ArchPro Carnuntum Project. Large-scale non-invasive archaeological prospection of the Roman town of Carnuntum

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The site of the Roman military camp and civil town of Carnuntum, on the southern bank of the Danube about 40 km southeast of Vienna, constitutes the largest archaeological landscape in Austria. It covers some 650 ha between between the modern-day villages of Petronell-Carnuntum and Bad Deutsch Altenburg. As the capital of the Roman province of Pannonia, Carnuntum was an important town during the first four centuries of the 1st millennium AD.

So far only small parts of this archaeological site and the surrounding landscape have been investigated using traditional archaeological methods. In the 19th century Carnuntum was the "Pompeii at the gates of Vienna" in view of the exceptionally good state of preservation of its ruins, but the situation has changed dramatically. Intensive farming involving deep ploughing, infrastructure development, the construction of new housing estates in the nearby villages and active looting by treasure hunters has increased dangerously irreversible erosion of archaeological layers and destruction of this important cultural heritage site.

The case study presents a long-term interdisciplinary archaeological survey of an entire Roman city. Through the combination of aerial archaeology with high-resolution geophysical subsurface mapping and GIS-based archaeological interpretation and spatial analysis, the archaeological site and hinterland of the ancient town of Carnuntum have been mapped and virtually imaged with blanket coverage and in great detail. The outcome of this integrative prospection approach provides an outstanding wealth of data and new information for future archaeological research.

THE ARCHPRO CARNUNTUM PROJECT

A dedicated project to make use of the great potential of large-scale non-invasive prospection was set up in 2011 by the government of lower Austria, the Central Institute for Geodynamics and Meteorology (ZAMG) and the Ludwig Boltzmann Institute for Archaeological

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Prospection and Virtual Archaeology (LBI ArchPro). The goal was to map the entire landscape surrounding the ancient town of Carnuntum. Within this project, an area covering 10 km² was chosen to be explored with all available non-invasive prospection methods.

While large-scale archaeological excavation and trenching was used in the past century for the investigation and reconstruction of the ancient city layout, modern archaeology increasingly makes use of non-invasive means for the exploration and mapping of the buried subsurface. In particular, aerial archaeology and geophysical archaeological prospection methods have proven to be ideally suited survey methods of great value for the mapping and documentation of Roman city sites, as exemplified by the archaeological prospection of the ancient town of Carnuntum.

AERIAL ARCHAEOLOGY

Following the strategy described here, over the past fifteen years considerable areas have been investigated at Carnuntum, using numerous aerial photographs and a large amount of topographical data. One of the basic problems of aerial archaeology is that the visibility of archaeological sites is dependent on many factors. Most of these cannot be controlled and therefore, only a systematic reconnaissance programme over several years can give a more or less complete overview of the archaeological subsurface. The time-consuming process of interpreting several thousands of aerial photos resulted in a very detailed visualization of the buried town-layout. Yet, several areas remained either void of crop- or soil-marks reflecting buried archaeological structures or only a very few interpretable structures were observed, obstructing archaeological analysis and interpretation.

GEOPHYSICAL PROSPECTION

To overcome this problem, it was necessary to combine aerial archaeological evidence with other prospection methods. High-resolution, near-surface geophysical survey methods have already been tested, developed and applied within the last decade, for the prospection of extensive areas within the archaeological park of Carnuntum.

Novel, motorised measurement devices for rapid, high-resolution magnetometer and GPR prospection were designed and developed over the last years within the LBI ArchPro and were extensively used on the Carnuntum project. Together with the integration and application of automated positioning systems as well as adequate, newly designed data processing and visualisation techniques, highly efficient archaeological survey and prospection systems were made available for the detailed survey of truly vast areas.

The motorised GPR-survey using a 16-channel MALÅ Imaging Radar Array with only 0.08 m measurement spacing, both in the direction of the GPR profiles as well as perpendicular to it, has enabled us to detect in several buildings structures that could be interpreted as hypocaust pillars. In case of the area of the civil town of Carnuntum, it has been possible to extract detailed depth-dependent information by moving through the three-dimensional data volumes from top to bottom, and to map the remains of individual structures, such as walls, drains, pavements, corridors, foundations, column bases and other internal architectural details. This novel approach even permitted the identification of staircases and heating systems within some of the buildings.

Fig. 1. Motorised 8-channel fluxgate magnetometer system used for the magnetic survey of Carnuntum

Fig. 2. MALÅ MIRA 16-channel GPR system in adapted version for the prospection of the Roman town of Carnuntum

Fig. 3. Three-dimensional view of the magnetic map s of the survey area from the west

The magnetic prospection conducted with a sample spacing of 25 cm cross-line and 20 cm in-line resulted in relevant and complementary information on magnetised structures, such as brick structures, hearths, filled pits, ditches and water-channels. In case of Roman remains and city sites, the combination of GPR and magnetic prospection proved to be of particular importance and value. Our integrative strategy for the survey of Roman city sites systematically combined large-scale aerial archaeology and ground-based high-resolution geophysical prospection, followed by joint archaeological interpretation of the digital data within a GIS environment.

CONCLUSIONS

The combination of advanced methods of airborne remote sensing and geophysical prospection permits the efficient and highly accurate detection, investigation and documentation of archaeological sites above and below ground, providing a wide range of spatial data in unprecedented quantity and quality for an efficient self-contained archaeological research approach, resulting in valuable and reliable new information on important cultural heritage sites. Until recently archaeology used the great potential offered by these modern prospection techniques only to a limited extent.

The archaeological maps and plans resulting from the archaeological methodology presented here, show individual buildings, streets, graveyards, temporary military camps and Roman infrastructure and thereby allow the virtual reconstruction of the city layout and the development of the ancient land- and townscapes in space and time, providing scholars, planning authorities and the public alike withnew detailed and valuable information on the ancient city of Carnuntum.