

**Geophysical GPR Survey
Al Bidda, Doha
Qatar**

**UTM: 39R 552600 2797500
(Lat/Long: 25o17'35", 51o31'21")**

**ASE Project No: 7235
ASE Report No: 2015090**



By Ed Blinkhorn

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Non-technical summary

Archaeology South-East was commissioned by the Origins of Doha project based at University College London Qatar (UCLQ) to undertake a geophysical ground penetrating radar (GPR) survey on land south of the Ministry of the Interior, Al Bidda, Doha, Qatar.

Rectilinear anomalies of various sizes suggestive of urban archaeological deposits were detected across the surveyed area. However, the alignments of these anomalies do not match digitised aerial photograph GIS interpretations of Al Bidda from the 1950s which demonstrate a broad cardinal orientation. Significantly, the anomalies are approximately oriented to the Qibla. It is suggested, therefore, that an earlier phase of construction than that represented in aerial photography is denoted by the GPR anomalies.

The configuration of the anomalies suggests that a mixture of discrete buildings, compounds and possibly alleys is represented, however, the level of disturbance at the site precludes confident extrapolation of these.

A significant level of ground disturbance was noted throughout the survey. Where this disturbance is encountered in the near surface there is potential that deeper targets are obscured. Because of this disturbance it is difficult to determine the extent of survival of the archaeological deposits. Nevertheless, archaeological deposits are suggested to exist to a depth of at least one metre.

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1.0 INTRODUCTION

1.1 Site Background

1.1.1 Archaeology South-East (ASE) a division of the Centre for Applied Archaeology (CAA), Institute of Archaeology (IoA), University College London (UCL) was commissioned by the Origins of Doha project based at University College London Qatar (UCLQ) to undertake a geophysical ground penetrating radar (GPR) survey at Al Bidda, Doha, Qatar, henceforth referred to as 'the site' (UTM 39R 552600 2797500; Figure 1). The surveyed area comprised two areas, one 0.81ha plot to the south of the Ministry of the Interior and one 0.18ha plot to the south-east (Figure 2).

1.2 Geology and Topography

1.2.1 The solid geology across most of Doha consists of weathered unconformity on the top of the Eocene Dammam formation, comprising dolomitic limestone (Al-Saad 2005; Ross 2010). A modelling study of groundwater at West Bay (Institute of Hydrology 1989) to the north of site suggests the potential presence of superficial 'coastal deposits', most likely sands.

1.2.2 Geographical Information System (GIS) layers supplied by UCLQ suggest the presence of numerous buildings forming the core of Al Bidda. Demolition of these structures and recent landscaping of the site, shown on Google Earth imagery of the site from at least 10th July 2003 and before 21st August 2004 (Figure 3), could suggest that depths of made ground exist.

1.2.3 The site comprises managed lawns and date palms to the south and south-east of the Ministry of the Interior. The site slopes gently down to the north across the majority of the area to the south of the Ministry, sharply dipping at the northern extent to the level of a flat car park.

1.3 Aims and Objectives of Geophysical Investigation

1.3.1 The aim of the project was to carry a detailed GPR geophysical survey of the site to assess the potential survival of archaeological deposits.

1.3.2 Project objectives were:

- To establish the presence or absence of buried structural remains in the Al Bidda area
- To establish the extent of any buried heritage in the survey area
- To establish if specific buildings visible on maps and aerial photographs of Al Bidda can be identified. This will include identifying any significant structures such as Al Bidda fort
- To establish the depth of any buried archaeological remains on the site

- To attempt to identify different phases of construction of the town

1.4 Scope of Report

1.4.1 This report details the findings of the survey with a view to contributing to the overall and ongoing assessment of the archaeological potential of the site. The survey was conducted by Ed Blinkhorn (ASE) assisted by Thomas Eley (UCLQ). The geophysical survey was project managed by Neil Griffin (fieldwork) and by Dan Swift (post-excavation).

2.0 SURVEY METHODOLOGY

2.1 GPR Survey Methodology

2.1.1 The fieldwork was undertaken between Thursday 19th and Thursday 26th February 2015. The weather remained hot and sunny throughout the survey.

2.1.2 A Radarteam Cobra Wireless GPR system utilizing an antenna with a central frequency of 500MHz was used to record along traverses with a 0.5 m separation at a sample interval of 0.03 m.

2.2 Geophysical Survey Methods Used

2.2.1 The area covered by the surveys is shown on Figure 2.

2.2.2 The survey was carried out over two areas. Area 1 comprised nine 30 x 30 m grids and Area 2 comprised two 30 x 30 m grids. Grids and traverses were located and marked using fabric tapes and survey nails.

2.3 Applied Geophysical Instrumentation

2.3.1 The GPR survey was carried out using a Radarteam Cobra Wireless GPR cart system using a 500MHz antenna on 50ns range setting. In GPR the relative magnetic permeability of the ground is assumed to be uniform (Milsom and Eriksen 2011). Therefore, variations in the radar signals are considered to be due to changes in the conductivity and the relative electric permittivity. The depth of penetration of a GPR system relies largely on the central frequency of the emitting antenna (Gaffney & Gater 2003). With lower frequencies (longer wavelengths) there is an increased depth of penetration with a corresponding decrease with higher frequencies (shorter wavelengths). However, longer wavelengths will reduce the resolution of the survey meaning only larger objects will be detectable at depth (English Heritage 2008). The resolution of a 500MHz antenna in damp soil would be between 0.05m and 0.135m (Basson 1992) with a velocity of radar energy calculated at 0.12m/nsec and a range setting of 64nsec a theoretical depth of scan is 3.84m. However, the indicative depth of investigation for a 500MHz radar would be approximately 2m.

2.4 Instrumentation Used for Setting out the Survey Grid

2.4.1 English Heritage guidelines (English Heritage 2008) state that no one corner of any given survey grid square should have more than a few centimetres of error. The survey grid for the site was set out by triangulating points using 50m tapes from a west-east baseline. These were surveyed and checked using a Leica Viva Network rtk Global Positioning System (GPS). This data is processed in survey-specific software to provide a sub-centimetre Qatar National Grid position. Each surveyed grid point has a Qatar National Grid position; therefore the geophysical survey can be directly referenced to the Qatar National Grid.

2.5 Data Processing

2.5.1 The radar data collected on site was processed and abstracted using Reflexw software. Processing was undertaken on the data. This involves a series of filters to reduce background noise and surface response, and to enhance data for presentation. The processing consisted of:

- Subtract-mean (dewow)
- Manual y-gain
- Move start time
- Band pass filter

2.6 Survey Limitations

2.6.1 The interface between the radar antenna and the ground surface can give a strong reflection. Therefore near-surface features may be obscured in GPR. Strong reflections which potentially obscured below-ground features were encountered in several areas where palm trees and drain covers stand, where sprinkler heads are embedded in the ground, and irregularly distributed presumed made ground components. In addition, the resolution of a GPR survey decreases with depth due to the conical spread of energy.

2.6.2 As the survey area was under constant management, including substantial daily watering of sections of lawn via a buried network of sprinklers, variable degrees of ground moisture were encountered during the survey. Whilst efforts were made to allow some evaporation/desaturation, comparable levels of ground moisture could not be ensured; a known issue in GPR area surveys (Ernenwein and Kvamme 2008). Problems charging the GPR system and tablet control unit meant that data from two days survey were compromised.

3.0 GPR SURVEY RESULTS (Figures 3-8)

3.0.1 The results should be read in conjunction with the Figures at the end of this report. The reflections recorded during the GPR survey are discussed below.

3.1 Area 1 GPR Interpretations

3.1.1 Few true hyperbolae are identifiable in the data, indicating the absence of services (other than the sprinkler network). For this reason a velocity adaption has not been possible to refine depth estimations.

3.1.2 Both strong and weak complex anomalies are found across the survey area, some of which appear to be associated with convincing linear anomalies discussed below. The distinction between complex and linear anomalies is largely arbitrary in this report, for the purposes of clarity. Where the electrical properties of different deposits are differentially reflected, both linear (the interface) and complex (the sedimentary unit) can be represented in the data. To present these most coherently, linear representation of the interfaces are preferred.

3.1.3 Linear anomalies occur throughout the plot. Numerous narrow linear anomalies which are only apparent in the upper timeslices are probably the buried hoses of the sprinkler system and their installation trenches, and appear in close association with sprinkler heads visible on the surface. These have been omitted from interpretation Figures.

3.1.4 Many further linear anomalies are apparent and while it is difficult to refine the form of these to the extent of identifying discrete units, the fairly uniform orientation of these suggests a contemporaneous phase of deposits.

3.1.5 The most complex concentration of anomalies appears in the western corner of the survey. Here the best contender for a discrete building/compound unit is found, potentially with detail of a small structure to the east.

3.1.6 In the southern corner, an area of disturbance is likely to represent structures visible on the surface, and probably shown on the Google Earth 2003 imagery (Figure 3).

3.1.7 There is a tendency for anomalies to become progressively less definable to the north, down-slope towards the car park. The general lack of convincing anomalies to the north of the survey is difficult to explain beyond post-depositional disturbance during landscaping.

3.1.8 Notably absent is any evidence for the fort identified from aerial photography. GIS rectification suggested that the corner of a fort was located in the centre north of the survey area (Figure 9). Neither evidence for this, nor any other convincing anomalies on different orientations are present in this area. A mosque identified on aerial photography was considered another possible target which might be conspicuous in the surveys but no evidence is identifiable in the data.

3.1.9 There is the possibility that some of the linear anomalies discussed above are the product of landscaping. As the contrast between different materials is likely to be differently reflective, linear anomalies could conceivably be produced with a bulldozer blade.

3.2 Area 2 GPR Interpretations

3.2.1 Area 2 was selected for survey to examine whether ground disturbance and preservation was similar to that in Area 1; by 2003 the earliest Google Earth imagery indicates that Area 2 was already under lawns (Figure 3). Anomalies in Area 2 follow the pattern apparent in Area 1. Comparable diffuse anomalies may represent demolition and/or landscaping deposits, and interference from the sprinkler system is also apparent.

3.2.2 A series of regularly spaced circular complex anomalies might represent either the former location of date palms, or enhanced localised soil moisture from the sprinkler system. Some internal rectilinear structures are discernible in the data, though the form and purpose of these is difficult to interpret.

3.2.3 Weak linear and complex anomalies across the survey are suggestive of structural evidence. They are found on the same qibla-oriented alignment as those in Area 1, suggesting a similar phase of deposits is represented.

3.2.4 Survival of deposits also appears to reflect the pattern in Area 1 where the northern portion of the survey is largely lacking in convincing anomalies, despite there being no comparable sharply dipping topography. Construction of the made ground during levelling works might therefore be suggested as a reason for differential survival.

4.0 Discussion and Conclusions

- 4.1 Anomalies from the GPR survey likely represent four phases of activity:
- Installation of sprinkler system and resulting localised moisture concentrations
 - Widespread admixed material resulting from landscaping
 - Archaeological deposits of near-contemporary origin
 - Archaeological deposits pre-dating 1950s aerial photography
- 4.2 The GPR surveys have indicated a significant amount of ground disturbance. This probably relates to the demolition of the terminal phase of buildings in old Al Bidda, landscaping, and the installation of a sprinkler system across the lawns.
- 4.3 Due to the history of landscaping on the site it is difficult to understand the extent to which archaeology survives intact. It is likely that foundations or wall-bases exist in places, and these appear to be associated with fragmented spreads of possible demolition or fill deposits. As no clear correlation between GPR results and aerial photograph interpretations can be made at this stage, the degree of truncation of archaeological deposits is difficult to estimate.
- 4.4 The majority of anomalies are found at shallow depth and are clearest in the ~0.4 – 0.6 m range (Figures 4 and 5). A few may exist at ~0.2 m below ground level, and clarity and resolution problems preclude confident analysis below ~1.0 m.
- 4.5 Due to the fragmentary evidence for structures in the surveys it has not been possible to identify different phases of construction at Al Bidda. Assuming that the digitised aerial photography GIS layers are correctly oriented, however, it seems reasonable to assert that qibla-aligned geophysical anomalies in the surveys represent a pre-1950 phase of construction/demolition.
- 4.6 Despite an unclear picture of activity at Al Bidda arising from the GPR survey, it can be considered successful in a number of respects. The likely presence of archaeological remains in the southern half of the surveyed area has been ascertained and it is possible that these represent an earlier phase of activity than anticipated.
- 4.7 There may be value at a later stage of the *Origins of Doha Project* to return to the GPR data. Information from aerial photography referred to in this report relates to data collected in the 1950s. Subsequent satellite imagery of the site may show further different structural elements at Al Bidda which better relate to the interpretations presented here. The geophysical data set should

therefore be considered as a resource open to reinterpretation as new information comes to light. It is possible that further clarity in the results could be achieved by a further close reading of the data.

5.0 Statement of Indemnity

- 5.1 Geophysical survey is the collection of data that relate to subtle variations in the form and nature of soil and which relies on there being a measurable difference between buried archaeological features and the natural geology. Geophysical techniques do not specifically target archaeological features and anomalies noted in the interpretation do not necessarily relate to buried archaeological features. As a result, geophysical survey may not always detect sub-surface archaeological features.

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© Archaeology South-East		GPR survey: Al Bidda, Doha, Qatar	Fig. 1
Project Ref: 7235	2015	Site location	
Report Ref: 2015090	Drawn by: EHB		



© Archaeology South-East		GPR survey: Al Bidda, Doha, Qatar	Fig. 2
Project Ref: 7235	2015	Site plan	
Report Ref: 2015090	Drawn by: EHB		



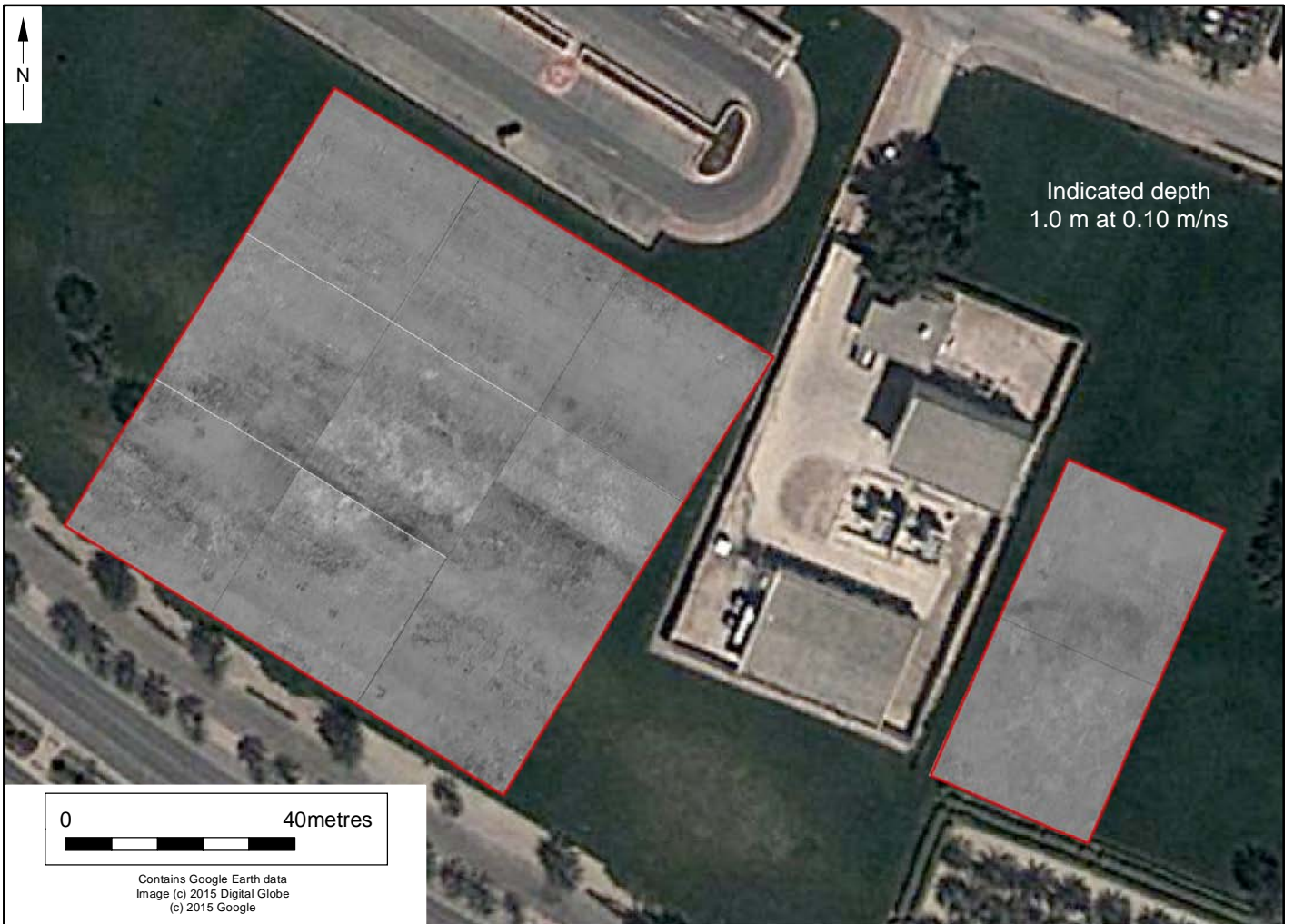
© Archaeology South-East		GPR survey: Al Bidda, Doha, Qatar	Fig. 3
Project Ref: 7235	2015	2003 Google Earth satellite imagery of site	
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Project Ref: 7235	2015	Timeslice plots	
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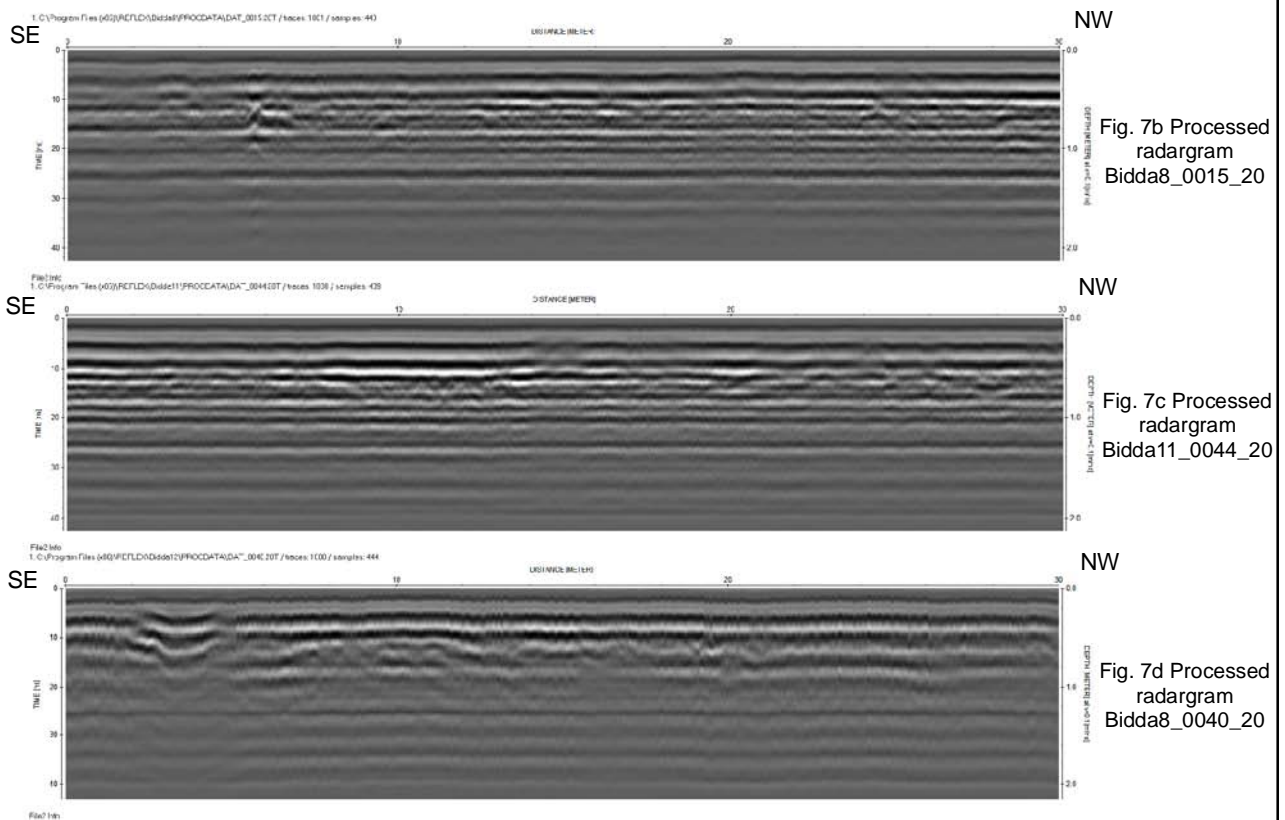
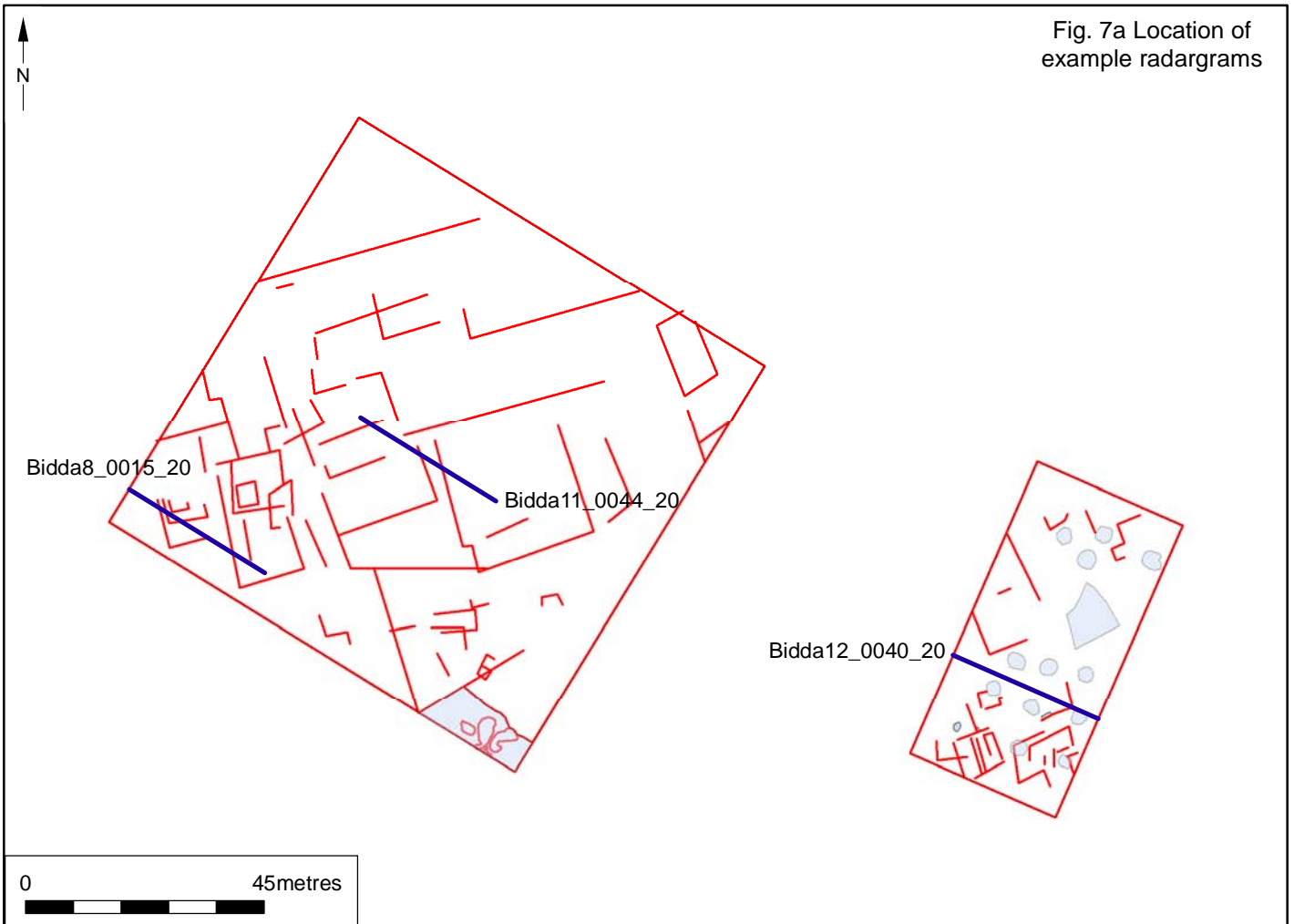


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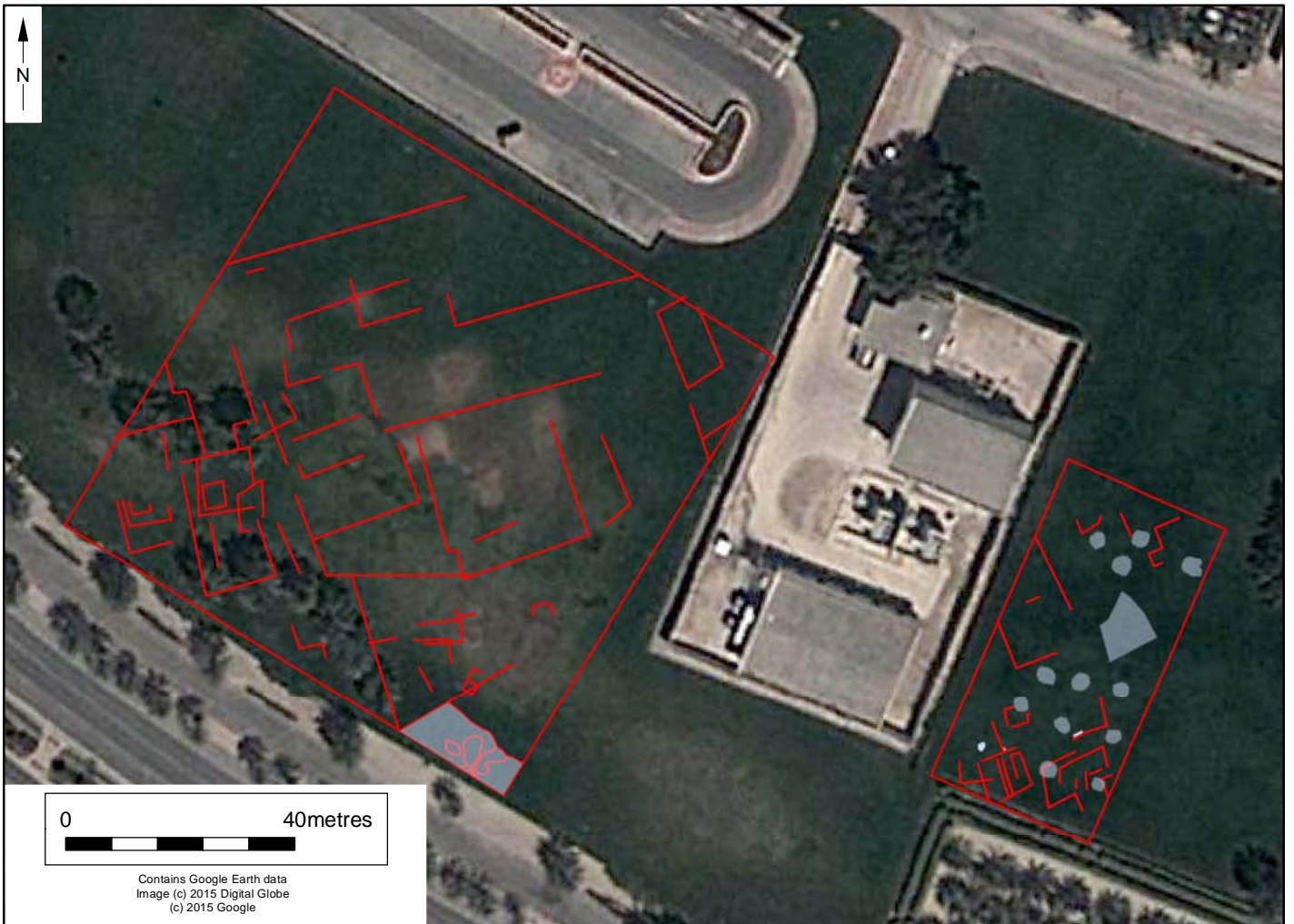
Fig. 7a Location of example radargrams



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Project Ref:	7235	2015	Comparison of GPR results and digitised aerial photography imagery	
Report Ref:	2015090	Drawn by: EHB		

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