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Loch of Yarrows Environs, Caithness: 'Testing the applicability of Ground Penetrating Radar survey in relation to wetland landscapes'

Report No. 1287

CONTENTS

1.	Introduction	3
2.	Research Aims and Objectives	7
3.	Methodology and techniques	8
4.	Olicalte Farm	12
5.	South Yarrows 1 and 2	16
6.	Swartigill Burn	19
7.	Discussion	21
8.	Conclusion	21
9.	Recommendation	22
10.	Bibliography	23

APPENDIX

1.	Photographic record	24
2.	pH data	25

FIGURES

Fig 1	Location map of the sites mentioned in text.	26
Fig 2	Location plan of Oliclate transect Grids A and B.	27
Fig 3	Oliclate Grid A probe transect and radargram profile.	28
Fig 4	Oliclate Grid B probe transect and radargram profile.	29
Fig 5	Location plan of South Yarrows 1 and 2.	30
Fig 6	South Yarrows 1 probe transect and radargram profile.	31
Fig 7	South Yarrows 2 probe transects and radargram profiles.	32
Fig 8	Location plan of Swartigill Burn GPR grid and township.	33
Fig 9a	Plate 1, exposed wall remains at Swartigill Burn	34
Fig 9b	Section drawing of the wall shown in Fig 9a	34
Fig 10	Swartigill Burn radargram showing orientation of survey and depths	35

PLATES (Bound at rear)

Plate 1 Exposed building remains eroding out of the burn section
Plate 2 Dr Susan Ovenden, Geopysics Unit, Orkney College explaining discussing the GPR data logger with the project volunteers.
Plate 3 GPR survey in progress at Olicalte Grid B.
Plate 4 Project volunteers carrying out the peat probing along a transect at Oliclate Site B.
Plate 5 Project volunteers recording peat stratigraphy at South Yarrows 1.
Plate 6 Blue-grey minerogenic silt recovered from the base of the core at Oliclate Grid A.
Plate 7 Project volunteers cleaning up the building remains exposed in section at Swartigill Burn. GPR transects are laid out along side the feature

DES ENTRY (Bound at rear)

1. INTRODUCTION

1 General

1.1.1 In January 2007, CFA Archaeology Ltd carried out a series of investigative surveys incorporating stratigraphical analysis combined with Ground Penetration Radar (GPR) survey within the vicinity of Loch of Yarrows, Caithness (NGR ND310 440 centred on). The study was designed to assess the applicability and potential use of GPR over different wetland environments. The work was commissioned by the Scottish Wetland Archaeology Programme (SWAP) as part of their on-going research agenda for Scottish wetland archaeology. The project was carried out according to a research design formulated by SWAP in 2006.

1.1.2 The research design was based on an earlier programme of GIS-based analysis of Caithness from which the Loch of Yarrows environment was identified as a candidate flagship study area for the Scottish Wetland Archaeology Programme. The region held all the appropriate criteria to address *Research Theme 2* of the SWAP agenda, *Peatland survey and wetland characterisation* (Cavers 2006). Peat coverage immediately around the Loch of Yarrows is of variable depth and has been improved for pastoral use in the past. To the north of the loch around the area of Oliclate Farm and to the west towards Camster, there are expansive areas of deeper peat in which organic palaeoenvironmental remains are now better understood (Tipping 2005 unpublished).

1.1.3 The immediate landscape around the Loch of Yarrows is a predominantly wetland one with sedge mires found to the east and moist Atlantic heather with blanket bog to the south and west. Extensive blanket peat is to be found beyond the western margins of the loch. The area around the Loch of Yarrows is particularly rich in prehistoric sites including Mesolithic blade scatter sites, well preserved Neolithic stone rows and burial cairns; Bronze Age hut circles; an Iron Age Broch; at least one crannog; and some evidence from the Pictish period including a cist (c.300-800 AD). The area thus offered the opportunity to study a densely packed archaeological landscape preserved in the peat and offer a wetland perspective on key periods in Scotland (Cavers 2006).

1.2 Archaeological background

1.2.1 The criteria of selecting appropriate study areas lies within the following SWAP statement " Where possible well studied areas and regions where active research is currently underway should be chosen over areas without a regional framework". The following discussion highlights just how rich and important the Loch of Yarrows area is in terms of its archaeological potential and its wealth of previous research spanning at least the last two hundred years.

1.2.2 The Yarrows landscape offers a prime opportunity to study the relationship between human beings and peat from a diachronic perspective. Recent dates from the peat bogs around Yarrows suggest they go back at least 10,000 years (Tipping *et al*. forthcoming). The Yarrows landscape is rare in North Western European terms in that it can be seen as the result of potentially traceable natural and human impacts occurring over some 10 millennia. The fact that much of the area is still settled today offers a rare opportunity to study how various human populations lived and work in a peat landscape over time. The area thus offers the opportunity to study a densely packed prehistoric landscape preserved in the peat and offers a wetland perspective on these key periods in Scotland.

Mesolithic

1.2.3 The Mesolithic flint working site at Oliclate, mentioned above, is located about one mile west of the Loch of Yarrows indicating that prehistoric sites may survive under the peat in this area. Mesolithic flints including blades, scrapers and a single blade core have also been found under peat deposits around the southern margins of the loch suggesting that there was activity along much of the loch edge from the Mesolithic onwards (Baines et al. 2003).

Neolithic

1.2.4 The Neolithic stone rows at Battle Moss were first surveyed back in 1871 but were not subject to more detailed examination until an excavation project was initiated by a joint team from Cardiff and Glasgow Universities in 2003 (Baines, Brophy and Pannett 2003). The site consists of eight irregular but parallel rows of 18 to 21 stones up to 2.5 metres apart with the longest row measuring 40 metres from north to south. The recent fieldwork also resulted in the discovery of a previously unrecorded ring cairn in the peat some 100 metres to the north of the stone rows, which has since been dated by pottery and radiocarbon assays from cremated bone to the Early to Middle Bronze Age (spanning c.2300 – 1500 BC).

1.2.5 There are numerous burial cairns located around the environs of the loch. The most significant of which includes the long cairn at South Yarrows (NMRS no. ND34SW 5), excavated by Joseph Anderson in 1865, which was probably originally built as a round cairn (the eastern end) before being enlarged into a long cairn at a later date. A second long cairn, South Yarrows North (NMRS no. ND34SW 6), which was also excavated by Anderson in 1865, sits some 200 metres to the north on the same peat covered ridge. It is described as an Orkney-Cromarty type long, horned cairn with a Camster-type chamber, where Anderson reportedly found a cist burial with an urn and seventy lignite disc beads of a single jet necklace. The site sits in peat and is partly overgrown and obscured by peat and heather growth. The margins of another burial cairn – South Yarrows (NMRS no. ND34SW 48) – are intact and clearly sit in peat despite later disturbance from a trench cut through the centre of the cairn probably to remove a skeleton as reported by Anderson in 1870.

Bronze Age

1.2.6 Bronze Age activity in the area is attested by the burial evidence mentioned above and more significantly by through the occurrence of circular huts or roundhouses sitting in the peat. Overlooking the Loch of Yarrows from the south is a circular roundhouse (NMRS no. ND34SW 53) featuring peat covered stone walls around 12 metres in diameter, with a smaller circular structure inside also featuring peat covered stone walls and utilising the same entrance to the east as the larger hut. Given the growth of peat on the walls we may suspect this hut to date from at least the Bronze Age. About 250 metres to the south of this site are a group of roundhouses with apparently associated field divisions. The enclosures and walls of the houses have stone footings where visible but are heavily overgrown with peat again pointing towards a prehistoric date.

Iron Age

1.2.7 The broch of Yarrows is significant as it features a complex range of secondary structures (including wags – an enigmatic and distinctive Caithness site type), and is located on a spur projecting directly into the north-west corner of the loch. Due to the raising of the loch level by damming not only is the interior of the broch waterlogged but a number of external structural features on the southern and eastern sides of the settlement are now either waterlogged or can be to seen to run underwater into the loch margins. Although damming occurred at the end of the 19th century it is highly likely that these waterlogged deposits will have preserved organic remains relating to the use of the broch. It is also possible given the brochs direct association and location next to the loch that midden and refuse deposits relating to the use of the broch will survive in the loch silts. In addition the site is defended by a large ditch on the western and south western sides which has not been excavated and offers a high likelihood that waterlogged organic remains will survive at its base.

1.2.8 Two small islands which were apparently occupied by buildings were reported as visible in the Loch of Yarrows in the 19th century AD (NMR: Anderson 1866). Today only one of the islands, apparently artificial and constructed from boulders, is visible in the loch as the water level is thought to have risen some 1.0 to 1.5 metres. This island has never been inspected and the existence of a possible second crannog has not been confirmed. These sites offer the potential to investigate and date crannog sites in close association with a broch site.

1.3 GPR Surveys in wetland environments

1.3.1 In the past GPR survey in extremely wet and waterlogged environments has been found to be problematical due to the reduction in speed of the transmission of radio waves emitted by the radar and hence reduction of the effective depth of operation (Clarke *et al* 1999). However, a GPR survey at North Ballachulish Moss, Highlands successfully recorded a suite of archaeological features of prehistoric date (Utsi 1996). Since the mid-1990s GPR equipment has improved and its applicability within Scottish wetland sites has hitherto been largely unexplored. The recognition that GPR survey works on terrestrial archaeological sites is well known but the potential of GPR to rapidly identify buried archaeological sites under peat has yet to be explored in as greater detail owing to the technical problems outlined below.

1.3.2 The limiting factor with GPR is the potential attenuation of the radar signal due to extreme waterlogging. To date, GPR work on Scottish wetland sites have tended to concentrate on mainly deep and expansive areas of peat such as that at North Ballachulish Moss and Moine Mhor in the Kilmartin Valley, (Clarke 2003) which provide variable results.

1.3.3 Elsewhere, various empirical trials have been undertaken showing the capabilities of GPR for mapping the thickness and stratigraphy of organic deposits in ponds and bogs. Depending on how much the physical properties vary with depth, GPR results varied from just detecting the bottom of the peat to differentiating the actual peat stratigraphy (Moorman 2001). GPR has had good success in charting the routes of natural sub-peat drainage pipes. This provides a non-destructive, fast technique which can produce continuous profiles of peat depth and indicate pipe locations across survey transects, (Holden *et al* 2002).

1.3.4 The GPR survey at Loch of Yarrows environs was carried out over a single weekend to allow members of the Caithness Field Club and Yarrows Archaeological Trust to take an active part in the fieldwork. The survey was carried out at locations that were deemed the most profitable and to provide positive results within the given time frame.

1.3.5 A six-fold set of general requirements were proposed within the SWAP research framework and were outlined in the Project Brief:

- the methodologies employed should involve minimal intervention in the existing sediment;
- local community groups should be involved in the work, where possible;
- local landowners were to be contacted about proposed fieldwork;
- Highland Archaeological Service were to be notified of project and of fieldwork schedule;
- a report on the results of the evaluation phase is required which will be integrated into an overall report to Historic Scotland on SWAP projects in 2006-7;
- a DES entry should be prepared;
- the project had be completed by the end of January 2007 (to allow the integration of reports)

1.4 Report Layout

1.4.1 Section 1 provides a general introduction. Section 2 outlines the research aims and objectives. Section 3 describes the methodology used during the course of the project. Sections 4-7 describes the results obtained from each of the four respective study areas. Section 8 discusses the implications of the results and Section 9 provides a series of recommendations. Section 10 list the bibliographic and cartographic sources examined. Appendix 1 lists the photographs taken. Appendix 2 lists the results oh pH and mV analysis.

1.5 Acknowledgements

1.5.1 The authors would like to extend their gratitude to Mrs Islay McLeod owner of the Thrumster Sporting Estate for allowing access to the survey areas, logistical support, field assistance and her hospitality during the fieldwork. The Orkney College Geophysics Unit is warmly thanked for technical assistance with the GPR survey. Members of the Caithness Archaeological Trust and Yarrows Archaeological Trust are also warmly thanked for giving up their weekend to take part in the project. Their enthusiasm during the fieldwork was very impressive especially when the weather turned foul. Paul Humphreys, volunteer group co-ordinator, is thanked for his assistance and for providing unpublished survey material for Swartigill Burn. Members of SWAP are thanked for their help and advice during the project.

2. RESEARCH AIMS AND OBJECTIVES

2.1 General

2.1.1 The objectives of the project were:

1. to test the applicability of GPR survey in relation to different types of archaeological site, in different types and depth of peat (eg deep, intermediate and shallow peat) formations within the vicinity of the Loch of Yarrows;

2. to obtain information on the potential of the peat surrounding Loch of Yarrows to preserve archaeological and palaeoenvironmental evidence;

3. to allow members of the Caithness Field Society and Yarrows Archaeological Trust to take an active role in the fieldwork;

4. to produce a survey report that can be integrated into the SWAP 2007 fieldwork publication.

3. METHODOLOGY AND TECHNIQUES

3.1 General

3.1.1 CFA follows the Institute of Field Archaeologists Code of Conduct, Standards and Guidelines. A four-stage strategy was adopted to fulfil the objectives of the investigative survey and included the four main tasks:

- Desk-based assessment and consultations
- Site reconnaissance and volunteer group co-ordination
- Fieldwork
- Report compilation

3.1.2 Local community involvement was considered essential to the aims and aspirations of the SWAP Policy and as a result this project was carried out in close co-operation with members of the Caithness Archaeology Trust (CAT) and members of the Yarrows Archaeology Trust. Both groups were well placed to assist in the project having an excellent working knowledge of the study area and fieldwork experience within the local wetland environment.

3.2 Consultations, desk-based analyses and site reconnaissance

Introduction

3.2.1 In October 2006 a series of consultations was carried out in order to establish contact with other researchers who had worked in the study area. Official bodies such as Historic Scotland, the Royal Commission on Ancient and Historical Monuments of Scotland (RCAHMS), Scottish Natural Heritage (SNH) and the Thrumster Sporting Estate (landowner) were also contacted.

Consultations

3.2.2 The following people were consulted for a variety of different reasons:

- Mr Richard Strachan, GIS Administrator at Historic Scotland was consulted for GIS digital shape-file data on the current distribution of Scheduled Ancient Monuments within a 1.5km radius of Yarrows Loch.

- Mr John Sherriff at RCAHMS was consulted for up to date information on the distribution of site and monuments most recently discovered during their 2005 field reconnaissance survey.

- Dr Richard Tipping of the Department of Environmental Sciences at Stirling University was consulted in order to discuss his recent programme of palaeoenvironmental research carried out in the in the vicinity of Oliclate Farm (described below) and to assess the likely areas most suitable for carrying out the new survey work.

- Ms Sally Ward, SNH Area Officer for Caithness was contacted for formal permission to carry out coring work within the boundary of a Site of Special Scientific Interest (SSSI, Oliclate). Digital map data showing the SSSI boundaries was also requested.

- Mr Nigel Ruckley a consultant geologist was also contacted for geological information of the study area.

Desk-based assessment.

3.2.3 Following the consultations, a desk-based assessment was carried out prior to undertaking a field visit, this would provide information on the likely study areas and to target specific areas for investigation. The following desk-based sources were examined:

- All Ordnance Survey maps held within the National Map Library of Scotland
- The CANMORE on-line database of sites and monuments within the study area
- Historic Scotland's Schedule Monument records where applicable
- Bibliographic sources relating to previous work carried out within the vicinity of Yarrows Loch
- Maps held by the Thrumster Sporting Estate.

Preliminary site reconnaissance and site selection

3.2.4 In October 2006 a site reconnaissance survey was carried out by CFA along with the landowner, Mrs Mary McLeod of the Thrumster Sporting Estate and Mr Paul Humphreys project co-ordinator for the Yarrows Archaeological Trust. Potential sites identified during the consultation process and the desk-based assessment were assessed on the ground.

3.2.5 Four sites were selected following a preliminary site appraisal that included depth probing with a 15mm diameter stainless steel peat probe to establish the relative depth of the basal morphology at each respective site. Basic depth and morphology was established to inform the geophysicists on the appropriate types of antenna to be selected.

3.2.6 Consideration was paid to the local topography and the nature of ground cover, which was recorded in order to inform the geophysicists on whether this might cause any undue problems in carrying out the GPR surveys over areas rich in heather and deep grass. Land-use history and local site conditions such as degree of slope and hydrological condition (eg. presence of pools and the moisture content of the peat) were noted.

3.3 Stage 2-Peat coring and GPR Survey

3.3.1 Table 1 lists the grid sites and their respective locations which are shown on the location map (Figure 1). All the grids and survey transects were plotted using a Leica GS50 Global Positioning Data Recorder with an accuracy of +/- 1m.

Site name	**NGR Ref**	**Survey area m^2**	**Max sediment depth**	**Vegetation type**
Oliclate A	ND 29955 45305	200	3.5m	Burnt heather/grass
Oliclate B	ND 30005 45313	200	3.5m	Burnt heather/grass
South Yarrows 1	ND 21044 45149	200	0.5m	Grass/heather
South Yarrows 2 (a and b)	ND 31005 43144	140	1.5m	Heather
Swartigburn	ND 32200 45800	100	0.5m	Pasture

Table 1 Site reference and environmental data

Stratigraphical recording

3.3.2 In the case of Oliclate A-B, South Yarrows 1-2 depth profiles and basal contouring was established at 1m intervals along the main axis of the grid (A-B) and at right angles on the C-D axis using peat probing rods. The biostratigraphic profiles were also reconstructed along the A-B axis. Peat sampling was carried out at 2m intervals using a Eijgalcamp (dutch) gouge. Munsell colour determinations were carried on fresh samples to record colour change prior to oxidation. Stratigraphic profile reconstruction follows a modified version of that defined by Troel Smith. Assessment of the degrees of decomposition was based on the Von Post H1-10 scale (ie H1 = undecomposed peat, H10=completely decomposed).

3.3.3 pH and conductivity determinations were established using a duel sensor Hannna HI8014 portable meter in the laboratory on peat samples stored in a cold store at 4°C. Conductivity was recorded using an appropriate probe on fresh sediment and expressed as mV. It was hoped that this work could be done in the field by the volunteer groups but due to the adverse weather it was decided that this was best done under laboratory conditions.

GPR Survey

3.3.4 In Ground Penetrating Radar surveys 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 which, in turn, are influenced by material type, moisture content and pore fluids. Contrasts in these properties cause 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 data are recorded as two-wave times i.e. how long it takes for the electromagnetic wave to travel to an interface and be reflected back to the receiver. As a result GPR records detailed vertical sections through the ground, which can provide a wealth of stratigraphic information and is one of the few geophysical techniques that can provide a good estimation of the depth of potential features.

3.3.5 The travel times can be converted to depth using an assumed, measured or calculated velocity. The dielectric constant of a material is a direct measure of its water content, which is directly related to the velocity of the electromagnetic energy. However, the velocity is also governed by the electrical conductivity of the subsurface. Some soils, for example clay rich soils, are highly conductive because of the salts within the pore water and can dramatically limit the use of GPR. Fortunately the pore water in peat generally has a low conductivity making GPR a valuable survey technique, even though there is a high moister content. Comparing the radargrams with the peat depth information collected by CFA Archaeology Ltd, dielectric constant of approximately 45 has been used. This is clearly higher than a typical value of 16 for average soils, but substantially lower that the relative dielectric permittivity of 73 measured by Usti (Usti 1996) during investigations at North Ballachulish Moss. The situation is also complicated by a constant velocity being applied to the data, even though the energy will travel at slightly different speeds through different layers of material resulting in slight under and over estimations of depth.

3.3.6 For this project data were collected using a GSSI SIR 3000 GPR system with 270MHz (Oliclate and South Yarrows) and 400 MHz (Swartigill Burn) antennas. Different frequency antennas provide different resolutions and depths of investigation. A 400 MHz antenna will retrieve high resolution data from up to the top 2m of the surface while a 270Mhz antenna can potentially record data to a depth

of about 5m, but at the expense of near surface resolution. As discussed above the depth of investigation will vary, depending on the nature of the soil. At Oliclate and Swartigill Burn data were collected at 0.02m intervals along traverse 0.5m apart. At South Yarrows 1 data were collected at 0.02m intervals along traverses 1m apart, while at South Yarrows 2 individual transects were collected.

3.4 Stage 3 GPS Data acquisition

3.4.1 The survey obtained both ground penetration radar and biostratigraphical information on both deep peat at sites Oliclate A-B intermediate peat; South Yarrows 2 and shallow peat formations at South Yarrows 1 and Swartigill Burn. All four sites were close to known archaeological sites and features of prehistoric age.

4. OLICLATE FARM

4.1 General

4.1.1 This section will now examine the results from Oliclate Sites A and B. First the site is placed in its local environmental context with a summary review of previous palaeoenvironmental and archaeological research. The section will then describe the findings of the fieldwork.

4.2 Environmental Setting

4.2.1 The grids (Oliclate A and B) are both located on a flat area of ground at c. 150m OD. The ground falls eastwards with fairly shallow gradient down to the metalled trackway leading to Oliclate Farm (Fig 2). The ground cover is mainly swards of grass and low stands of ling heather. The site has been burnt in the last ten years according to the landowner (Islay McLeod *pers comm*). The site is flanked on the south side by an area of scrubby ground about 1m lower than the grid sites. The vegetation is dominated by sedges and scrubby heather typical of an area of peat that is regenerating after being cut for fuel, probably by tenants of Olicate Farm. On the north side of the site there is a small burn that runs under the track, the burn forms a boundary between the survey area and an expansive area of rough grazing land. Downslope from the study area the land is undulating and very marshy in places with small, slow water courses that drain towards the Swartigill Burn.

Previous research

4.2.2 Two research projects have been carried out in the near vicinity of the study area. The first was an archaeological investigation carried out by Pannet (2002) which involved the excavation of Mesolithic artefact scatters and ard marks from beneath a hill side almost entirely buried by blanket and marsh peat. Later research undertaken by Richard Tipping established the rates of peat migration across a single hillside at Oliclate resulting in a better understood of the peats' chronological development. Tipping *et al* (2005) carried out a large scale palaeoenvironmental study on the peat using test-pits, excavated trenches and hand coring at 10m intervals along several transects. The results of this study have allowed the chronological framework of the timing of the inception of the valley peats to be set alongside important issues such as landform processes, effect of climatic changes and the impact that cultivation may have had, including peat removal on the environmental record. Biostratigraphic recording supported by 26 radiocarbon dates confirm that as early as 6000 cal BP the land to the east of their survey area had peat formations present as early as this period. By 4000 cal BP blanket peat was dominating the landscape. At 3500 cal BP, the pollen record shows that the lower slopes were cultivated and the battle to maintain land that could be farmed is set against the backdrop of ever encroaching peat. This event is mainly observed in the record of colluviation within the lower slopes that received a higher volume of hillwash sediment that is ascribed from increased ploughing of peaty soils further upslope. Following soil instability, the sediment record by c.2100 cal BP marks the increase in peat formation and alterations to slope hydrology, possibly driven by climate change and increased precipitation that continued through to the later prehistoric period. The cultivation areas are concentrated on the till mounds which would have been better drained within unenclosed field systems as there is no archaeological evidence for field walls. Local abandonment of the fertile areas of cultivation appear to have finally occurred by 1400 cal BP as the farmers lost the battle with the peat.

4.3 Oliclate Grid A Coring Transect A-B

4.3.1 The 20m long transect is shown in Figure 3a. The stratigraphic profile attained an average depth of c.2.60m and has a fairly regular basal profile in comparison to Grid B which is highly irregular (described below). The biostratigraphy is described in Table 2. Due to the level of peat saturation the corer failed to contain the sediment when the chamber was extracted. At three positions along the transect (4, 8 and 12m) the situation remained the same owing to the sheer level of waterlogging.

Unit	Depth	Description	Von Post Scale
1	10-0.10m	Poorly humified root material with living turf (10 YR 3/3 dark brown	H5
2	0.10m-2.60m	Homogenous saturated blanket peat, very humified with occasional woody plant remains at 1.70m depth, 2.5 YR 5/3 reddish brown	H9
	2.60m	Base of profile, minerogenic	N/a

Table 2 peat biostratigraphy

Oliclate C-D transect

4.3.2 The C-D transect (Fig 3a) confirms that the basal profile is relatively level, especially between the 11-20m section. Although there is c.40m between the two survey areas there does appear to be a gradual deepening of the peat towards the track (ie eastwards).

4.4 GPR Results for Oliclate Grid A

4.4.1 The radargrams from this area show a clear and relatively well-defined, interface suggesting a discontinuity between approximately 90ns and 100ns equivalent to approximately 2m – 2.7m below the ground surface. Above this interface there are very weak reflections, consistent with waterlogged peat. Given the attenuation of the signal within the peat few reflections are clearly visible in the data, although some hints of stratigraphy within the peat are just discernable. Reflections are apparent beneath the interface but are near to the limits of the antenna and gain levels applied to the operating system.

4.4.2 There is relatively good correlation between the probe profile and the GPR data collected along the same transect Line 19, (Fig 3b). There will inevitably be some differences between the two. There are two primary reasons for this. Firstly, the probe profile is constructed from measurements taken every metre while the GPR is recording data at 0.02m intervals along the transect. Secondly, and perhaps more importantly, the probe is providing ‘point source’ data while the GPR data are retrieved from an elliptical footprint the size of which is dependant on the antenna frequency, the nature of the ground and the depth of the target. However, both profiles show the same general trends; an undulating interface marking the base of the peat with a general deepening of the peat layer to the north. The weaker response from the base of the peat in the north is likely to be due to attenuation of the signal and the slightly greater depth, indicating that the antenna is at its limit of depth penetration.

4.5 Oliclate Grid B (A-B Transect)

4.5.1 The 20m long transect is shown in Figure 4a . The stratigraphic profile shows that the deepest position attained was at the 20m point along the 1m interval probe transect where c.3.50m of peat is recorded. Here the probe has bottomed out into a gully or basin feature. Elsewhere along the transect the depth of peat ranges from between c.320m to 3.30m. The peat probing results also confirm that the basal morphology is undulating and irregular. The sedimentary units within the master core described at 0m on the transect is described in Table 3.

Unit	Depth	Description	Von Post Scale
1	10-0.10m	Poorly humified root material with living turf (10 YR 3/3 dark brown	H5
2	0.10m-2.60m	Homogenous saturated fiberous blanket peat, very humified with occasional woody plant remains at 1.70m depth, 2.5 YR 5/3 reddish brown	H9
3	2.60m-2.80m	Grey silt. Plastic consistency G 6/1 Greenish grey with small granular peds	N/a
4	2.80m-3.10m	Humified greasy peat, 2.5YR 2.5/1 reddish black. No visible inclusions.	H10

Table 3 Biostratigraphical units recorded in the Oliclate A profile A-B.

C-D Transect

4.5.2 A probing transect at right-angles to the A-B transect was established at the mid-point (10m) to determine if there was any variability down-slope from the transect. The depth profile is very similar to the main transect with a mean depth range of c.3.20m. Again the basal sediment is irregular and appears to be hummocky. The 1m interval probe points tend to exaggerate the peaks and troughs. The biostratigraphy was found to be the same as that described in the Grid A transect and was not recorded in detail due to its general homogeneity. Although on the surface, the ground slopes gently towards the trackway leading to Oliclate Farm this is not reflected in the basal morophology within the transect profile. Drainage channels cutting through the base of the soft basal clays appear to account for the irregular character of the peat floor.

Unit	Depth	Description	Von Post Scale
1	0-0.10m	Poorly humified visible root matter under living turf (10 YR 3/3 dark brown	H5
2	0.10m-2.60m	Homogenous saturated blanket peat, very humified with occasional woody plant remains at 1.70m depth, 2.5 YR 5/3 reddish brown	H9
	2.60m	Base of profile character undifferentiated.	N/a

Table 4 Biostratigraphical units recorded in the Oliclate A profile A-B

4.5.3 The pH and conductivity results show that the pH results are in keeping with those recorded by Tipping *et al* (2005) who recorded pH values of 4.0 ± 0.3 (n= 30 samples) on blanket peat above the 100m contour. Blanket peats tend to be highly acidic because of the abundance of acidifying Sphagnum mosses. Sphagnum's unusual physiognomy means that rhe genus has a high cation exchange ability, swapping scarce nutrients for hydrogen ions. As a result, Sphagnum species acidify their surroundings (Clymo 1963, Brooks and Stoneman 1997).

4.6 GPR Survey Results for Grid B

4.6.1 Although only some 30m to the east of Grid A, the results from this grid (Fig 4b) are markedly different from the previous area. No coherent basal layer is evident in the radargrams even though data were recorded over a greater time window. However the probe survey recorded a depth of peat of approximately 3.3m and it appears this is beyond the depth resolution of the 270MHz antenna due to attenuation of the signal in the wet conditions with very little data being retrieved below 3m. In future the depth penetration of the GPR could be improved by carrying out the survey at a drier time of year or using a 100MHz antenna but this would be at the expense of near surface resolution. These surveys were carried out immediately following two of the wettest months on record.

4.6.2 However, the nature of the peat may also be affecting the efficacy of the technique in this particular area. Line 45 on the southern edge of the block, and along the probe and auger profile, shows a lack of signal for the first 0.8m and an intermittent interface at about 1.8m below the surface. It is possible that this may indicate the woody plant horizon noted in the auger survey. It is of potential interest that little signal has been retrieved below approximately 2.6m. This coincides with the silt layer observed in the field and this layer may be causing further, rapid, attenuation of the signal resulting in the base of the peat at 2.8m – 3.1m remaining undetected.

4.6.3 Comparisons between the two radargrams along the coring transects (3b and 4b) show marked differences. In grid A, increased pore-water saturation within the peat has led to some loss of signal in the upper layers, with a better signal return towards the base. In contrast, Grid B which was up slope shows a better signal return within the peat but loss of signal on its base. Saturation of the peat appears to be a causative factor resulting in poorer signal quality.

5. SOUTH YARROWS 1 and 2

5.1 South Yarrows 1

5.1.1 The area to the south of Loch of Yarrows (Fig 5, hereafter South Yarrows) is predominately a wetland one with sedge mires found to the east and moist Atlantic heather with blanket bog to the south and west. The local topography is very irregular and rises steeply south-westwards towards Warehouse Hill. Immediately to the south of Loch of Yarrows there is a plateau below the 100m contour overlooked by a sandstone ridge that forms a distinct feature in this area. On top of the ridge there is a line of later prehistoric hutcircles that are covered in heather but still visible and are part of the Loch of Yarrows Archaeological Trail. These features lie within a Scheduled Area (Fig 5). No archaeological work has been undertaken within the immediate area of South Yarrows 1.

5.1.2 The Site of South Yarrows 1 was selected on the ground that it was fairly level and free of dense heather cover. A clearance mound or possible archaeological feature lay close to the grid site (Fig 5).

5.1.3 The survey grid measured 20m by 10m with the long axis aligned east-west (Transect A-B, Fig 6a). A probe transect was also placed at right-angles to the long axis starting from the 10m mid-point (see inset below Fig 6a)

5.1.4 The basal profile on both transect are very regular with a maximum depth of 0.60m. There is no noticeable variability in the overlying sediment that was examined in the sections of five small test-pits (0.5m by 0.50m) placed strategically along the main grid axis. The test pits confirm the presence of only two visible horizons over bedrock.

Unit	Depth	Description	Von Post Scale
1	0-0.10m	Poorly humified visible root matter under living turf (10 YR 3/3 dark brown	H5
2	0.10m-0.60m	Homogenous peat, very humified with occasional woody plant remains at depth, 10YR 3/3dark brown	H7
	0.60m	Basal rock, fractured sandstone	N/a

Table 5 Principal visible bisotratigraphic units at South Yarrows 2.

5.2 The GPR Survey Results.

5.2.1 The vegetation within this survey area was long and a hindrance to the collection of the GPR data. As a result data were collected at 2cm intervals along transects 1m. Although much of the vegetation was flattened using a quad bike prior to survey, the adverse ground conditions have introduced noticeable noise in to the data. This is clearly visible as discrete zones of ‘ringing’ visible in the raw data.

5.2.2 Line 56, Figure 6b, is along the line of the probe profile and the radargram shows good correlation with an undulating interface at *circa* 0.3m - 0.7m below the modern ground surface. The response is not as coherent as that recorded at Oliclate Grid A. This is likely to be due to the nature of the interface at the base of the peat recorded as fractured sandstone bedrock. However, it could be partly due to the lack of near

surface resolution of the 270MHz antenna. In addition the adverse ground conditions may affect the consistency of the signal along the profile.

5.2.3 The probe data indicate that the peat is slightly deeper at the eastern limit of the survey block. This is confirmed by the GPR data from which shows slightly deeper peat (circa 0.8m) at the centre of the transect.

5.2.4 Deeper reflections, beneath the interface assumed to relate to the base of the peat, have been recorded in several of the radargrams. These are likely to relate to the limits of the weathered layer or stratigraphy within the bedrock.

5.3 South Yarrows 2

5.3.1 South Yarrows 2 lies approximately 400m south-west from Yarrows Site 1 and is located in a shallow cleft between two small knolls (Fig 5). The topography is characterised by a small basin with gentle slopes within which lies a small channel feature that slopes down to a very wet and marshy area on the edge of a mire. The ground is covered by heather. Owing to the depth of surface vegetation it was decided to place two linear transects across the channel (Transect A-B) which are separated by a distance of c. 25m with Transect A being upslope and Transect B being downslope. Probing across both transects were at 1m intervals and both measured c.40m in length.

Transect A

5.3.2 Transect A (Fig 7a) is shallow and only attained a maximum depth of 0.80m at 13m on the main baseline. The profile is characteristic of a small palaeochannel that is draining the area to the east in the direction of the aforementioned mire. A single core was extracted and taken as representative for both transects. A small test pit was also dug at the end of each transect to establish the character of the underlying lithology on top of the slopes.

Unit	Depth	Description	Von Post Scale
1	0-0.10m	Poorly humified visible root matter under living turf (10 YR 3/3 dark brown	H5
2	0.10m-0.60m	Homogenous peat, very humified with occasional woody plant remains at depth, 10YR */* dark brown	H7
	0.60m	Basal rock, fractured sandstone	N/a

Table 6 Biostratiographic units recording in South Yarrows Transect 1

Transect B

5.3.3 Transect B (Fig 7a) attained a maximum depth at 2m at the 19m position along its length. The stratigraphy is the same as that recorded in Transect A. The profile however displays U-shaped character with an irregular base at c.20m along the baseline. The margins of the profile are very shallow and characterised by thick heather growth owing to the dryness of the soils. In the middle the vegetation is predominantly grass swards with only occasional patches of heather.

5.3.4 The results confirm that Transect 1 and 2 are characteristic of a peat in-filled palaeochannel that drains into a large mire. It is possible that Transect B lies close to its former shoreline as the topography surrounding the mire suggest that it was at one time much larger. The juxtoposition between the nearest hut circle and the palaeochannel as a source of drinking water seems not to be a coincidence. Running water close to the occupation site appears to have not been an accident but deliberate.

5.4 GPR Survey Results

Transect A

5.4.1 The depth of the peat along this profile was shallower than expected reaching a maximum depth of *circa* 0.8m at the centre of the peat probe profile. The GPR data, Line 57 (Fig 7b), confirms this and shows excellent correlation with the probe profile. There is an expected lack of strong reflections within the peat due to attenuation of the signal, although some hints of internal stratigraphy are discernable. The radargram shows stronger reflections from the base of the peat at the eastern limit of the traverse, this suggests a more marked dielectric contrast between the base of the peat and the underlying bedrock in this area. Other reflections are apparent throughout the radargrams suggesting stratigraphy within the bedrock.

Transect B

5.4.2 The Transect B profile, although only approximately situated 25m to the north, revealed substantially deeper peat recording a maximum depth of approximately 2m. As with Profile A, there is excellent correlation between the GPR data and the probe information as illustrated in the radargram for Line 59, (Fig 7c). Profile B does, as suggested by the probe data, reveal a more pronounced topography of the base of the peat.

5.4.3 The nature of the GPR data is comparable to Profile A with additional deeper interfaces suggesting the possible extent of the weathered bedrock and stratigraphy within the sandstone. As before the reflections towards the eastern limits of the traverses are much stronger, suggesting a more coherent bedrock interface.

6. SWARTIGILL BURN

6.1 Introduction

6.1.1 The site of Swartigill Burn was selected as part of the study owing to the presence of known archaeological remains within a flat area of alluvium alongside the burn of the same name. The extent of the structural remains are not known and it was hoped that the result of the GPR survey would shed light on the extent of the remains, as well as test the effectiveness of the GPR equipment over a different soil regime.

6.1.2 The site of Swartigill Burn lies about 1.5km to the north east of Loch of Yarrows (Fig 1). The burn drains a large area of marsh and fields associated Oliclate Farm and eventually flows into Loch Hemprigs. The survey area rests on an alluvial plateau formed between two former river terraces. The area has history of probable medieval settlement with run-rig field systems and field banks that have been mapped during a survey carried out by members of the Yarrows Archaeological Trust (Fig 8). More or less in the middle of two farmsteads and exposed on the north facing side of the stream is an assortment of building remains (Plate 1). These remains were identified by John Sherriff in 2004 (RCAHMS ND 34 NW66) during a field survey. The principal features comprise two possible drystone walls measuring up to 0.6m in height and 11m apart, seem to retain between them a mass of small boulders, slabs and stones. The upper part of this stony mass is relatively loose and set within topsoil, but the lower part is set within a matrix of clay that were seen to contain charcoal and burnt bone. Within the mass there is a structure resembling a small cist or culvert built of slabs and measuiring about 0.3m square in section (Plate 1). Its interior extends at least 0.4m back into the face of the eroding bank.

6.1.3 A 6m by 12m GPR survey grid was laid parallel to the burn in order to include the alignment of the possible dry stone walls (Fig 8). No test pitting was carried out but a general assessment of the character of the soil was observed within the exposed stream section.

6.1.4 The Yarrows Archaeological Trust hand-cleaned part of the westernmost exposed feature so it could be assessed and photographed (Plate 7). The results of the clean-up confirmed that since 2004 several of the stones making up the wall feature have slumped out of the section. No bone or charcoal was observed, suggesting that this material had also been lost. However, a thick deposit of creamy-pink marl clay is still visible at the base of the wall, but this is also now eroding. A single broken Mesolithic microlith was found at the base of the cliff.

6.2 GPR Survey Results.

6.2.1 The radargrams from this survey are noticeably different from those from the previous surveys. This is primarily due to the reflections being from ‘point’ sources, e.g. stones, rather than stratigraphic interfaces, such as the base of the peat. The somewhat ‘cluttered’ nature of the radargrams is also the product of the higher frequency of the antenna which has better lateral and near surface resolution.

6.2.2 While several reflections are apparent in the individual radargrams no coherent pattern is discernable making it difficult to ascertain whether the reflection are from archaeologically significant material or naturally occurring stone. However, given the context of the site, it seems likely that these reflections indicate potentially significant *in-situ* archaeological material between approximately 0.5m and 1.25 below the modern ground surface.

6.2.3 When the data are processed as a three dimensional block and displayed as depth slices more information is available. A dielectric constant of 19 has been used for converting travel time to depth, given the nature of the soils.

6.2.4 Within the first slice, showing anomalies within the top approximately 0.25m of the ground surface, strong reflections are visible in the north of the slice. While this is in an area of longer vegetation the nature of the reflections and the rectilinear form of the anomalies in the time slice map suggest that they are potentially significant and may indicate the possible continuation of walls and / or drains visible in the stream section.

6.2.5 Between about 0.25m and 0.5m beneath the ground strong response are visible on the western edge of the survey area and may relate to stone work visible in the stream section.

6.2.6 In the 0.5m – 0.75m and 0.75m – 1.00m slices numerous reflections are apparent. While there is no clearly definable form to the anomalies there are general trends and the zone of reflections itself is well defined, possibly defining the limits of the postulated archaeological site. The lack of clear responses and somewhat 'scrappy' nature of the results is not unusual given the likely mix of *in-situ* stonework and rubble. It would be of interest to compare the GPR results with plans from the stream section.

6.2.7 Below 1.25m few reflections of interest are apparent. While it is likely that this is due to a lack of archaeological remains, the possibility that it is due to attenuation of the signal cannot be dismissed.

7. DISCUSSION

7.1 This study was carried out following the wettest autumn on record with 261mm of rain for the north-east of Scotland. This represents an increase of 36% more than the monthly average. Eastern and northern areas of Scotland in particular had a third more rain than the November average for the nineteen-year period between 1971-2000. This exceptionally wet autumn accounts for the high levels of peat saturation noted in particular on the Oliclate blanket peats (Sites A and B). Peat hydrology is complex and related to factors such as seasonal rainfall, ecology, modern and historical drainage regimes, depth variability in the *acrotelm* (active partially living upper layers) and the *catotelm* (virtually dead and waterlogged layers). The geochemistry of peat is also complex, but basic parameters such as pH (acidity) eH (conductivity) and redox potential (expressed as mV) have the potential to provide important ecological information and provide an indication of aerobic/anaerobic conditions over a given site (Brooks and Stoneman 1997). Anaerobic conditions are critical for the potential survival of certain biological palaeoenvironmental remains such as skin/leather, wood and other plant remains.

7.2 The GPR survey has produced, on the whole, exceptionally good results given the site conditions and the time of year and shows excellent correlation with the peat probe and auger data, proving the suitability of GPR on such sites.

7.3 Survey at Oliclate had mixed results. The results from Grid A were excellent, clearly mapping the base of the peat. The results from Grid B were, by comparison, disappointing. However, the data is still of interest providing a good example of the potential limitations of the technique in certain conditions, notably survey over non-homogenous peat. Nevertheless, these limitations could potentially be overcome by using a lower frequency antenna.

7.4 Survey at South Yarrows was successful with the base of the peat being located at both South Yarrows 1 and South Yarrows 2. The data from the profiles at the latter site clearly illustrate the usefulness of using GPR to map the peat interface over larger areas.

7.5 The results from Swartigill Burn have been mixed. While it appears that the technique has successfully defined the potential limits of the postulated site, it has failed to clearly delimit individual features such as walls. Although this is likely to be a reflection of both the nature of the technique and the nature of the archaeological deposit. GPR cannot differentiate between *in-situ* stonework and rubble. However, other techniques, like area resistance survey can be equally ambiguous on such sites.

7.6 While this project has focused on small, targeted detailed survey it has also shown the potential to map the peat interface over more extensive areas at wider traverse intervals as a reconnaissance survey and to then carry out selected detailed survey over potential sites. The potential of the peat surrounding Loch of Yarrows to preserve archaeological and palaeoenvironmental evidence is excellent. The waterlogged nature of the deeper peat formations in the region of Oliclate Farm holds great potential. The location of such remains is problematical according to the sheer scale of the spatial extent of the blanket peat.

8. CONCLUSION

8.1 This study has investigated the applicability of GPR radar survey on a range of different sub-surface peat formations within the region of Loch of Yarrows and has focused on deep (Oliclate A and B), intermediate (South Yarrows 2) and shallow peat (South Yarrows 1). The results obtained from these sites show that there is good correlation between peat probe results and the GPR data, especially over the deep peat which was extremely waterlogged. The results from the alluvial terrace site at Swartigill Burn has provided additional evidence for structural remains associated with a building.

8.2 The method has provided a non-destructive method of examining sub-surface peats over a range of topographical settings. The profiles have been established using rapid peat-probing backed up by biostratigraphic profiling where appropriate.

8.3 In line with SWAP research policies, local community groups were involved in all aspects of the project during the course of the fieldwork weekend and the group members showed great enthusiasm during the adverse weather conditions. The project has provided the members with a better understanding of peat formation dynamics and introduced them to sampling and field interpretation techniques. Equally important the project has allowed them to take part in GPR survey, a technique that would not ordinarily be available to such organisations.

9. RECCOMENDATIONS

9.1 The results of this study should be disseminated to the members of the Caithness Archaeological Trust and Yarrows Archaeological Trust. This would be in accordance with SWAP's outreach aims and objectives, especially when set against the backdrop of Highland 2007 the Scottish culture festival.

9.2 Further archaeological work should be carried out at the Swartigill Burn site to establish what type of structure is present. The northern edge of the site is rapidly eroding and should be fully recorded as a matter of urgency. This site would be a prime candidate for a community archaeology project. It has all the attributes for a successful small-scale project that would provide members of the Yarrows Archaeological Trust and Caithness Archaeological Trust with valuable experience of excavating an archaeological site within a wetland environment.

9.3 The site of Mye Plantation (NMRS NX15SW2) a previously identified SWAP candidate site where three of five Neolithic pit-falls for trapping game were excavated would be an excellent site with which to carry out new GPR research. GPR would provide the most cost-effective method of locating the site of prehistoric pit-fall traps that were found to be cut into the natural substrate below c.2.5m of peat.

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APPENDIX 1 PHOTOGRAPHIC RECORD

Shot No	Description (2006 pilot survey)	Date
001	Looking eastwards onto Oliclate Sites A and B	5/10/06
002	Looking eastwards onto Oliclate Sites A and B	5/10/06
003	Looking eastwards onto Oliclate Sites A and B	5/10/06
004	South Yarrows 2 site looking west	5/10/06
005	South Yarrows 2 site looking west	5/10/06
006	Rock escarpment overlooking South Yarrows Site 2	5/10/06
007	Pilot core transect work ar South Yarrows 2	5/10/06
008	General topography at South Yarrows and small lochan	5/10/06
009	Pilot transect work at South Yarrows 2	5/10/06
010	Pilot coring work at South Yarrows 1	5/10/06
011	Pilot coring work at South Yarrows 1	5/10/06
012	Nigel Ruckley (geologist) at South Yarrows 2	5/10/06
013	General view over South Yarrows 2 from the west	5/10/06
	Fieldwork 2007	
001	General view northwards over Loch of Yarrows	14/1/07
002	Peat probing at Oliclate Site A	14/1/07
003	Biostratigraphic recording at Oliclate Site A	14/1/07
004	Members of CAT and YAT working at Oliclate Site A	14/1/07
005	Peat probing and GPR survey at Oliclate Site A	14/1/07
006	Blue-grey deposit at the base of the core at Oliclate Site A	14/1/07
007	Homogenous peat above the blue-grey layer at Oloclate Site A	14/1/07
008	Homogenous peat above the blue-grey layer at Oloclate Site A	14/1/07
009	Peat probing at Oliclate Site A	14/1/07
010	General view of Oliclate Site A from the west	14/1/07
011	GPR data logger with display	14/1/07
012	GPR data logger with display	14/1/07
013	GPR apparatus in use at Oliclate Site B	14/1/07
014	Loch of Yarrows, south end near broch	14/1/07
015	Swartigill burn eroding stream bank and GPR survey	15/1/07
016	GPR survey in progress at Swartigill burn	15/1/07
017	YAT members cleaning eroding section	15/1/07
018	General view looking up Swartigill Burn	15/1/07
019	Looking east on Swartigill Burn GPR site and CAT members at work	15/1/07
020	Detail shot of eroding archaeology at Swartigill Burn	15/1/07
021	Detail shot of eroding archaeology at Swartigill Burn	15/1/07
022	Eroding feature at Swartigill Burn from the north bank of the stream	15/1/07
023	North facing side of the stream with eroding archaeological remains	15/1/07
024	Topography over the South Yarrows 1 site	15/1/07
025	Peg marking the corner of the South Yarrows grid survey	15/1/07
026	GPS survey in progress at South Yarrows Site 1	15/1/07
027	GPS survey in progress at South Yarrows Site 1	15/1/07
028	GPS survey in progress at South Yarrows Site 1	15/1/07
029	GPS survey in progress at South Yarrows Site 1	15/1/07
030	South Yarrows 1 Site with Loch of Yarrows in the distance	15/1/07
031	South Yarrows 1 site from the small knoll close to the site grid	15/1/07
032	Outcropping sandstone escarpment overlooking the South Yarrows 1 site	15/1/07
033	Outcropping escarpment with rough vegetation below	15/1/07
034	Base of test pit at the end of South Yarrows Transect 1	15/1/07
035	Base of test pit at the end of South Yarrows Transect 2	15/1/07
036	Looking west on the South Yarrows 2 site	15/1/07

APPENDIX 2 pH and mV DATA

Oliclate Site B

Sample	Depth m	pH	mV
1	0.1	3.94	394
2	1.2	3.59	359
3	1.36	3.76	376
4	1.5	3.6	360
5	3.1	4.16	416
	MEAN	3.81	381

South Yarrow 1 basal sample

Sample	Depth m	pH	mV
1	0.3	2.54	254

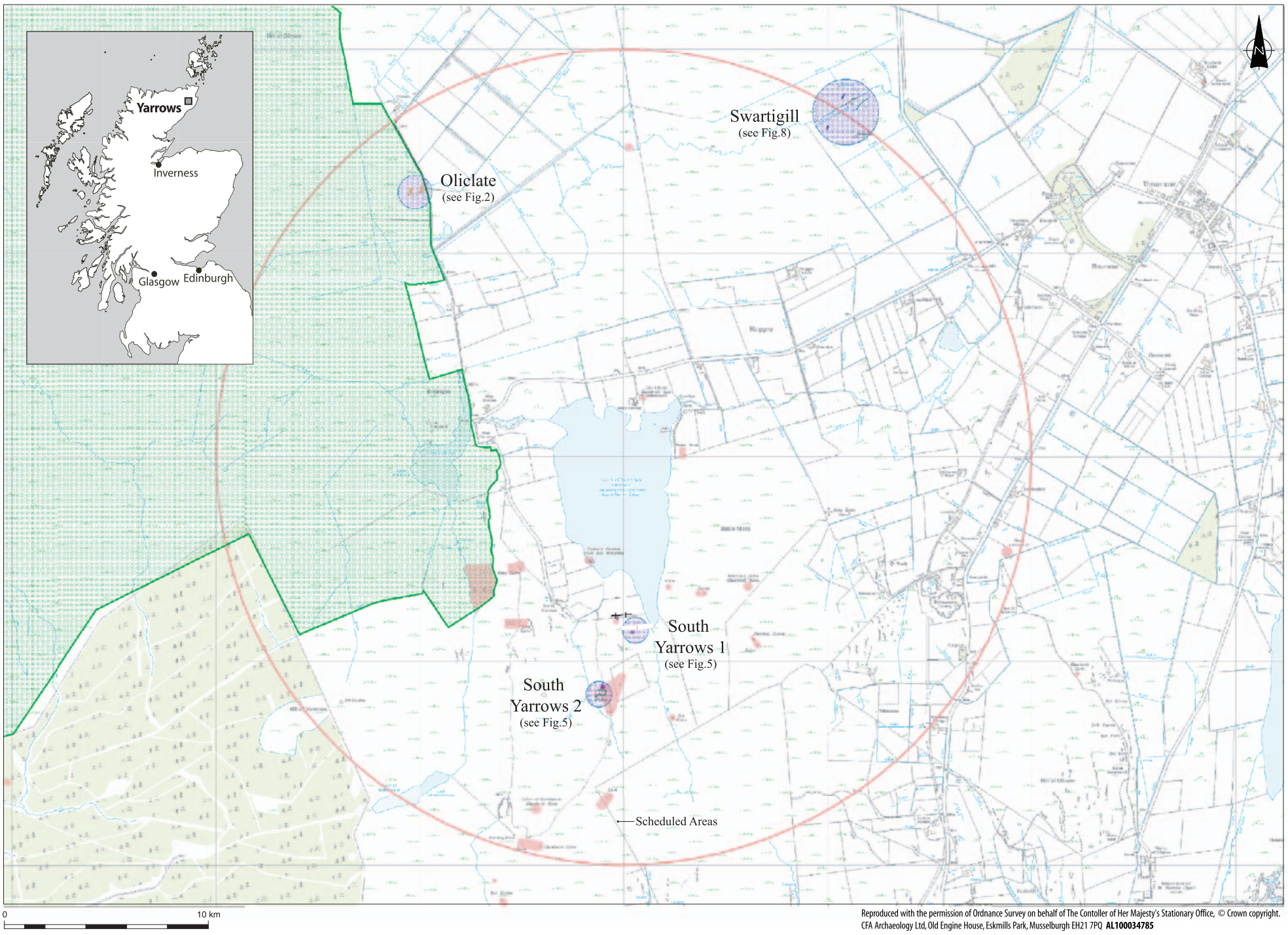


Fig.1 - Location map of the sites mentioned in text.

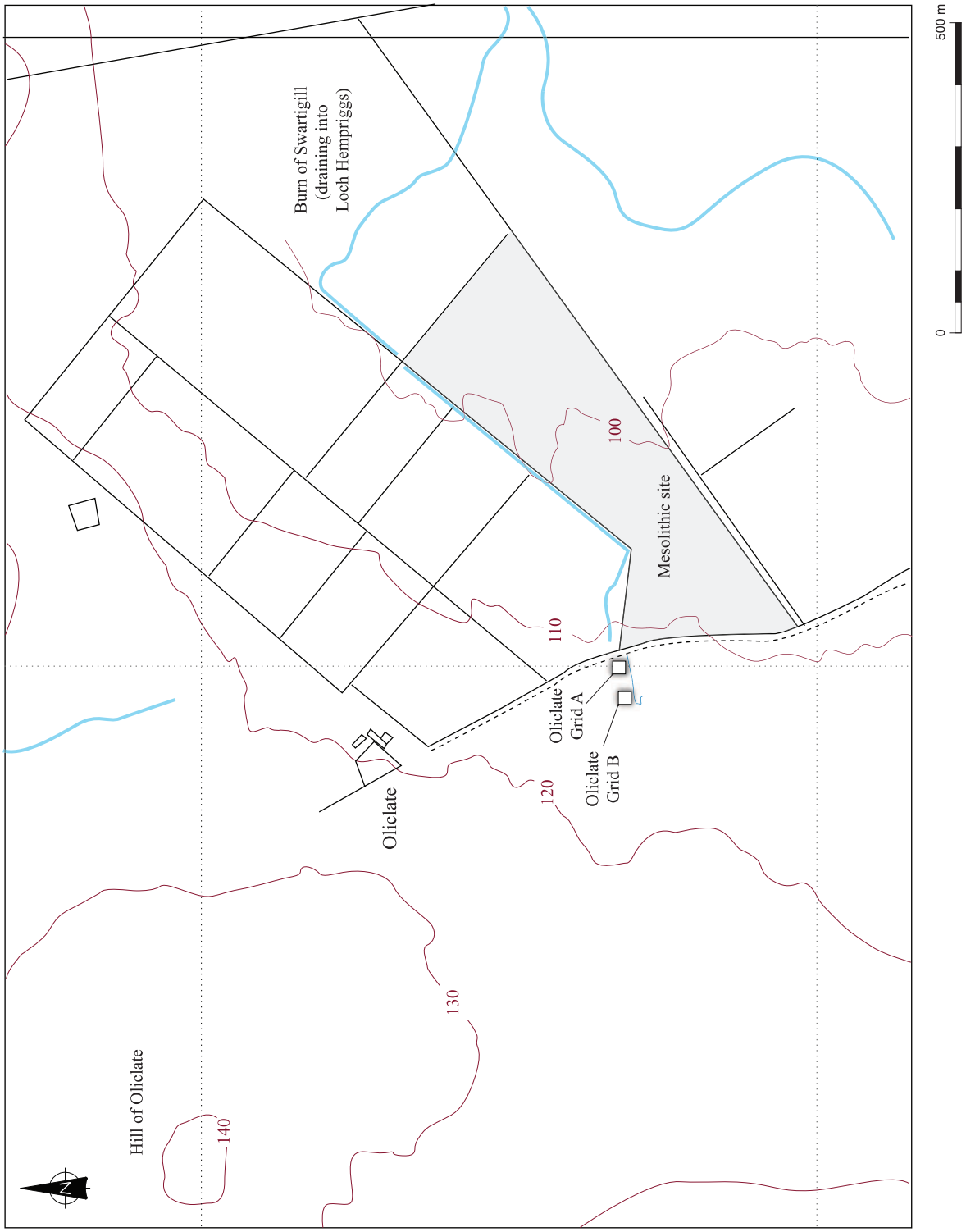


Fig 2 - Location plan of Oliclate transect grids A & B.

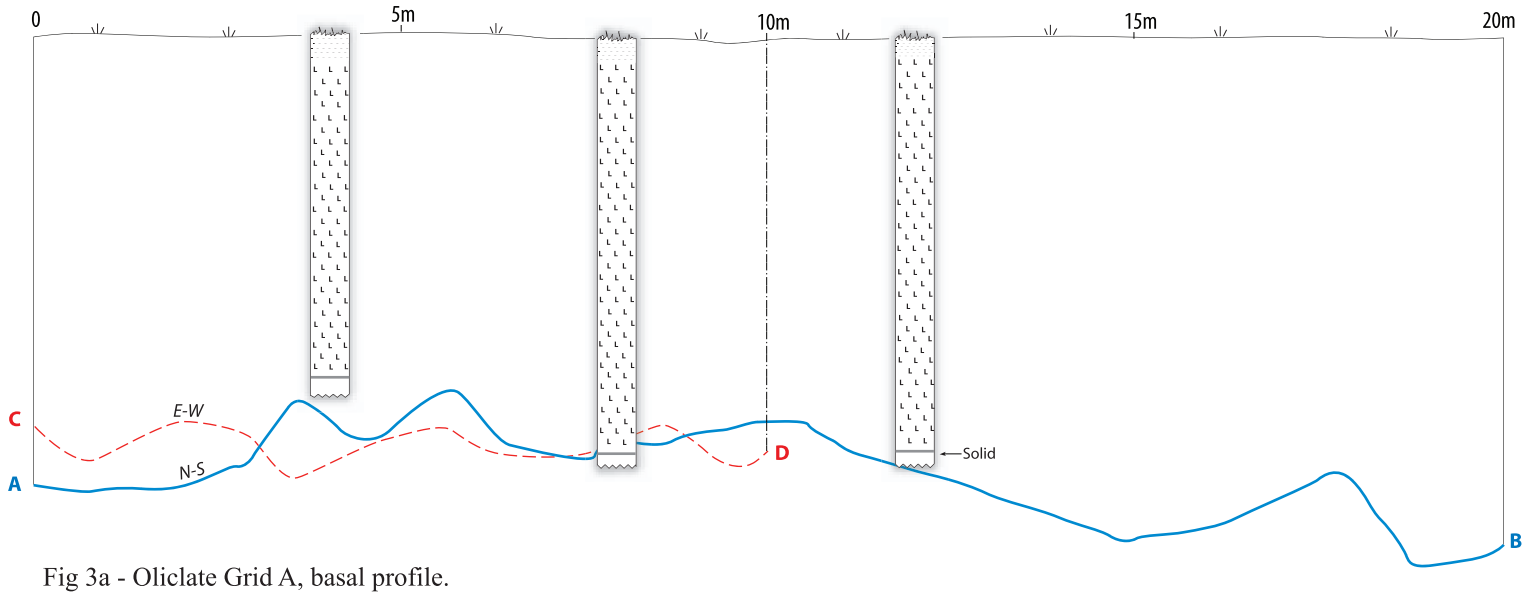


Fig 3a - Oliclate Grid A, basal profile.

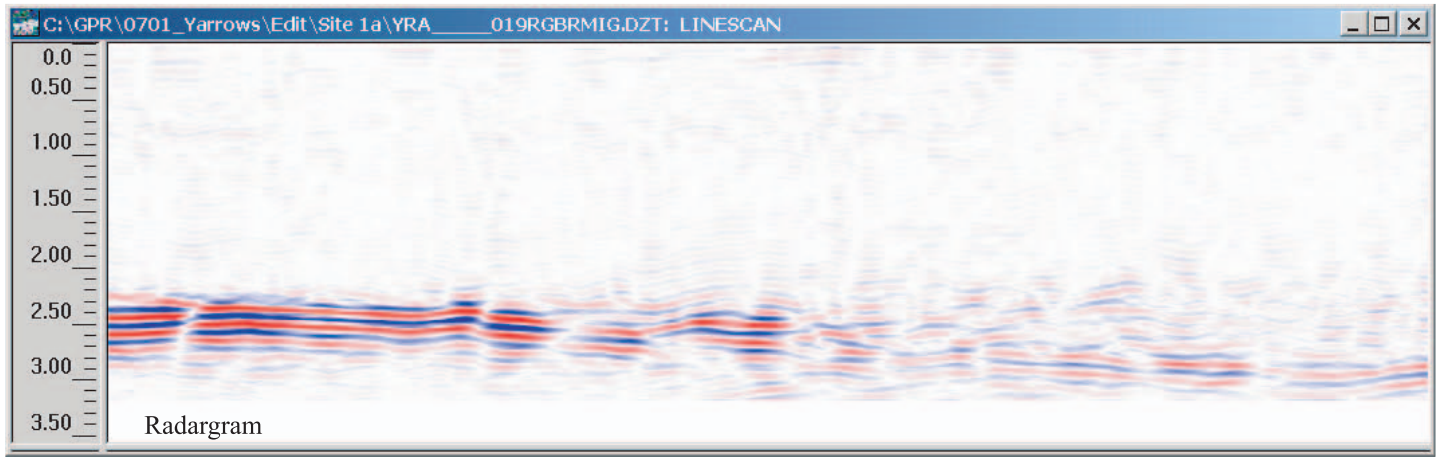
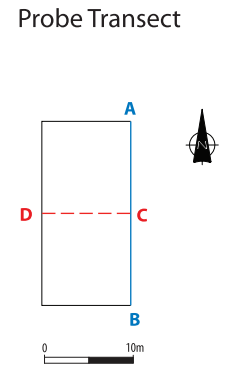
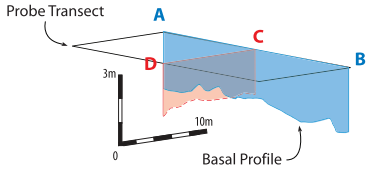


Fig 3b - Oliclate Grid A, radargram A-B.





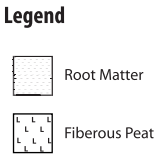


Fig 3 - Grid A Oliclate probe transect, and radargram profile.

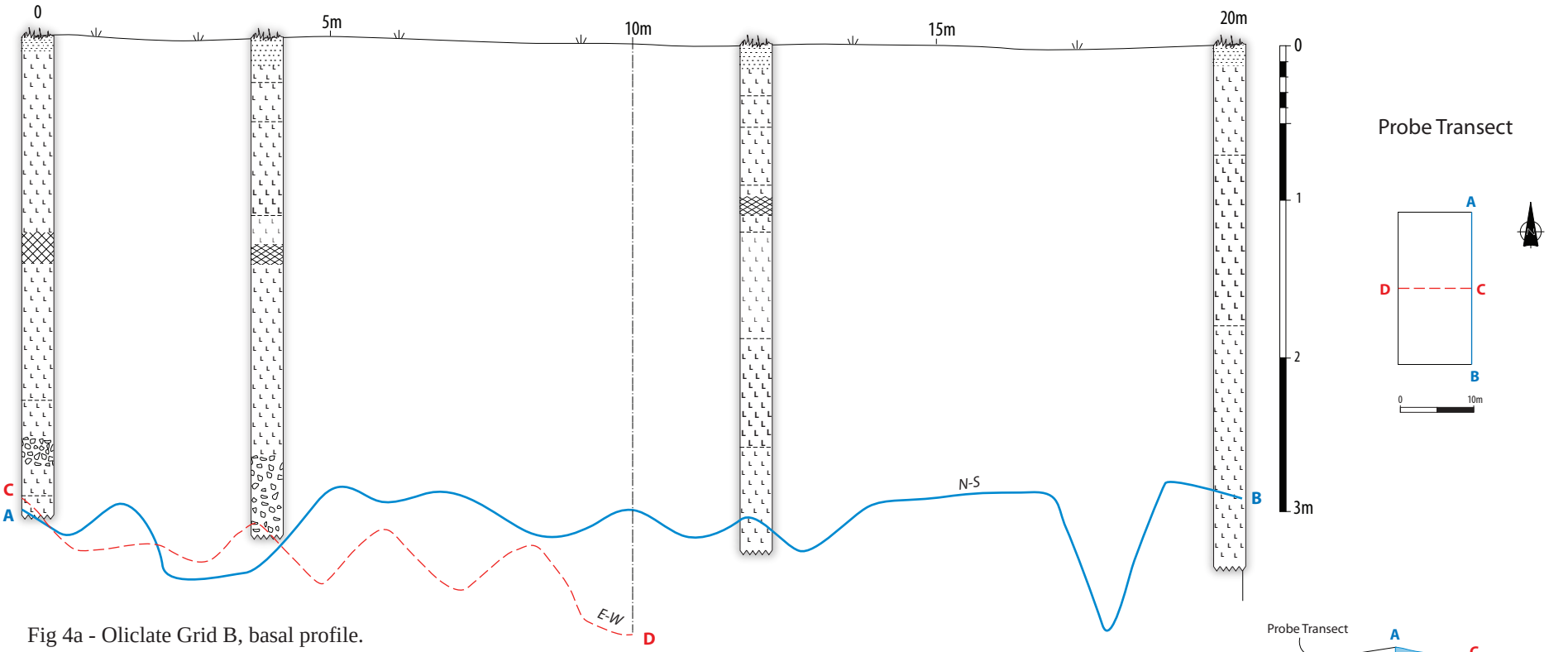
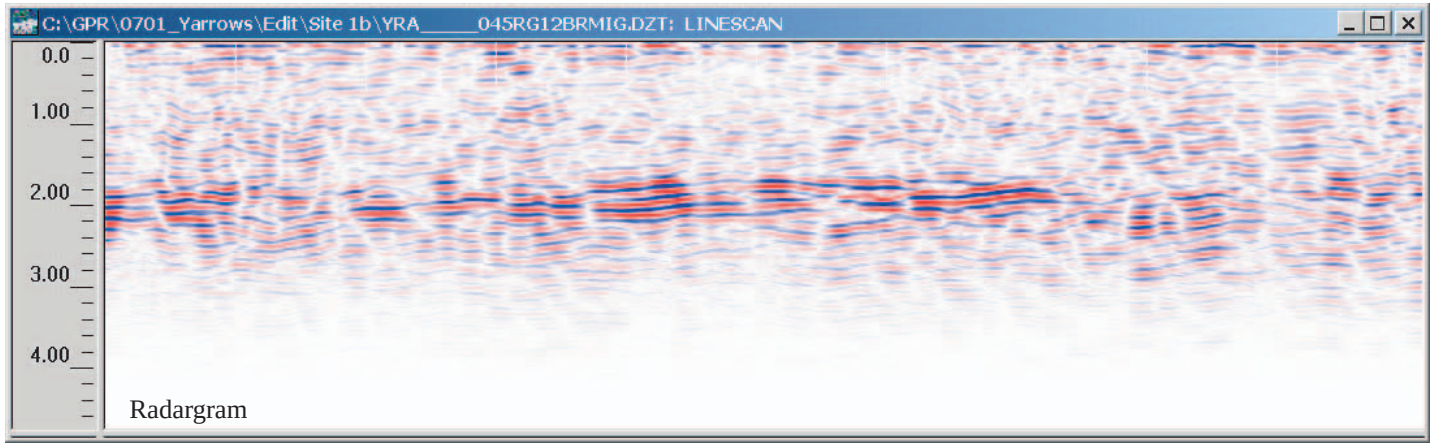
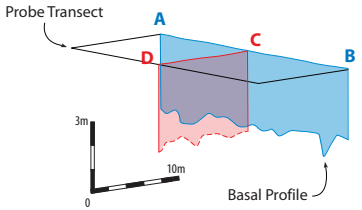


Fig 4a - Oliclate Grid B, basal profile.





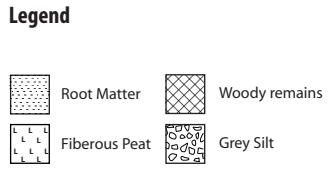


Fig 4b - Oliclate Grid B, radargram A-B.

Fig 4 - Grid B Oliclate probe transect, and radargram profile.

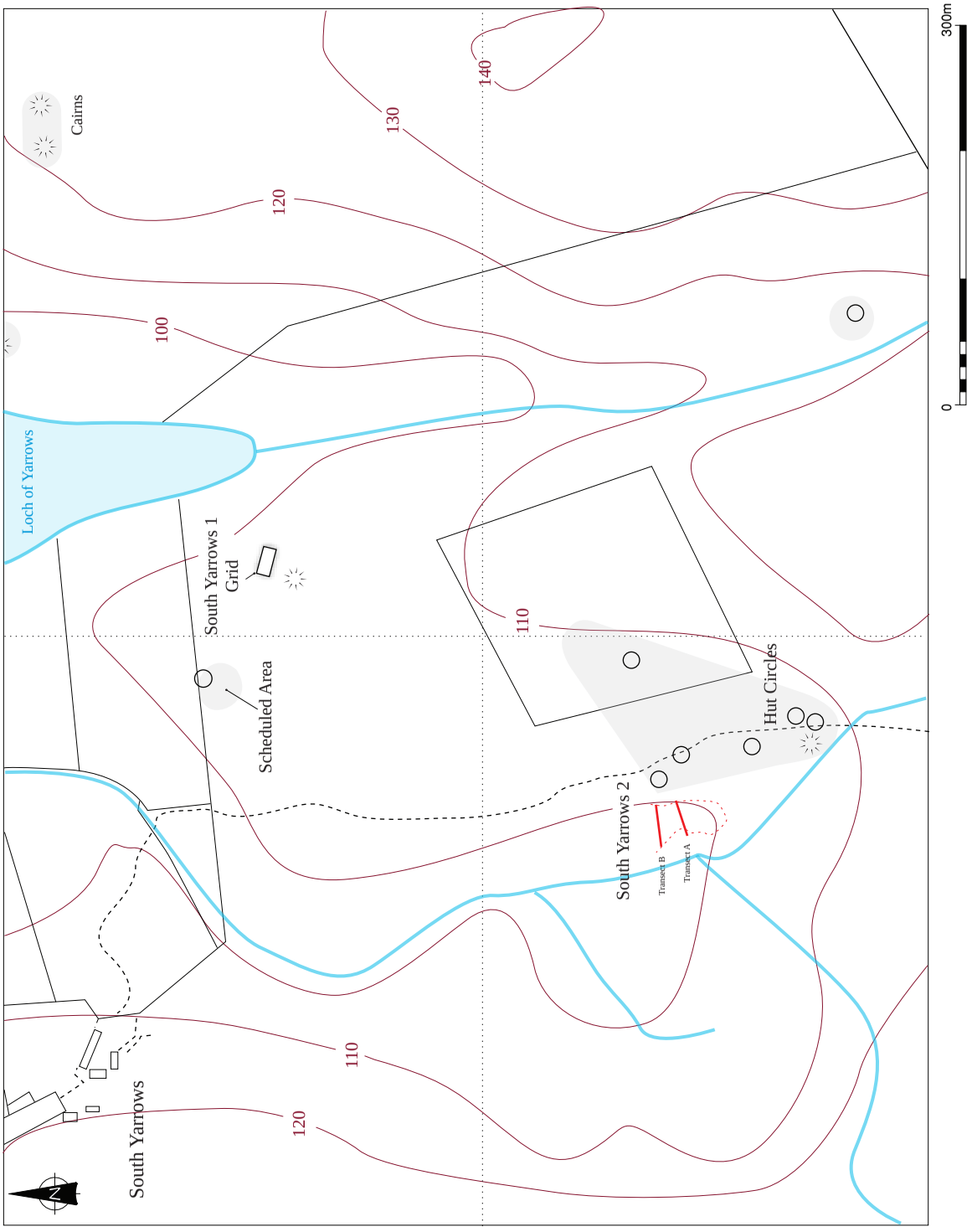


Fig 5 - Location plan of South Yarrows 1 & 2.

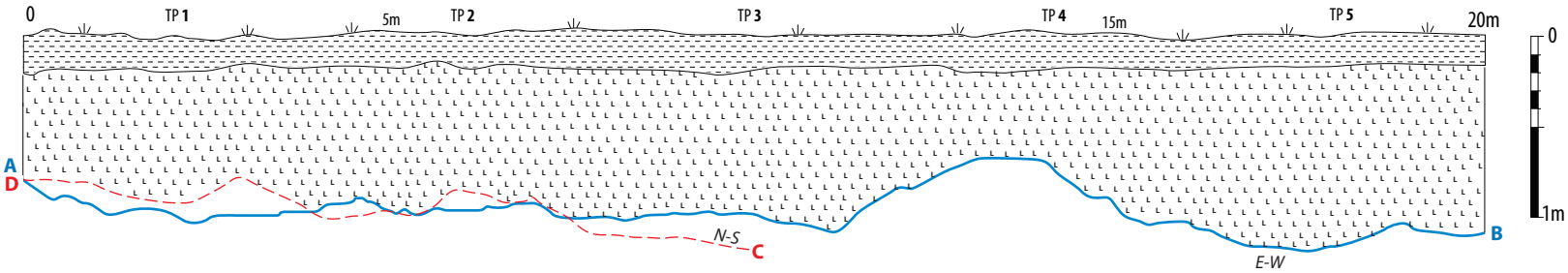
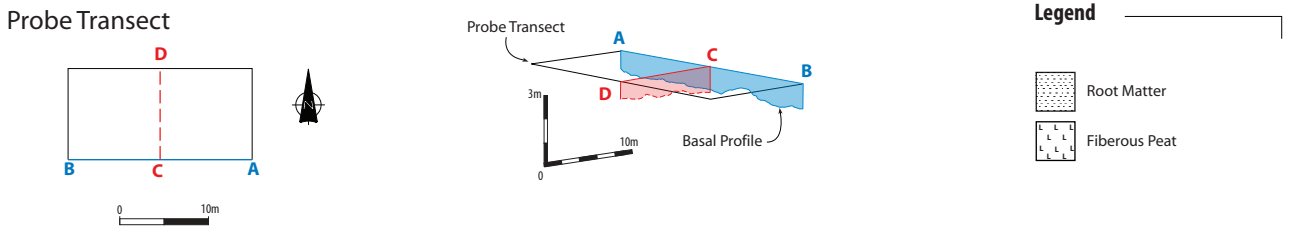


Fig 6a - South Yarrows 1, basal profile.



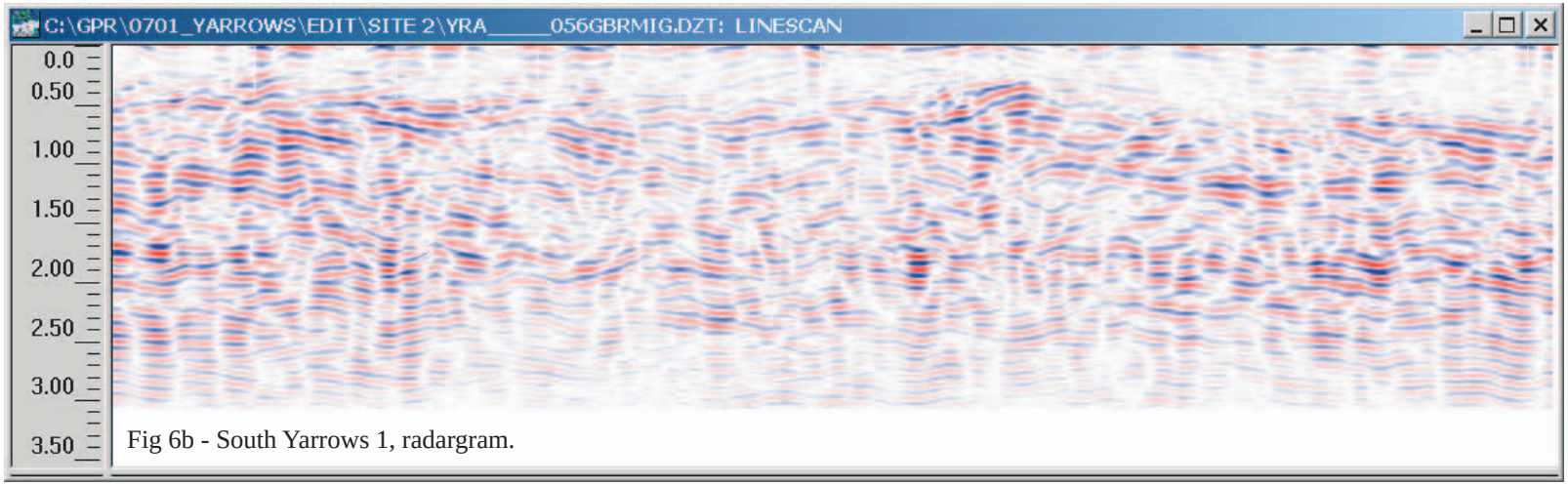


Fig 6b - South Yarrows 1, radargram.

Fig 6 - South Yarrows 1 probe transect and profile showing the depth of peat.

Fig 7 - South Yarrows 2 probe transects and radargram profiles.

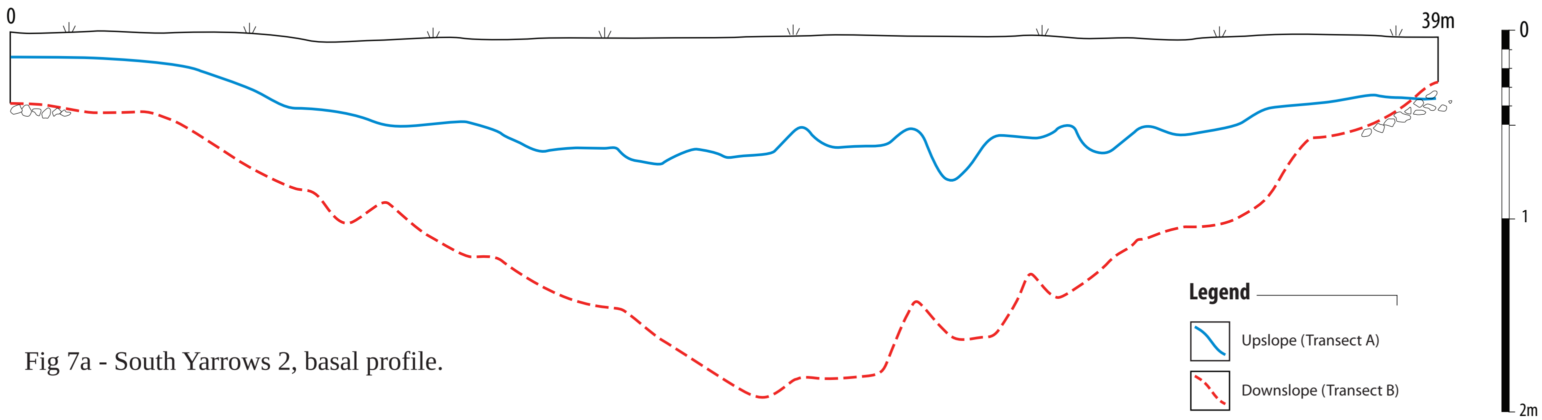


Fig 7a - South Yarrows 2, basal profile.

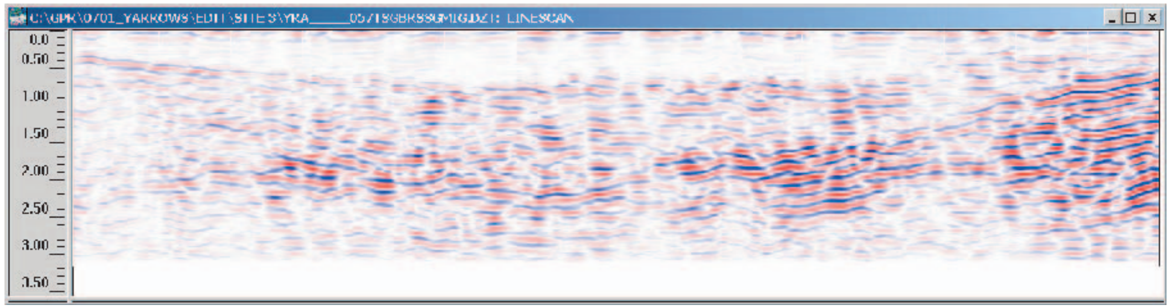


Fig 7b - Transect A Radargam

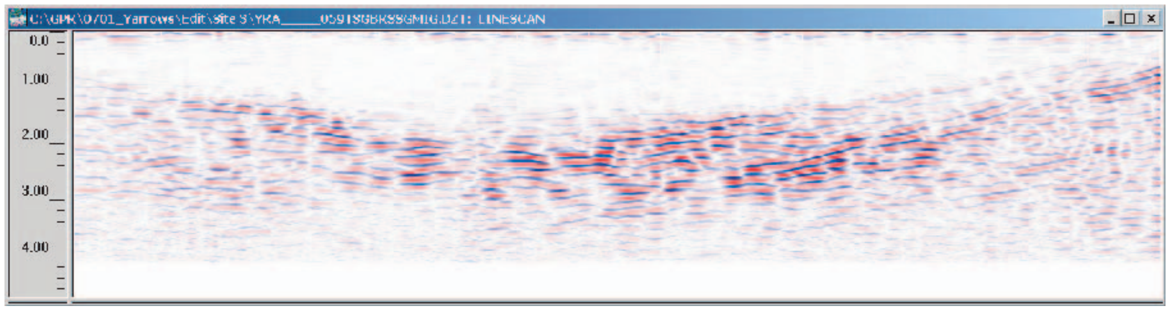


Fig 7c - Transect B Radargram

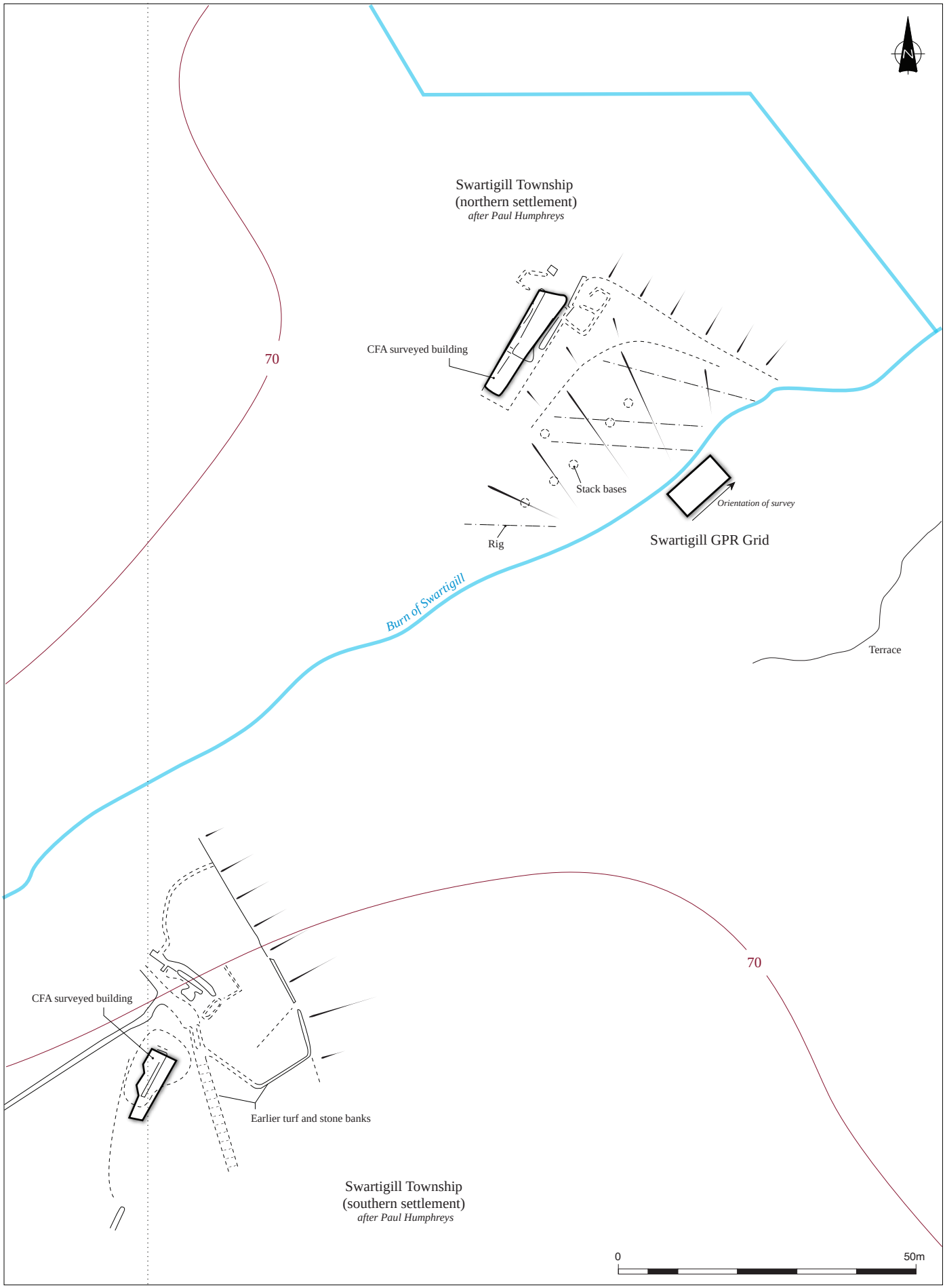


Fig 8 - Location plan of Swartigill .GPR grid and township.

Fig 9a - (Plate 1) Exposed wall remains at Swartigill Burn.

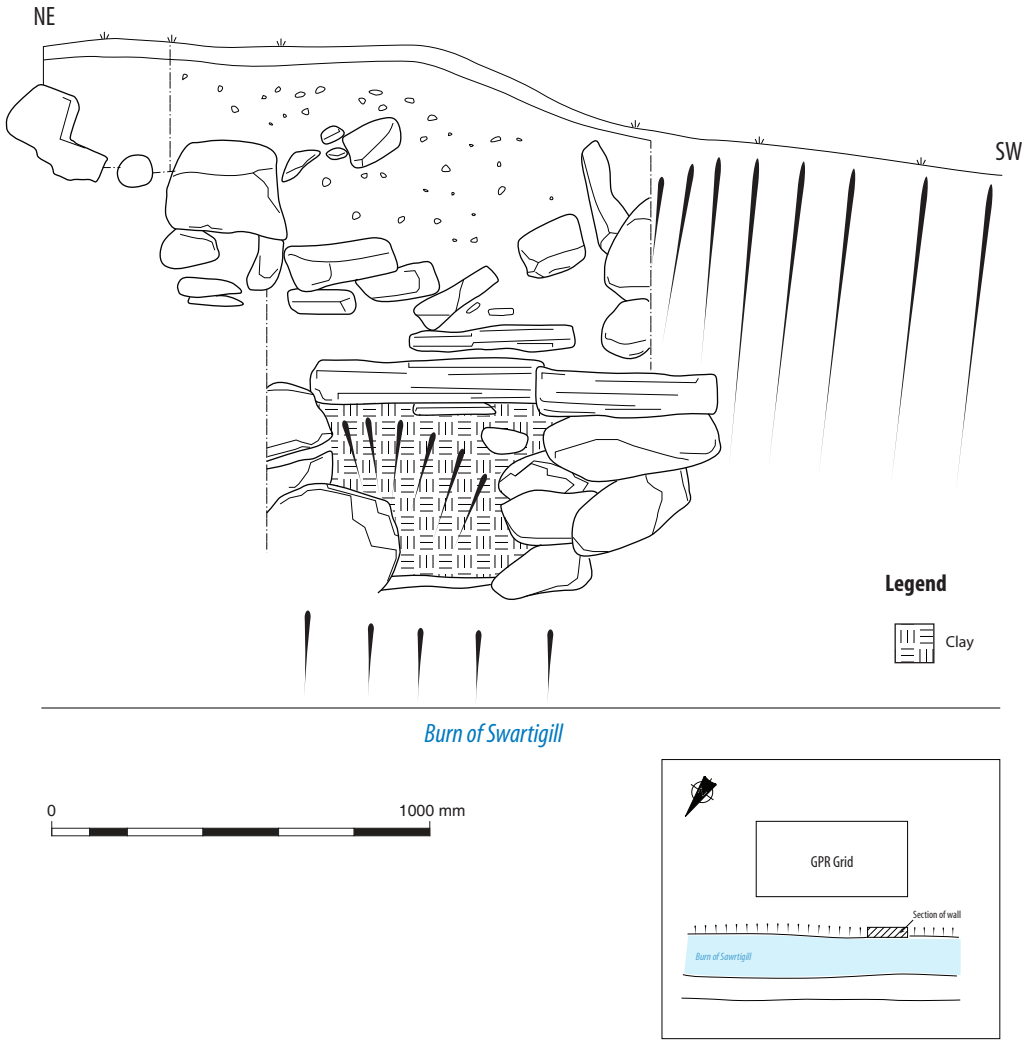


Fig 9b - Section of Wall to the north of the Swartigill GPR grid.

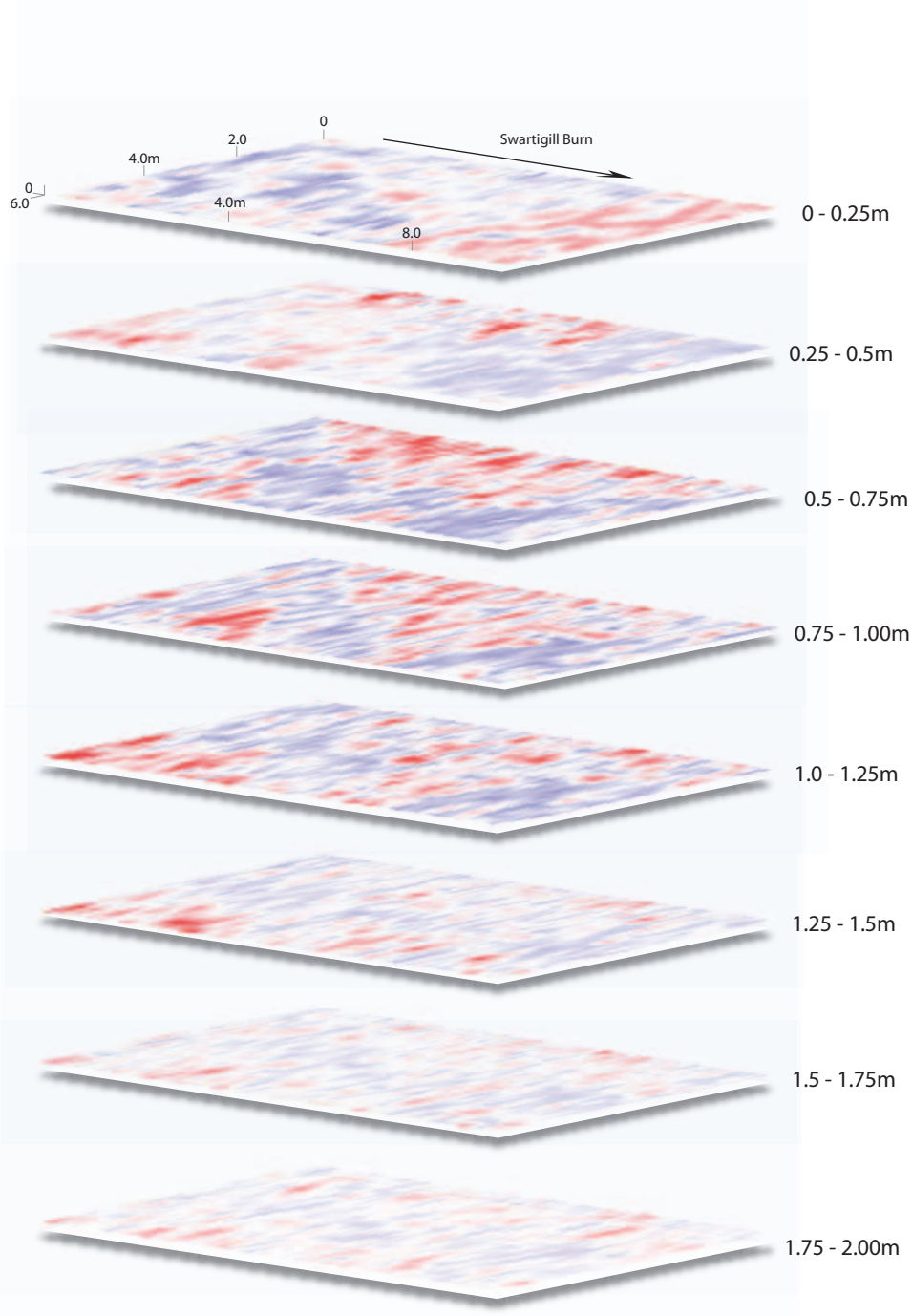


Fig 10 - Swatigill burn radargrams showing the orientation of survey and depths.

Plate 2 - Dr Susan Ovenden, of the Geophysics Unit, Orkney College explaining the data logging equipment to the project volunteers.

Plate 3 - GPR equipment in use at Oliclate, grid B.

Plate 4 - Volunteers, peat probing of Oliclate, Site A.

Plate 5 - Volunteers recording the peat stratigraphy of S Yarrows 1.

Plate 6 - Blue-grey minerogenic silt recovered from the base of the core at Oliclate Grid A.

Plate 7 - Volunteers cleaning up the building remains shown in Fig 10, GPR grid survey lines are shown adjacent

LOCAL AUTHORITY:	Highland
PROJECT TITLE/SITE NAME:	Loch of Yarrows Environs, Caithness: 'Testing the applicability of Ground Penetrating Radar survey in relation to wetland landscapes'
PROJECT CODE:	YARR
PARISH:	Wick
NAME OF CONTRIBUTOR:	M Cressey on behalf of Scottish Wetlands Archaeology Programme (SWAP)
NAME OF ORGANISATION:	CFA Archaeology Ltd
TYPE(S) OF PROJECT:	Palaeoenvironmental research and GPR survey
NMRS NO(S):	ND 34 NW 66 Hut circles, possible cairn and enclosure ND 34 NW 66 (Yarrows 04 512) Swartigill Burn, structural remains.
SITE/MONUMENT TYPE(S):	Peat formations close to known later prehistoric settlement remains.
SIGNIFICANT FINDS:	N/a
NGR (2 letters, 6 figures)	Swaritigill Burn (ND 320 845) Oliclate Farm (ND 301 452) South Yarrows 1 and 2 (ND 309 431- ND 310 431)
START DATE (this season)	January 2007
END DATE (this season)	January 2007
PREVIOUS WORK (incl. *DES* ref.)	Tipping R. 2005 (in press) 'Living with peat in the flow country: prehistoric farming communities and blanket peat spread at Oliclate, Caithness, and Northern Scotland'. SWAP/WARP 2005 Wetland Archaeology Conference Proceedings. SWAP (forthcoming) Crone et al (eds) Title to be confirmed.
MAIN (NARRATIVE) DESCRIPTION: (May include information from other fields)	In January 2007, CFA Archaeology Ltd carried out a programme of palaeoenvionmental survey on behalf of the Scottish Wetlands Archaeology Programme (SWAP) within the locality of Loch of Yarrows, Caithness. This project is one of several research studies carried out by SWAP during 2006 as part of a wider framework to promote Scottish Wetland Archaeology (SWAP 2007 forthcoming) . The survey was carried with the help of volunteer members of the Caithness Archaeological Trust (CAT) and the Loch of Yarrows Archaeological Trust (YAT). The project was designed to test the viability of Ground Penetrating Radar (GPR) over variable depths of blanket or mire peat formations. Three study areas were selected and included a sequence of deep, intermediate and shallow peat. The project was carried out following above average winter rainfalls that resulted in high saturation of the blanket peat which covers much of the area surrounding the study areas. A series of grids were peat probed and cored providing a biostratigraphic and basal profile of each survey grid. Each grid was subjected to GPR survey. The three sites selected for survey were as follows: Oliclate Farm to the north of Loch of Yarrows (grids A and B) South of Loch of Yarrows (Yarrows 1 and 2) Swartigill Burn, to the north of Loch of Yarrows The results confirm that at Oliclate Farm, there is good correlation with the basal profile and biostratigraphic profiles obtained fom coring, although slight attenuation (loss of the radar signal) did occur owing to the very saturated nature of the peat. There is good

	correlation within the biostratigraphic profile and those obtained to the east by Tipping et al (2005). At South Yarrows 1, the shallow peat area, again good correlation was recorded between the environmental record and GPR results. At South Yarrows 2, an infilled palaeochannel provided the best correlation between the environmental record and the GPR results. At Swartigill Burn, the site of possible building remains resting on alluvial clay, the radar returns were confused by the distribution of building stone, possibly demolition material that was spread across the site. Although no wall alignments could be defined from within the radar patterns, the extent of the site within the survey grid itself is visible. The results of this pilot study confirm that severely saturated peat does not adversely effect the radar returns gained from the apparatus used and both peat stratigraphy and basal morphology can be measured. GPR survey can provide a cost effective, non-destructive method for site demarcation of archaeological sites and monuments buried below deep peat.