditch. The ditch can be interpreted as possibly prehistoric due to its width of approx. 6 m and the irregular ditch edges. The further course of the ditch to the north can be traced in the LiDAR data for about 230 m. The prehistoric rampart is also clearly recognisable in the LiDAR data in the north-east. It can be assumed that the rampart in the meadow area is no longer present due to the slope and the advanced erosion over time. However, the course of the rampart can be reconstructed on the basis of the ditch identified in the magnetometry survey in this area (Fig. 2).

In all three ERT profiles, areas with low resistivity values up to 100 Ωm can be associated with fissured sandstone and mudstone layers from the Flysch zone (Figure 3 presents an example of the results of the inversion and the interpretation of profile 3). The transition from Flysch to the areas of increased electrical resistivity is marked by a moderately electrically conductive zone. The areas with relatively high resistivities (> 200 Ωm) can presumably correspond to sandy backfills or fills of the presumed rampart. Within the wall zones with even higher resistivity values of more than 300 Ωm could be identified. These zones can be interpreted as stone layers or block material of the rampart construction. The stone layers are approx. 1 m thick and at a depth of 0.5 m below ground level.

Conclusion

The course of the rampart in the northeast could be perfectly shown in the LiDAR data. It is likely that the rampart continues southwards due to the clear ditch anomaly in the magnetics. The geoelectric results indicate that the rampart has massive stone constructions in its core, which suggests that it could indeed be of prehistoric date. An excavation cutting an accessible part of the rampart is planned to investigate the stratigraphy, explore potential phases of use and obtain datable material from the construction. The location of the actual settlement center is still unclear, which is why additional geophysical measurements are intended. Initial geomagnetic measurements on Elisabethhöhe revealed massive modifications of the plateau during the last wars, including trenches, military installations, and recent artefacts.

References

Blanchy G, Saneiyan S, Boyd J, McLachlan P, Binley A. ResIPy, an Intuitive Open Source Software for Complex Geoelectrical Inversion/Modeling. Computers & Geosciences; 2020 Apr. doi: 10.1016/j.cageo.2020.104423.

Kaus M. Altmaterial aus einer mittelbronzezeitlichen Höhensiedlung am Bisamberg bei Wien. Mitteilungen der Urgeschichtlichen Arbeitsgemeinschaft in der Anthropologischen Gesellschaft in Wien 36; 1986. p 33-56. German.

Kmoch L. Eine Mesolith-Station auf dem Bisamberg bei Wien, Rund um den Bisamberg. Ein Heimatbuch 3; 1966. p 6. German.

Much M. Ein befestigtes Lager der Steinzeit auf dem Bisamberg bei Wien. Mitteilungen der Anthropologischen Gesellschaft in Wien 4; 1874. p 69-86. German.

Neugebauer-Maresch C. Altsteinzeit im Osten Österreichs. Wissenschaftliche Schriftenreihe Niederösterreich. St. Pölten-Wien: Niederösterreichisches Pressehaus; 1993. German.

KIEL-UP • DOI: https://doi.org/10.38072/978-3-928794-83-1/p45