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Launceston Castle, Launceston, Cornwall, Report on Geophysical Surveys, January 2022

Neil Linford and Andrew Payne

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LAUNCESTON CASTLE, LAUNCESTON, CORNWALL

REPORT ON GEOPHYSICAL SURVEYS, JANUARY 2022

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SUMMARY

Ground Penetrating Radar (GPR) and earth resistance surveys were conducted over accessible areas of the Castle Green and bailey at Launceston Castle, Launceston, Cornwall following a request from the English Heritage Trust who manage the site. The aim of the geophysical survey was to identify any significant remains surviving within this area, to improve visitor information and better inform the management of the site. GPR survey (0.37ha) was conducted over the majority of the Castle Green, with additional earth resistance (0.1ha) coverage across limited areas of level ground within the boundary of the guardianship site. While anomalies were detected over the Castle Green many of these appear to be associated with the wartime hospital buildings that formerly covered most of the site. Some deeper lying, fragmented responses share the orientation of the excavated medieval buildings and may, possibly, represent more significant wall footings or drains. Interpretation of the earth resistance data was hampered by the keyhole nature of the available survey area interrupted by modern paths, although some areas of raised response could represent more significant deposits of building rubble over the presumed location of the former town gaol.

CONTRIBUTORS
The geophysical fieldwork was conducted by Neil Linford and Andrew Payne.

ACKNOWLEDGEMENTS
The authors are grateful to colleagues from the English Heritage Trust who made arrangements for access to conduct the survey and provided welfare facilities whilst we were on site.

ARCHIVE LOCATION
Fort Cumberland, Portsmouth.

DATE OF SURVEY
The fieldwork was conducted on the 27th January 2022 and the report completed on 28th June 2022. The cover image shows a view of the area covered by the earth resistance survey towards the shell keep in the background (photograph taken by A Payne).

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INTRODUCTION

Ground Penetrating Radar (GPR) and earth resistance surveys were conducted over accessible areas of the Castle Green at Launceston Castle, Launceston, Cornwall, following a request from the English Heritage Trust who manage the site. The aim of the geophysical survey was to identify any significant remains surviving within this area, to improve visitor information and better inform the management of the site.

Launceston Castle (NHLE list entry 1017575) is a well-preserved example of a Norman period motte-and-bailey castle, developing into a 12th century shell keep castle with extensive 13th century modifications evident to both the keep and bailey structures. Limited excavations have demonstrated the survival of extensive well-preserved archaeological remains of all periods of the castle's history, including traces of long narrow timber houses, ovoid huts and a large timber post-built hall (Saunders 2006). It is considered that similar structures will occur throughout the bailey enclosure.

The foundations of a major administrative and service complex survive in the south-west quarter of the replanned bailey, including a new Great Hall, a kitchen, a courtroom and yard areas. The Great Hall remained in use as an Assize Hall until the early 17th century, but following this all of the bailey's internal buildings apart from the gate-houses had been reduced to the foundation survivals present today. A thick packing of clay was laid against the north side of the motte in around 1700 to stabilise it, producing the profile visible today. A water-pump (Listed Grade II) bearing the date 1769 stands in the eastern half of the bailey on the site of the post-medieval county gaol, demolished in 1842. In 1944 the site was used to house a hutted hospital for the US Army, which occupied much of the bailey and is thought to have impacted much of the underlying archaeology (Saunders 2006, Figures 1.8 and 1.10). Early masonry was exposed when the concrete floors, foundations and services of the wartime hospital structures were removed in 1965.

The site consists of the Castle Green, an open amenity area down to grass partially interrupted by masonry building remains, and the guardianship site containing the motte to the east. Well drained fine loamy soils of the Denbigh 2 (541k) Association have developed over Upper Devonian grey greenish slate, grey slate, silt stone and sandstone of the Liddaton formation and dark grey to black slate of the Yeolmbridge formation. However, near-surface deposits within the castle bailey are likely to have been influenced by later demolition deposits and clay introduced for landscaping the site. Weather conditions were wet during the start of the field work, but cleared towards the end of the day.

METHOD

Ground Penetrating Radar survey

A 3d-Radar MkIV GeoScope Continuous Wave Step Frequency (CWSF) Ground Penetrating Radar (GPR) system was used to conduct the survey collecting data with a multi-element DXG1820 vehicle towed, ground coupled antenna array (Linford *et al.* 2010; Eide *et al.* 2018). A roving Trimble R8s Global Navigation Satellite System (GNSS) receiver, together with a second R8s base station receiver established using the Ordnance Survey VRS Now correction service, was mounted on the GPR antenna array to provide continuous positional control for the survey collected along the instrument swaths shown on Figure 1. Data were acquired at a 0.075m x 0.075m sample interval across a continuous wave stepped frequency range from 40MHz to 2.99GHz in 4MHz increments using a dwell time of 3ms. A single antenna element was monitored continuously to ensure data quality during acquisition together with automated processing software to produce real time amplitude time slice representations of the data as each successive instrument swath was recorded in the field (Linford 2013).

Post-acquisition processing involved conversion of the raw data to time-domain profiles (through a time window of 0 to 75ns), adjustment of time-zero to coincide with the true ground surface, background and noise removal, and the application of a suitable gain function to enhance late arrivals. Representative profiles from the full GPR survey data set are shown on Figure 3. To aid visualisation amplitude time slices were created from the entire data set by averaging data within successive 2.5ns (two-way travel time) windows (e.g. Linford 2004). An average sub-surface velocity of 0.104m/ns was assumed following constant velocity tests on the data and was used as the velocity field for the time to estimated depth conversion. Each of the resulting time slices therefore represents the variation of reflection strength through successive ~0.13m intervals from the ground surface, shown as individual greyscale images in Figures 2, 4 and 5. Further details of both the frequency and time domain algorithms developed for processing this data can be found in Sala and Linford (2012).

Due to the size of the resultant data set a semi-automated algorithm has been employed to extract the vector outline of significant anomalies shown on Figure 7. The algorithm uses edge detection to identify bounded regions followed by a morphological classification based on the size and shape of the extracted anomalies. For example, the location of possible pits is made by selecting small, sub circular anomalies from the data set (Linford and Linford 2017).

Earth resistance survey

A series of partial 30m grid squares was set out using a Trimble R8s GNSS over accessible areas of the bailey within the guardianship site (Figure 1). Measurements were recorded using a Geoscan RM85 resistance meter, internal multiplexer, and a PA5 electrode frame in the Twin-Electrode configuration, to allow two separate surveys, with electrode separations of 0.5m and 1.0m, to be collected simultaneously. The 0.5m electrode separation coverage was designed to detect near-surface anomalies in the upper 0.5m of the subsurface whilst the 1.0m separation survey allowed anomalies to a depth of about 1-1.25m to be detected. For the 0.5m electrode separation survey readings were taken at a density of 0.5m x 1.0m whilst for the 1.0m separation survey they were taken at a density of 1.0m x 1.0m.

Extreme values caused by high contact resistance were suppressed using an adaptive thresholding median filter with radius 1m (Scollar *et al.* 1990), and the resulting data from the near-surface 0.5m electrode separation survey is presented as a linear greyscale image in Figure 2 superimposed on the base OS map data. Figure 6 shows the minimally processed data from both the 0.5m and 1.0m electrode separation data presented as trace plots and both linear and contrast enhanced histogram equalised greyscale images. The linear and histogram equalised greyscale images of the 0.5m electrode separation data are shown following the application of a 0.5m radius Gaussian low-pass filter to suppress measurement noise (Figures 6(B) and 6(C)).

RESULTS

Ground Penetrating Radar survey

A graphical summary of the significant GPR anomalies, [**gpr1-22**] discussed in the following text, superimposed on the base OS map data, is provided in Figure 7.

The very near-surface data between 0 and 2.5ns (0.0 to 0.14m) shows the location of kerbing [**gpr1**] on the edge of the metalled paths and raised masonry remains [**gpr2**] of the Great Hall and adjacent buildings over the green. A high-amplitude linear response [**gpr3**] is found to the north east of the survey area and develops into a more complex anomaly [**gpr4**] with depth. It is unclear whether [**gpr3**] and [**gpr4**] are, together with fragmented wall-type anomalies [**gpr5**] and [**gpr6**] found to the south, associated with more significant structural remains built against the western extent of the Castle Green or, perhaps, shoring of the steep scarp on the edge of the plateau. Anomalies [**gpr5**] and [**gpr6**] do not appear to represent the location of

previous excavation trenches recorded in this area (Saunders 2006, trenches marked 'Y' on Figure 4.2).

From 2.5ns (0.13m) onwards high-amplitude anomalies [**gpr7**] appear to indicate the location of rectilinear hut platforms, and wall-type responses [**gpr8**] most likely associated with the hospital buildings on the site. It is possible that [**gpr3**] and [**gpr4**] may also be associated with these, perhaps drains or a track way. There is also evidence for the former path to the Lodge shown on historic mapping [**gpr9**], a possible former fence line [**gpr10**], and four discrete high-amplitude anomalies [**gpr11**] associated with near-surface localised compaction, perhaps tree planting pits or flagstones (OS Historic County Mapping Series: Cornwall 1884 Epoch 1).

A series of more fragmented linear anomalies [**gpr12-14**] follow an approximate north-south alignment beyond the extent of the known excavations, but are possibly associated with the former hospital buildings located here (Saunders 2006, Figure 1.8). Immediately to the south, a group of rectilinear anomalies [**gpr15**] and [**gpr16**] found between 7.5 and 20.0ns (0.39 to 1.05m) could, possibly, be suggestive of structural remains immediately to the west of the Great Hall on a slightly different orientation. There is also an additional, more deeply buried linear anomaly [**gpr17**] between 25.0 and 37.5ns (1.31 to 1.97m), sharing the same alignment as [**gpr15**] and [**gpr16**], possibly a wall footing, drain or service passing beneath [**gpr12-14**] to the north. Further short, linear anomalies [**gpr18-20**] are found across the castle green, but are difficult to fully interpret and do not, necessarily represent significant structural remains, but could be associated with clay deposits introduced to landscape the bailey and support the motte (Saunders 2006).

Discrete high amplitude anomalies at [**gpr21**] are found between 5.0 and 50.0ns (0.26 to 2.63m) in the south west corner of the green, and there is some suggestion that these are located within a surrounding low amplitude response, possibly a former excavation trench, although it is difficult to suggest any more precise interpretation.

A short linear anomaly [**gpr22**] is found between 17.5 and 27.5ns (0.92 to 1.44m) to the east of the Great Hall and sharing the same alignment. Again, it is difficult to suggest a more complete interpretation given the limited extent of the anomaly although this may well represent a wall footing. There does not appear to be any direct correspondence with the earth resistance anomalies at [**r9**] within the guardianship area but this may, perhaps, be due to the depth of overburden above [**gpr22**].

Earth resistance survey

A graphical summary of significant earth resistance anomalies [**r1-16**] discussed in the following text superimposed on the base OS map data is provided in Figure 7.

The survey area is interrupted by both the steep slopes up towards the eastern curtain wall and modern tarmac footpaths where it was not possible to acquire readings.

The moisture retaining ditch at the base of the motte mound has produced both low resistance responses [**r1**] and [**r2**], together with raised anomalies [**r3**] and [**r4**] adjacent to the lower slopes or retaining walls of the motte mound. Areas of lower resistance at [**r5**] and [**r6**] are found to the west, and are possibly due to either near-surface effects from the footpaths (Scollar *et al.* 1990, 350) or moisture retentive deposits associated with the motte ditch.

A series of high resistance anomalies [**r7-9**] may, tentatively, be associated with demolition or rubble deposits and share an approximate alignment with the Great Hall to the west, together with suggestions of ground disturbance at [**r10]** and [**r11**], possibly representing pits or evidence for stone robbing. It is possible that [**r7-11**] may be associated with the site of the former town gaol, although there was only limited evidence for survival with no apparent structural remains revealed through excavation (Saunders 2006, Figure 7.7).

The visible surface depression to the south of the water pump and trough, situated over the site of a former large tree, may well be associated with a broad amorphous area of low resistance [**r12**], perhaps due to water collecting in the root ball of the tree or leaking from a possible water pipe supply trench [**r13**].

A high resistance anomaly [**r14**] may represent the stub end of a masonry structure projecting from the scarp of the slope, perhaps sealed by collapsed material from the eastern section of the curtain wall above. Further areas of high resistance [**r15**] to the south are of uncertain significance, together with weakly defined narrow linear anomalies at [**r16**] possibly associated with modern services for the visitor centre facilities.

CONCLUSIONS

The Ground Penetrating Radar survey has revealed anomalies over much of the Castle Green, but many of these appear to be associated with the wartime hospital buildings that covered this area. Some deeper lying, fragmented responses share the orientation of the excavated medieval buildings and may, possibly, represent more significant wall footings or drains. Limited earth resistance coverage over level areas within the guardianship site revealed more fragmented anomalies with the interpretation of the data hampered by the keyhole nature of the available survey area that is also interrupted by modern paths. However, some areas of raised resistance could represent more significant deposits of building rubble over the presumed location of the former town gaol.

LIST OF ENCLOSED FIGURES

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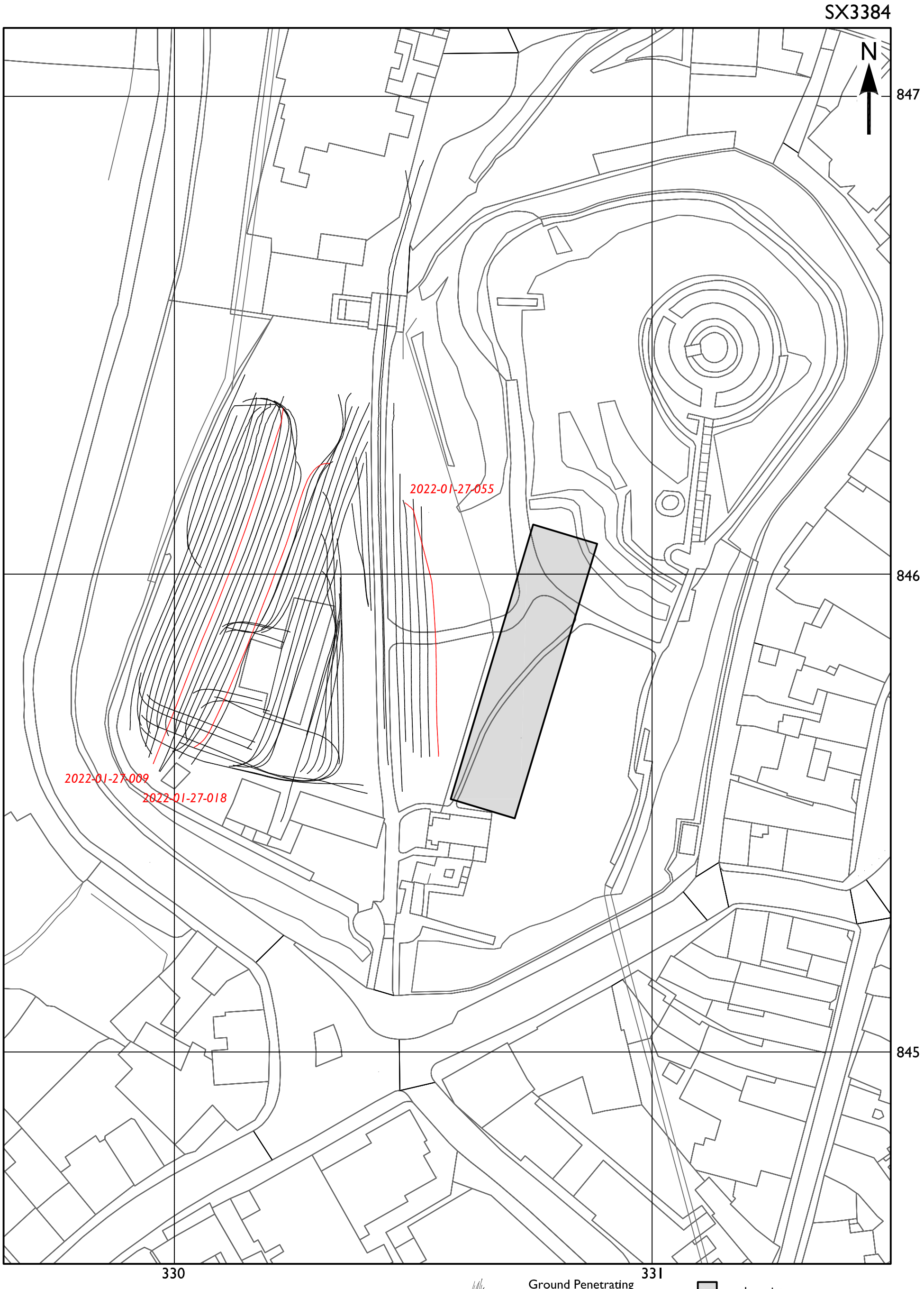
LAUNCESTON CASTLE, LAUNCESTON, CORNWALL

Figure 1

Location of GPR instrument swaths, and earth resistance survey grids, January 2022



0 30m

1:750

Ground Penetrating Radar survey swaths

2022-01-27-001 Location of selected GPR profiles shown on Figure 3

earth resistance survey

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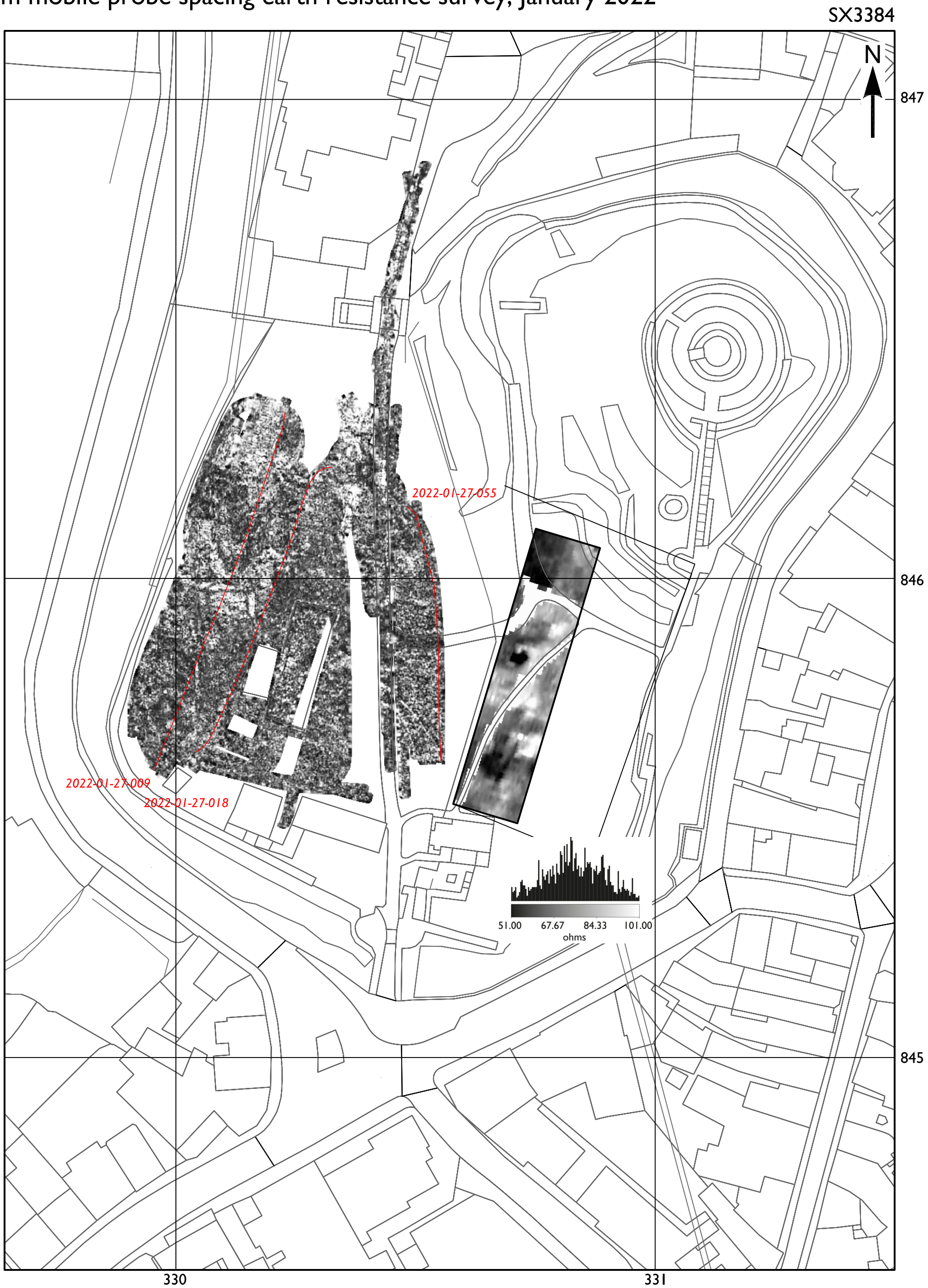
LAUNCESTON CASTLE, LAUNCESTON, CORNWALL

Figure 2

GPR amplitude time slice between 10.0 and 12.5ns (0.53 to 0.66m) and 0.5m mobile probe spacing earth resistance survey, January 2022



0 30m

1:750

Low *High*

relative reflector strength

2022-01-27-001 Location of selected GPR profiles shown on Figure 3

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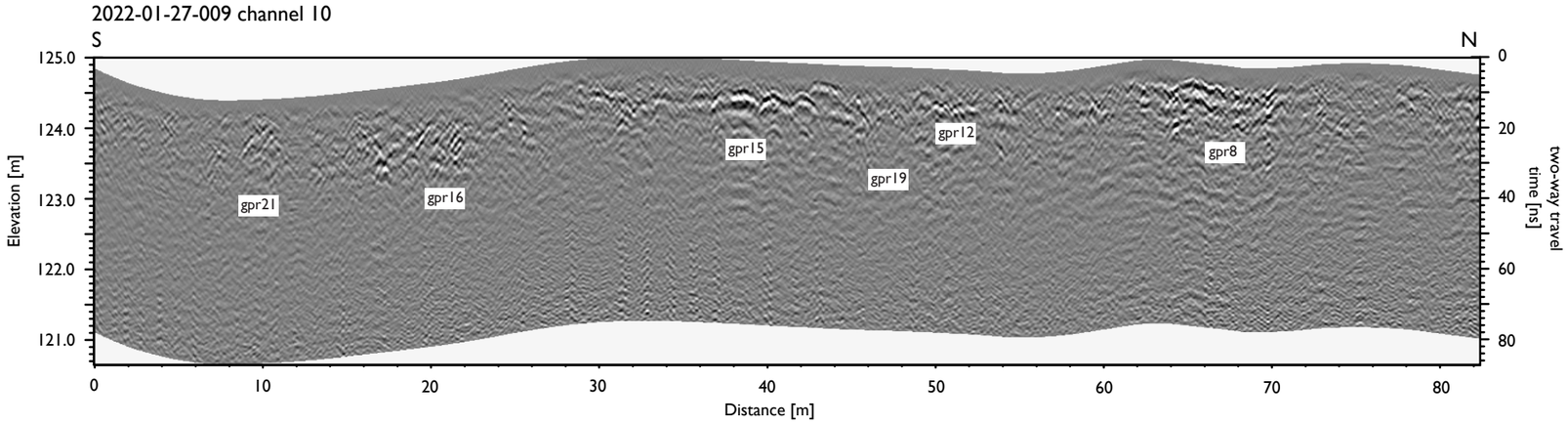
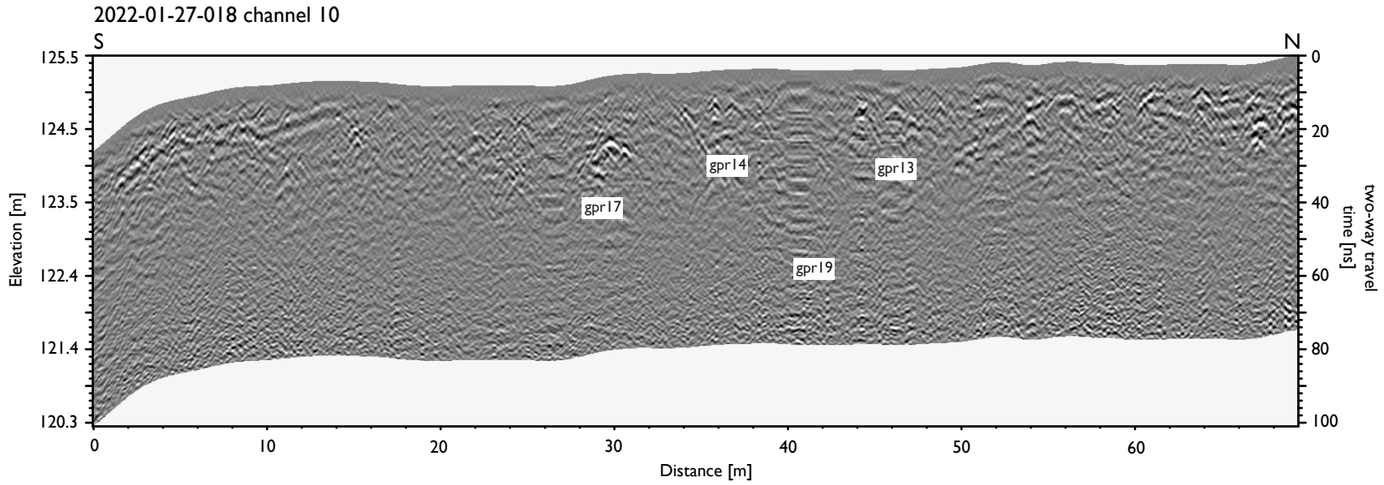
LAUNCESTON CASTLE, LAUNCESTON, CORNWALL

Figure 3

Selected GPR profiles, January 2022





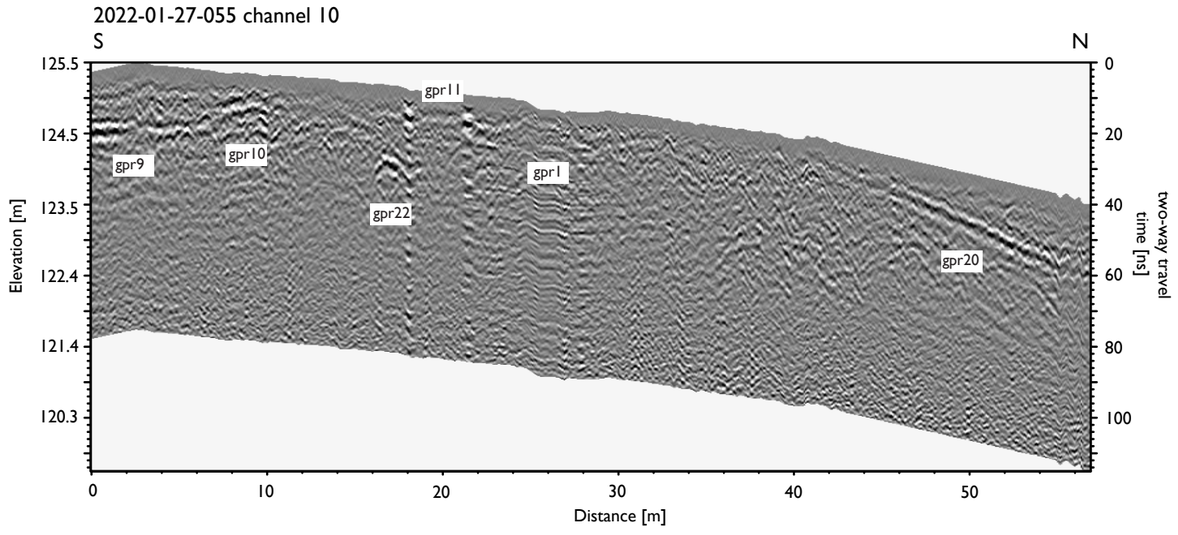


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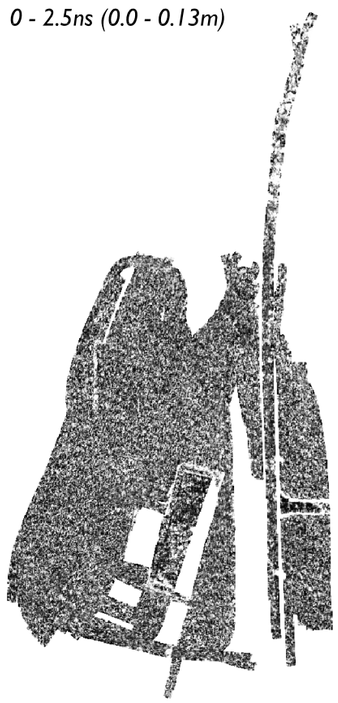
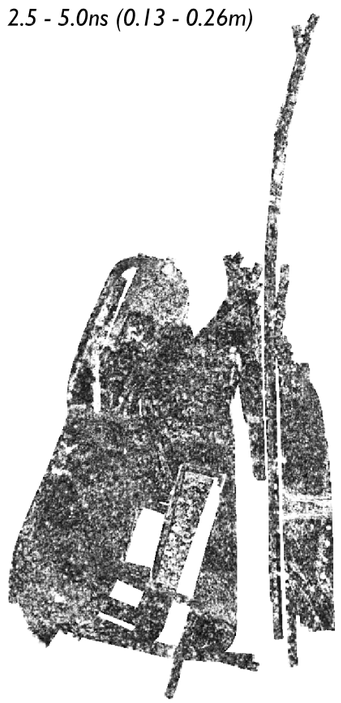
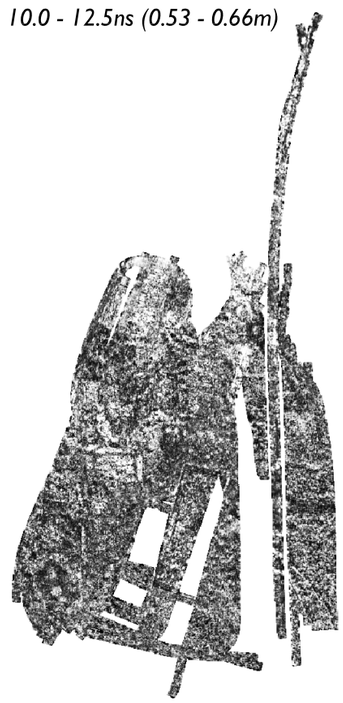
Figure 4

LAUNCESTON CASTLE, LAUNCESTON, CORNWALL

GPR amplitude time slices between 0.0 and 30.0ns (0.0 to 1.58m), January 2022







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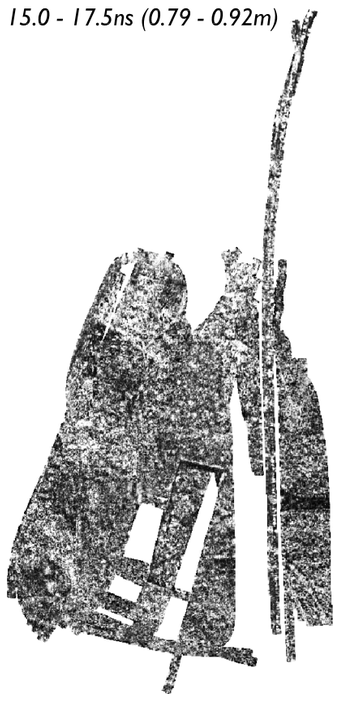

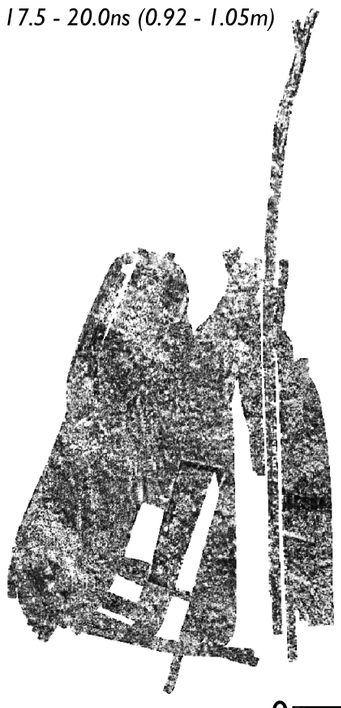

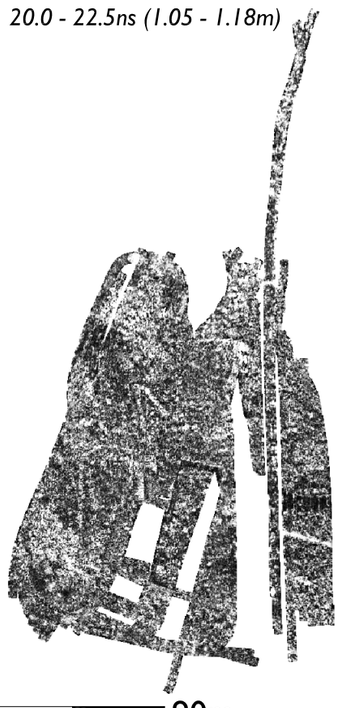

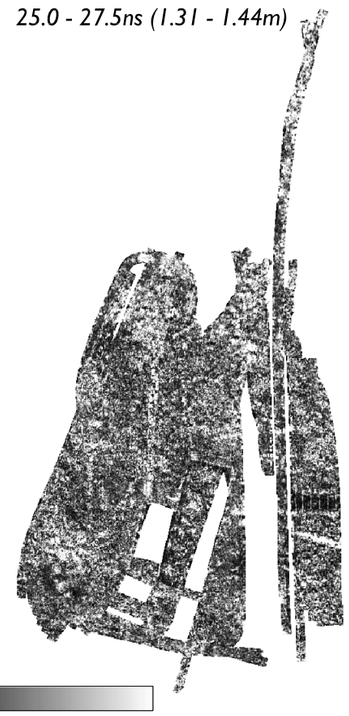

0 90m

1:2000

Low High

relative reflector strength

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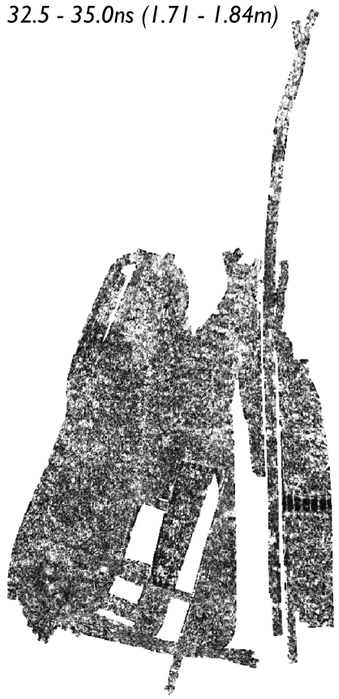
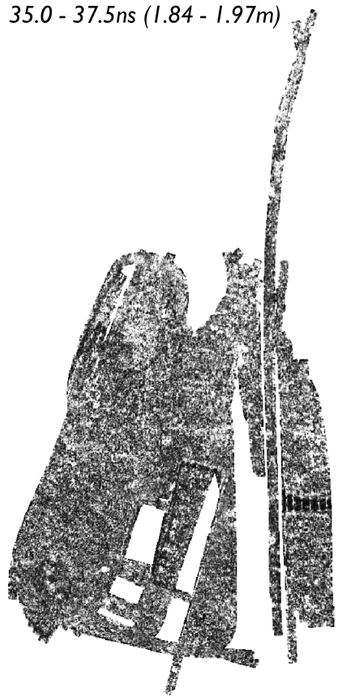
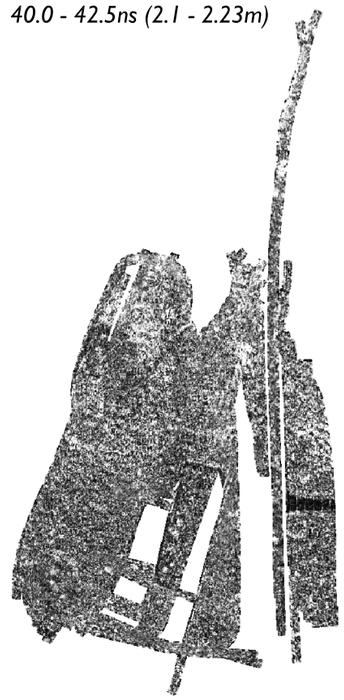
Figure 5

LAUNCESTON CASTLE, LAUNCESTON, CORNWALL

GPR amplitude time slices between 30.0 and 60.0ns (1.58 to 3.15m), January 2022







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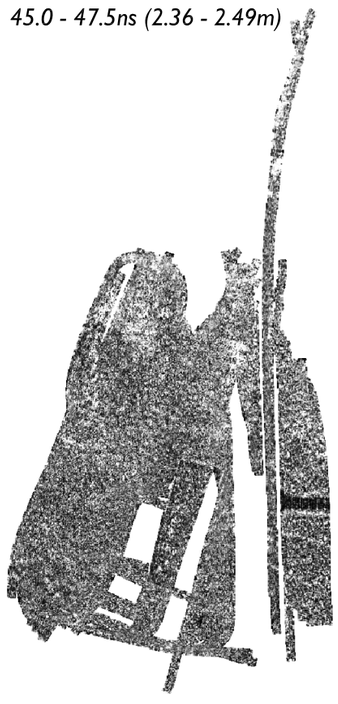

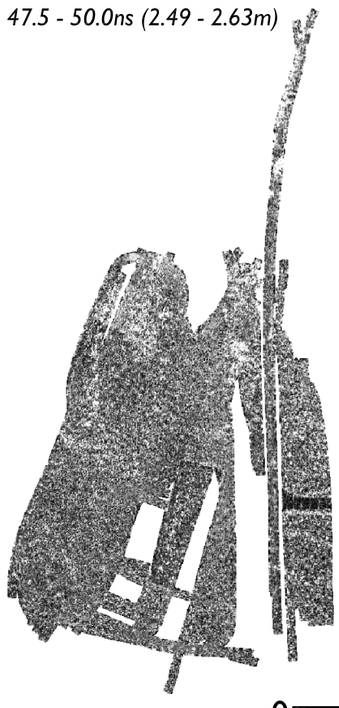

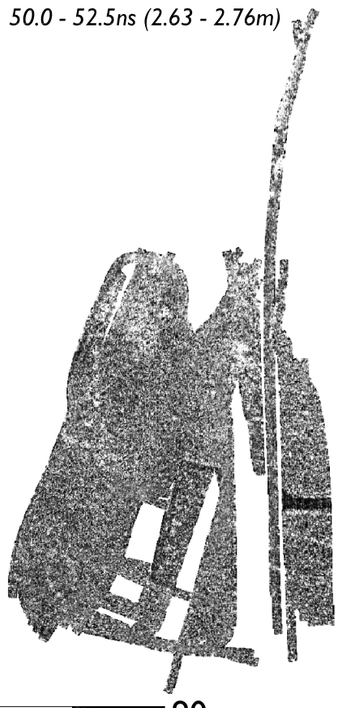

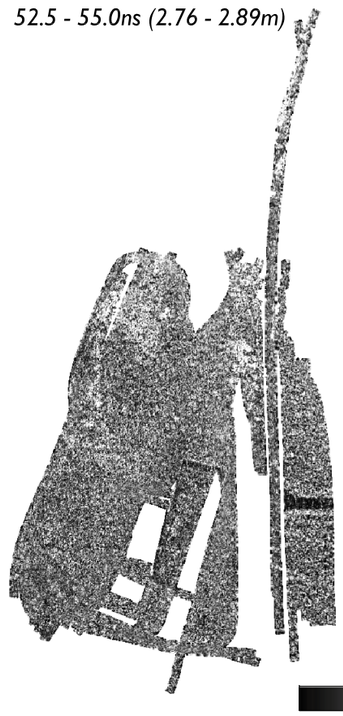

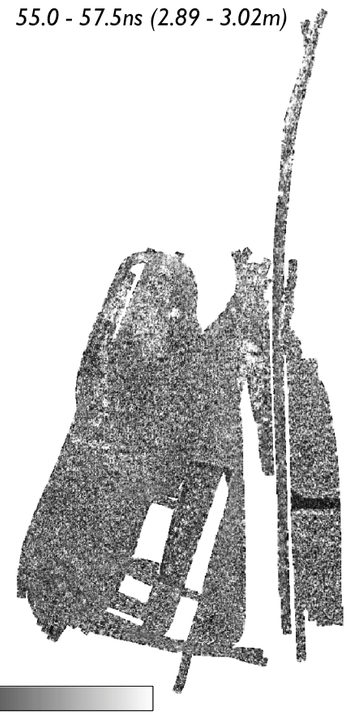

0 90m

1:2000

Low High

relative reflector strength

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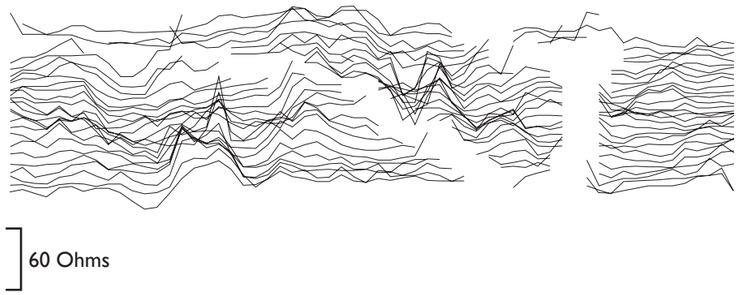
Figure 6

LAUNCESTON CASTLE, LAUNCESTON, CORNWALL
Earth resistance survey, January 2022

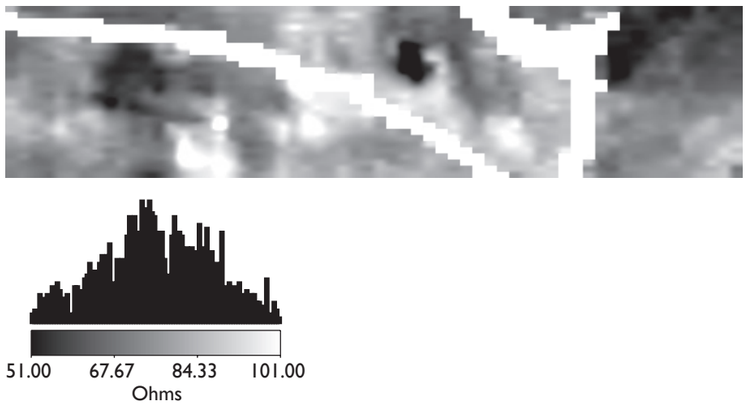
N

0.5m mobile probe separation data

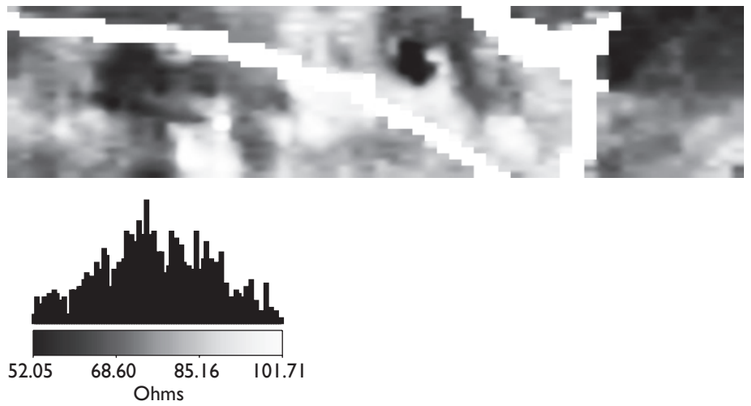
(A) Trace plot of raw data after initial despiking



(B) Linear greyscale image of low-pass filtered data

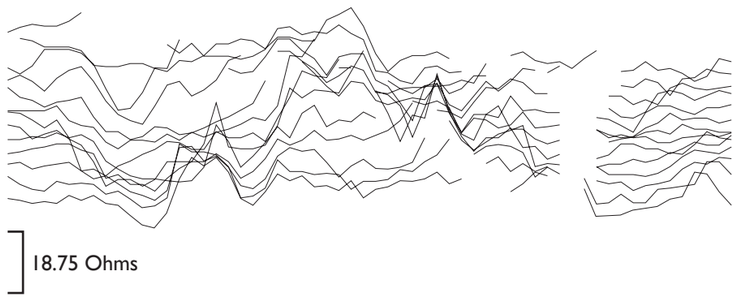


(C) Histogram equalised greyscale image of ow-pass filtered data

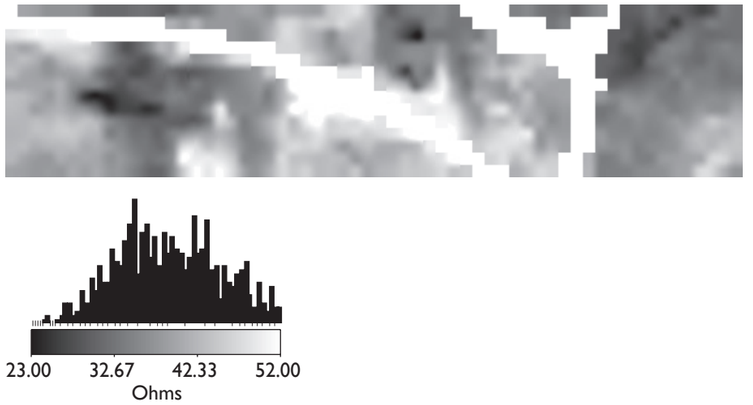


1.0m mobile probe separation data

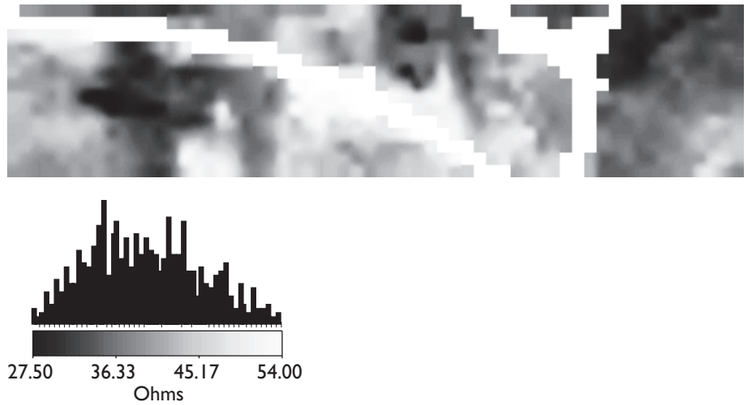
(D) Trace plot of raw data after initial despiking



(E) Linear greyscale image of raw data after initial despiking



(F) Histogram equalised greyscale image of raw data after initial despiking



0 60m

1:500

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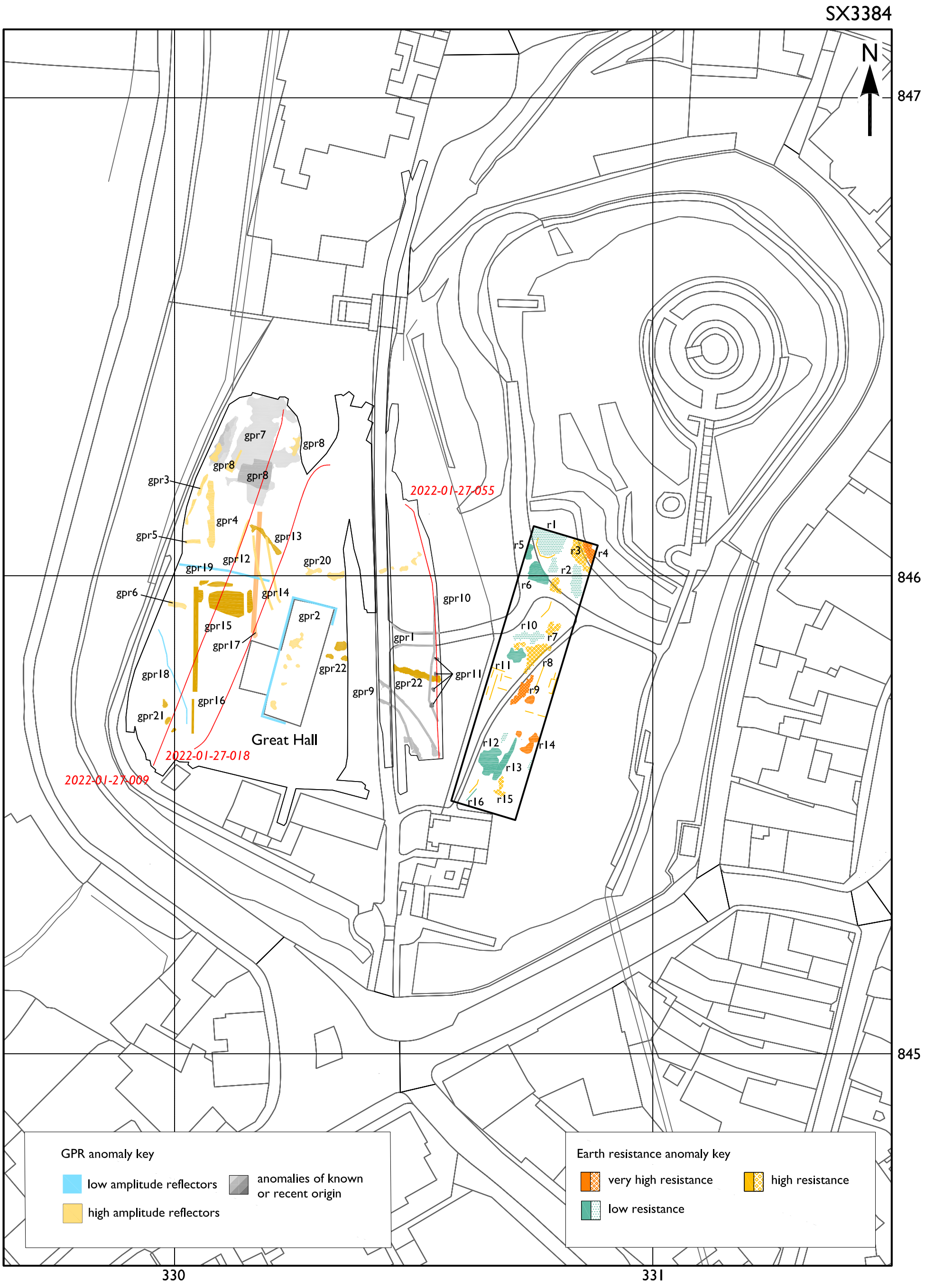
LAUNCESTON CASTLE, LAUNCESTON, CORNWALL

Figure 7

Graphical summary of significant GPR and earth resistance anomalies, January 2022



0 30m

1:750

2022-01-27-001 Location of selected GPR profiles shown on Figure 3

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