Geophysical Survey Report
Keith Marischal House

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Commissioned by:

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Advancing the Understanding of Castles

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Executive Summary

Geophysical survey was undertaken within the grounds to the north of Keith Marischal House, East Lothian, to help investigate what remains of the lost renaissance palace of the Earls Marischal. The current house is largely a 19th and early 20th century construct with a late 16th century tower incorporated into its south-east corner. The first reference to a castle on the site is in 1525 when the castle's description would suggest a noble residence with an enclosed courtyard. In the mid-18th century the house is recorded as having a courtyard and large 3 story dining hall opposite. Neither the courtyard nor the dining hall are now in evidence on the site.

The area surveyed covers approximately 0.2ha and was investigated by Resistance and Ground Penetrating Radar (GPR) Survey.

While neither the resistance nor the GPR survey has categorically confirmed the layout of the original house, both sets of results have detected anomalies which may indicate partial survival of possible structural remains.

Survey:	Keith Marischal House
Client:	Miles Kerr-Peterson funded by Castle Studies Group
Date of Survey:	17th & 18th May 2018
Survey Personnel:	Dr S M Ovenden and A S Wilson
Report Author:	Dr S M Ovenden
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1. Introduction

1.1 Geophysical survey was undertaken within the grounds to the north of Keith Marischal House, East Lothian, to help investigate what remains of the lost renaissance palace of the Earls Marischal.

1.2 The current house is largely a 19th and early 20th century construct with a late 16th century tower incorporated into its south-east corner. The first reference to a castle on the site is in 1525 when the castle's description would suggest a noble residence with an enclosed courtyard. In the mid-18th century the house is recorded as having a courtyard and large 3 story dining hall opposite. Neither the courtyard nor the dining hall are now in evidence on the site.

1.3 The area surveyed covers approximately 0.2ha and was investigated by Resistance and Ground Penetrating Radar (GPR) Survey as indicated on Figure 1, at a scale of 1:500.

1.4 Figures 2 - 6 display data plots of the resistance data. These are all produced at a scale of 1:500. An interpretation diagram is provided in Figure 7. The results from the GPR survey are displayed as a series of 0.25m thick depth slices maps, with accompanying interpretations in Figures 8 – 29.

2. Methodology

2.1 Prior to data collection a series of 20m grids were established across the survey area and geo-referenced using a Trimble R8s GPS system. Geo-referencing information and CAD maps have been supplied to the client.

Resistance Survey

2.2 Resistance survey is ideally suited to locating walls, foundations and rubble spreads. It can also identify ditches and pits in areas with little magnetic enhancement. It is particularly useful when underlying geology or modern ferrous contamination reduces the efficacy of gradiometer survey.

2.3 Earth resistance surveys measure variations in the moisture content of the earth's subsurface by passing a small electrical current through the subsurface. Features such as walls and paths will show as high resistance anomalies, while features such as ditches, robber trenches and planting beds, with their humic fill, will usually result in a low resistance response.

2.4 Resistance survey was carried out using a Geoscan RM85 resistance meter. For this survey a standard twin probe configuration was used with a mobile probe separation of 0.5m providing a depth resolution of approximately 0.75m. Data was collected at 0.5m by 0.5m intervals.

2.5 The data was processed with Geoscan Research Geoplot 4.00 software, using a standard range of corrections and processing algorithms. Raw, interpolated and high pass filtered data have been included in the report. Interpolating data has the effect of smoothing the data image by interpolating the data in the X and Y direction resulting in the appearance of a 0.25m by 0.25m sample interval. Running a high pass filter on the data effectively removes background trends within the data thereby enhancing more discrete anomalies.

2.6 The data have been displayed at a variety of levels, in an attempt to enhance subtler anomalies. In area resistance survey the data values themselves are not significant but rather the changes relative to the background level of response. In some of the figures the data are plotted at absolute values in ohms (Ω) to try to pull out different anomalies. In other plots the statistics of the full data range are used and the data are plotted at plus/minus one or two standard deviations (SD).

Ground Penetrating Radar Survey

2.7 GPR survey is the best technique for providing information of the depth and stratigraphy of a site and is required if archaeological deposits may extend to a depth greater than *circa* 0.75m. Unlike gradiometry and resistance surveys it can also be used on paved/tarmac areas.

2.8 In a GPR survey pulses of electromagnetic energy are directed downwards into the earth. The transmitted wave is affected by variations in the electrical properties of the subsurface, specifically the dielectric constant and the conductivity of the subsurface. Contrasts in these properties cause differential reflection of the energy wave creating an anomaly. The subsurface is mapped by recording the amplitude of this reflected energy and its travel time. The travel times are converted to depth using a calculated velocity.

2.9 The data were collected with a Mala X3M GPR system with a 500MHz antenna and processed using the GPRSlice software package. The data were collected at 0.02m intervals along individual transects 0.5m apart. All the traverses were then assembled into a block of data and processed and displayed as a series of time slice or depth maps. This type of data processing and visualisation can allow more subtle features and relationships between features to be analysed more readily.

3. General Considerations / Complicating Factors

3.1 Geophysical data can be ambiguous and while every effort has been made to ensure that the interpretations contained within this report represent an accurate record of potential surviving archaeological deposits, it is a subjective analysis of the data.

3.2 Most of the survey area comprised short grass and a circular gravel drive.

Resistance Survey

3.3 For this survey differentiation between 'Possible Archaeology' and 'High Resistance' is based on the form of the response. However, it is possible that an anomaly noted as indicating a 'Possible Structure' may be due to rubble spreads or natural variations such as tree roots.

3.4 It was not possible to collect resistance data over the gravel drive due to a lack of electrical contact.

Ground Penetrating Radar Survey

3.5 Given the shallow nature of the potential archaeological deposits survey with a 500MHz antenna was deemed most appropriate. Data has been retrieved to a depth of approximately 2m.

3.6 GPR is very sensitive to marked variations in surface/near surface material e.g outcropping bedrock, metal, surface stones etc. This may result in 'ringing' of the signal. This is the result of near surface anomalies re-appearing in deeper depth slices due to the signal bouncing back and forth between the antenna and the feature.

3.7 The velocity value used to convert the recorded two-way travel time to depth has been established using software analysis. While the depths provided should be a reasonable estimation of the depth of features, there may be some variation as a constant value has been applied and the velocity can vary vertically and laterally within the subsurface.

3.8 Due to the generally level nature of the GPR survey areas, only depth slices parallel to the ground surface have been produced. However, overlapping shallow depth slices have been included. The accompanying CD contains parallel and horizontal depth slice animations.

4. Results of Resistance Survey (Figures 2 – 7)

Anomaly numbers referred to below are shown on the accompanying interpretation diagram.

4.1 There is a clear change in the level of response across the site, with low resistance being recorded to the east of the existing house.

4.2 The most coherent responses within the data are two parallel linear high resistance anomalies (1) and (2) which have been detected in the west of the survey area. These are about 5m – 6m apart and may be associated with the earlier structure. It appears that (2) extends further to the north suggesting it may be a drain / service or a feature not associated with the possible earlier structure. However, the extent of (1) is unclear due to a large tree which prevented survey. Although there is some suggestion that (1) may extend further, particularly in Figure 5, the high resistance readings along the limits of the survey area may simply be associated with the bank and roots immediately to the east. It may be significant that both (1) and (2) are broader and more substantial to the south, perhaps suggesting that the apparent northern extension of (2) is due to a different feature such as a drain; see section 5.14 below.

4.3 There is a suggestion of a possible north-eastern wing / wall (3) in the east of the survey area. However, this anomaly does not extend to the extant structure. That does not mean that (3) is not significant, but rather that preservation of the earlier foundations, if present, might be inconsistent.

4.4 The data suggests a very rectilinear anomaly (4) in the far northeast of the survey. While this may well be associated with an earlier structure given its well-defined nature, the limits of the survey area and adjacent trees make interpretation cautious. It is possible that this area of high resistance (4) is simply due to tree roots, although as stated above, the very distinct edges of the anomaly suggest it may not be entirely natural in origin, particularly when viewed in conjunction with anomaly (3).

4.5 Within the small lawn area at the centre of the drive rectilinear low resistance trends (5) have been detected. It is likely that these may be due to a former path and / or service trench leading to the entrance of the house, although they could be relatively modern.

4.6 More amorphous anomalies (6) have been noted in the southwest of the survey area. While these may be archaeologically significant, they could simply be associated with earlier paths etc., and /or even previous planting as suggested on earlier OS maps.

4.7 There is no clear evidence in the data for the northern wing (dining hall) within the data. However, elements (7) of the more amorphous responses in the west, may be of interest, particularly given their location relative to the change in the width and nature of anomalies (1) and (2). There is some suggestion that this response may extend to the east (8), although such an interpretation is extremely cautious given the small area available for survey within the centre of the drive. However, its apparent correlation with anomaly (3) may be significant.

4.8 The linear trend (9) in the east of the area is believed to be due to a pipe leading from an heating oil storage tank located to the northeast of the survey area.

5. Results of Ground Penetrating Radar Survey

Anomaly letters referred to below are shown on the accompanying interpretation diagrams.

0.00m – 0.25m Depth Slices (Figures 8 & 9)

5.1 This surface depth slice is dominated by responses caused by changes in the surface material. The low amplitude response (a) is due to the grass in the centre of the drive, while the high amplitude reflections (b) are due to the gravel drive, and variations within it. The well-defined anomaly (c) immediately to the north of the house is due to an area of surface paving.

5. 2 It is likely that the areas of high amplitude response (d) and (e) are due to tree roots. However, anomaly (e) is very well-defined and corresponds with resistance anomaly (4).

0.13m – 0.38m Depth Slices (Figure 10 & 11)

5.3 Within this overlapping near surface slice the response from surface changes, (a), (b) and (c), are still evident.

5.4 Anomaly (d) in the west of the area is still apparent at this depth although it covers a smaller area and shows some correlation with resistance anomaly (7). The area of high amplitude response (e) in the north of the survey area is still well-defined at this depth supporting a possible structural origin, although a natural cause such as tree roots can still not be dismissed.

0.25m – 0.50m Depth Slice (Figure 12 & 13)

5.5 It seems likely that most of the anomalies within this depth slice are due to natural variations in the topsoil. The responses (f) are most likely due to earlier layouts of the drive or simply different thicknesses of gravels.

5.6 Anomaly (g) may be of interest given its location relative to the 16th century tower and shows some correlation, in terms of width and alignment, with resistance anomaly (3). However, it may simply be due to buried utilities such as drainage / water mains leading to / from the kitchen.

5.7 At this depth (e) is still well defined and shows good correlation with the resistance data. Although a natural origin (i.e. tree roots) is possible, an archaeological origin cannot be dismissed given its regular nature and depth.

5.8 The well-defined response (h) in the south west of the area shows good correlation with resistance anomaly (1). However, its location adjacent to rhododendron bushes make interpretation cautious as the high amplitude response could be associated with root systems, rather than a southern extension of resistance anomaly (1).

0.38m – 0.63m Depth Slice (Figures 14 & 15)

5.9 Suggestions of linear trends (i) and (j) are evident within this depth slice. While not as 'substantial' as the resistance anomalies (1) and (2), there is very good correlation between the anomalies supporting an interpretation of potential surviving structural remains.

5.10 Anomy (g) in the east of the area also has a more linear appearance suggesting possible structural remains, although interpretation is tentative.

5.11 Anomalies (e) and (h) are also still apparent at this depth, but are less defined.

5.12 The origin of the broad area of high amplitude response (k) is unclear. While its apparent association with (j) could suggest a possible paved area, early OS maps indicate this area was planted in the past and as such this broad area of high amplitude response may be due to disturbance caused by earlier root systems.

0.50m – 0.75m Depth Slice (Figures 16 & 17)

5.13 The linear anomaly (i) is very well-defined at this depth and shows very good correlation with the western edge of resistance anomaly (1). It is not unusual for the two techniques to give slightly different responses. However, the narrow nature of the GPR response suggests it may simply be due to a drain.

5.14 The edge (j) is still clear and shows some correlation with resistance anomaly (2). However, an additional anomaly (l) is becoming clear at this depth which is on a slightly different alignment and may explain the apparent extension of resistance anomaly (2) i.e. resistance anomaly (2) is potentially due to possible structural remains in the south and a drain / service in the north.

5.15 The significance of (m) in the centre of the survey area is unclear. Within all data sets there is no clear evidence for the northern range of buildings. However, (m) is in the correct location and may be of interest. Although some corresponding anomalies have also been detected in the resistance data interpretation is cautious due to the previous layout of the drive. Similarly interpretation of the weak trends (n) in the centre of the survey area is cautious. While their rectilinear nature may be significant they are very ephemeral and may be associated, in part, with service trenches.

5.16 As with the previous depth slice numerous amorphous responses (k) have been recorded in the southwest of the area. It seems probable that these have a natural or modern origin, although an archaeological significance cannot be entirely dismissed.

5.17 Anomaly (g) is still evident at with depth with an associated linear trend, which may be significant.

0.63m – 0.88m Depth Slice (Figures 18 & 19)

5.18 The strong linear anomaly (l) it clear at this depth. Its strength and orientation suggest it is most likely a service type feature. However, geophysical survey cannot determine its age.

5.19 Anomaly (i) is still evident at this depth.

5.20 By this depth response (m) is still evident but not as well-defined.

0.75m – 1.00m Depth Slice (Figures 20 & 21)

5.21 At this depth the data are dominated by the response from the presumed drain / service (l). This depth is beyond the depth of investigation of the resistance survey which explains why it is not clear, expect perhaps for its northern section, in the resistance data.

1.00m – 1.25m to 1.75m – 2.00m Depth Slices (Figures 22 & 29)

5.22 It is thought that most of these responses are due to natural variations and ringing of the signal.

6. Conclusions

6.1 While neither the resistance nor the GPR survey has categorically confirmed the layout of the original house, both sets of results have detected anomalies which may indicate partial survival of possible structural remains.

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