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Integrated GPR and laser scanning of Piazza Sant'Anastasia, Rome

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Introduction

The application of non-invasive techniques for archaeological research, in particular geophysical prospection and 3D-modelling, have been at the forefront of the research conducted by the British School at Rome (BSR), in particular at the sites of Portus and San Giovanni in Laterano. The techniques have been used for the investigation of both large-scale sites as well as documenting complex buildings, in many cases as a precursor to archaeological excavations. However, when sites are embedded in a complex urban landscape, non-intrusive methods offer the only possibility for a detailed investigation of the subsurface. The survey at Piazza Sant' Anastasia falls within this context.

The church of Sant'Anastasia and the adjoining piazza occupy an area of great importance in the topography of ancient Rome. Seated between the Palatine and the Aventine hills, the area is adjacent to the Circus Maximus and very close to the Forum Boarium (for the ancient topographical context of the study area, see among others Coarelli 2008).

The aim of the survey was to locate archaeological features underneath the piazza with Ground-Penetrating Radar (GPR) and to record the current layout of the area, dominated by the church façade, with high-resolution 3D laser scanning. The ultimate objective was to combine the data in a shared 3D environment capable of representing the diachronic evolution of the site.

Historical and archaeological context

The basilica of Sant'Anastasia is one of the oldest churches in Rome, its construction dated to the time of Pope Damasus in the 4th century AD. The structure was rebuilt and renovated numerous times up until the major Baroque intervention of 1722 (Krautheimer 1937: 54-60). Prior the restoration of the façade in the 17th century the basilica was accessed by a staircase, which is visible in 16th century illustrations (Krautheimer 1937: 43).

The Paleochristian church was built over a group of Roman structures, dated from the 1st to the 4th century AD, which were used as foundations of the new building (Whitehead 1927: 405-410). Below the nave a series of Roman tabernae, rectangular in shape, opened onto a road which runs underneath the right-hand aisle, parallel to the modern via dei Cerchi. Traces of an upper floor, likely belonging to an insula, are still visible incorporated into the wall of the church towards the Palatine hill (Figure 1). Excavations beneath the church were conducted between 1857 and 1863 (Detlefsen 1859; Bergau 1863) and the structures were later studied by Whitehead (1927) and subsequently by Krautheimer (1937). More recently scholarship in this immediate area of the Valle Murcia has focused on the relation to the primordial legends of Rome, as some scholars place the Lupercal cave in the surrounding area of Sant'Anastasia (Carandini 2008; Vukovic 2018).

Challenges and strategy

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The location and intense urbanisation of the surrounding area of Piazza Sant'Anastasia have meant that no previous excavations have taken place. Clues as to the continuation of structures beneath the piazza are provided by the excavations beneath the church, however, to test this hypothesis a geophysical survey of the piazza was undertaken.

Among the geophysical instruments commonly applied in archaeology, the context and the aim of the project suggested GPR as the most suitable technique. The urban nature of the site, paving, modern services and depth excluded the application of magnetometry. Electrical Resistivity Tomography (ERT), whilst suitable for urban environments, was excluded due to practical issues (primarily the paving of the piazza and access to the church from the piazza).

Together with the geophysical prospection, a 3D laser scan of the piazza and the church façade, was undertaken. The aim of the laser scanning was to collect a 3D point cloud, allowing in the first instance the creation of a Digital Terrain Model (DTM) to topographically correct the GPR data. The piazza lies at the foot of the Palatine Hill with a slope from east to west with a variance up to 3m, therefore topographical correction was required of the GPR data to allow a correct interpretation.

Finally, in order to house all the data within a shared 3D environment, including the geophysical and laser scan data and digitised plans of the structures underneath the church, a topographical survey was carried out with a Global Position System (GPS).

Survey method

The geophysical prospection was carried out using a GSSI SIR-3000 coupled with 200MHz and 400MHz antennas. The complementary use of two antennas at different frequencies was intended to maximise the spatial resolution at different penetration depths (Conyers 2013). The GPR survey was conducted in the accessible areas of the piazza (1108m2) along parallel NE-SW traverses at a regular distance of 0.5m for the 200MHz antenna and 0.25m for the 400MHz antenna.

The 3D laser scanning was undertaken using a Leica RTC 360 scanner with fixed targets, the position of which were subsequently recorded with a GPS (Leica GS18). The GPS was also used for establishing the geophysics grid.

The data was processed in dedicated software (ESRI ArcMap for the GPS data, GPR-Slice for the GPS data and Leica Cyclone for the laser scanner) and then subsequently combined for additional post- processing. The DTM generated from the laser scanner point cloud was exported as an ASCII file (.xyz) and added into the GPR software for the topographical correction of the GPR data. The processed GPR data were subsequently exported as an ASCII file (.xyzirgb) and combined with the georeferenced point cloud and the digitize plan from Whitehead (1927: Plate 11) in a shared 3D environment. A future step, in collaboration with the Parco Archeologico del Colosseo, will be to integrate the new 3D model and geophysics data with a 3D model of the excavated standing structures beneath the church.

Results

Beyond the shallowest level, where the modern services underneath the piazza were recorded, the GPR located a series of linear features of potential archaeological interest. A comparison of the GPR time-slices with the cartographic sources (including the modern Carta Tecnica Regionale, the 'Forma Urbis' of Lanciani and the plan of the Roman tabernae) in the Geographic Information System (GIS) environment allow for several archaeological interpretations to be made of the data.

At a depth of approximately 0.9m below the pavement of the piazza an elongated NE-SW feature, parallel to the church façade, was recorded up to a depth of -1.6m. The feature likely locates the remaining footings of the staircase which originally gave access to the church before its Baroque restoration.

The clearest results regarding the Roman structures were collected at a greater depth, between -1.6m and -3.5m with the 200MHz antenna. A series of high amplitude reflectors indicate the continuation of the tabernae westward, beyond the façade of the church (Figure 2). Two large parallel features are oriented NW-SE, in accordance with the Roman topographic organization of the area. Of these, the southern feature (26m in length) is aligned with the road onto which the tabernae opened, whilst the northern feature (35m in length) is aligned with the wall that divided the tabernae from the rear rooms. The two linear anomalies delimit a rectangular space whose width, 14.5m, corresponds with the length of the rooms in the plan of Whitehead. Some internal divisions of the space are also indicated by other reflectors.

An analysis of the geophysical data indicates that the structures beneath the piazza follow the same plan of those under the church. The area occupied by the rear rooms of the tabernae probably lie just beyond the survey grid to the north, where benches and potted plants prevented accessibility.

The integration of all the data types provides a virtual three-dimensional representation of the historical evolution of the site, including the Roman buildings, the church with traces of its initial building phase and the present appearance of the area (Figure 3).

Conclusions

The centre of Rome is characterised by a deep stratigraphy of archaeological sequences, whose traces are often hidden by the modern urban landscape. The survey at Sant'Anastasia, through the virtual combination of the excavated structures with the standing building and the buried remains, offers an example of the advantages derived from the application of non-invasive techniques in an urban context. In such a complex situation, where invasive excavation is unfeasible, non-intrusive methodologies offer a clear and advantageous opportunity to generate new important data.

Acknowledgements

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Figures



Figure 1. Lefthand side of the church of Sant'Anastasia, towards the Palatine hill (BSR Photographic Archive, John Henry Parker Collection, jhp-1922).

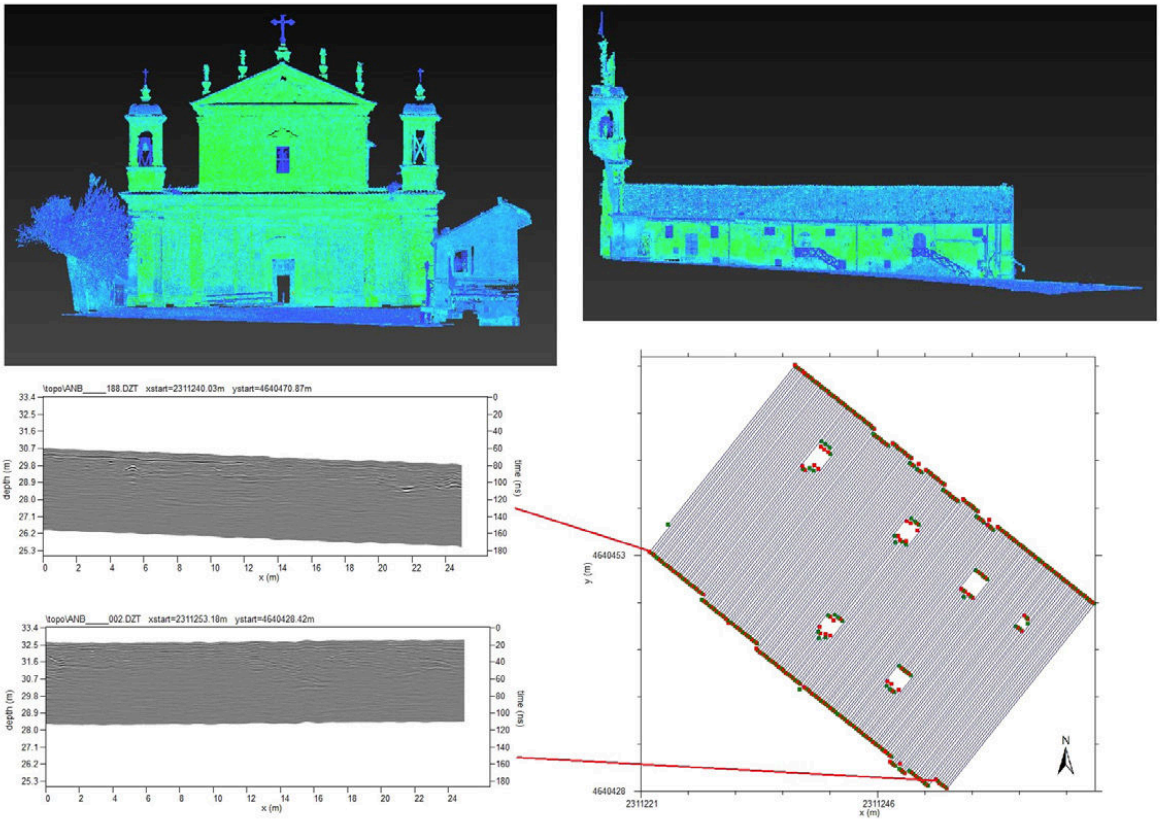


Figure 2. Composite image showing the slope of the piazza and the topographical correction applied to the GPR data.

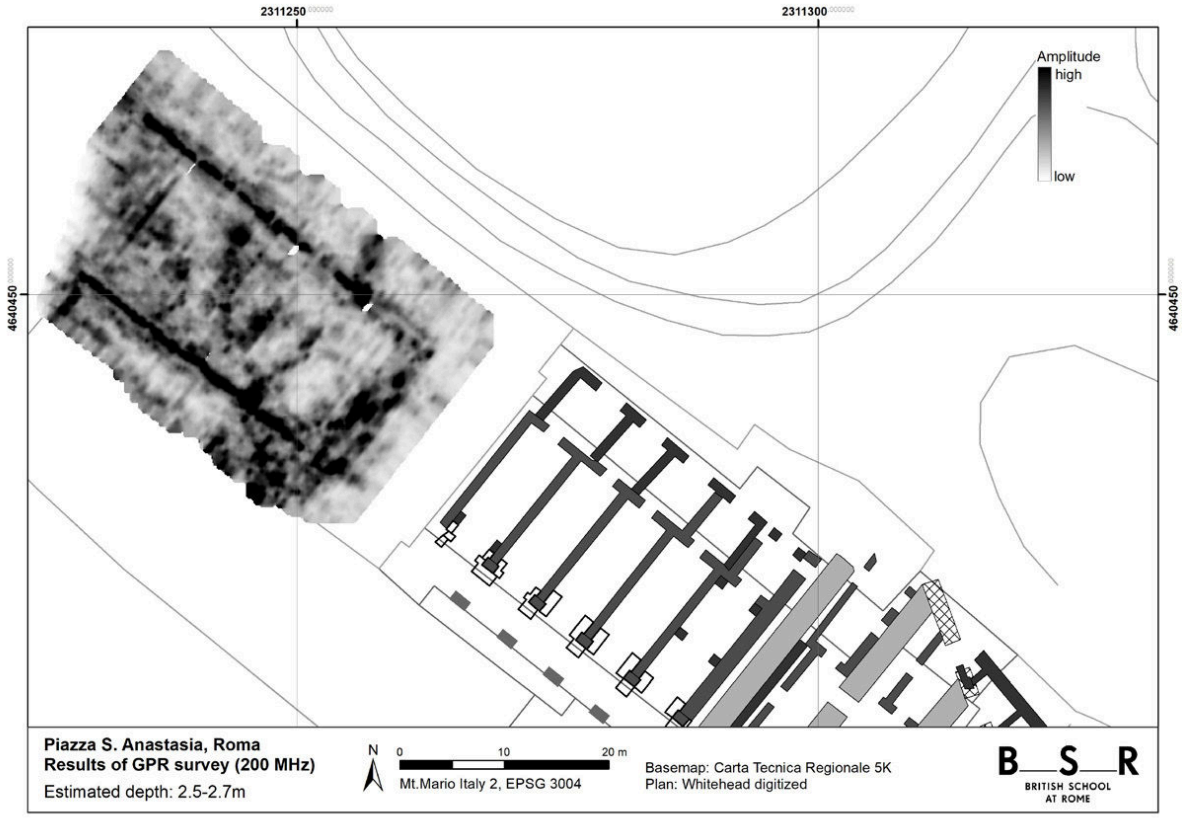


Figure 3. Results of the 200MHz GPR prospection between 2.5m and 2.7m below ground level.

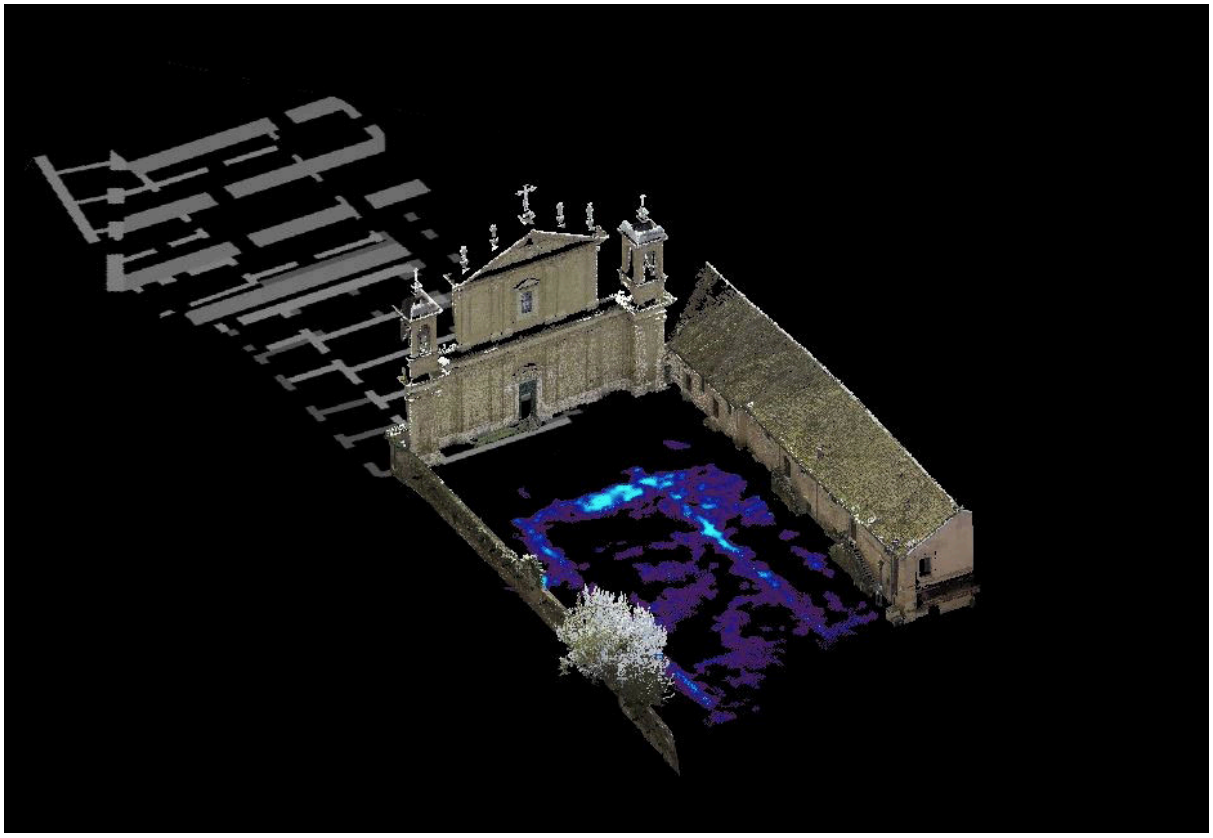


Figure 4. 3D representation of the full dataset collected by the project.

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