ISAPNEWS

The Newsletter of the International Society for Archaeological Prospection

Issue 72, September 2024

Editorial – Issue 72

Welcome to Issue 72 of ISAPNews!

This issue will be of particular interest to fans of central European archaeology, with three different case studies exploring surveys of medieval and post-medieval remains.

We start off at the Church of St Margaret of Antioch, Kopčany, beside the Morava River on the Czech-Slovak border, before heading to Baden-Württemberg, Germany, where the detection of medieval masonry (or, more specifically, the lack thereof) provides information about the castle mound. From here, it's a short hop through time and space to 19th-century Bavaria, where the geophysical results confirm and complement historical sources shedding light on a former farmstead.

We also have the next instalment of our 'Born to Survey' feature: last time we met the current and outgoing ICAP Conference Secretaries, this time we have the current Chair and Vice Chair of ISAP - read on to catch up with Armin Schmidt and Natalie Pickartz...

Happy surveying!

Hannah Brown & Michal Pisz

editor@archprospection.org

Cover: Spot the castle! Survey areas measured out and ready to go in Röttingen, southwestern Germany (Photo: B. Rieger; see page 11).

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Examples of the use of non-destructive geophysical methods within the Kopčany Monument Zone, Senica District, Slovakia

Roman Křivánek[1] & Peter Baxa

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The Kopčany Monument Zone is part of the Mikulčice-Kopčany Archeopark, located on both banks of the Morava River that forms the border between the Czech Republic and Slovakia. Situated on the western (Czech) bank is the important early medieval fortified Mikulčice hillfort (intensively used in the 9th-10th centuries AD, with minor indications of settlement in the 11th-12th centuries AD) and the extensive archaeological excavations carried out at this site are presented as part of an exhibition. On the eastern (Slovak) bank of the Morava River is the Church of St Margaret of Antioch, which is the only original building from the time of Great Moravia (9th-10th centuries AD) in Slovakia (Figure 1).

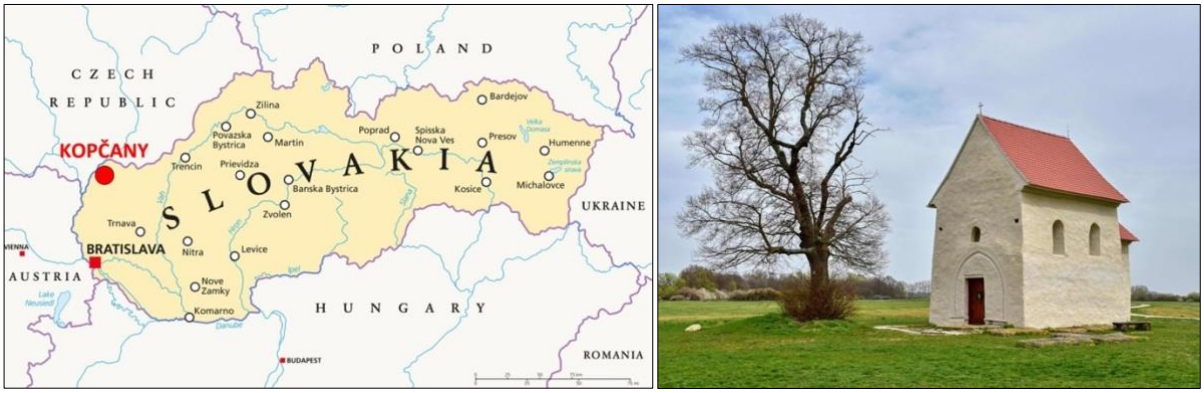

Figure 1: Kopčany site location and the Church of St Margaret of Antioch.

As part of the long-term reconstruction of the building, and also of the nearby Baroque Kačenáreň building, systematic surveys and archaeological excavations of a limited scope were carried out here in the last two decades. All the archaeological excavations here have proved a clear, close connection with the Mikulčice hillfort during the period of Great Moravia, with confirmation of intensive settlement, localised indication of production activities and relics of a defunct court, in addition to burial activity both in the vicinity of the Church of St Margaret of Antioch and the wider area. The Za

jazerom (Behind the Lake) site in the vicinity of the church thus represented an important part of the context of the Mikulčice hillfort, along the access road from the east.

As part of the reconstruction of the historical landscape in the area around the church, including the network of roads and settlements, the results of various methods and specialized analyses were used (including pedology, geology, research into the use of the landscape in the Baroque period of Austria-Hungary, old maps, historical aerial photographs, historical building surveys etc.). Since 2006, geophysical surveys have also been used in the Kopčany area, to verify the intensity and structure of settlement and other activities in the wider surroundings of the church and on the adjacent terraces. The scope and possibilities of prospecting were limited by current agricultural use of the area, as well as by the local soil/geological conditions (including flood sediments and palaeomeanders of an earlier course of the Morava River). Therefore, geophysical surveys undertaken between 2006 and 2023 were divided into a number of stages, with different geophysical methods and procedures used in different stages of prospecting (Figure 2).

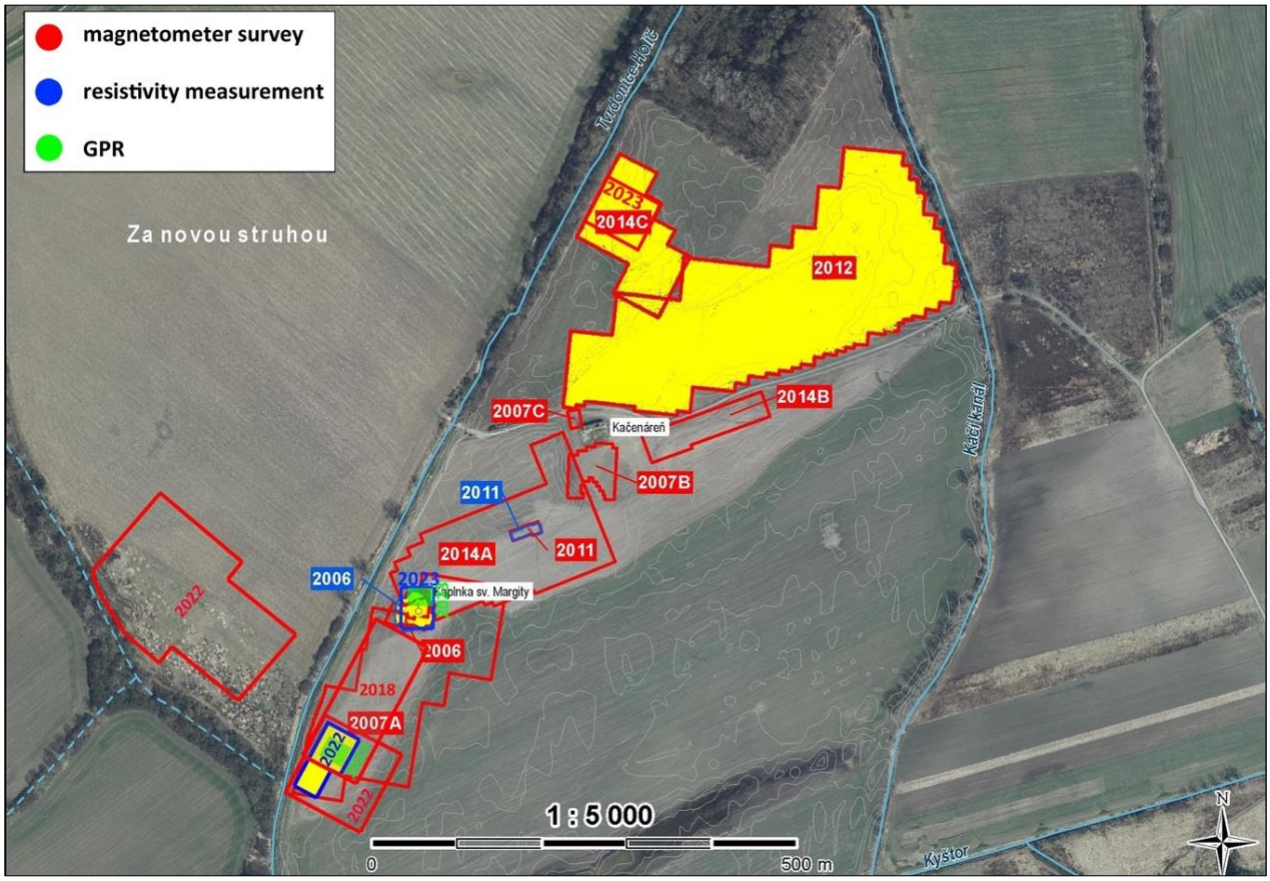

Figure 2: Summary of geophysical survey in the area of the Church of St Margaret of Antioch, 2005-2023. Yellow denotes areas shown in Figures 3 to 6.

When verifying the presence of settlement with anticipated cut features, magnetometry was used to the widest extent. In the early stages of research, a Smartmag SM-4g caesium magnetometer (Scintrex, Canada), modified for single-profile measurements of the vertical gradient of changes in the magnetic field, in a grid of 1 m x 0.25 m resolution was employed. Since 2011, a DLM-98 five-channel fluxgate gradiometer (Sensys, Germany) has been used for area magnetometer measurements at measurement densities of 0.5 m x 0.2 m to 0.25 x 0.1 m. When verifying possible stone remains or accumulations, geoelectrical resistance measurements were collected with a Geoscan Research (UK) RM-15 instrument, using the Wenner arrangement of electrodes (A0.5M0.5N0.5B) with measurement densities of 1 m x 1 m to 0.5 m x 0.5 m. Selected areas were also recently surveyed using the Cobra WIFI II radar (Radarteam, Sweden) or by measuring the magnetic susceptibility with the Multi-Kappa apparatus (GF-Instruments, Czech Republic), with a depth range of up to 0.5 m.

The results of the geophysical measurements could subsequently be compared with the results of archaeological excavations by the Bratislava Monument Office. In other cases, the results of earlier excavations, information from old maps and historical aerial photographs (which also documented modern activities and their impacts on the site) contributed to the narrowing of some interpretations. Using the example of the geoelectrical resistance results in the immediate vicinity of the Church of St Margaret of Antioch, it is possible to distinguish the relics of the arc of the contemporary perimeter wall (no longer extant) of the original cemetery and also, apparently, the subsurface remains of the stone foundations of another (destroyed, undated) building (Figure 3).

In contrast, the large spatial extent of the early medieval settlement can be seen in the magnetometer results collected to the east of the Baroque Kačenáreň building: the settlement comprises mainly smaller cut features without a clear overall structure, located on the elevated aggradational embankment above the original course of the Morava River (Figure 4). The results also clearly indicate the magnetic inhomogeneity of the gravel/sand sedimentary bedrock with a shallow groundwater level, with most of the magnetic anomalies over sunken features showing only low magnitude; the western edge of the area was contaminated by recent deposits.

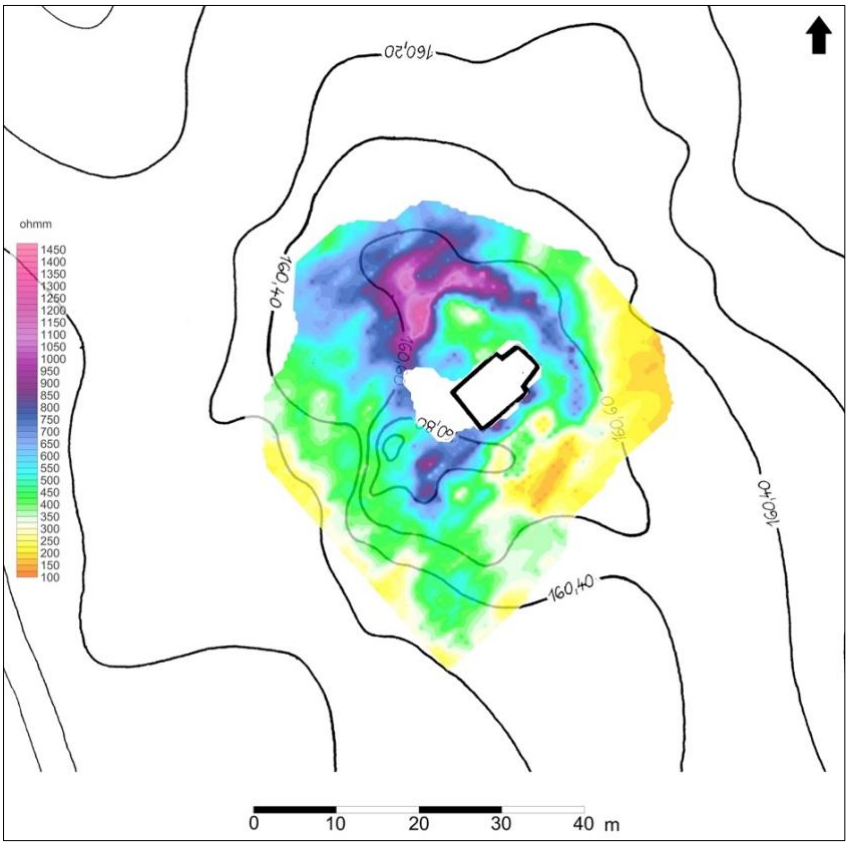

Figure 3: Geoelectric resistivity measurements (with contour plan) in the immediate vicinity of the Church of St Margaret of Antioch (survey area: approx. 0.2 ha; survey: Křivánek 2006).

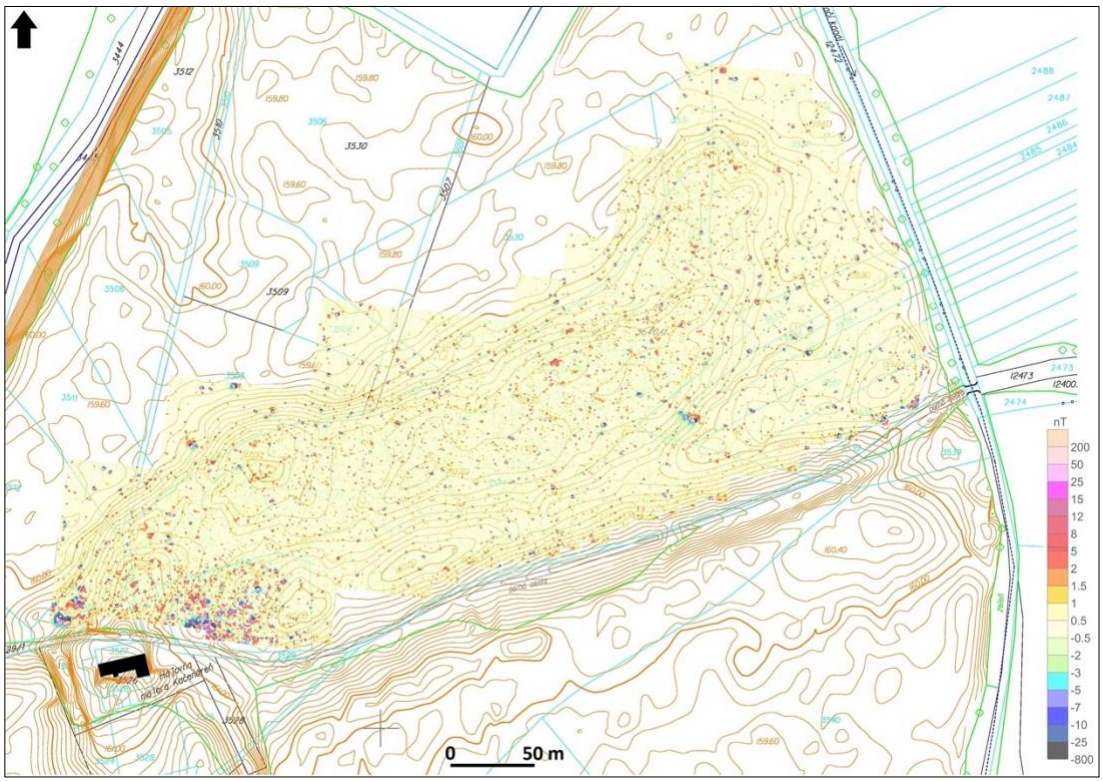

Figure 4: Magnetometer results (with contour plan) north and northeast of the Kačenáreň building (survey area: approx. 6.7 ha; survey: Křivánek 2012).

Using a combination of the results of aerial photography, magnetometer and resistivity measurements, we can then take a closer look at a section of slightly elevated terrain to the south of the church. Buried features here have not been archaeologically verified and are undated but are interpreted as a distinct rectangular ditched enclosure with and entrance and a conspicuous accumulation of stone (remains of a destroyed structure) inside (Figure 5). However, in the space to the north of the discussed area, a courtyard was previously identified by archaeological test pits, which also confirms the settlement of the area to the south of the Church of St Margaret of Antioch.

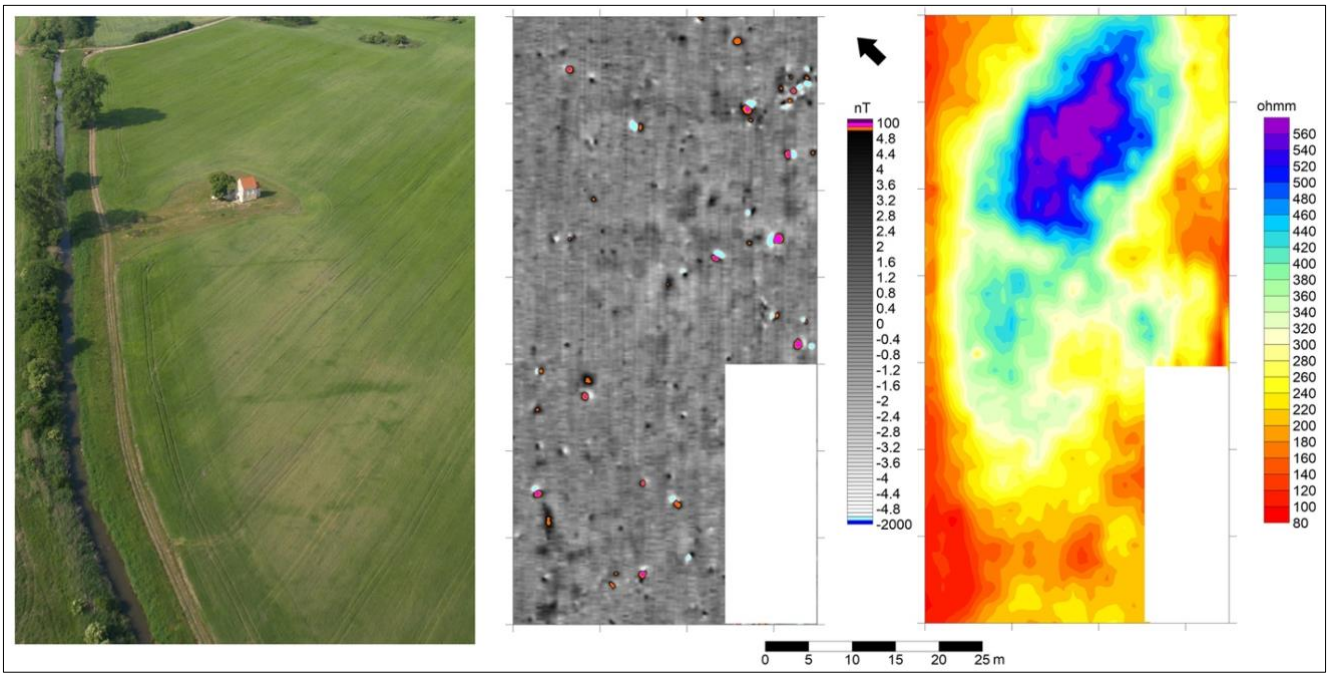

Figure 5: Comparison of aerial photograph, magnetometry and geoelectric resistivity data over elevated terrain with rectangular ditch enclosure of unknown origin south of the Church of St Margaret of Antioch (survey area: approx. 0.3 ha; survey: Křivánek 2022 & 2023).

Other magnetometer measurements from the former flood plain area confirmed that not all identified magnetic anomalies reflect early medieval activities. Some parts of the landscape underwent large-scale remodelling in the Austro-Hungarian Baroque period, with the creation of water channels and reservoirs for duck farming and hunting (Figure 6). These landscape changes are known from old maps and historical aerial photographs.

The Kopčany monument zone represents a complex of various anthropogenic activities from the 9th-10th centuries AD that have not yet been verified by destructive archaeological methods to the same degree and extent as those at the Mikulčice hillfort located further west. This is also why, both for

archaeology and for monument protection, it will be necessary for more non-destructive (and destructive) methods to be continued in the systematic research of the area. The possibilities of using geophysical prospection have not yet been exhausted and the continuation of surveys is planned as part of the ongoing project.

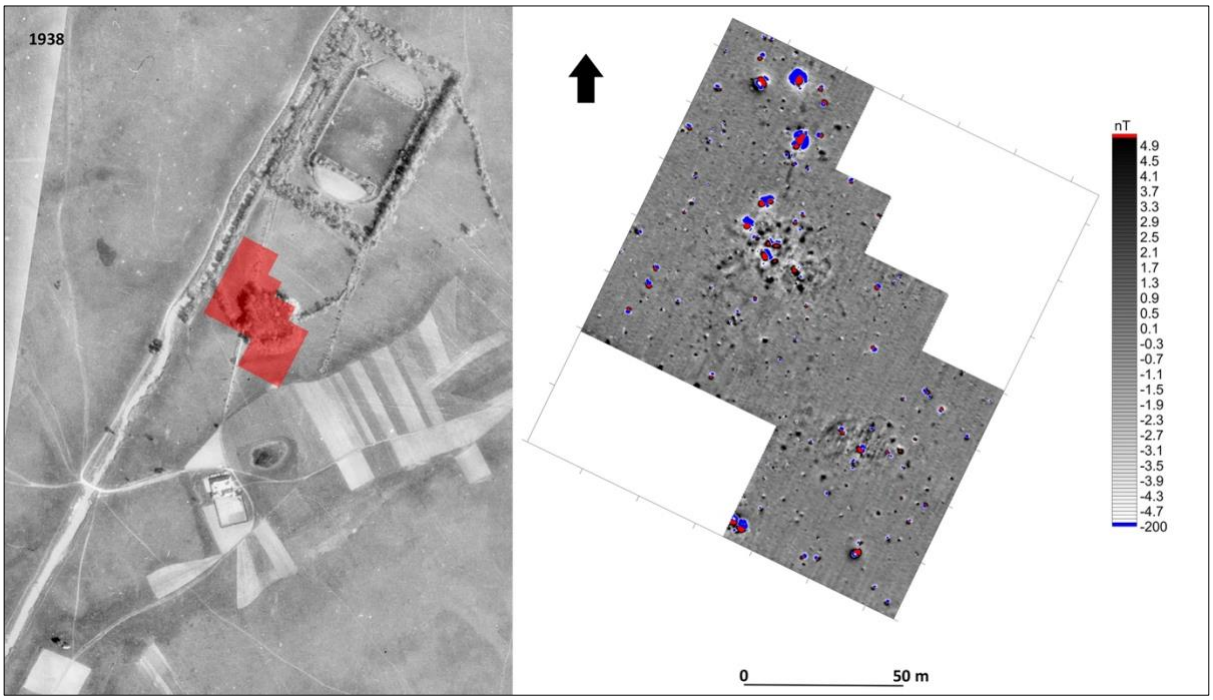

Figure 6: Comparison of aerial photograph from 1938 and magnetometer results in the flood plain area modified by Baroque-period water management (survey area: approx. 1.25 ha; survey: Křivánek 2017 & 2023).

Acknowledgements

This article was created with support from the project 'The Early Medieval Area Surrounding the Church of St–Margaret in Kopčany (SK) as a Part of the Mikulčice-Kopčany Settlement Agglomeration. The Contribution of Non-Destructive Geophysical Research to the Study of the Supra-Regional Centre', realised in cooperation with the Institute of Archaeology in Prague, Czech Academy of Science; the Faculty of the Philosophy of Comenius University in Bratislava; and the Slovak archaeologist Peter Baxa (formerly Heritage Institute Bratislava), and financed by the Research Programme AV21 (Anatomy of European Society).

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Robbed masonry as evidence of medieval brick recycling

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In the context of scientific evaluation of medieval castles of the Ostalbkreis (southwestern Germany), unanswered questions concerning the architecture, construction, usage and extension of some fortified castles in the area can be clarified with the help of geophysical methods. The primary intention was to determine whether traces of unknown archaeological features could be detected and mapped with the help of geophysical methods to deepen our knowledge of these historical monuments.

Figure 1: General view of the survey areas and castle earthworks at Röttingen, looking across the main rectangular plateau (FL01) towards the tower mound (FL02); the survey tape runs along the bottom of the moat (in shadow).

Figure 2: General view of the tower mound survey area (FL02) with the earthworks of the elevated rectangular plateau (FL01) behind.

In agreement with the State Office for Cultural Heritage of Baden-Württemberg the geophysical investigations took place in 2021. The main survey areas (Figures 1 & 2) were the elevated plateau (FL01), which measured approximately 50 m x 40 m (2000 m²/0.2 ha) and is believed to have been the main castle area, and the adjacent mound (FL02, 900 m²/0.09 ha), where remains of a medieval tower were expected.

GPR survey was carried out with a GSSI SIR-3000 unit with a 400 MHz antenna. An inline trace spacing of 0.02 m and a crossline trace spacing of 0.25 m were chosen for the whole survey. Gradiometer survey was also carried out, using an FM256 dual gradiometer system from Geoscan Research with a chosen sample interval of 0.125 m and a traverse interval of 0.25 m.

Evaluation and Interpretation (GPR) (see Figure 3)

Survey Area FL01: *Inner wall (Anomaly 1):*

In the depth range of 0.50 m - 2.10 m, the inner wall of the former castle complex clearly stands out. While the northern and western parts of the wall seem to have been preserved entirely, the southern and eastern walls seem to break off halfway. A preserved wall height of about 1.60 m and a wall thickness of about 1.20 m can be expected.

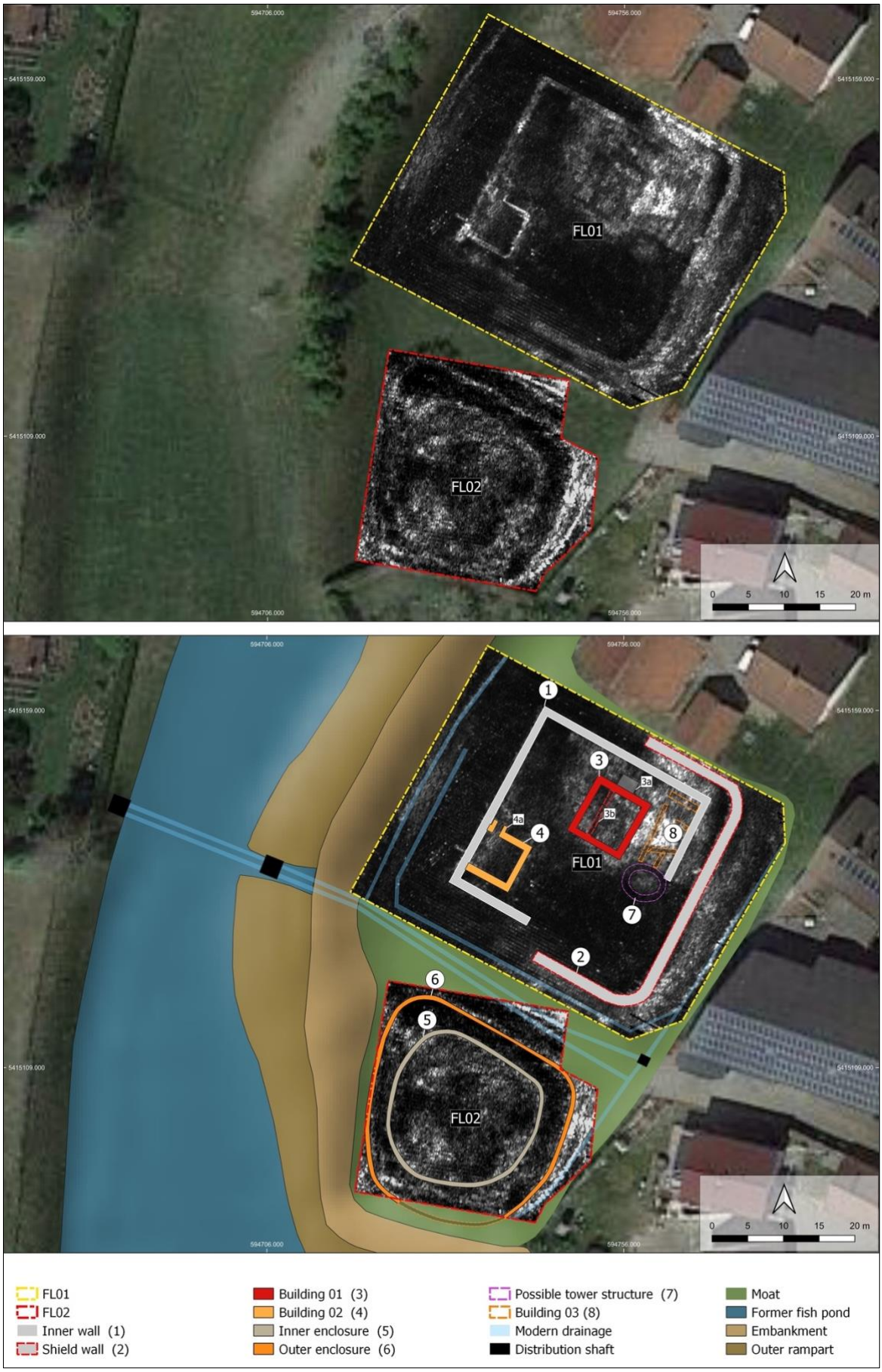

Figure 3: Selected GPR survey data and interpretation. See also Figure 4.

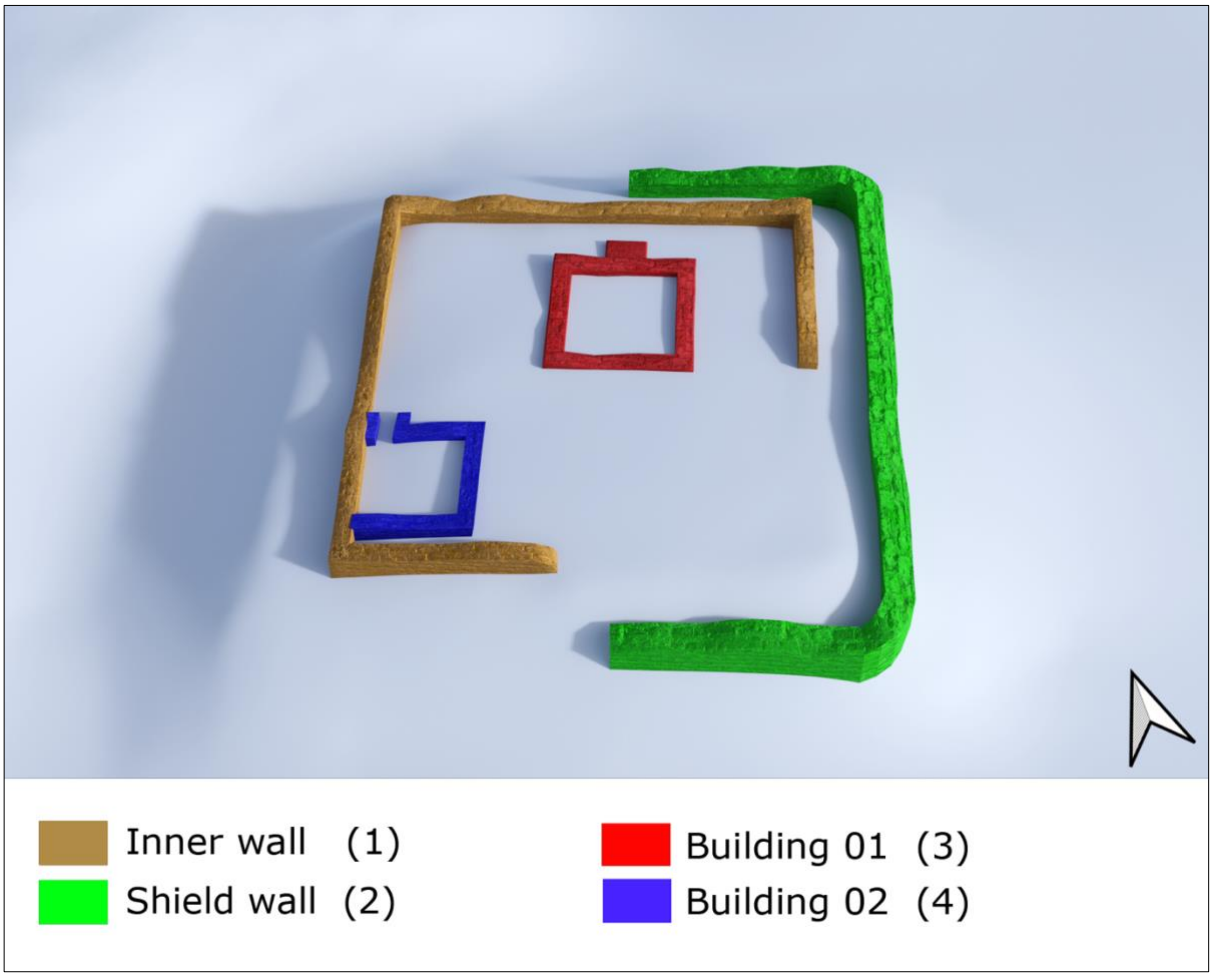

Figure 4: Selected GPR survey data and interpretation.

The shield wall (Anomaly 2):

Anomaly 2 stands out clearly as a 2.00 m thick wall structure with rounded corners that encloses the eastern half of the entire inner bailey. This structure is present at a depth range of approx. 0.50 m - 2.00 m in the time slices. The wall structure found here is very likely to be a shield wall. Since the moat, the rampart and the waters of the large fishpond offered sufficient protection in the west, this shield wall was probably intended to protect against attacks from the east.

Building 01 (Anomaly 3):

In the depth range of approx. 0.50 - 1.50 m, former wall features are clearly visible in the form of a quadrangular building structure with wall lengths of approx. 8.70 m each and a wall thickness of approx. 1.00 m. Inside this building more wall structures (inner partitions) are present. Remains of a

small porch (entrance) are visible on the northern side of the building. Building 01 (Anomaly 3) is probably the former main building of the castle (former residential tower).

Anomaly 3 is typical evidence of 'robber trenches'. While wall features preserved in the ground normally show up in amplitude maps as positive values (in our case as white lineaments), Anomaly 3 shows up as a negative anomaly (black lineaments) in the form of a clearly recognizable quadrangular building structure. This phenomenon occurs when reusable stones are removed from the ground and especially when complete wall segments are deliberately dismantled after the castle has been abandoned. The stone material obtained in this way could be reused for other construction projects and, in most cases, was used for the construction of buildings in the immediate vicinity of the castle complex. Medieval bricks from the former castle can often be found in adjacent historical buildings.

In the present example, the extraction area of the walls can be clearly distinguished within the surrounding debris material. Without the broadly scattered debris in this area, the building structures (as indicated by the detected robber trenches) would be a lot harder to interpret or at least would not be identifiable in the timeslices.

Due to the strong thermoremanent magnetisation of debris consisting of burned bricks and rooftiles that is scattered over and around Building 01, it was not possible to identify the robber trenches in the gradiometer data because all the underlying features were masked by the strong magnetisation of the debris above.

Building 02:

The preserved foundations of Building 02 (Anomaly 4) can clearly be traced at a depth range of about 0.50 m - 1.90 m in the time slices. The building also has a quadrangular structure with side lengths of approx. 7.00 m. Its northeastern and southwestern walls connect directly to the western perimeter wall (Anomaly 1). Close to its northern corner, two wall segments of about 0.80 m (length) x 0.40 m (width) project at right angles, marking an entrance. The northeastern wall itself is interrupted here, providing an entrance of about 1.20 m in width.

Anomalies 7 and 8:

Anomaly 7 is an oval/round structure (inner diameter 3.10 m x 4.40 m, outer diameter 4.20 m x 6.50 m), which appears at a depth range of about 1.00 m - 1.50 m. This round anomaly could be further evidence of robbed stones. Possibly the masonry of a round castle tower, along with its stone foundations, were robbed from here and recycled in the past.

Anomaly 8 is not clear enough for a definite interpretation and cannot be clearly classified without further investigation on the site itself. Most likely, this anomaly indicates the remains of a former rectangular building adjoining the interior of the eastern perimeter wall.

Survey Area FL02

Anomalies 5 and 6:

Anomaly 5 shows up in the depth range of 0.60 m - 0.80 m in the time slices. This structure (about 0.60 m in width) appears in the form of an irregular circle of round 40.00 m diameter. This structure could be the remains of the foundation of a former enclosure wall.

Anomaly 6 is probably a second former enclosure around the upper mound area (about 25m in diameter). This anomaly is present in a depth range of 0.40 m - 1.20 m in the time slices.

No meaningful remains of an expected tower could be detected on the mound plateau itself (FL02). Nevertheless, the recorded surrounding mound enclosures (Anomaly 05 and 06) suggest a former building on the mound plateau (possibly a wooden construction). A slight, trough-shaped depression located centrally in the mound plateau and evidenced in the GPR profiles, may also indicate a potential building. The gradiometer survey did not produce meaningful results in Area FL02.

Conclusion

The geophysical prospection in Röttingen, allowed a large area of the medieval castle complex to be mapped and reconstructed. The use of GPR in particular led to new insights regarding the architecture and spatial expansion. The results also provide a good example of the potential for mapping areas of

extracted masonry with GPR, where enough difference exists between the physical properties of the infill of the robber trenches and the surrounding material.

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Excerpts from archive data collected by Werner Kowarsch.

Note

Geophysical investigations in the former Roman town of *Petuaria* (Brough, East Riding of Yorkshire, UK) found that robber trenches visible in the timeslices correlated with subsequent excavations. Entire building complexes could be mapped there on the basis of robbed out structures visible in the amplitude plots.

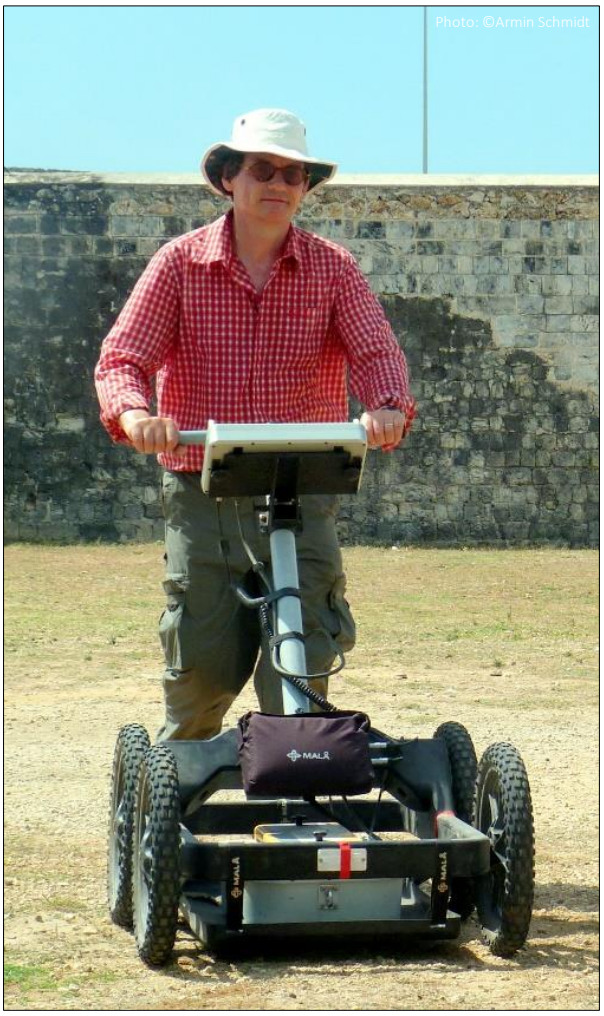
BORN TO SURVEY

You know their name, may have seen their faces – but how, you wonder, have they got into archaeological prospection? And why? And do they have any tips for the rest of us?

ISAPNews is here to answer these questions. And for that the editorial team approached various members of ISAP, starting with the Management Committee. It's not the Spanish Inquisition, but a set of questions with light-hearted responses and funny stories. This time, we're delighted to introduce Armin Schmidt (Chair) and Natalie Pickartz (Vice Chair).

ARMIN SCHMIDT

BORN: Munich, Germany (I long thought it is the best city ever, but I now admit that Melbourne is also quite good)



LIVES: Remagen, Germany (much quieter …)

AFFILIATIONS / COMPANY: My company 'Dr Schmidt – GeodataWIZ' is based in Germany and I am an 'Honorary Visiting Researcher' at the University of Bradford, UK.

EDUCATIONAL BACKGROUND: I studied physics in Germany, obtaining a degree of Dipl.-Phys. (comparable to a combined BSc & MSc in Physics) from the Technical University Munich, and followed this up with a doctorate at the Rhineland Westphalian Technical University Aachen (RWTH Aachen). The thesis investigated magnetic properties of high-temperature superconductors – so the magnetism theme was set then. During the time in Munich I attended a seminar presentation by Helmut Becker on the results he obtained with caesium magnetometer surveys over archaeological sites. That must

have been around 1985 and the results were truly amazing for that time. And so it all started.

FIELD OF EXPERTISE: Ask me anything; I am never shy to provide an opinion. But you could narrow it down to archaeological geophysics.

HOW WOULD YOU NAME / DESCRIBE WHAT YOU DO: Archaeological geophysics. And giving my opinion.

YOUR FIRST SURVEY (OF AN ARCHAEOLOGICAL TARGET): After my doctorate in physics I looked for the best place to learn about archaeological geophysics and found the University of Bradford, where I began my career in archaeological geophysics. It was the time when the Department of Archaeological Sciences had just started the new journal 'Archaeological Prospection' and the course 'MSc in Archaeological Prospection', Geophysical Surveys of Bradford (GSB) were the heroes of 'Time Team', and 'Geoscan Research' was producing field-ready equipment in the outskirts of Bradford for increasingly larger surveys. Arnold Aspinall and Paul Cheetham took me to the nearby Roman Fort at Adel (Leeds) to teach me the art of setting up an FM18 fluxgate gradiometer. I often returned later to that site with students to expand the survey area year by year. I suppose one is always partial to the first site one has worked on.

WHY ARCHAEOLOGICAL PROSPECTION: A great combination: outdoor fieldwork, data processing and archaeological discoveries.

FAVOURITE GEOPHYSICAL METHOD: Magnetometer surveys (since it is enigmatic) and GPR (since it is amazing).

LEAST FAVOURITE METHOD: Can't think of one.

BEST PROFESSIONAL EXPERIENCE: Meeting all the lovely people who are also passionate about archaeological geophysics. Mostly at ICAP conferences. In terms of survey excitement, probably the work at Buddha's birthplace in Lumbini, Nepal.

WORST SURVEY/PROFESSIONAL EXPERIENCE: When it was raining so hard during student training that even the Geoscan equipment stopped working. I must mention that students did not complain and just took it as another experience!

MOST SATISFYING RESULT: GPR showing probable Iron Age houses in Anatolia. We were looking for the site where the mother-goddess Cybele initially had her altar (it ended up in Rome as a trophy). And maybe that was the site. It's all ploughed out now ;-(

MOST SURPRISING RESULT: Low earth resistance over a large stone foundation (due to standing water).

LEAST SATISFYING RESULT: A field littered with ferrous rubbish - no possibility to identify any anomalies that might have been caused by archaeological features. And that was even before they started spreading 'green waste'.

THOUGHT PROVOKING / YOUR FAVOURITE PUBLICATION YOU WOULD RECOMMEND: I still find new insights in Irwin Schollar's 'black book' on archaeological prospection (1990).

YOUR BIGGEST DREAM FOR THE FUTURE: That everyone who works in archaeological geophysics has a good education in the subject.

BEST CAREER ADVICE: 1. Follow your passion - do what you find really interesting.

2. Talk with people about archaeological geophysics; and listen to them - you will learn something relevant from everyone: farmers, students, bureaucrats, peers.

NATALIE PICKARTZ


Photo: ©LAD/Landesamt für Denkmalpflege

BORN: In the countryside close to Cologne, Germany.

AGE: Born in 1989. **LIVES:** Ludwigsburg, Germany.

AFFILIATIONS / COMPANY: Landesamt für Denkmalpflege im Regierungspräsidium Stuttgart (State Office for Cultural Heritage Management Baden-Wuerttemberg).

EDUCATIONAL BACKGROUND: B.Sc. Physics and M.Sc. Geophysics, both at the University of Cologne. Doctoral degree in Geophysics at Kiel University.

FIELD OF EXPERTISE: Near Surface Geophysics especially for archaeological targets.

HOW WOULD YOU DESCRIBE WHAT YOU DO: I'm a geophysicist specialising in archaeological targets. To laypeople I explain my work like this: I do something comparable to imaging methods in medicine, like x-ray or ultrasound. I'm just using different physics to look into the ground and make an image of archaeological sites.

YOUR FIRST SURVEY (OF AN ARCHAEOLOGICAL TARGET): In summer 2008, just after I finished school and before I started my studies. I assisted on a magnetic survey in eastern France. Magnetics and me, it was love at the first site... ;)

WHY ARCHAEOLOGICAL PROSPECTION: My parents report that they distracted me on vacations from signs advertising museums because they didn't want to spend every day in a museum. Of course, we visited a lot of them. My mother had to translate each sign in an archaeological museum in southern France to her daughter at the age of 6. However, I'm not


Photo: ©LAD/Landesamt für Denkmalpflege

good at remembering things by heart. I like to understand correlations, physics and mathematics. Consequently, archaeological prospection was the perfect connection between my talents in natural science and my long-term interest in archaeology.

FAVOURITE GEOPHYSICAL METHOD: Magnetics and susceptibility measurements, especially downhole in manually cored holes.

FAVOURITE INSTRUMENT: Bartington's MS2H susceptibility downhole sensor at Kiel University. The sensor and I spent many hours together for my PhD.

BEST SURVEY EXPERIENCE: I'm lucky and there are a lot of them. Maybe one for every educational or career stage. One of the latest ones during my time at Kiel University: In summer 2021, my team and I had an amazing time while surveying in Romania. A perfectly matched team made those days unforgettable.

MOST SATISFYING RESULT: Leading my first own survey for my Master's thesis in Israel and seeing the map of the site at Elusa grow each day.

MOST SURPRISING RESULT: Well-known scientists being interested in my research.

YOUR BIGGEST DREAM FOR THE FUTURE: Lean bureaucracy in Germany, a *Nature* paper and my own little team rather than a one-woman set-up… dream big or go home. I wonder if any of those are realistic ;)

BEST CAREER ADVICE: Pursue your dreams! Work on topics that excite you. Don't wait for opportunities but create the opportunities by yourself by getting to know the right people and showing interest. At least, that's the way I was able to survey the site in Israel for my Master's thesis.

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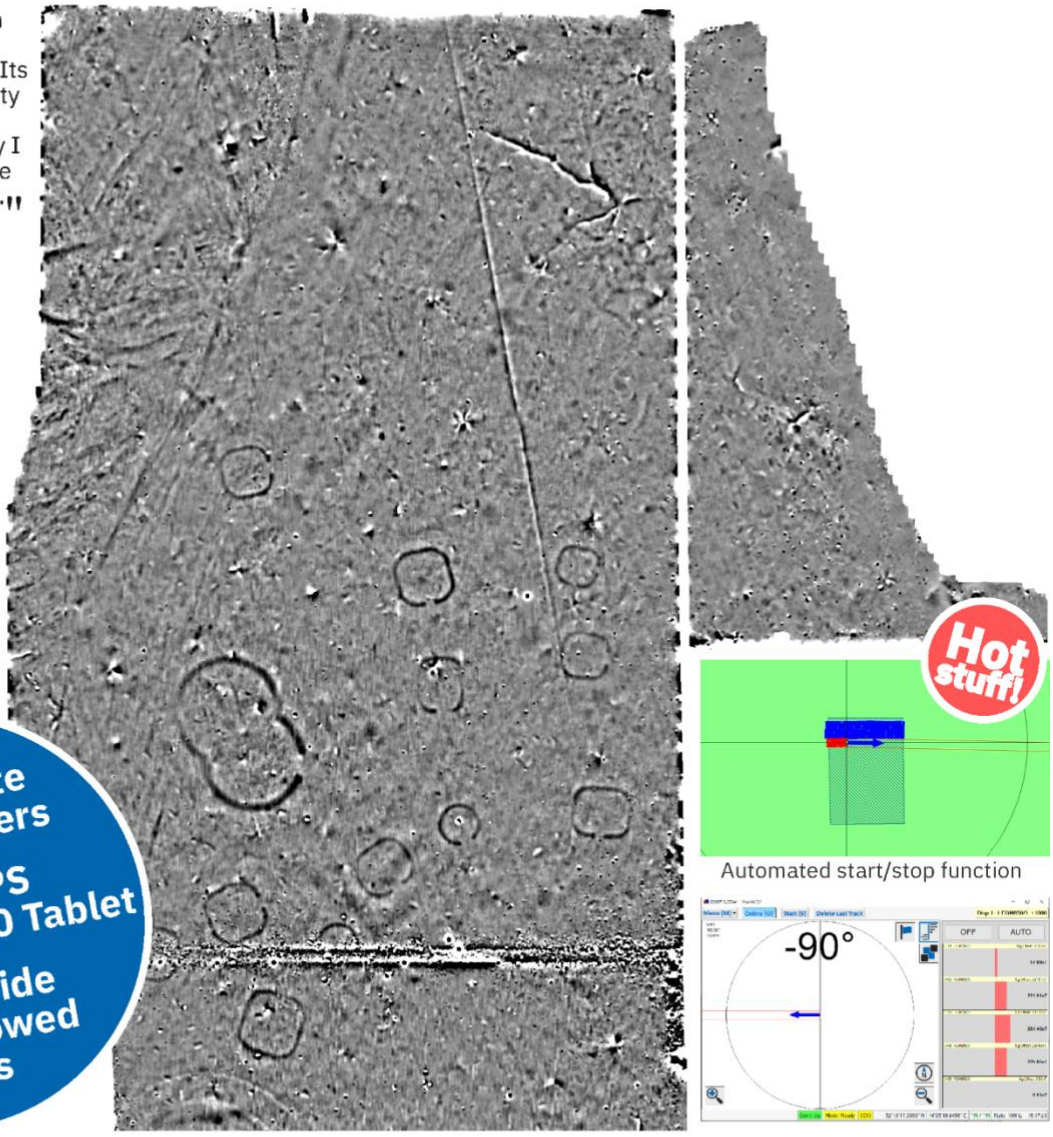

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Tracing the remains of the deserted village ‘Mallertshofen’, north of Munich, Bavaria, by geophysical prospection

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The site and its historical sources

The archaeological site is located approximately 15 km north of Munich, near the motorway from Munich to Nuremberg. Nowadays, the area is a nature reserve, with a swimming lake in a former gravel pit from the second half of the 20th century. In former times, a rural settlement was located there, of which only a small church remains.

Mallertshofen is documented for the first time around 1060, as ‘Schwaighof’, owned by the Counts of Ottenburg. During the 11th century ownership was transferred to Weihenstephan Abbey (Christoph 2012). In 1165, written sources mention a village named ‘Adelhershofen’ and in 1190 ‘Mallertshofen’ was an independent parish and a prosperous municipality (Stahleder 1980; Weber 1985; Christoph 2012). The settlement was mentioned in 1315 in the ‘Konradinischen Matrikeln’, an ecclesiastical register of the Diocese of Freising, with subsidiary churches in Garching, Fröttmaning, Freimann and Unterschleißheim (von Deutinger 1850; Weber 1985; Christoph 2012). This is evidence that Mallertshofen was relatively important during this time. Due to the poor heathland that could only be used as meadow or for a single grass swath per year, in late medieval times and especially in the 17th century (after the Thirty Years' War), Mallertshofen declined severely and nearly all farmsteads were abandoned (Weber 1985; Christoph 2012).

Additionally, the inhabitants suffered greatly at this time and later, during the War of the Spanish Succession and the Napoleonic Wars, as the Fröttmaninger Heath area was used for training and manoeuvres by Bavarian and foreign troops over centuries (Christoph 2012). There were only two

surviving farmsteads in the 17th century, when the Bavarian elector Maximilian I purchased the settlement. In 1818, only 12-14 inhabitants are recorded and the number diminished to eight persons in 1849 (Christoph 2012). Finally, the last farmstead, with five inhabitants, was demolished in 1880 (Paula & Weski 1997). Hence, only old maps can give an impression of the detailed layout of the last building phases in 1809 and 1858 (Figure 1).

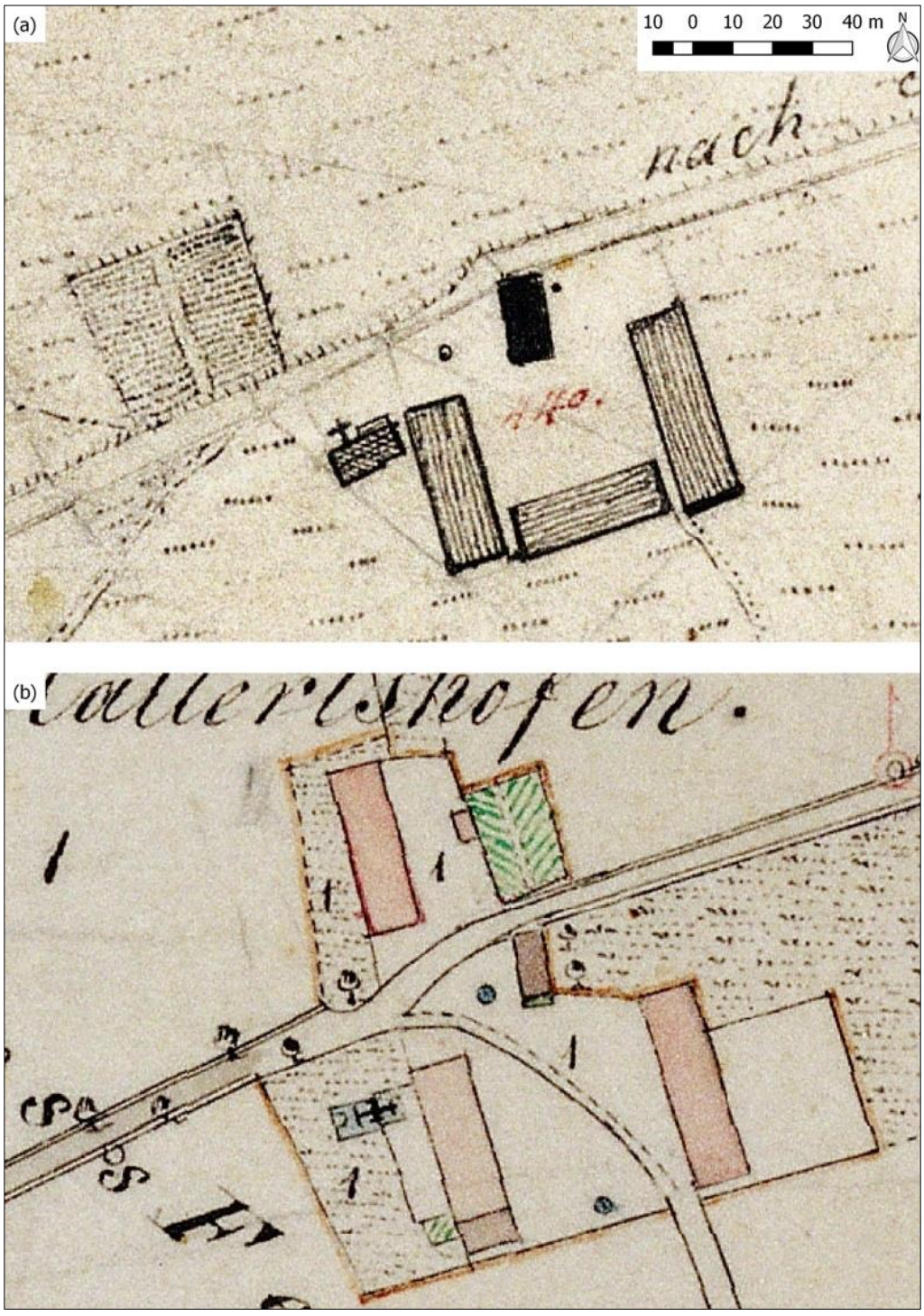

Figure 1: Old topographical maps of Mallertshofen showing the last building phases of the farmstead: (a) map from 1809; (b) map from 1858.

Results of the geophysical survey

To locate and document the remaining subsurface building structures of the late farmstead Mallertshofen, we executed an integrated geophysical survey with fluxgate gradiometer and Ground-Penetrating Radar (GPR) over two days in summer 2023. Both methods covered an area of approximately 0.8 hectares in the southern part of the former settlement. The other parts of the settlement are now covered with dense vegetation, bushes and trees and are therefore not accessible for prospection. Partial structures were faintly visible at the surface during the survey, as some parts of the buildings were excavated in 1988. However, the corresponding plans are not available anymore.

In addition to the geophysical surveys, the *in situ* soil parameters were monitored by Time-Domain-Reflectometry (TDR) for a better interpretation of the GPR data. Due to the extreme drought in summer 2023 in Bavaria, the soil moisture was only 13 vol%. There was virtually no variation in the value over the survey time or even between the different days. Together with the low conductivity of 0.08 dS/m, due to the nutrient-poor heath soil, this environment is quite suitable for a successful GPR survey.

The archaeological remains are detectable in the GPR data between 30 cm and 90 cm depth, indicating a preservation height of 60 cm. Whereas the upper limit is quite reliable, for the lower one a certain amount of deviation can be expected due to the varying electromagnetic wave velocity in the stone foundations compared with the surrounding soil. This variation cannot be properly taken into account during data processing. The relatively shallow burial depth of the remains is due to the fact that the buildings were demolished since the end of the 19th century and the area has been used only as heath rather than agricultural fields, which does not allow the accumulation of a thick soil.

Figure 2: Selection of depth slices in the relevant range of 40-80 cm below the modern surface. GSSI SIR-4000 with 400 MHz-antenna, sample interval: 6 x 25 cm. Project-No. Mal23rad.

Figure 3: GIS-based interpretation map of the archaeological remains of the farmstead Mallertshofen. North to top.

The depth slices show the remains of three former buildings of the farmstead Mallertshofen (Figure 2). Of the westernmost building, only the southern part could be surveyed due to dense vegetation. The location and size of the building, however, fits quite well with the 1858 map (Figure 1b). This building is orientated northwest-southeast and is 15 m wide; the length can be traced for 15 m before it extends beyond the northwestern edge of the survey area (Figure 3). The interior is subdivided into several small rooms with sizes between 1 x 2 m and 3.5 x 5 m. The elongated area in between the rooms probably represents a former corridor. A possible interpretation of the southernmost part of the building would be as servants' accommodation. The two very small rooms directly south of the corridor may represent the vestibules of the servants' quarters. To the north of these, there are several bigger rooms. Presumably, this can be interpreted as a barn with separated zones for various field crops or single workshops. Such a bisection with two different purposes of utilisation fits well against the 1858 map.

A second building with a 90° rotated orientation (southwest-northeast) is visible further to the east (Figures 2 & 3). It measured 40 m x 13 m and was divided in the middle. Again, usage as a barn or stable is most probable. This

building is only documented in the older 1809 map (Figure 1a). It was demolished in the 50 years between the two maps and in the newer one there is a curved road shown in this area, which is also visible as soil compaction in the GPR data. South of this building, a stone-built well of 4 m diameter, also recorded in the 1858 map, can be seen in the data.

Further to the east, a third former building is discernible in the depth slices. Its width is 15 m and it is at least 29 m in length (Figures 2 & 3). The northern limit could not be mapped, as the remains vanish towards the north. There are no hints regarding internal division into individual rooms. Overall, this building is worse preserved than the other two. Perhaps, it had never been a full stone construction, but a wooden one on top of a stone-built footing that was not as massive as a stone house would require. Another explanation could be that this area was heavily altered in modern times. Corresponding indications are visible in the magnetic results (see below).

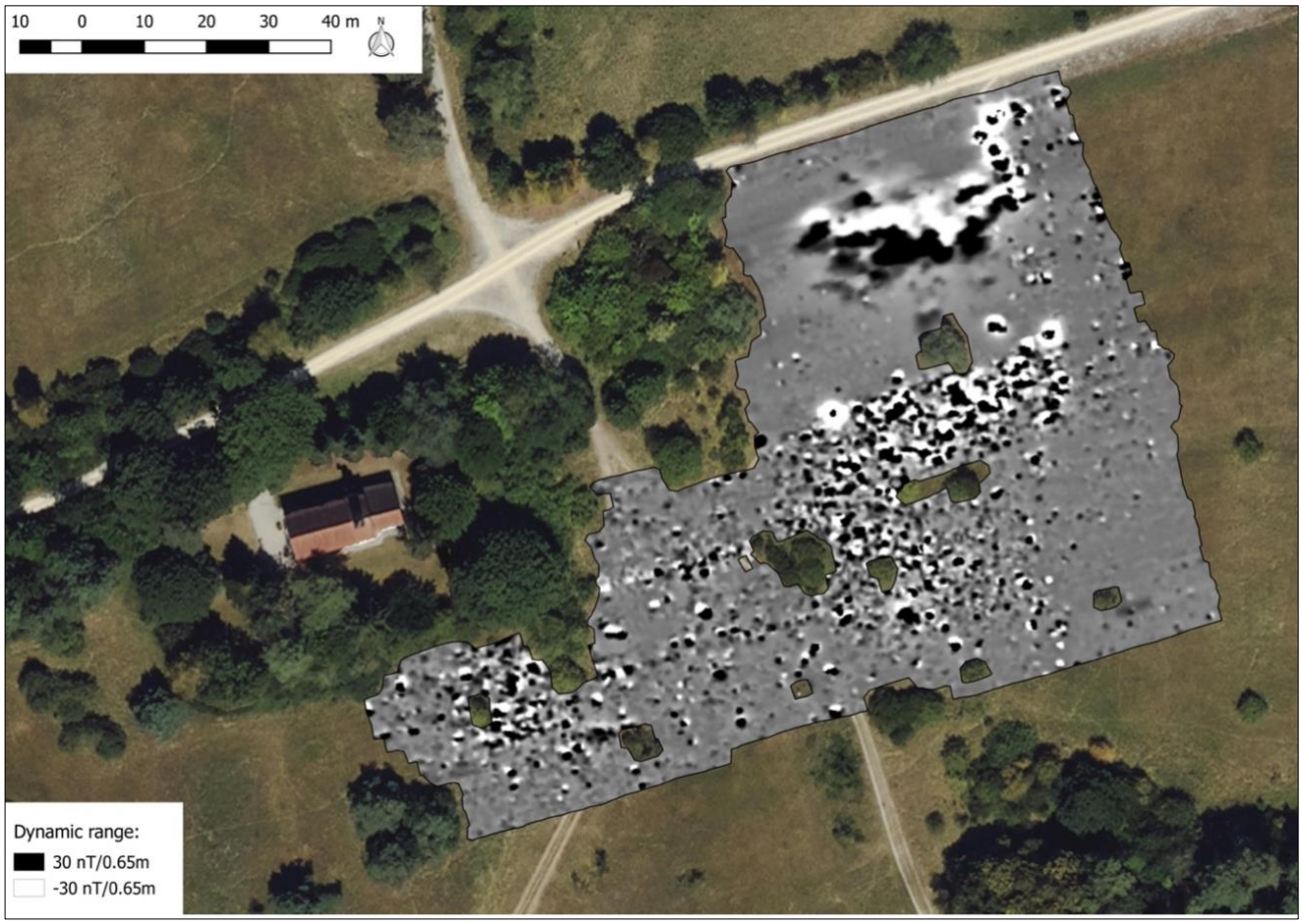

Figure 4: Magnetogram of the farmstead Mallertshofen. Sensys MAGNETO MXPDA Gradiometer with 5 CON650 probes, GPS-Mode, sample interval interpolated to 0.2 x 0.2 m. Project-No. Mal23f.

In the magnetogram (Figure 4) the whole survey area is laced with dipole anomalies caused by modern rubbish. However, the data supports the GPR interpretation, as it appears to be more inhomogeneous in areas where buildings were mapped, especially the westernmost building and the transverse middle one, where the course of the walls is partly identifiable. The lack of dipole anomalies in the northeastern part of the survey area is particularly prominent, and suggests that this region was deeply dredged and refilled with demolition waste in modern times. The occurrence of soil importation was noted during the survey due to a completely different surface material. Furthermore, the elevation model calculated from the GPS-coordinates collected with the magnetic survey data reveals an artificial plateau there (Figure 5).

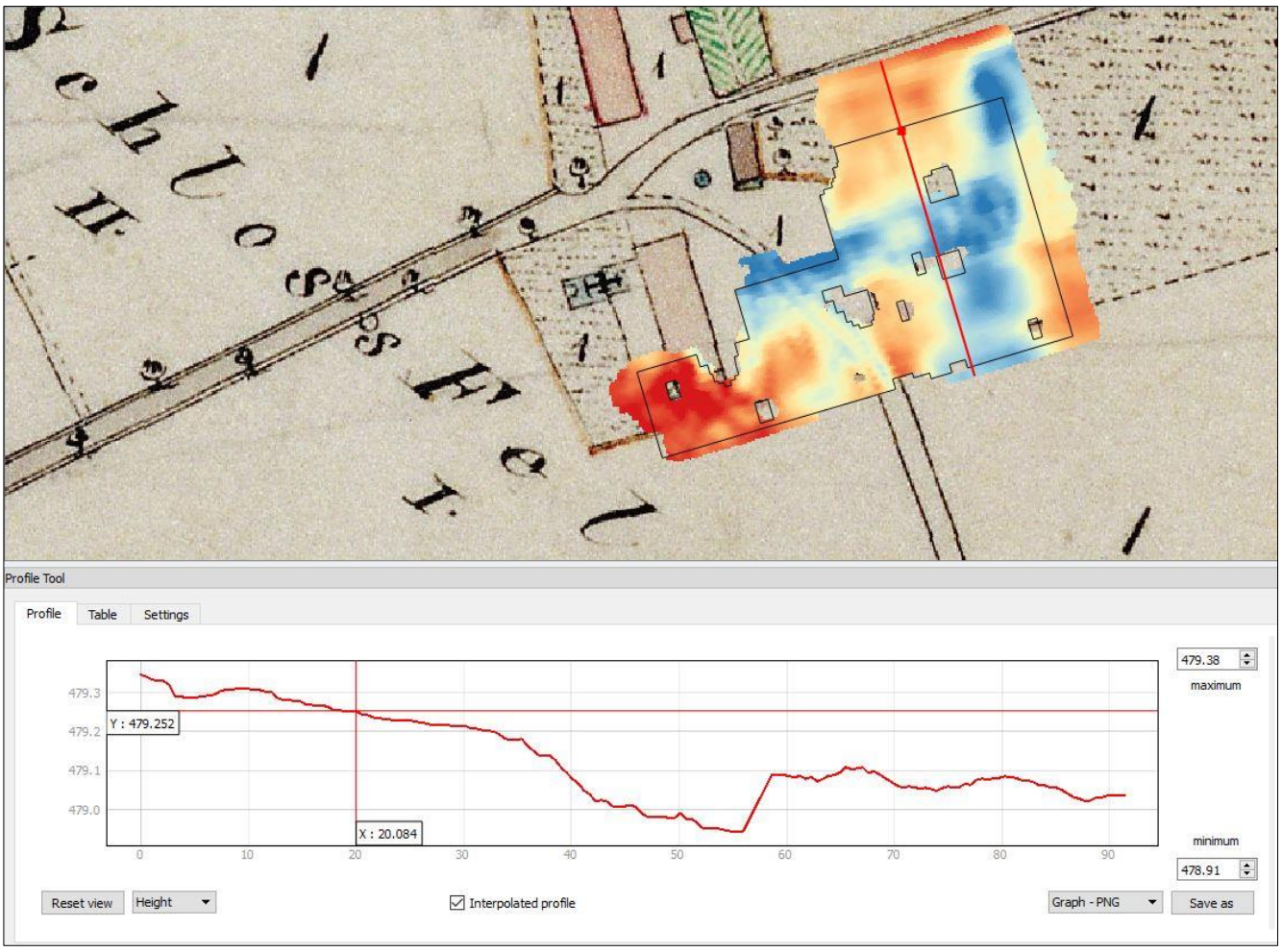

Figure 5: Digital elevation model created from the magnetometer GPS sample coordinates. The red line shows the location of the profile below. The red dot (map) and crosshair (profile) locate the modern artificial plateau mentioned.

Conclusion

Based on the geophysical results, the remains of the deserted farmstead Mallertshofen were precisely located. Furthermore, these results show the state of preservation of the demolished buildings in a non-destructive manner without re-excavating. Based on the GPR depth slices in particular, a detailed plan of the layout of three buildings was drawn and, for the first time, the internal layout was visualised. The three buildings form a U-shaped courtyard layout of the last farmstead in Mallertshofen, as it is documented on the old maps. Another impression of the mid-19th century settlement is visible in a drawing that is preserved in the 'Alte Pinakothek', one of the Munich art museums (Figure 6). All these datasets are now available for a further analysis with regard to heritage protection issues. Additionally, they can be used for a public dissemination of the subsurface remains of this deserted site.

Figure 6: 19th-century painting of Mallertshofen by Philipp Heldersdorf (before 1856). Held by the Alte Pinakothek Munich (© Bayerische Staatsgemäldesammlungen - Alte Pinakothek München, CC-BY-SA 4.0).

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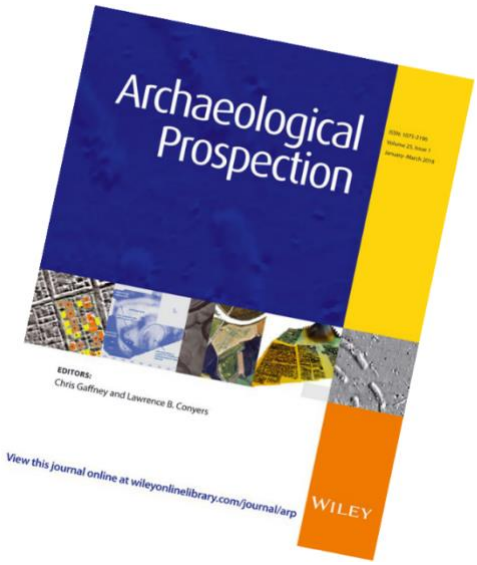

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