School at Rome with the kind assistance of Stefania Peterlini. Survey of the site and essential technical support was provided by Franco Taccogna (Gravina), and restoration of the metal objects was conducted by Tonia Petrafesa (Gravina). The excavators are grateful to numerous organizations and individuals for their support of the project, and especially to: the land owner of Vagnari, Dott. Mario De Gemmis Pellicciari; the British School at Rome; the Soprintendenza per i Beni Archeologici della Puglia, in particular the Superintendent, Dott. Luigi LaRocca, as well as Dott.ssa Francesca Radina and Dott.ssa Maria Rosaria Depalo from the Centro Operativo per l'Archeologia in Bari; and the Fondazione Ettore Pomarici Santomasi of Gravina. We also gratefully acknowledge the participation of students and volunteers from the United Kingdom, North America and Italy.

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GEOPHYSICS PROJECTS

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The archaeological geophysics programme of the British School at Rome in collaboration with the University of Southampton (Archaeological Prospection Service of Southampton) continued to conduct surveys across a broad geographical area from south Etruria to Sudan and from Tivoli to Turkey. This year saw continued survey work at Tivoli in collaboration with the British Museum; we are investigating the region of the Pantanello basin which lies in the grounds of Hadrian's Villa. Surveys of the Hellenistic port towns of Çandarlı as well as a brief return to Kane, both in western Turkey, were conducted as part of the wider ERC-funded Portus Limen — Rome's Mediterranean Ports Project (http://portuslimen.eu), directed by Professor Simon Keay (above). A short season of gradiometry at Lucus Feroniae (Hay, 2015: 296–8) was successful in its aim to identify the possible southern extent of the settlement. We will complete this work in 2016 and report in the next *PBSR*. We are indebted to the De Haan Charitable Trust for supporting this important project and our geophysics intern, Eleanor Maw.

DANGEIL, SUDAN

The archaeological investigation of Dangeil is co-directed by Julie Anderson, Department of Ancient Egypt and Sudan, The British Museum, and Mahmoud Suliman and Rihab Khidir of the National Corporation for Antiquities and Museums, Sudan, with support from the Qatar-Sudan Archaeological Project (QSAP).

The project aims to re-evaluate the history and significance of the settlement of Dangeil, its cemeteries and its inhabitants. The contribution of the BSR–APSS

collaboration has been to provide a comprehensive and detailed geophysical survey of Dangeil's sacred precinct that encloses an area around the partially excavated Amun temple. Our survey work began in 2014 (Berry, 2014; Anderson *et al.*, 2015), when we trialled two different geophysical techniques: gradiometry and ground-penetrating radar (GPR), and continued in 2015 (Hay, 2016) using just GPR.

Dangeil lies a short distance from the banks of the Nile, 350 km north of Khartoum. Like its famous neighbour, Meroe, Dangeil was a royal city during the Kushite Period (eighth century BC to fourth century AD). The name 'Dangeil' means 'broken red brick' and the ground is littered with the vestiges of bricks that once made up the buildings associated with the rectangular sacred precinct. The temenos wall encloses an area of 150 × 125 m and it was this area, once cleared of the surface rubble, that formed the focus for the geophysical survey. The last phase of the Amun temple can be dated to the first century AD. It was destroyed by fire, perhaps intentionally. The temple has been partially excavated and well studied (Anderson and Ahmed, 2008; Anderson and Ahmed, 2010; Anderson *et al.*, 2015), but little was known about the nature of the sacred precinct.

Although the initial survey strategy was to use GPR over the site, given the proliferation of red brick in the construction of the temple it was thought that a gradiometry survey could be a more efficient method for detecting walls of this type. A trial area immediately to the south of the Amun temple was investigated with this technique and the results revealed that the strong response of the high quantities of red brick at a shallow depth was potentially obscuring the identification of more deeply buried archaeological remains. The same area was explored with GPR to investigate and compare these initial findings, and the results demonstrated just how much information about the archaeological remains was being eclipsed by the disturbance near the surface (Fig. 1). The eastern course of the temenos wall is totally obscured by surface material in the gradiometry results whereas the GPR results not only map the position of the enclosure but indicate that its construction is composed of red-brick outer faces with a mud-brick core. The structure within the enclosure, to the west of the wall, is also more clearly defined in the GPR results and a series of rooms delineated by mud-brick walls with possible evidence of paving is visible. As a trial, the comparison between data sets has demonstrated the potential of GPR survey in this area.

The use of GPR within the rest of the temenos enclosure (Fig. 2) defined the buried structures. These included a pylon structure to the south of the Amun temple and possibly the footprint of a small temple to the north. Unknown prior to this survey was an inner enclosure wall, which lies at a gently oblique alignment to the main precinct wall and is visible, though fragmented, on all sides of the complex. Initially, it was considered to be a precursor to the outer precinct wall and perhaps contemporary with the earlier structures identified in the excavations. However, the possible evidence of small walls between the two enclosure boundaries at various points along its course, demonstrated by our survey, suggests that the outer and inner precinct walls coexisted for a period of time.

Excavations at Dangeil exposed the standing remains of the Amun temple, with carved reliefs on the columns and painted walls. A fundamental objective of the project is now the preservation of the architecture by sustainable means (Anderson and Ahmed, 2011). By using locally sourced materials and training local inhabitants in the basic skills of conservation, intermediate measures were taken to protect the decorated surfaces. A

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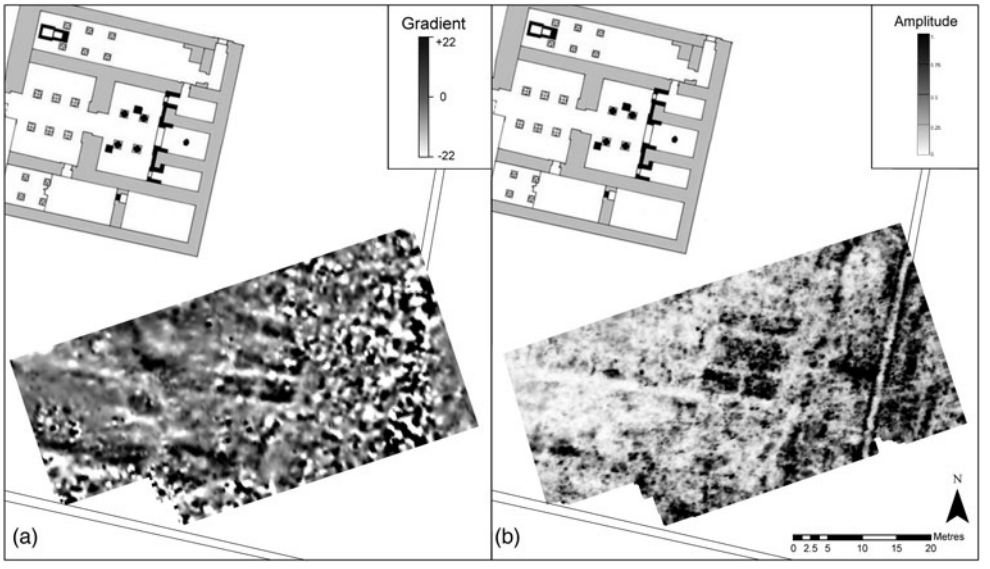

Fig. 1. Dangeil, Sudan. Geophysics surveys within the temenos wall south of the temple of Amun. Comparison between (a) gradiometer survey and (b) GPR survey. *(Plan of temple: J. Dobrowolski.)*

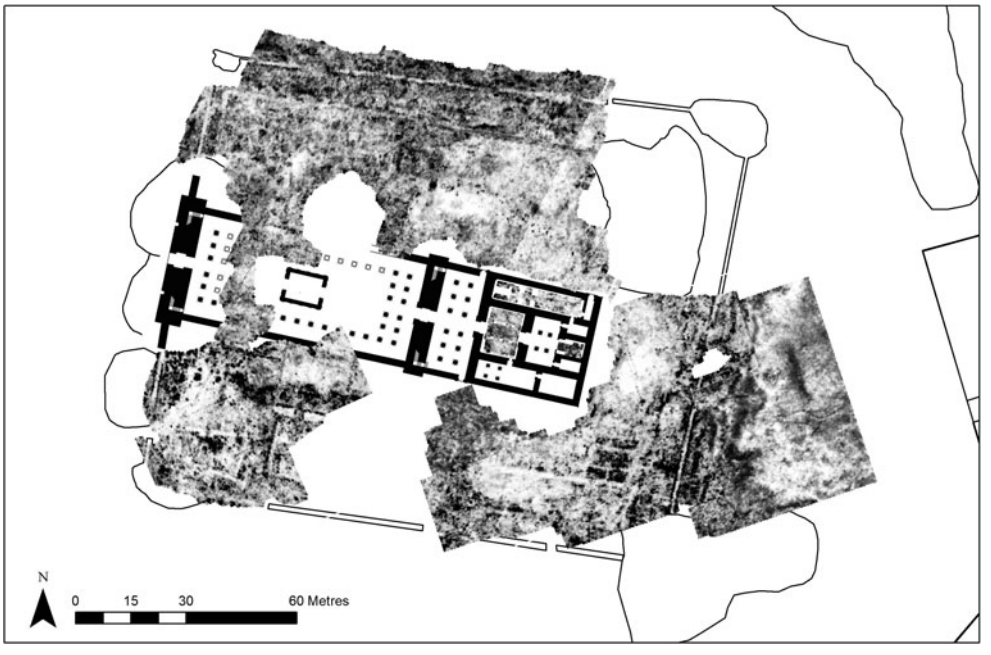

Fig. 2. Dangeil, Sudan. GPR survey results within the sacred precinct showing the main architectural features. *(Plan of temple: J. Dobrowolski.)*

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permanent, protective roofed structure is being designed. The project aims to promote an understanding of the site and its cultural importance within the local community and ultimately create an archaeological park and museum for visitors from further afield.

The geophysical survey has played an important role in aiding the process of conservation and planning the strategy of heritage management of the site. The choice of GPR as a survey method to map and describe the buried remains has enabled a greater understanding of the sacred precinct as a whole and of the nature of the buried structures. The benefits of the survey for the overall project are twofold. First, should there be further excavations of the temple and possibly the surrounding buildings, the GPR survey results can be used reliably to predict the findings and the depth of preservation of the structural remains. Measures, therefore, can be put in place to manage the immediate conservation and protection of the remains. Second, in the absence of further excavations the GPR results have provided a three-dimensional map of the buried structures and revealed the extent and form of the surrounding monuments. The resulting new plan of Dangeil is far richer, and because the sacred precinct is one the best preserved in Sudan, its architectural layout and significance represent a major advance in knowledge.

In addition to the archaeological park, an on-site museum is planned in Dangeil. In order to identify an area where archaeological remains would not be at risk of damage by the construction of such a building we surveyed two areas outside the temenos enclosure wall, on the fringes of the site. The results from both locations indicated an absence of archaeological structures and have therefore contributed to the choice of the new museum site.

Overall, the non-destructive method of geophysical survey at Dangeil will prove formative in both shaping and influencing any subsequent archaeological excavation and has aided heritage management strategies in line with the specific aims of the current British Museum–National Corporation for Antiquities and Museums project. As with past surveys in collaboration with the Superintendency of Rome at the Domus Aurea and on-site with the Herculaneum Conservation Project, geophysics has proved that it can play a fundamental role in conservation strategies of archaeological sites — a key research theme at the British School at Rome.

Further details and a full summary of all of the work, both past and present, conducted by the British School at Rome and APSS, can be found on the online database of *Fasti Online* (www.fastionline.org), as well as on the archaeology research pages of the British School at Rome website (www.bsr.ac.uk/research/Archaeology).

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