Geophysical Survey Report
Doune Castle Phase I

RGC17254/DC1

Commissioned by:

CFA ARCHAEOLOGY LTD

On Behalf of:

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

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Executive Summary

A programme of geophysical survey was undertaken within and immediately surrounding Doune Castle. This survey forms part of wider archaeological investigations of the site with the aim of answering outstanding research questions. A combination of Gradiometer, Resistance and Ground Penetrating Radar (GPR) surveys were undertaken. A second phase of fieldwork, covering the southern limits of the PIC area, is reported on separately (RGC17254/DC2).

The survey has identified a wealth of anomalies of possible archaeological interest, although natural responses are confusing the data to some extent.

The gradiometer data has been adversely affected by broad zones of magnetic disturbance generated by ferrous material within and surrounding the survey area. Although a coherent cluster of responses has been detected to the north of the castle which may indicate an area of potential burning / activity and may be archaeologically significant, interpretation is cautious given the wider context.

Resistance & GPR survey within the courtyard has identified a few anomalies of possible archaeological interest, but the results are dominated by natural responses. The resistance and GPR survey to the north of the castle has identified at least one possible structure, although natural trends in the data may be causing some aliasing of the result.

Both datasets appear to have detected an eastward extension of the extant ditch. Both data sets also suggest a possible feature to the north of and parallel to the existing ditch. However, the gradiometer data does not suggest a second ditch exists. It is possible that the resistance and GPR data are perhaps detecting the remains of an outer wall and / or bank.

Survey:	Doune Castle; Phase 1 (RGC17254/DC1)
Client:	CFA Archaeology on behalf of Historic Environment Scotland
Date of Survey:	8th – 12th January 2018
Survey Personnel:	Dr S M Ovenden and A S Wilson
Report Author:	Dr S M Ovenden
Date of Report:	29th June 2018

1. INTRODUCTION

1.1 A programme of geophysical survey was undertaken within and around Doune Castle. This survey forms part of wider archaeological investigations of the site with the aim of answering outstanding research questions.

1.2 The survey has been divided into two phases. Phase I, reported on here, covers approximately 0.9ha and lies within the northern section of the Properties in Care (PIC) area with survey being carried out within and immediately surrounding the Castle. A combination of Gradiometer, Resistance and Ground Penetrating Radar (GPR) surveys were undertaken. A second phase of fieldwork, covering survey in the south of the PIC area, is reported on separately (RGC17254/DC2).

1.3 The areas covered by each technique are indicated on Figure 1 at a scale of 1:500. Figures 2 - 9 display data plots and interpretations of the gradiometer and resistance survey data, with a combined interpretation plot provided in Figure 10. These are all produced at a scale of 1:500.

1.4 The results from the GPR survey are displayed as a series of depth slices maps, with accompanying interpretations, in Figures 11 – 36 also at a scale of 1:500. Selected radargrams are provided in Figures 37 and 38. Animations of the GPR depth slices are provided on the accompanying CD.

1.5 For ease of discussion, the results from the courtyard area and the areas outside the Castle are discussed separately.

2. METHODOLOGY

2.1 Prior to data collection a series of 20m grids were established across the site and georeferenced using a Trimble R8 GPS system. Georeferenced CAD maps have been supplied to the client.

Gradiometer Survey

2.2 Gradiometer survey is ideally suited to locating ditches, pits, areas of settlement, midden deposits, and kilns/fired areas.

2.3 Gradiometer survey was undertaken using a Bartington Grad601-2 gradiometer. This gradiometer comprises two fluxgate sensors mounted 1m apart on a vertical axis. Each sensor measures the earth's magnetic field, in nanoTesla (nT), and the instrument records the difference between the observed readings for each sensor. As a result the instrument is able to record subtle changes or anomalies in the earth's magnetic field caused by material in the top metre or so of the earth's surface. Data was collected at 0.25m intervals along traverses 1m apart within the series of 20m grids, which were later merged together.

2.4 The data were processed with Geoscan Research Geoplot 4.00 software, using a standard range of corrections and processing algorithms. These include setting the data mean to zero and the application of destagger of the data. The edited data are displayed as XY traces and grey-scale images. Interpolated data are displayed as grey-scale images. In these images the data have been interpolated in the Y direction to create a 'square dataset' which has the overall effect of smoothing the data.

Resistance Survey

2.5 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.

2.6 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.

2.7 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.

2.8 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.

2.9 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

2.10 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.

2.11 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.

2.12 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 as individual traverses at 0.02m intervals along 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 Survey was not possible in some areas due to scaffolding, steep slopes and dense vegetation. An area of temporary hardstanding for coach parking to the northeast of the Castle also precluded survey.

Gradiometer Survey

3.3 Gradiometers are extremely sensitive to ferrous material and areas of magnetic disturbance are to be expected close to fences and other ferrous material, and certain modern materials e.g. tarmac.

3.4 Throughout the survey areas numerous isolated 'iron spikes' have been noted. These indicate isolated ferrous or fired material within the topsoil/subsoil. Only the most prominent of these are noted on the interpretation and are only discussed when relevant. The differentiation between an 'iron-spike' and a 'pit-type' response is based on the strength and form of the anomaly, and the wider context. However, more deeply buried fired/ferrous material will give an anomaly comparable to that produced by a pit.

Resistance Survey

3.5 The distinction between natural/modern/archaeological responses is based on the nature of the anomalies, their strength and form, and their wider context within the survey data.

3.6 The differentiation between 'Possible Archaeology' and 'Possible Natural / Archaeology' anomalies is based on the form of the response. However, it is possible that an anomaly noted as potentially indicating an archaeological feature may have a natural origin, and vice versa.

Ground Penetrating Radar Survey

3.7 GPR is very sensitive to marked variations in surface/near surface material e.g. modern paths. This may result in 'ringing' of the signal. This can result in near surface anomalies re-appearing in deeper depth slices due to the signal bouncing back and forth between the antenna and the feature.

3.8 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.

3.9 Only parallel depth slices and a few selected radargrams are displayed in the report. The accompanying CD contains animations of parallel and horizontal depth slices and all the radargrams.

4. DISCUSSION OF RESULTS FROM COURTYARD AREA

4.1 Results of Gradiometer Survey (Figures 2 – 3, 10)

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

4.1.1 The gradiometer results from the courtyard area are dominated by areas of magnetic disturbance (A) generated by ferrous material adjacent to the survey area e.g. scaffolding, iron grill covering the well, etc.

4.1.2 The origin of the area of magnetic disturbance (B) within the centre of the area is unclear. However, ferrous material was noted embedded in the surface and as a result it is assumed to have a modern origin.

4.1.3 A small pit type anomaly and curving trend (C) has been detected in the northeast of the area. While an archaeological origin for these cannot be dismissed, a modern origin seems likely.

4.1.4 Numerous ferrous / fired responses (D) are evident within the data. It seems most likely that these are due to modern ferrous material within the topsoil

4.2 Results of Resistance Survey (Figures 4 – 10)

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

4.2.1 The resistance survey has recorded a wide range of values across the site, with a very strong well-defined anomaly (1) being detected within the east of the area. While such a well-defined, rectilinear response would normally be viewed as having a potential structural origin, such an interpretation is extremely cautious in this instance. The primary reason for this caution is the alignment of the response which is not consistent with the extant structure. While it could indicate some earlier structure, it is assumed that if such a substantial feature survives there would be some knowledge of it from previous excavations within the area. In addition, the well-defined low resistance anomalies (2), which are very clear in the shaded relief plot (Figure 7), suggest that these broad areas of high (1) and low (2) resistance may simply be due to differing depths of bedrock. There is some evidence in the GPR data to support such an interpretation. In addition, the high pass filtered data, Figure 5, also suggest a natural origin for anomaly (1).

4.2.2 A discrete, well-defined rectangular anomaly (3) has been detected in the southwest of the area. The nature of the response suggests a likely archaeological origin. However, the response could indicate a past excavation trench.

4.2.3 Several trends have been noted in the area, but these are thought to primarily be associated with the natural alignments within the data. However, the trend and small anomaly (4), immediately to the west of (3), may be archaeologically significant.

4.3 Results of Ground Penetrating Radar Survey (Figures 11 – 37)

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

0.00m – 0.25m & 0.13m – 0.38m Parallel Depth Slices (Figures 11 -14)

4.3.1 Several strong reflections are evident within these very shallow depth slices. The response (a) in the west of the area is due to a paved surface.

4.3.2 The origin of (b) is unclear. Given its alignment with the entrance it seems likely that it may indicate a former path or simply an area of greater compaction.

4.3.3 A well-defend response (c) has been detected in the southeast of the area. Unfortunately, survey to the east was not possible due to scaffolding. An archaeological origin seems possible and there is an apparently associated rectilinear trend (d) in the 0.25m – 0.50m depth slice which may be significant. However, once again, this could be due to past excavations in the area.

4.3.4 Numerous trends have been noted within the 0.13m – 0.38m depth slice, generally on a NW-SE alignment which are likely to have a natural origin.

0.25m – 0.50m Parallel Depth Slice (Figures 15 &16)

4.3.5 Anomaly (c) is still evident within this depth slice, together with a weaker rectilinear anomaly (d). These responses are suggestive of some earlier surface or possibly structural remains. The radargram from Traverse A8, Figure 37, shows clear reflections (c) indicating a possible surface However, interpretation is cautious given presumed natural responses in the area and (c) appears to respect the limits of resistance anomaly (1).

4.3.6 A similar response (e) has been detected in the west of the area and shows some correlation with resistance anomaly (3).

4.3.7 A cluster of responses (f) may be of archaeological interest given their association with an extant structure immediately to the north.

4.3.8 A very ephemeral rectangular area of slightly higher amplitude reflections (g) is apparent towards the centre of the survey area. This is approximately 5.5m by 6m and may be of archaeological interest, but interpretation is cautious due to its very weak nature and the lack of any corresponding response in the resistance survey data, although its western and northern edges do correspond with the limits of resistance anomaly (1).

4.3.9 Numerous trends have been noted within this depth slice. While some may be significant it seems likely that the majority are due to natural variations in the subsoil and / or recent ground disturbance.

0.38m – 0.63m & 0.50m – 0.75m Parallel Depth Slices (Figures 17 - 20)

4.3.10 Anomalies (c) and (e) are still evident within these two overlapping depth slices, but they are less well-defined.

4.3.11 The clear linear response (h) is a buried service which continues beyond the south of the castle and is clear in the gradiometer and resistance data from that area, discussed below.

4.3.12 Additional trends are evident within the data which may indicate additional services and natural variations within the subsoil.

0.63m – 0.88m & 0.75m – 1.00m Parallel Depth Slices (Figures 21 - 24)

4.3.13 The buried service (h) is still evident within the 0.63m – 0.88m depth slice.

4.3.14 Anomalies (c) and (e) are also still clear within these depth slices. However, when viewing the radargram from Traverse A8, Figure 37, a clear surface is evident at these depths. While this could indicate an earlier surface within the castle, the nature of the response suggests this is a natural horizon, most likely bedrock.

4.3.15 Additional discrete anomalies (i) are starting to emerge within this depth slice within the centre of the survey area. The shape and trends of (i) show good correlation with the high pass filtered resistance data, Figure 6. The radargram from Traverse A21, shows clear reflections in this area suggesting an interrupted surface. While an archaeological origin cannot be dismissed, when viewing the data as a whole and alongside the resistance data, it is likely that these responses are due to natural variations. However, it is not clear if the interrupted nature is simply due to variations in the bedrock profile or is indicative of areas that have not been disturbed.

4.3.16 An anomaly (j) has been recorded in the northwest of the area. This may be significant suggesting possible structures around the entrance, particularly when viewed together with (f) in shallower slices. However, given its proximity to the entrance a modern origin is possible.

1.00m – 1.25m & 1.25m – 1.50m Parallel Depth Slices (Figures 25 – 28)

4.3.17 Anomalies (i) and (j) are still clear within this depth slice. Although (j) is strong at this depth the radargram from Traverse A61 suggests a natural origin.

4.3.18 The anomalies in the south (k) are becoming more ephemeral.

4.3.19 As can be seen from the radargrams in Figure 37, which have been topographically corrected, responses (i) and (j) are at a similar absolute depth, with anomalies (k) in the south being deeper suggesting the bedrock slopes gently down to the south.

4.3.20 Several trends are apparent, although given their depth a natural origin seems most likely.

1.50m – 1.75m & 1.75m – 2.00m Parallel Depth Slices (Figures 29 - 32)

4.3.21 Responses (i), (j) and (k) dominate these depth slices suggesting a natural origin.

2.00m – 2.25m & 2.25m – 2.50m Parallel Depth Slice (Figures 33 - 36)

4.3.22 The responses within these deep depth slices are most likely due to natural variations and ringing of the signal.

5. DISCUSSION OF RESULTS FROM AREAS SURROUNDING THE CASTLE

5.1 Results of Gradiometer Survey (Figures 2 – 3, 10)

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

5.1.1 Broad areas of magnetic disturbance (E) have been recorded on the limits of the survey areas due to ferrous material within fencing, scaffolding etc. The cobble paths have also generated zones of magnetic disturbance (F).

5.1.2 A linear anomaly characteristic of a buried service (G) has been detected to the south of the Castle and appears to be a continuation of the service detected within the courtyard.

5.1.3 To the northeast of the castle a broad zone of increased magnetic response (H) has been recorded. The nature of the responses suggests a relatively modern origin, most likely associated with buildings that were in this area until relatively recently.

5.1.4 A cluster of large pit type anomalies (I) has been recorded to the north of the castle. While these responses are very strong their form does not suggest they are simply due to modern ferrous material, although they could still have a relatively modern origin. They may be archaeologically significant indicating an area of burning / heating, or perhaps midden deposits. There is some correlation with the resistance and GPR results which is discussed below.

5.1.5 Isolated pit type anomalies and trends have been noted but their interpretation is cautious, and they are likely to have a natural / modern origin.

5.2 Results of Resistance Survey (Figures 4 – 10)

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

5.2.1 The resistance survey has recorded a wide range of values across the site. The well-defined low resistance linear response (5) to the south of the Castle coincides with gradiometer anomaly (G) and is believed to be the continuation on the drain (h) detected within the courtyard. Additional low resistance trends to the west of the castle may also be due to buried drains.

5.2.2 A linear high resistance response (6) to the south of the Castle, which is very clear in the shaded relief plot (Figure 7) could indicate a stone drain given its apparent spatial relationship with (5). However, given the wider data sets it may be due to geological variations.

5.2.3 The high resistance readings (7) south of the Castle may be archaeologically significant but could equally simply be due natural variations in the moisture content of the ground caused by adjacent slopes. The liner trend (8), just to the south of the castle, coincides with the location of a former fence.

5.2.4 A wide variety of anomalies have been recorded to the north and northeast of the Castle. Given the topographical variations within this area some images showing the data draped over the topography have been included in Figure 8.

5.2.5 A strong high resistance anomaly (9) has been recorded over the bank immediately to the north of the main ditch. The correlation with the bank is clear in the topographic plots in Figure 8. It seems likely that this response is due to revetment within the bank rather than simply due to preferential drainage. Weaker anomalies (10) to the east suggest a continuation of this bank / revetment even though there is no obvious expression of such a feature on the surface. In addition, the area to the south of (9) and (10) is relatively low which would be consistent with a ditch continuing of the east beyond the ditch visible on the surface.

5.2.6 A further high resistance response (11) may indicate possible revetment on the south side of this postulated extension to the ditch. The suggestion of this feature is particularly clear in the high pass filtered data and the shaded relief plot (Figures 6 & 7).

5.2.7 A further band of high resistance response (12) has been recorded to the north of (9). As can be seen in Figure 8, this does not show a clear correlation with the topography of the site. Although there is a suggestion of a further ditch between (9) and (12) suggested by a low resistance trend, with the potential for (12) indicating a collapsed revetment / bank, such an interpretation is extremely cautious given the lack of a ditch type anomaly in the gradiometer data. It is possible that the resistance is perhaps detecting the remains of an outer wall and / or bank.

5.2.8 The area to the north of the Castle and the west of the path leading to the Castle shows a range of responses. The area also has marked topography variations. Within the general area of high resistance several discrete anomalies have been noted. The anomalies (13) correspond with slight banks, as can be seen in Figure 8, surrounding a well-defined depression. It is not clear if the resistance survey is simply mapping the topographic variations or suggesting the survival of potential structures beneath the surface. There is correlation with the GPR data suggesting possible rectangular structures, but it is complex as discussed below.

5.2.9 A series of parallel trends (14) suggest a possible former path or trackway although it is not very well defined. It is thought the high resistance responses (15) may simply be due to former layouts of the area.

5.2.10 The high resistance anomaly (16) between the path and the track coincides with an area of slightly higher ground and are thought to have a natural origin based on the GPR survey.

5.2.11 The high resistance responses (17) to the east of the track coincide with areas of short grass paths. However, it is perplexing that not all the paths in this area show as high resistance anomalies. This could just be due to drainage on the slightly higher ground or perhaps this path has been in existence for a longer period of time or are used more frequently by the public resulting in greater compaction of the ground. The latter is likely from our observations on site.

5.2.12 A more coherent response (18) has been noted which may be of archaeological interest and does appear to perhaps be a continuation of (12), although such an interpretation is cautious.

5.2.13 Numerous additional trends and pit type anomalies have been detected to the east of the track. While some of these may be significant, e.g. (19), they may simply be associated with the former farm buildings.

5.3 Results of Ground Penetrating Radar Survey (Figures 11 – 36, 38)

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

<u>0.00m – 0.25m Parallel Depth Slice (Figures 11 &12)</u>

5.3.1 The strongest responses (I) within this shallow depth slice are due to the cobble path and track and the mown grass paths.

5.3.2 A rectilinear zone of high amplitude reflections (m) has been detected in the north of the area. These are not very strong, but they are coherent and show good correlation with resistance anomalies (13). However, as with the resistance data it is not clear if, within this shallow slice, the survey is simply mapping the topographic changes within the area. A sample radargram from this area, Traverse B29 Figure 38, shows a distinct response within this area.

0.13m – 0.38m Parallel Depth Slice (Figures 13 &14)

5.3.3 Anomaly (m) is still clear within this overlapping depth slice. An apparently associated low amplitude response (n) is also evident. This shows some correlation with resistance trends (14) supporting interpretation of a possible trackway.

5.3.4 Two parallel trends (o) have been detected in the east of the area. While these may be archaeologically significant they could simply indicate a former path. Numerous additional trends are visible throughout the survey area, but it is difficult to formulate a precise interpretation for these and they may have a natural origin.

0.25m – 0.50m Parallel Depth Slice (Figures 15 &16)

5.3.5 The result within this depth slice are not particularly coherent, although the low amplitude response (n) and the linear trends (o) are still clear.

5.3.6 A relatively well-defined response (p) is evident in the north of the area and is discussed in more detail below. Although several discrete high amplitude anomalies are evident in the west of the area, it is difficult to assign a clear interpretation and they may be due to natural variations in the subsoil.

5.3.7 It is likely that the trends (q) in the east of the area show some correlation with the resistance data (10) and may indicate the postulated continuation of the ditch running through this area.

0.38m – 0.63m & 0.50m – 0.75m Parallel Depth Slices (Figures 17 - 20)

5.3.8 Within these depth slices anomaly (p) is becoming more coherent and stronger. The data suggests a general NW-SE trend in the data within this area. It is possible that these anomalies and trends indicate a former track / path running through the area. Alternatively, they could be natural trends in the data given their comparable alignment to the presumed natural responses recorded within the courtyard.

5.3.9 Similarly, trends (q) are still visible and show some correlation with the resistance anomalies (10) perhaps suggesting a continuation of the ditch.

5.3.10 More discrete anomalies (r) are becoming clearer within these depth slices

0.63m – 0.88m & 0.75m – 1.00m Parallel Depth Slices (Figures 21 - 24)

5.3.11 Within these depth slices anomaly (p) has resolved into a well-defined recliner anomaly with a possibly associated curving response (s). While the nature and form of the response certainly suggests a potentially structural origin, interpretation is still cautious due to the natural trends and responses within the wider area. These anomalies lie to the north of rectilinear responses (m) seen in the shallower depth slices.

5.3.12 Anomaly (r) is also more coherent and shows some correlation with resistance anomaly (12) suggesting a possible revetment. A sample radargram, Traverse C3 Figure 38, show this response. As discussed above there is some suggestion in the data for a second ditch to the north of the existing one but it is not very well defined and not visible in the gradiometer data suggesting that these anomalies are due to a wall or bank.

1.00m – 1.25m Parallel Depth Slice (Figures 25 & 26)

5.3.13 Within this depth slice anomaly (p) is still apparent

5.3.14 Anomaly (r) is still clear and has a clear eastward extension, which corresponds to resistance anomaly (10) adding to the impression of a ditch and / or bank beyond the main extant ditch. The parallel response (t) to the south appears to be a continuation of the extant bank.

1.25m – 1.50m, 1.50m – 1.75m & 1.75m – 2.00m Parallel Depth Slices (Figures 27 – 32)

5.3.15 Anomaly (r) suggesting an outer bank is still clear within these depth slices. Additional trends (u) have been noted which may be of archaeological interest, but interpretation is cautious.

5.3.16 In the north of the survey area more amorphous high and low amplitude anomalies (v) are apparent which are thought to have a natural origin.

5.3.17 The response (w) is due to bedrock with a distinct response visible in the radargram for Traverse B57, Figure 38.

2.00m – 2.25m & 2.25m – 2.50m Parallel Depth Slice (Figures 33 - 36)

5.3.18 The responses within these deep depth slices are most likely due to natural variations and ringing of the signal.

6. CONCLUSIONS

6.1 The survey has identified a wealth of anomalies of possible archaeological interest, although natural responses are confusing the data to some extent.

6.2 The gradiometer data has been adversely affected by broad zones of magnetic disturbance generated by ferrous material within and surrounding the survey area. Although a coherent cluster of responses has been detected to the north of the castle which may indicate an area of potential burning / activity and may be archaeologically significant, interpretation is cautious given the wider context.

6.3 Resistance & GPR survey within the courtyard has identified a few anomalies of possible archaeological interest, but the results are dominated by natural responses.

6.4 The resistance and GPR survey to the north of the castle has identified at least one possible structure, although natural trends in the data may be causing some aliasing of the result.

6.5 Both resistance and GPR datasets appear to have detected an eastward extension of the extant ditch. Both data sets also suggest a possible feature to the north of and parallel to the existing ditch. However, the gradiometer data does not suggest a second ditch exists. It is possible that the resistance and GPR data are perhaps detecting the remains of an outer wall and / or bank.

List of Figures

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

Location Diagram

Gradiometer Survey

Resistance Survey

GPR Survey

N

0m 20m

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Figure 1

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

Gradiometer Survey

Interpolated Data

12

nT

-10

N

0m 20m

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Figure 2

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey
Gradiometer Survey
Interpretation

E
I
F
F
E
H
E
E
A
A
C
D
B
A
A
D
A
G
E

Positive Magnetic Response

Area of Increased Response

Trend

Ferrous

Magnetic Disturbance

Buried Service

N

0m 20m

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Figure 3

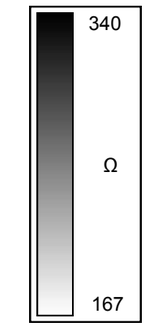
Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

Resistance Survey

Raw Data



N

0m 20m

Rose Geophysical Consultants

Figure 4

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

Resistance Survey

Interpolated Data

365

Ω

150

N

0m 20m

Rose Geophysical Consultants

Figure 5

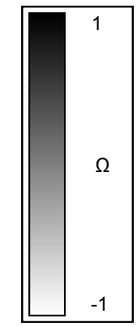
Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

Resistance Survey

High Pass Filtered Data



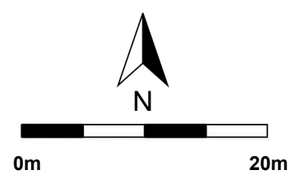


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Figure 6

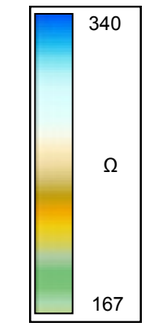
Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

Resistance Survey

Shaded Relief Plot



N

0m 20m

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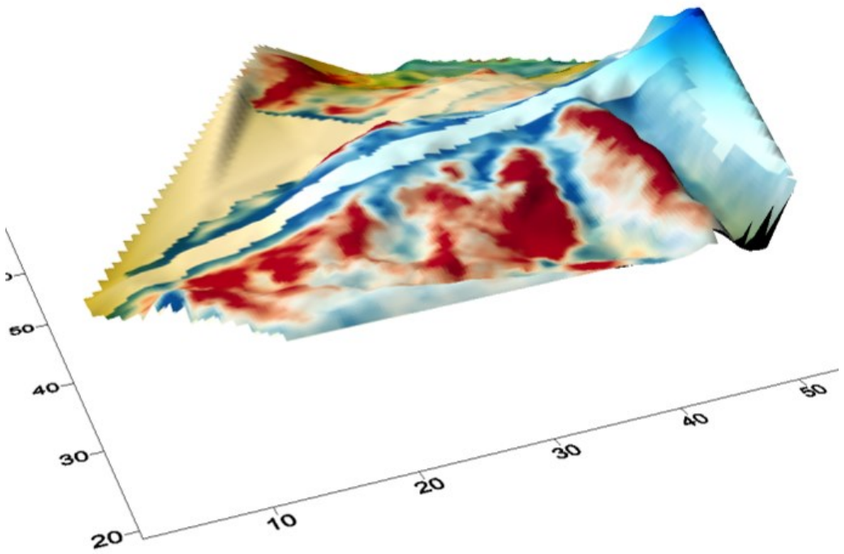
Figure 7

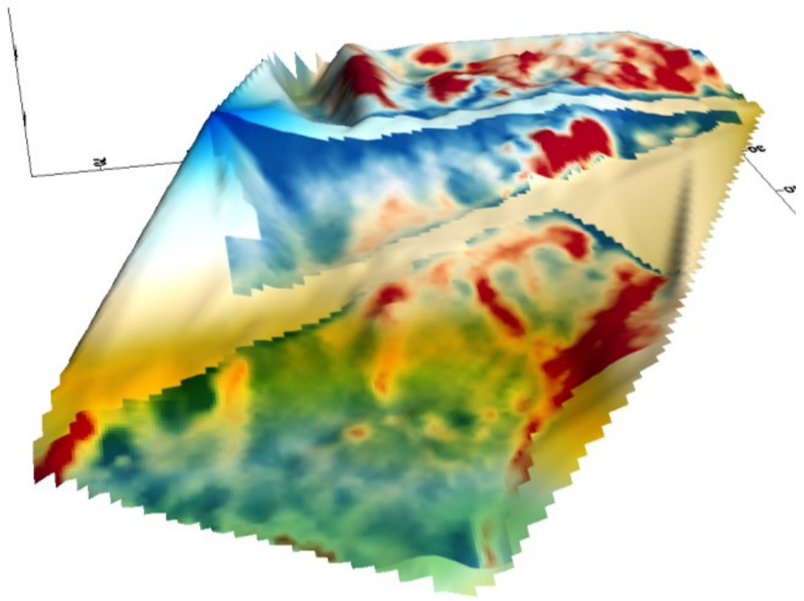
DOUNE CASTLE

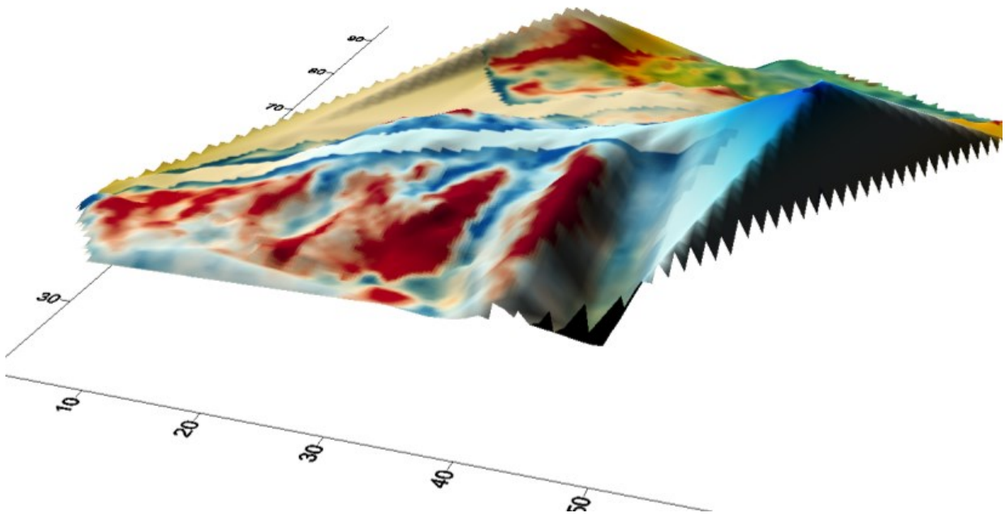
Castle Area Survey

Resistance Survey

Interpolated Data over Topography







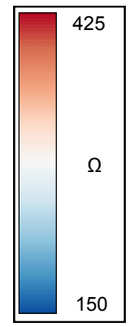


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Figure 8

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

Resistance Survey

Interpretation

High Resistance:
?Archaeology

High Resistance:
?Natural / Archaeology

High Resistance:
Trend

High Resistance:
? Natural

Low Resistance:
Trend

N

0m 20m

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Figure 9

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

Geophysical Survey

Combined Interpretation

Positive Magnetic Response

Area of Increased Response

Gradiometer Trend

High Resistance:
?Archaeology

High Resistance:
?Natural / Archaeology

High Resistance:
Trend

High Resistance:
? Natural

Low Resistance:
Trend

N

0m 20m

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Figure 10

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 0.00m - 0.25m

High

Low

N

0m 20m

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Figure 11

Based on plan supplied by HES

m

l

l

l

l

b

a

c

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DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 0.00m - 0.25m

- Modern Surface
- High Amplitude: Possible Archaeology
- High Amplitude
- Trend
- Low Amplitude: Possible Natural
- Natural
- Ringing

N

0m 20m

Figure 12

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 0.13m - 0.38m

High

Low

N

0m 20m

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Figure 13

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 0.13m - 0.38m

m

n

l

o

l

a

b

c

Modern Surface

High Amplitude:
Possible Archaeology

High Amplitude

Trend

Low Amplitude:
Possible Natural

Natural

Ringing

N

0m 20m

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Figure 14

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 0.25m - 0.50m

High

Low

N

0m 20m

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Figure 15

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 0.25m - 0.50m

- Modern Surface
- High Amplitude: Possible Archaeology
- High Amplitude
- Trend
- Low Amplitude: Possible Natural
- Natural
- Ringing

N

0m 20m

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Figure 16

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 0.38m - 0.63m

High

Low

N

0m 20m

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Figure 17

Based on plan supplied by HES

p

r

o

q

h

f

e

c

DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 0.38m - 0.63m

Modern Surface

High Amplitude:
Possible Archaeology

High Amplitude

Trend

Low Amplitude:
Possible Natural

Natural

Ringing

N

0m 20m

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Figure 18

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 0.50m - 0.75m

High

Low

N

0m 20m

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Figure 19

Based on plan supplied by HES

p

r

o

q

h

e

c

DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 0.50m - 0.75m

- Modern Surface
- High Amplitude: Possible Archaeology
- High Amplitude
- Trend
- Low Amplitude: Possible Natural
- Natural
- Ringing

N

0m 20m

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Figure 20

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 0.63m - 0.88m

High

Low

N

0m 20m

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Figure 21

Based on plan supplied by HES

p

s

r

q

j

i

h

i

e

c

DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 0.63m - 0.88m

- Modern Surface
- High Amplitude: Possible Archaeology
- High Amplitude
- Trend
- Low Amplitude: Possible Natural
- Natural
- Ringing

N

0m 20m

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Figure 22

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 0.75m - 1.00m

High

Low

N

0m 20m

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Figure 23

Based on plan supplied by HES

p

s

r

j

i

i

e

c

DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 0.75m - 1.00m

Modern Surface

High Amplitude:
Possible Archaeology

High Amplitude

Trend

Low Amplitude:
Possible Natural

Natural

Ringing

N

0m 20m

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Figure 24

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 1.00m - 1.25m

High

Low

N

0m 20m

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Figure 25

Based on plan supplied by HES

p

r

r

t

j

i

i

k

k

DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 1.00m - 1.25m

- Modern Surface
- High Amplitude: Possible Archaeology
- High Amplitude
- Trend
- Low Amplitude: Possible Natural
- Natural
- Ringing

N

0m 20m

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Figure 26

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 1.25m - 1.50m

High

Low

N

0m 20m

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Figure 27

Based on plan supplied by HES

v

r

u

r

j

i

i

k

DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 1.25m - 1.50m

- Modern Surface
- High Amplitude: Possible Archaeology
- High Amplitude
- Trend
- Low Amplitude: Possible Natural
- Natural
- Ringing

N

0m 20m

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Figure 28

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 1.50m - 1.75m

High

Low

N

0m 20m

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Figure 29

Based on plan supplied by HES

v

W

r

u

r

j

k

k

DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 1.50m - 1.75m

- Modern Surface
- High Amplitude: Possible Archaeology
- High Amplitude
- Trend
- Low Amplitude: Possible Natural
- Natural
- Ringing

N

0m 20m

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Figure 30

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 1.75m - 2.00m

High

Low

N

0m 20m

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Figure 31

Based on plan supplied by HES

v

r

u

r

k

k

j

DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 1.75m - 2.00m

- Modern Surface
- High Amplitude: Possible Archaeology
- High Amplitude
- Trend
- Low Amplitude: Possible Natural
- Natural
- Ringing

N

0m 20m

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Figure 32

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 2.00m - 2.25m

High

Low

N

0m 20m

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Figure 33

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 2.00m - 2.25m

- Modern Surface
- High Amplitude: Possible Archaeology
- High Amplitude
- Trend
- Low Amplitude: Possible Natural
- Natural
- Ringing

N

0m 20m

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Figure 34

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Depth Slice: 2.25m - 2.50m

High

Low

N

0m 20m

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Figure 35

Based on plan supplied by HES

DOUNE CASTLE

Castle Area Survey

GPR Survey

Interpretation: 2.25m - 2.50m

- Modern Surface
- High Amplitude: Possible Archaeology
- High Amplitude
- Trend
- Low Amplitude: Possible Natural
- Natural
- Ringing

N

0m 20m

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Figure 36

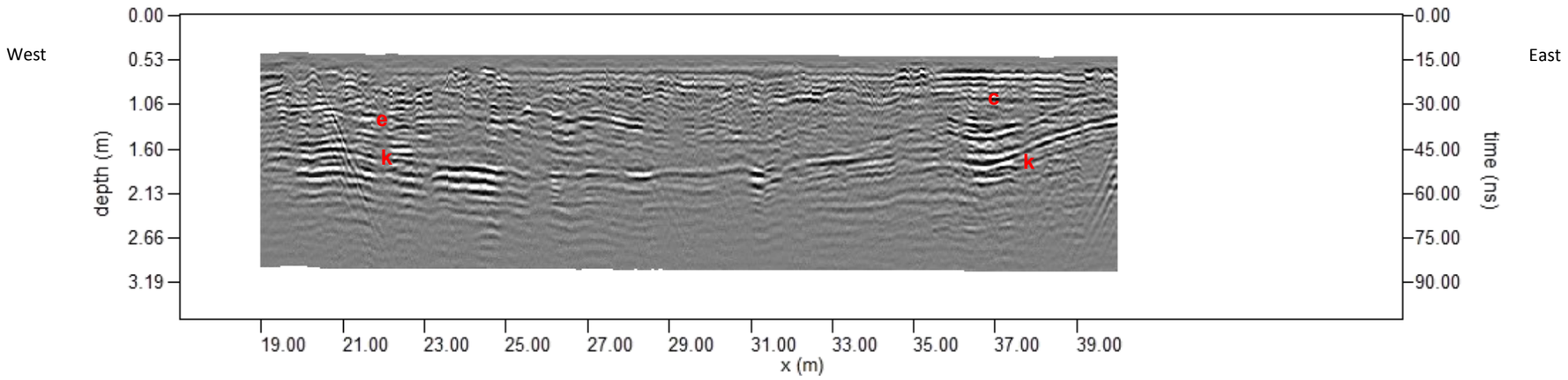
DOUNE CASTLE

Castle Area Survey

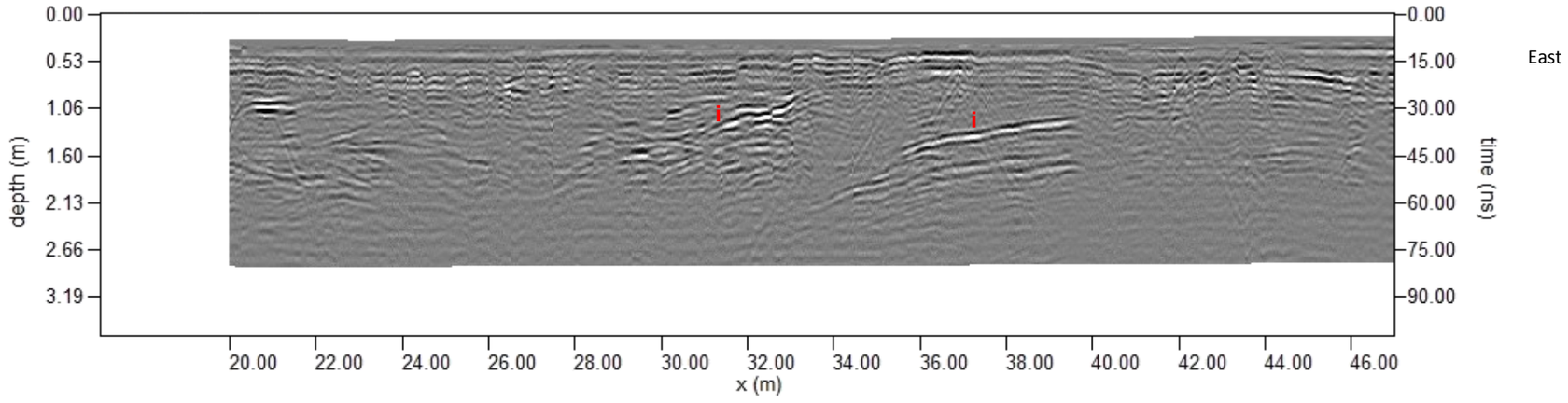
GPR Survey

Selected Radargrams: Courtyard

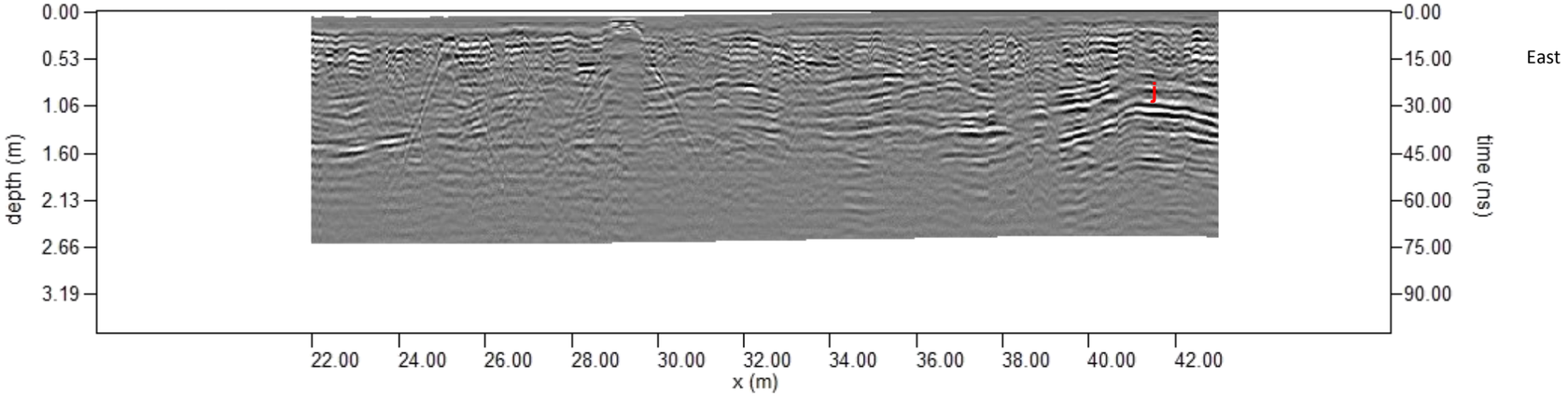
Traverse A8



Traverse A29



Traverse A61



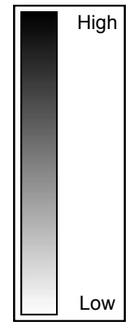


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Figure 37

DOUNE CASTLE

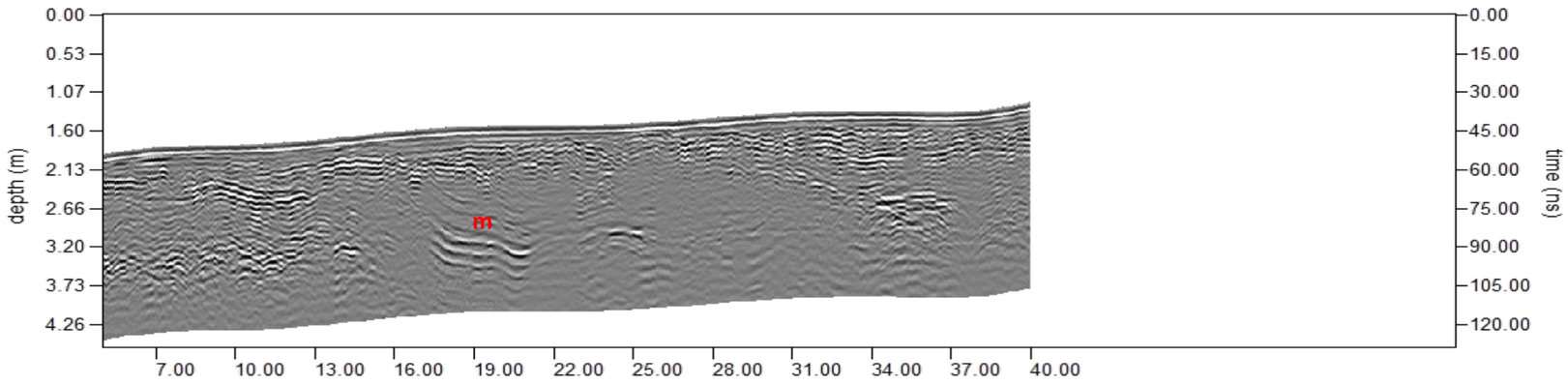
Castle Area Survey

GPR Survey

Selected Radargrams: North

Traverse B29

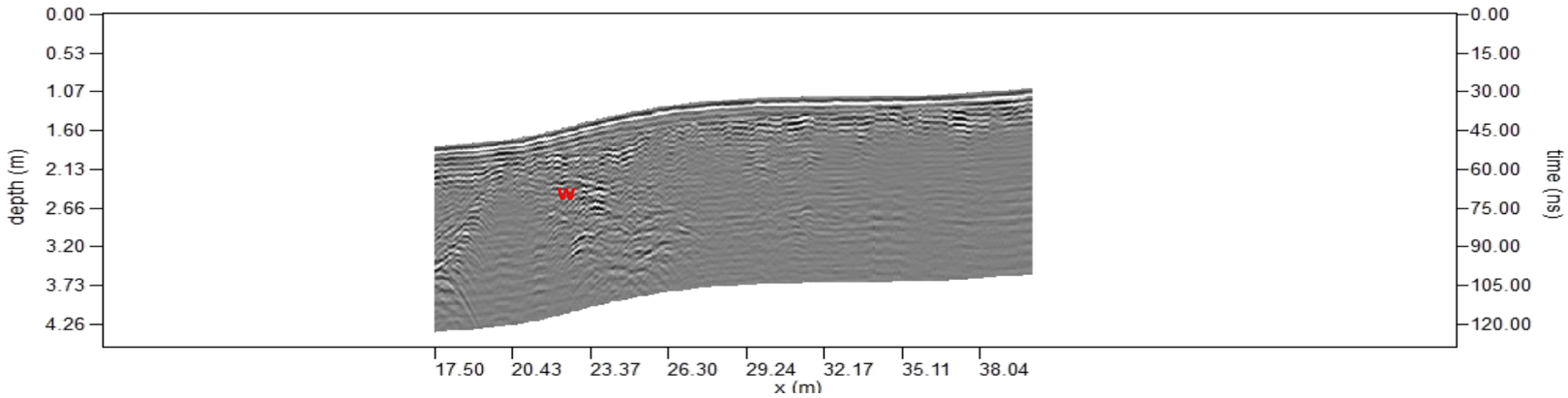
South



North

Traverse B57

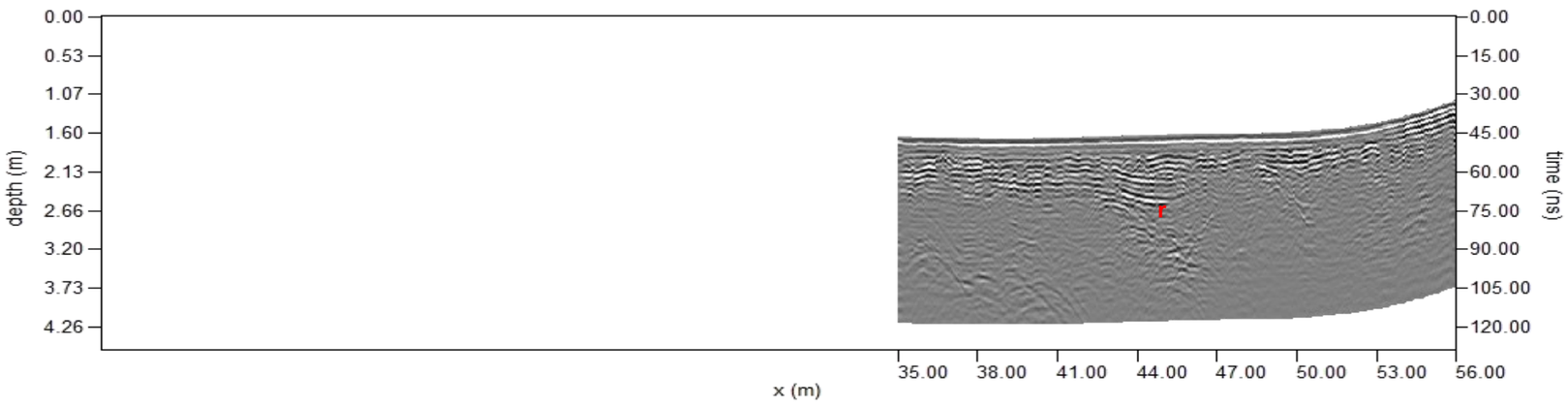
South



North

Traverse C3

South



North

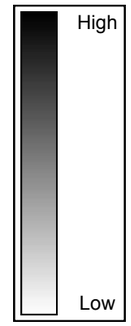


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Figure 38