Is this settlement intersected by a ditch? A comparison between magnetic prospection data, ALS data, and archaeological and geological excavation results from the Early Bronze Age fortified hilltop settlement of Ratzersdorf, Lower Austria

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Abstract
In this case study we present preliminary results from a joint analysis of magnetometry data, remote sensing data, and excavation results generated in the course of research on the Early Bronze Age fortified hilltop settlement of Ratzersdorf/Am Dachsgraben in Lower Austria. In an effort to evaluate the interpretive potential of each data set we conclude that a combined analysis of all available data is essential for a comprehensive understanding of anthropogenic and natural features and formation processes. At the Ratzersdorf site specifically, the visibility of both anthropogenic and geological structures in the magnetometry data demonstrates the importance of the combination of complementary data for the verification or falsification of preliminary interpretive ideas.

Keywords
ALS data; Early Bronze Age; excavation; fortified hilltop settlement; magnetic prospection

Introduction

When studying archaeological sites, having various sets of data available for analysis and interpretation is paramount. Different kinds of anthropogenic, geological, and other natural features will manifest differently in different data, or may not show up in some data at all. Accordingly, the use of several complementing data sets such as remote sensing data, prospection data, and excavation data has become a standard in archaeological research.

In this paper, we present preliminary results gained from the joint analysis of data sets generated within the Ratzersdorf project, an archaeological research project focusing on the Early Bronze Age fortified hilltop settlement of Ratzersdorf/Am Dachsgraben near Wölbling in Lower

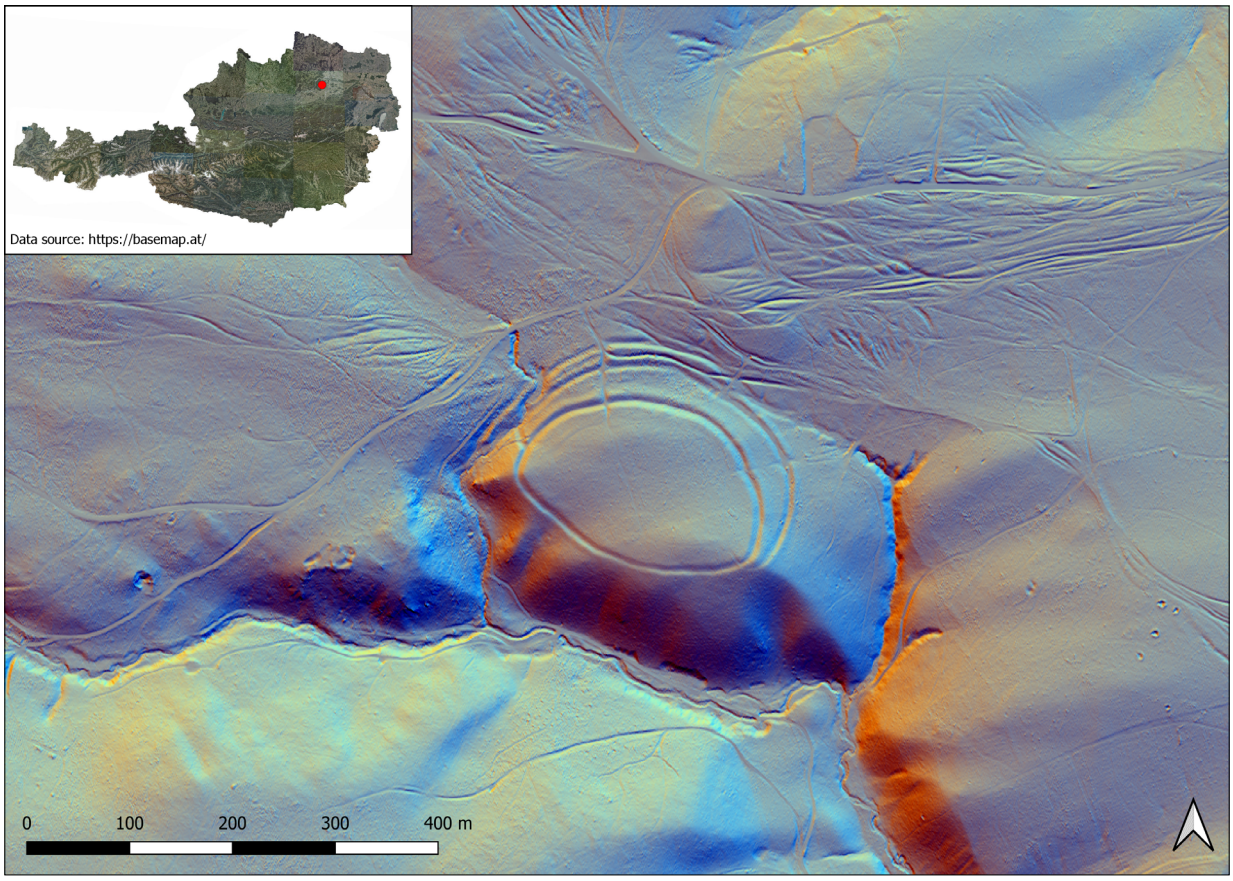

Fig. 1: Location and topography of the Ratzersdorf site as seen in a 1 m resolution DTM derived from ALS data. Ramparts and ditches are clearly visible (Ratzersdorf project, IUHA Vienna; LiDAR NÖGIS, BEV; data source: https://basemap.at/).

Austria. The data consist of magnetometry data, Airborne Laser Scanning (ALS) data, and archaeological and geological excavation results. The aim of the presented study was to compare these data to assess which features show up in which data sets and how the combination of different data during analysis influences the interpretation of identified features. Results from the study help to evaluate the merits and limits of each individual data set as well as those of the combined analysis.

Materials and methods

The Ratzersdorf site

The Early Bronze Age fortified hilltop settlement of Ratzersdorf/Am Dachsgraben was first discovered in 1928 and is under monument protection since 2006 (Blesl 2002; Krenn-Leeb 2021). The site is situated on an east-west oriented hilly outcrop on the western edge of the Wölbling Basin in Lower Austria (Fig. 1). The hilltop plateau comprises an area of approximately 25.000 m² and is surrounded by a rampart-ditch-rampart system. To the north and east, a second rampart-ditch-rampart construction reinforces the fortification while the flat, easily accessible northern slope is protected by at least two additional rampart-ditch systems. The steep western, eastern, and southern slopes act as natural fortifications (Krenn-Leeb and Weßling 2020). Since 2018, an annual research excavation and fieldschool led by Alexandra Krenn-Leeb of the Department of Prehistoric and Historical Archaeology of the University of Vienna takes place at Ratzersdorf (Krenn-Leeb 2021).

Data sets and methodology

At the start of the 2018 and 2019 fieldwork, magnetic prospection was carried out by Volker Lindinger of the ARDIG Archäologischer Dienst GesmbH. The majority of the settlement area on the hilltop plateau as well as parts of the open space between the second and third rampart were measured, covering a total of 30.347 m² (Fig. 2). Magnetic measurements were conducted with a Bartington GRAD

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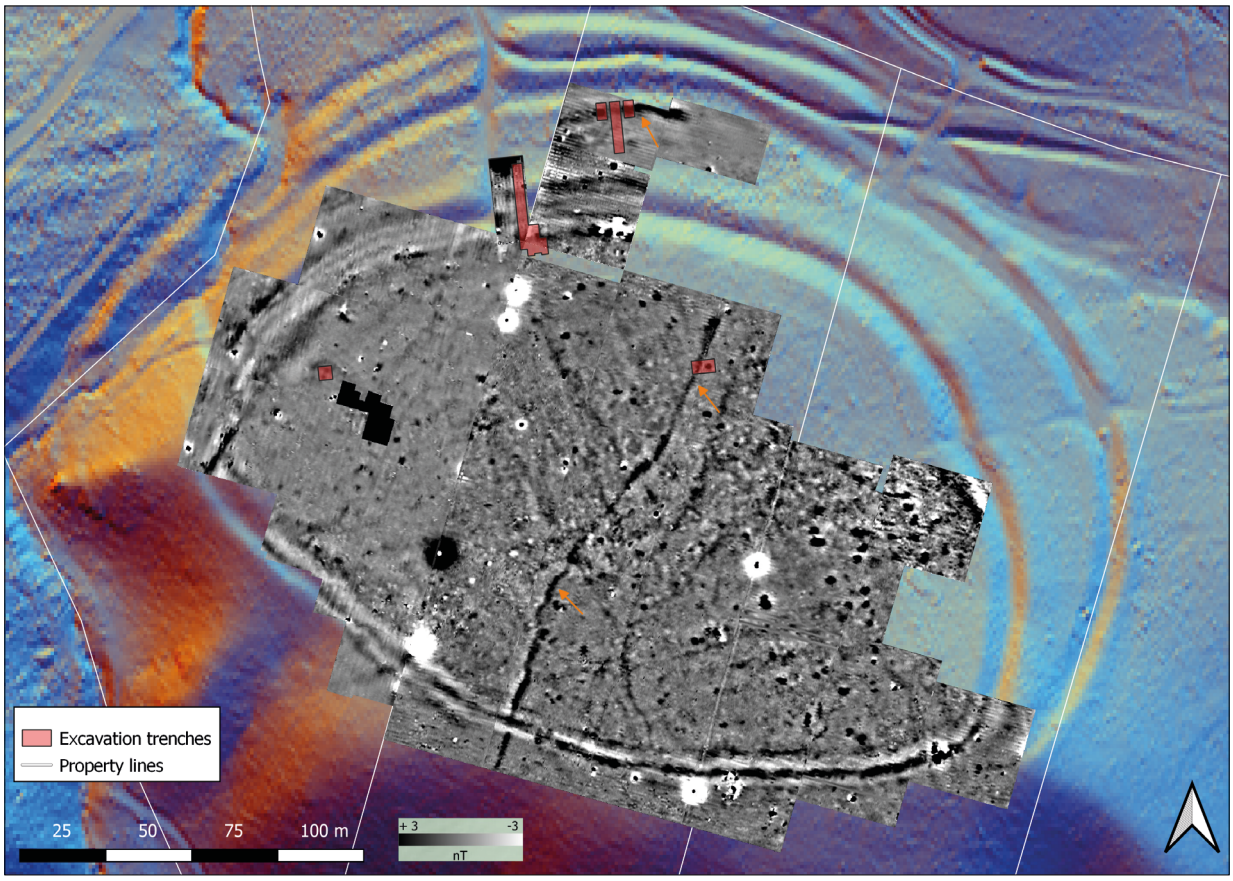

Fig. 2: Magnetometry data obtained in 2018–2019 and locations of the 2018–2022 excavation trenches (Ratzersdorf project, IUHA Vienna; Lindinger V./ARDIG; LiDAR NÖGIS, BEV).

601 dual fluxgate gradiometer with a resolution of 0.1 nT, a cross-line spacing of 0.5 m, and an inline spacing of 0.125 m (Lindinger 2019).

The excavation areas were selected according to possible anthropogenic features visible in the magnetometry data to confirm the existence of these features in the subsurface and gather information on their composition. Preliminary interpretations based on the magnetometry data were complemented by results of the archaeological excavations and of geological test trenching. ALS data provided by the Department of Geoinformation of the Government of Lower Austria (LiDAR NÖGIS, BEV) further supplemented the data base, helping to determine which features were still visible in the modern topography.

Results

The geophysical prospection revealed several potentially archaeologically relevant structures, among them the innermost and part of the second rampart-ditch-rampart systems as well as a large number of positive magnetic anomalies on the hilltop plateau interpreted as pits and ditches. In this study, we concentrate on two specific anomalies: Firstly, a north-south oriented positive, slightly bent linear anomaly on the plateau that was initially interpreted as a ditch that appears to intersect large parts of the settlement. Secondly, a positive linear anomaly following the course of the third rampart and its southern slope (Fig. 2, anomalies indicated by orange arrows). In the ALS data, the strong, north-south oriented anomaly is not visible, while the anomaly at rampart 3 appears to be partly identical with the rampart itself. Due to this inconclusive evidence, both anomalies were cut during excavations to gather additional information.

The linear anomaly on the plateau was clearly distinguishable during excavations and was discovered to be not a ditch, but a geological feature that was likely formed in the course of periglacial processes. It was visible as a fissure filled with eolian, clay-rich sediment which may cause the

Fig. 3: Likely periglacial fissure filled with clay-rich sediment (a). Post hole and daub on rampart 3 (b) (Ratzersdorf project, IUHA Vienna).

magnetic signal (Fig. 3a). The geological feature was also confirmed during Electrical Resistivity Tomography (ERT) measurements (Krenn-Leeb et al. 2023). Conversely, the anomaly on rampart 3 did not show up as one distinct structure during excavations. Geological test trenching revealed west-east oriented fluvial processes in the location of the anomaly beneath and to the south of the rampart which appear to be following the natural slope and may show up in the magnetic data. A linear array of daub and postholes running roughly along the top of the rampart could intensify the positive magnetic anomaly (Fig. 3: b). Preliminary interpretations as to the cause of this anomaly are thus still inconclusive. The current state of research indicates that both anthropogenic and geological processes and structures are visible in the magnetic data and can be verified through excavations. Additional results are expected as excavations in this part of the site are still ongoing.

Discussion

The study results have revealed several important insights. The targeted excavations have proven crucial for the interpretation of features in cases where the prospection and remote sensing data were conflicting or inconclusive. Additional information generated through the excavations and the geological test trenching was able to expand and complement the first interpretive approaches based on the prospection data. Thus, the combination of all data sets is paramount for a comprehensive, informed analysis and interpretation of features at the Ratzersdorf site.

In addition, in the course of this study we were able to identify anthropogenic as well as geological structures and formation processes at the site. Both anthropogenic and geological features are therefore proven to show up in the magnetic data, but they are not distinguishable as one or the other. This circumstance again speaks to the necessity of combining several different data sets for feature analysis and interpretation and especially emphasizes the importance of targeted excavations.

Conclusion

Comparison between and joint analysis of magnetic prospection data, ALS data, and excavation results in the course of the Ratzersdorf project have been successful to date, enabling researchers to identify and comprehensively interpret anthropogenic as well as geological features and processes at the Ratzersdorf site. Aside from feature identification and interpretation itself, these results further our understanding of the Ratzersdorf site as a whole by providing insights into the construction of its anthropogenic structures and the local geology and formation processes.

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