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QUEEN CAMEL, SOMERSET
REPORT ON GEOPHYSICAL SURVEY, NOVEMBER 2008

Andrew Payne

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SUMMARY

A geophysical survey was conducted over the location of a segment of tessellated pavement partially uncovered following metal detector finds in an arable field at Queen Camel, Somerset. Magnetometer and earth resistance surveys were undertaken to help further define the extent and character of the Roman activity, and to inform the on-going management of the site in light of the potential threat from plough damage and un-supervised treasure hunting. The geophysical surveys revealed the presence of a large, aisled hall type Roman building containing the mosaic and apparently set within a more extensive system of angular ditched enclosures.

CONTRIBUTORS

The fieldwork was conducted by Neil Linford, Louise Martin and Andrew Payne. Data-processing and report preparation was undertaken by Andrew Payne with the assistance of Paul Linford and Neil Linford.

ACKNOWLEDGEMENTS

The author wishes to thank the land owner, Andrew Case, who granted permission for the survey to take place, and Naomi Payne and Bob Croft for arranging access to the site. Anne Laverty and Mike Pittard are thanked for contributing useful background information on the local distribution of metal detecting finds and the results of a small, exploratory excavation of the Roman remains.

ARCHIVE LOCATION

Fort Cumberland.

DATE OF FIELDWORK AND REPORT

The fieldwork was conducted from the 3rd to the 5th November 2008 and the report was completed on 21 August 2009. The cover photograph is a view across the site showing the field conditions at the time of the survey.

CONTACT DETAILS

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INTRODUCTION

During 2007 a concentration of Romano-British coinage, fragments of building stone and tesserae were noted by metal detectorists in an arable field near the village of Queen Camel, Somerset (NGR ST 592245). A subsequent exploratory excavation uncovered part of a mosaic pavement of geometrical design, surviving in good condition at a depth of about 0.2m below the present ground surface indicative of a previously unrecorded Roman villa site. In response to this discovery, and due to the potential risk from plough damage and un-supervised treasure hunting, an initial geophysical survey of the locality of the find-spot was requested by Bob Croft (Somerset County Council Historic Environment Service) through Rob Iles (IAM English Heritage, South West region) to evaluate the extent and character of the archaeological activity associated with the find spot.

The site is located on flat terrain extending south from the valley of the River Cam. The local solid geology consists of Jurassic Lower Lias clay with limestone (Geological Survey of Great Britain 1973) overlain by clayey soils of the Oxpasture association (Soil Survey of England and Wales 1983). Ground conditions at the time of the survey consisted of an uneven ploughed surface covered by the stubble from a harvested maize crop. Weather conditions were cloudy and overcast, but largely dry throughout the survey, although considerable surface water was present on the ground from a preceding period of wet weather (front cover image).

METHOD

A grid consisting of twelve 30m by 30m squares was set out using a Trimble 4800 series survey grade differential global positioning system (GPS) to cover the area of interest surrounding the find spot (Figure 1).

Magnetometer survey

Magnetometer survey was carried out using Bartington Grad601-2 dual sensor fluxgate gradiometers over an area of 1.44 hectares shown on Figure 1. Readings were recorded at intervals of 0.25m along successive north-south traverses spaced 1.0m apart using the 100 nanotesla per metre (nT/m) instrument range setting. Processing of the data involved initial truncation of the recorded data-range to remove extreme readings (values outside the range of +/-50 nT/m caused by ferrous disturbance from the fences and buildings adjacent to the survey area) and subsequent setting of each traverse to a zero mean, to remove directional sensitivity and instrument drift. A linear greyscale plot of the resulting data is displayed superimposed over the Ordnance Survey (OS) base map on Figure 2. Additional representations of the data as a linear greyscale plot and an X-Y traceplot are presented on Figure 4.

Earth resistance survey

Resistance measurements were initially recorded with a Geoscan RM15 resistance meter, MPX15 multiplexer and an adjustable PA20 electrode frame in the twin electrode configuration, over a 60m by 60m block to encompass the location of the building based on the magnetic data. Readings were collected with a mobile electrode separation of both

0.5m and 1.0m, taking readings at 1.0m along each traverse producing two data-sets responding to different depths of current penetration. The sample intervals for these were 1.0m x 0.5m and 1.0m x 1.0m for the 0.5m and 1.0m electrode separations respectively. All data has been 'despiked' using a 1.0m radius threshold median filter to remove isolated high readings caused by poor electrical contact (Scollar *et al.* 1990). Each traverse of the 0.5m mobile probe separation data was additionally set to a zero mean to correct for an offset in background resistance between alternate lines of data collected with separate electrode pairs.

Unfortunately, equipment failure curtailed the use of the twin electrode system and a further two 30m squares were surveyed with a Geoscan MSP40 wheeled square probe array (Figure 1; Walker *et al.* 2005; Walker and Linford 2006). Two electrode orientations of the square array (alpha and beta data-sets with a 0.75m electrode separation) were collected simultaneously using a Geoscan RM15 resistance meter, multiplexer and the timed trigger mode of operation at 0.5m sample intervals along traverses separated by 1.0m. The MSP40 system did suffer from more frequent poor probe contact and the resulting data was considerably noisier than the twin electrode data. Data processing involved combining the alpha and beta electrode orientations followed by the application of a 1.0m radius 'despiking' median thresholding filter (Scollar *et al.* 1990, 190), to reduce the effect of the poor contact readings. An attempt was made to combine the twin electrode and MSP40 data-sets, although the rather noisier nature of the MSP40 survey can be seen (Figures 3 and 5).

Figure 3 displays a greyscale plot of the combined earth resistance data superimposed over the Ordnance Survey (OS) base-map. The same data is presented as greyscale and traceplots at a larger scale in Figure 5.

RESULTS

Graphical summaries of the anomalies discussed in the following text, superimposed on the base Ordnance Survey map data, are provided in Figures 6 and 7.

Magnetometer survey

The magnetometer survey has revealed the outline of a single building of rectangular plan, visible as negative anomalies [M1on Figure 6], presumably from limestone walling. A number of stronger localised magnetic responses within the building may be indicative of fired structures such as ovens, furnaces or hearths. The long axis of the building is aligned roughly east-west and it is set within a system of adjacent ditch-type anomalies [M2-M6], representing a series of enclosures together with access routes or drove-ways. The survey has also recorded magnetic disturbance from the modern sports pavilion buildings [M7], directly to the east and the course of a service pipe to this building from the road [M8].

Earth resistance survey

Earth resistance survey targeted over the location of the Roman building suggested this is an aisled hall, with two parallel rows of footings for the timber roof support framework visible as localised high resistance responses (Figure 7; [R1]). Also visible is an area of high resistance at the eastern end of the building [R2], that may represent a paved area or extant hypocaust and a series of internal room partitions near the western end. The overall dimensions of the building are estimated at 35m by 14m and the reported location of the excavated mosaic appears to lie towards the western end of the structure. Although the remains of only one building are fully described in the current survey area, additional high resistance anomalies [R3 and R4] may represent further masonry structures orientated at right angles to the aisled hall, continuing into the pasture fields to the south. The ditches of the associated enclosures also appear to run into the pasture fields, again suggesting the likely extension of the Romano-British activity to the south. The pasture fields are partly covered by ridge and furrow, which is likely to have protected any earlier archaeological activity, and some remnants may even extend over the aisled building [R5], perhaps affording better protection to the remains in an area of modern cultivation.

Parallel to the north wall of the main aisled building a series of 5 closely spaced, weak linear high resistance anomalies [R6] are found. These anomalies also coincide with a series of ditched boundaries detected by the magnetometer survey and may be associated with contemporary viniculture or other agricultural activity (B. Cunliffe, *pers. comm.*).

Areas of increased background resistance [R7] occur in the north-west and north-east corners of the earth resistance coverage which are probably geological in origin, but more extended survey would be required to confirm this. The service pipe running to the sports pavilion detected by the magnetometer survey is also apparent in the resistance data as a linear high resistance anomaly running on a similar south-west to north-east alignment.

CONCLUSION

The geophysical investigation of the mosaic find succeeded in providing a context for the discovery, indicating the presence of a substantial rectangular Romano-British building of probable aisled hall type design. The building was detected both as magnetic and resistance anomalies and clearly coincides with the recorded location of the mosaic. The resolution of the internal features within the layout of the building with both techniques, particularly the earth resistance data, suggests that structural preservation may be better than expected for a site in arable cultivation. On the evidence of the wider magnetic data the building appears to be associated with a surrounding system of rectangular enclosures extending beyond the limits of the survey coverage to the north, east and south. Some tentative evidence for the location of two further masonry structures has also been suggested by the earth resistance survey, extending beyond the main villa into pasture fields to the south.

LIST OF ENCLOSED FIGURES

REFERENCES

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Walker, R, Gaffney, C, Gater, J and Wood, E 2005 'Fluxgate Gradiometry and Square Array Resistance Survey at Drumlanrig, Dumfries and Galloway, Scotland'. *Archaeological Prospection*, 12, 131-136.

Walker, R and Linford, P 2006 'Resistance and magnetic surveying with the MSP40 Mobile Sensor Platform at Kelmarsh Hall'. ISAP News: The Newsletter of the International Society for Archaeological Prospection, 9 (October 2006), 3-4.

ANNEX 1: NOTES ON STANDARD PROCEDURES

1) Earth Resistance Survey

Each 30 metre grid square is surveyed by making repeated parallel traverses across it, all aligned parallel to one pair of the grid square's edges, and each separated by a distance of 1 metre from the last; the first and last traverses being 0.5 metres from the nearest parallel grid square edge. Readings are taken along each traverse at 1 metre intervals, the first and last readings being 0.5 metres from the nearest grid square edge.

Unless otherwise stated the measurements are made with a Geoscan RM15 earth resistance meter incorporating a built-in data logger, using the twin electrode configuration with a 0.5 metre mobile electrode separation. As it is usually only relative changes in earth resistance that are of interest in archaeological prospecting, no attempt is made to correct these measurements for the geometry of the twin electrode array to produce an estimate of the true apparent resistivity. Thus, the readings presented in plots will be the actual values of earth resistance recorded by the meter, measured in Ohms (Ω). Where correction to apparent resistivity has been made, for comparison with other electrical prospecting techniques, the results are quoted in the units of apparent resistivity, Ohm-m (Ωm).

Measurements are recorded digitally by the RM15 meter and subsequently transferred to a portable laptop computer for permanent storage and preliminary processing. Additional processing is performed on return to Fort Cumberland using desktop workstations.

2) Magnetometer Survey

Each 30 metre grid square is surveyed by making repeated parallel traverses across it, all parallel to that pair of grid square edges most closely aligned with the direction of magnetic N. Each traverse is separated by a distance of 1 metre from the last; the first and last traverses being 0.5 metre from the nearest parallel grid square edge. Readings are taken along each traverse at 0.25 metre intervals, the first and last readings being 0.125 metre from the nearest grid square edge.

These traverses are walked in so called 'zig-zag' fashion, in which the direction of travel alternates between adjacent traverses to maximise survey speed. Where possible, the magnetometer is always kept facing in the same direction, regardless of the direction of travel, to minimise heading error. However, this may be dependent on the instrument design in use.

Unless otherwise stated the measurements are made with either a Bartington Grad601 or a Geoscan FM36 fluxgate gradiometer which incorporate two vertically aligned fluxgates, one situated either 1.0m or 0.5 metres above the other; the bottom fluxgate is carried at a height of approximately 0.2 metres above the ground surface. Both instruments incorporate a built-in data logger that records measurements digitally; these are subsequently transferred to a portable laptop computer for permanent storage and preliminary processing. Additional processing is performed on return to Fort Cumberland using desktop workstations.

It is the opinion of the manufacturer of the Geoscan instrument that two sensors placed 0.5 metres apart cannot produce a true estimate of vertical magnetic gradient unless the bottom sensor is far removed from the ground surface. Hence, when results are presented, the difference between the field intensity measured by the top and bottom sensors is quoted in units of nano-Tesla (nT) rather than in the units of magnetic gradient, nano-Tesla per metre (nT/m).

3) Resistivity Profiling

This technique measures the electrical resistivity of the subsurface in a similar manner to the standard resistivity mapping method outlined in note 1. However, instead of mapping changes in the near surface resistivity over an area, it produces a vertical section, illustrating how resistivity varies with increasing depth. This is possible because the resistivity meter becomes sensitive to more deeply buried anomalies as the separation between the measurement electrodes is increased. Hence, instead of using a single, fixed electrode separation as in resistivity mapping, readings are repeated over the same point with increasing separations to investigate the resistivity at greater depths. It should be noted that the relationship between electrode separation and depth sensitivity is complex so the vertical scale quoted for the section is only approximate. Furthermore, as depth of investigation increases the size of the smallest anomaly that can be resolved also increases.

Typically a line of 25 electrodes is laid out separated by 1 or 0.5 metre intervals. The resistivity of a vertical section is measured by selecting successive four electrode subsets at increasing separations and making a resistivity measurement with each. Several different schemes may be employed to determine which electrode subsets to use, of which the Wenner and Dipole-Dipole are typical examples. A Campus Geopulse earth resistance meter, with built in multiplexer, is used to make the measurements and the Campus Imager software is used to automate reading collection and construct a resistivity section from the results.

FIGURE 1

QUEEN CAMEL, SOMERSET Location of Geophysical Surveys, November 2008

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FIGURE 2

QUEEN CAMEL, SOMERSET Magnetometer Survey, November 2008

1:2500

0 50 100 150m

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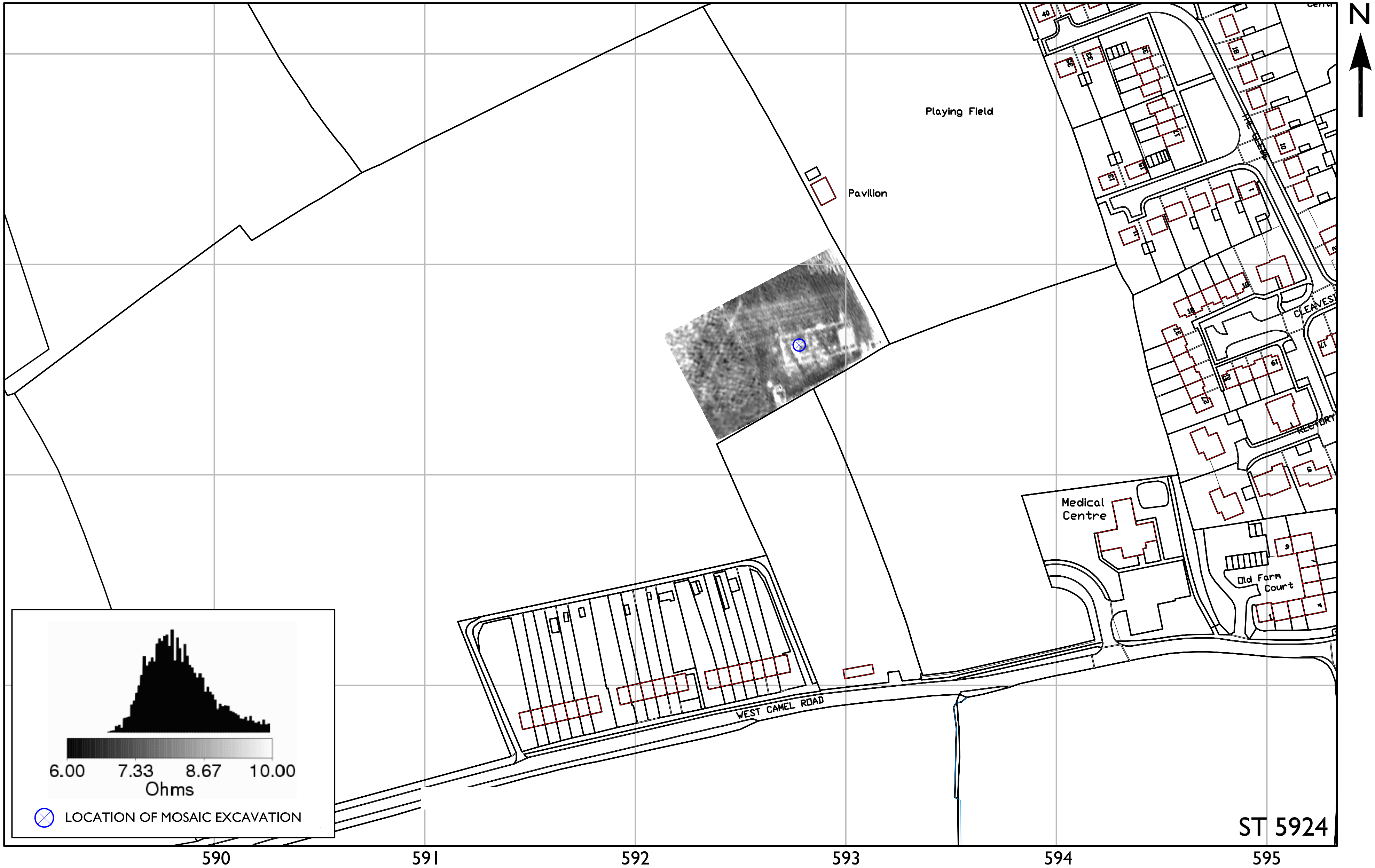
FIGURE 3

QUEEN CAMEL, SOMERSET Earth Resistance Survey, November 2008



1:2500

0 50 100 150m

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FIGURE 4

QUEEN CAMEL, SOMERSET Fluxgate Magnetometer Survey, November 2008

X-Y traceplot (A) and linear greyscale plot (B) of range truncated (-50 to +50 nT/m) and drift corrected magnetometer data

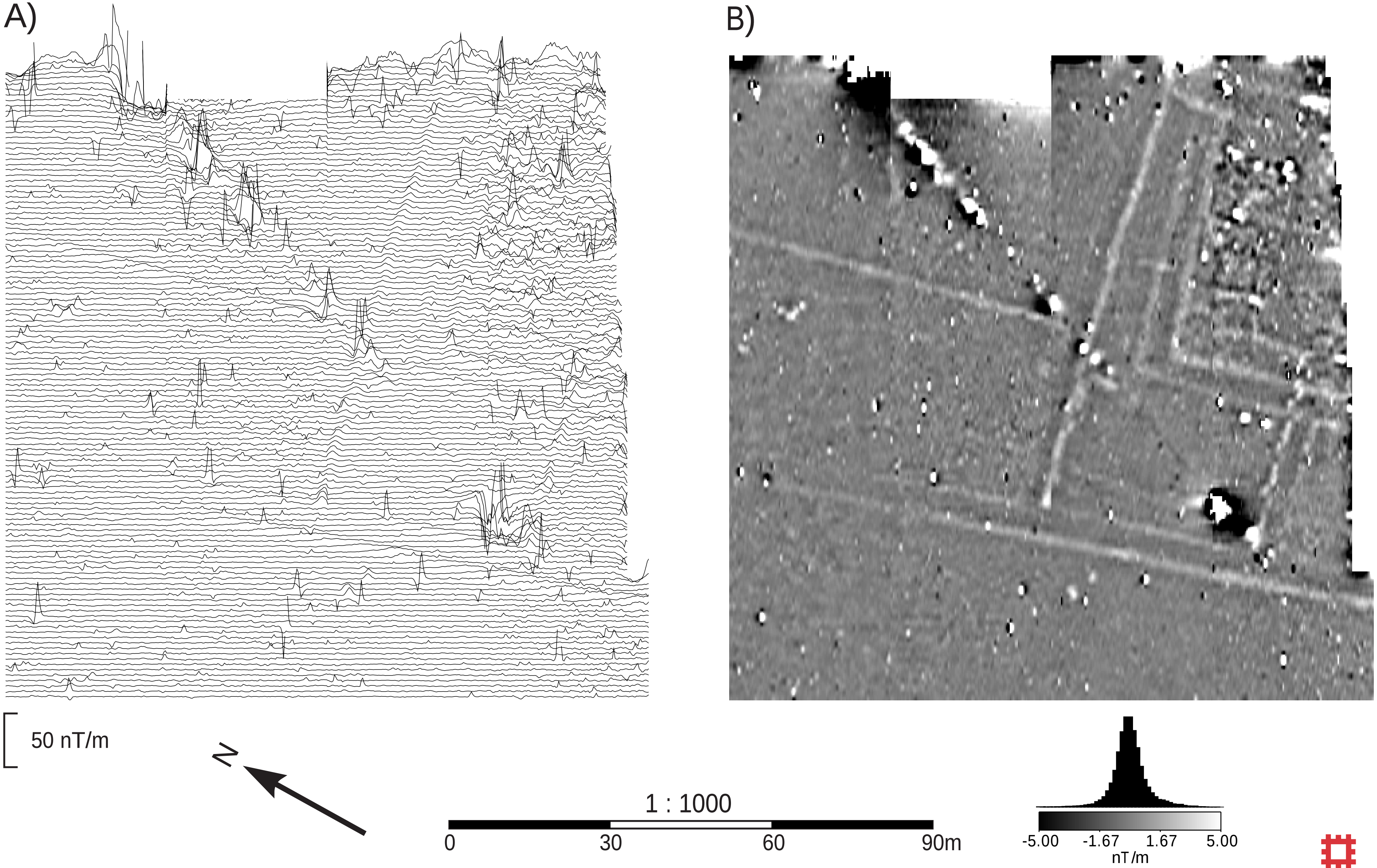

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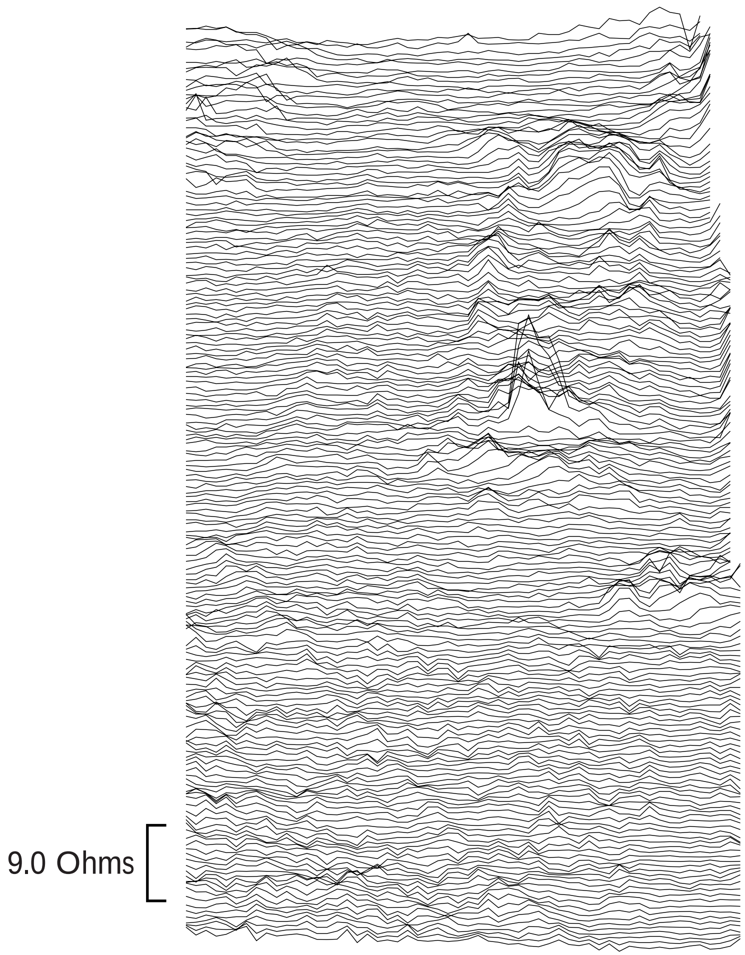
FIGURE 5

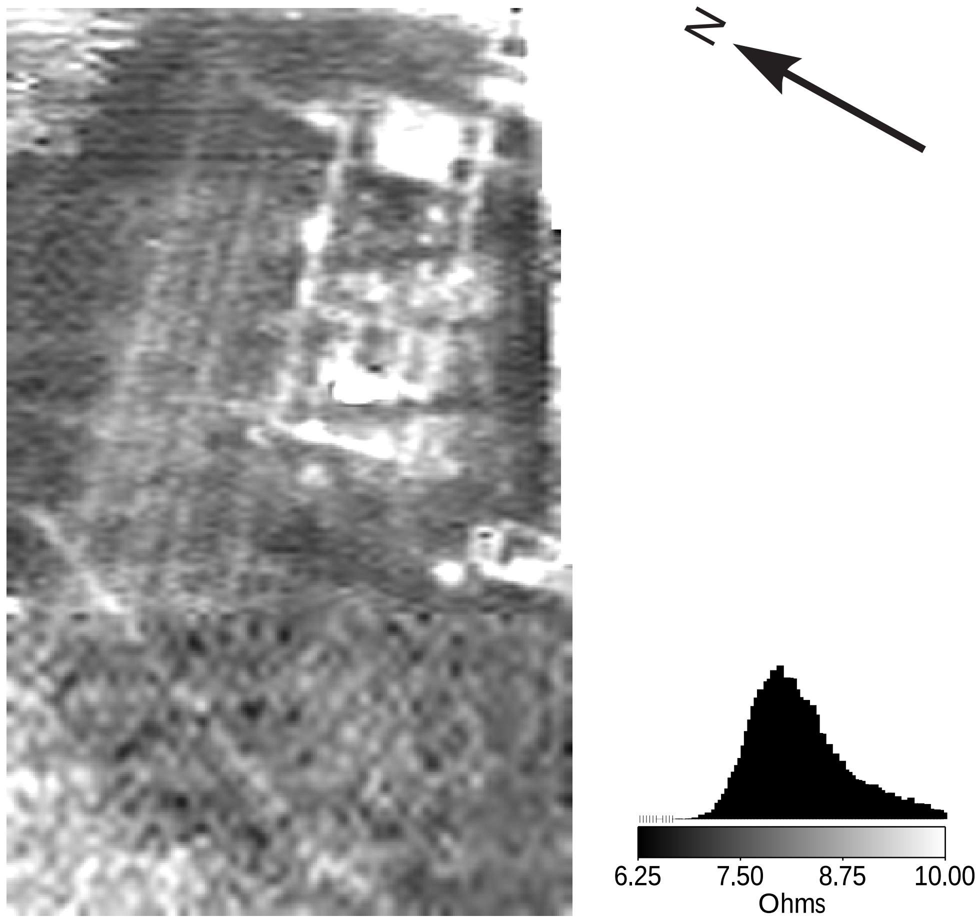
QUEEN CAMEL, SOMERSET Earth Resistance Survey, November 2008

Combined alpha and beta square array data and raw twin electrode data after initial removal of noise spikes

A) X-Y traceplot



B) Greyscale plot



1 : 750

0 30 60 90m

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FIGURE 6

QUEEN CAMEL, SOMERSET Graphical Summary of Significant Magnetic Anomalies

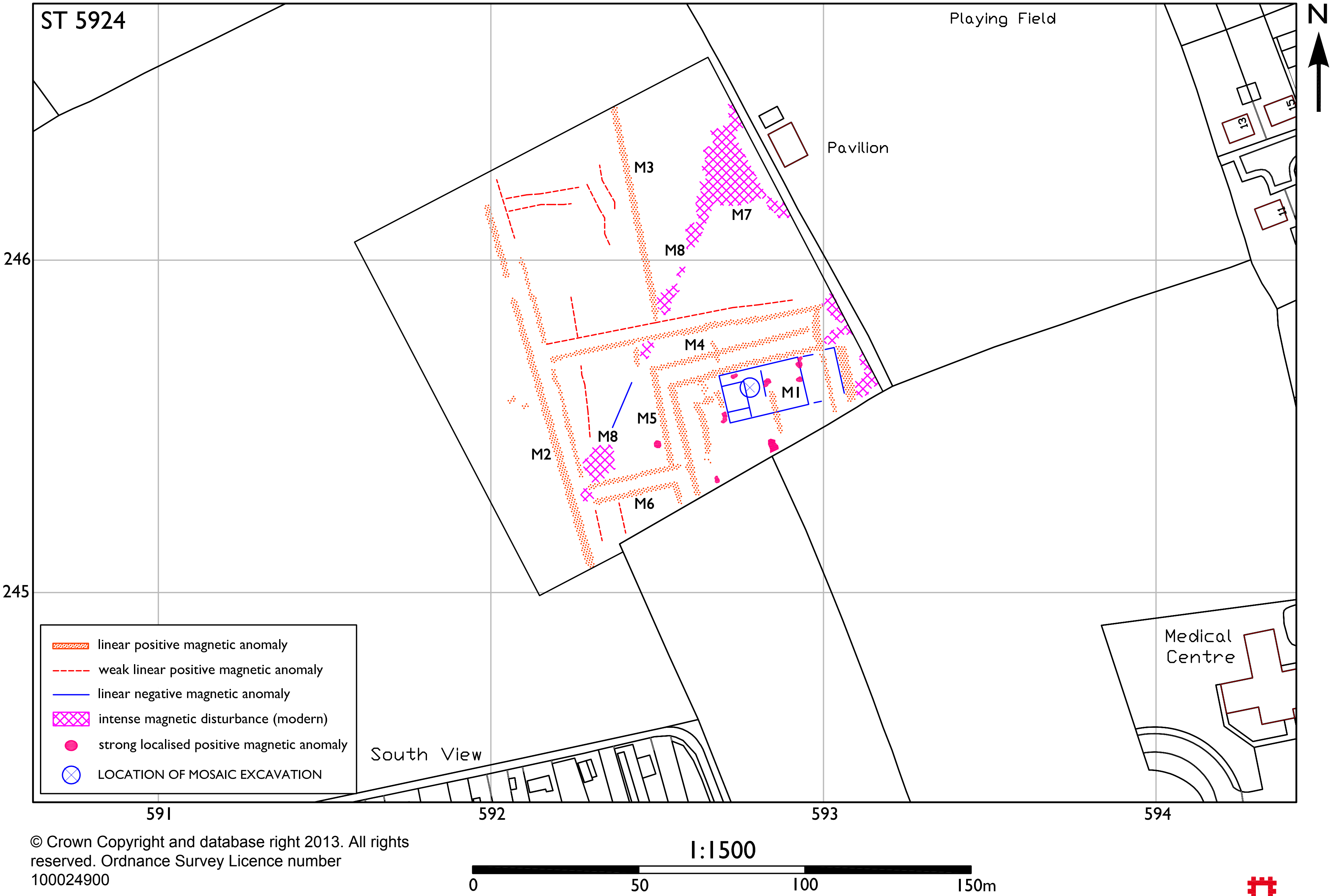

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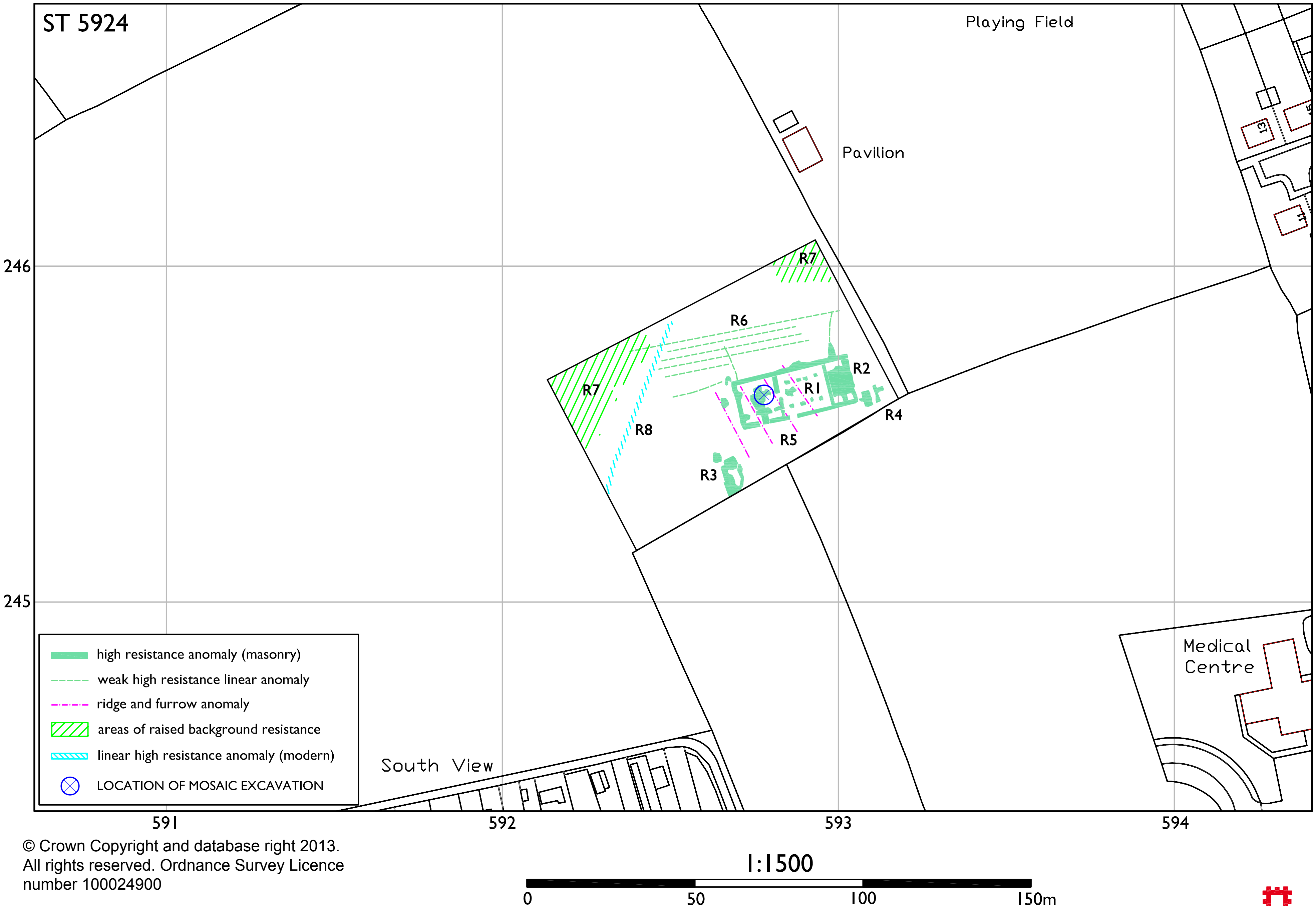
FIGURE 7

QUEEN CAMEL, SOMERSET Graphical Summary of Significant Earth Resistance Anomalies



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