

Geophysical Survey of the Dorset Palaeoeskimo Site of Point Riche

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INTRODUCTION

THIS PAPER PRESENTS the results of geophysical survey (geoprospection) conducted during the summer of 2001 at the Dorset Palaeoeskimo site (EeBi-20) at Point Riche, Newfoundland (Figure 1). This work illustrates the capabilities of two of the most common geophysical techniques used in archaeology: magnetometry and resistivity, as applied to the characterization of semi-subterranean dwellings.

Geophysical survey encompasses a range of scientific techniques developed in the earth sciences for subsurface prospection and mapping. Geophysical techniques measure a variety of physical properties of the earth and can be divided into two distinct types: passive and active (Reynolds 1997). Passive methods measure variations in the natural fields of the earth, for example its gravitational or magnetic fields. Active methods transmit energy into the ground in the form of a signal or current. As this energy encounters different subsurface materials it is modified depending upon the physical characteristics of the material encountered, and the variation recorded.

Over the last 40 years, many of these geophysical techniques have been adapted by archaeologists for the exploration and investigation of archaeological sites. These techniques provide a rapid and non-invasive method for the identification of cultural features, as opposed to more traditional archaeological survey methods, such as test pitting. Archaeological sites can therefore, in appropriate circumstances, be identified and mapped without the need for costly excavation, thus saving both time and money whilst leaving the archaeological resource intact. Geophysical techniques can also provide information on the preservation potential of

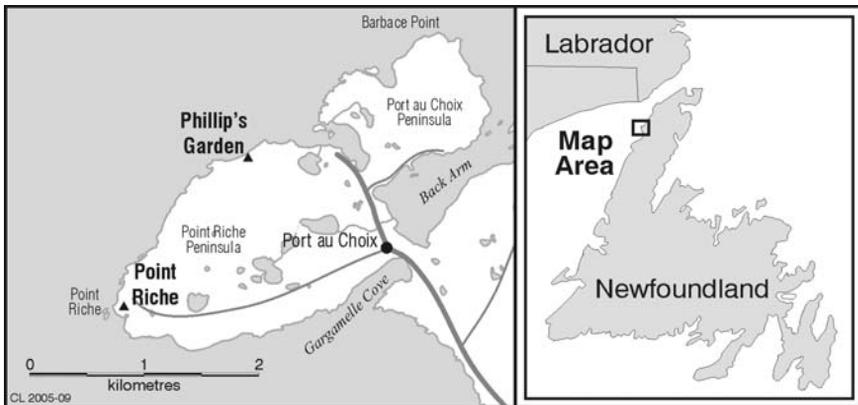


Figure 1. Location of the Point Riche site.

archaeological features on a site enabling archaeologists to pinpoint the most suitable areas for subsequent excavation (Shell 1997).

MAGNETOMETER SURVEY

Magnetometer survey is an example of a passive method, and is based on the measurement of small anomalies in the earth's magnetic field. Most rocks and soils are very weakly magnetic, although the intensity of the magnetism is dependent on the amount and type of magnetic compounds in them (Clark 1990). Topsoil, for example, is generally more magnetic than the underlying subsoil, as under normal pedogenic (soil forming) conditions, iron compounds, which are relatively insoluble, tend to concentrate in the soil (Clark 1990). This is of particular interest to archaeologists, as during the occupation of a site the relatively iron-rich topsoil, as well as other magnetic materials, are often disturbed and moved around as the inhabitants construct dwellings, ditches, banks, and other features. This movement of soils and rocks can artificially enhance or reduce the magnetism of a given area, thereby creating tiny, yet observable variations in the earth's magnetic field (anomalies) across the site. For example, during the construction of a pit house, the topsoil in the centre of the dwelling is removed as the central depression is excavated, and piled up around the depression to create low platforms or walls. The removal of the iron-rich topsoil from the centre of the dwelling creates an artificially low magnetic anomaly in the centre of the house. The platforms and walls, on the other hand, will have relatively higher magnetic properties, due to the increased volume of iron-rich topsoil. Additionally, other materials with magnetic properties different than the topsoil might also be used to construct the dwelling. Rock, which often has lower magnetic properties than topsoil (depending upon the rock's composition and for-

mation history), would be a case in point. Sections of the dwelling that are constructed from rock will potentially have weaker magnetic properties than elements of the house constructed from soil banks.

Some human activity can also substantially enhance the magnetic properties of a soil. Burning, for example, has a significant effect because certain iron compounds become more strongly magnetic when they are heated. Additionally, the process of heating, if at a high enough temperature, can produce a strong form of permanent magnetization known as thermomagnetic magnetism. This is achieved when the ferromagnetic substances in the materials being heated become completely demagnetized as they reach their Curie point (675°C for haematite and 565°C for magnetite). On cooling the compounds are re-magnetized en masse by the earth's magnetic field and aligned to the geomagnetic field (Clark 1990: 65). Archaeological features that commonly have these properties are hearths, kilns, and ovens. These features have very high positive magnetic properties compared to the natural soil and are easily detected through magnetometry. The same can be true for features that contain a high proportion of burnt material, such as burnt rocks and soils, charcoal, ash, and fired clays including brick, tile, and pottery, if the parent material from which they are formed contained iron minerals. Features that contain large quantities of organic matter also often create magnetic anomalies. This is because the breakdown of organic matter can lead to the production of large quantities of bacterial magnetite, a highly magnetic form of iron mineral (Faßbinder and Stanjek 1993). Typically, such deposits might include middens (refuse dumps) or the fills of ditches and pits or any other feature which has a high organic content.

RESISTIVITY SURVEY

Resistivity is an active geophysical method, which measures the electrical resistance of a specific volume of earth. *Resistance* (measured in ohms) is the bulk measurement of the restriction of current within a particular piece of ground. *Resistivity* is the term used for the electrical resistance of a specific volume of earth, which allows the resistance of different materials to be compared. The unit of measurement is the ohm-metre ($\Omega\text{-m}$): the resistance of a 1-metre cube of a material when a potential of one volt is applied between two opposite faces of the cube (Clark 1990). This term is usually used if discussing results collected using the same probe array or type of instrument. Resistivity varies with moisture content (Clark 1990: 27), which in turn is influenced by the grain size, sorting and composition of a material. Buried archaeological features will have differing levels of electrical resistance from each other, and from the surrounding soil, depending upon their moisture content. For example, a stone wall, being generally moisture resistant, will have a higher electrical resistance than a pit filled with damp soil. These differences can be detected and measured by a resistivity meter.

THE DORSET PALAEOESKIMOS

The Dorset Palaeoeskimos were a widespread culture that occupied most of the Canadian arctic east of Victoria Island, north to Greenland and south to (McGhee 1990). They were an Arctic-adapted people, who in most areas specialized in marine mammal hunting, particularly seals. The Dorset occupation of the Arctic is divided into three chronological periods: Early, Middle, and Late. They inhabited Port au Choix, Newfoundland, between approximately 1990 and 1180 cal BP (Renouf et al. 2000), which falls entirely in the Middle Dorset Period.

THE DORSET SITE AT POINT RICHE

The Dorset site (EeBi-20) at Point Riche is located on the southeastern corner of the Point Riche Peninsula, approximately 4 kilometres west of the town of Port au Choix (Figure 1). Calibrated radiocarbon dates show it was occupied between 1870 and 1360 cal BP.¹ The site is situated on an exposed and slightly elevated grassy terrace that runs parallel to and approximately 100 metres from the modern shoreline, and averaging 10 metres above high water mark. The bedrock of the peninsula consists of well-bedded, dark grey, fossiliferous limestone with characteristic dolomite-argillaceous seams (Dept. of Mines and Energy 1992). Above this bedrock lies a rounded limestone gravel substratum at least 75 centimetres in depth, which in turn is covered by thin peaty topsoil up to 20 centimetres in depth.

Thirty-six rounded depressions are located at the site, particularly along the terrace edge. These depressions range in size between 2 and 5 metres in diameter and up to 70 centimetres in depth (Figure 2). Test-pitting at the site in 1984 (Renouf 1985) determined that nineteen of these depressions contained stone tools from the Middle Dorset period. Thus many of the depressions were initially thought to be the remains of Dorset Palaeoeskimo dwellings. Three rectangular clusters of iris were thought to mark other dwellings, as these flowers were known to favour the growing conditions provided by house depressions at Phillip's Garden (Renouf and Murray 1999), a larger and better understood Dorset Palaeoeskimo site approximately 4 kilometres north of Point Riche.

Between 1985 and 1991, excavation of two of the depressions at Point Riche revealed the remains of two very different archaeological features (Renouf 1985, 1986, 1987, 1992). One (House Feature 8) was a well-defined Palaeoeskimo dwelling 5.5 metres wide and 7 metres long, with gravel walls up to 0.15 metres high and 1.5 metres wide, built up on three sides of the structure (Renouf 1992). Around the dwelling was a number of smaller features, including a linear arrangement of limestone and sandstone rocks that abutted the southern wall. This was interpreted as the equivalent of the axial pavements often found inside Palaeoeskimo houses elsewhere in their geographic range (Renouf 1992: 60). A hearth was identified approx-

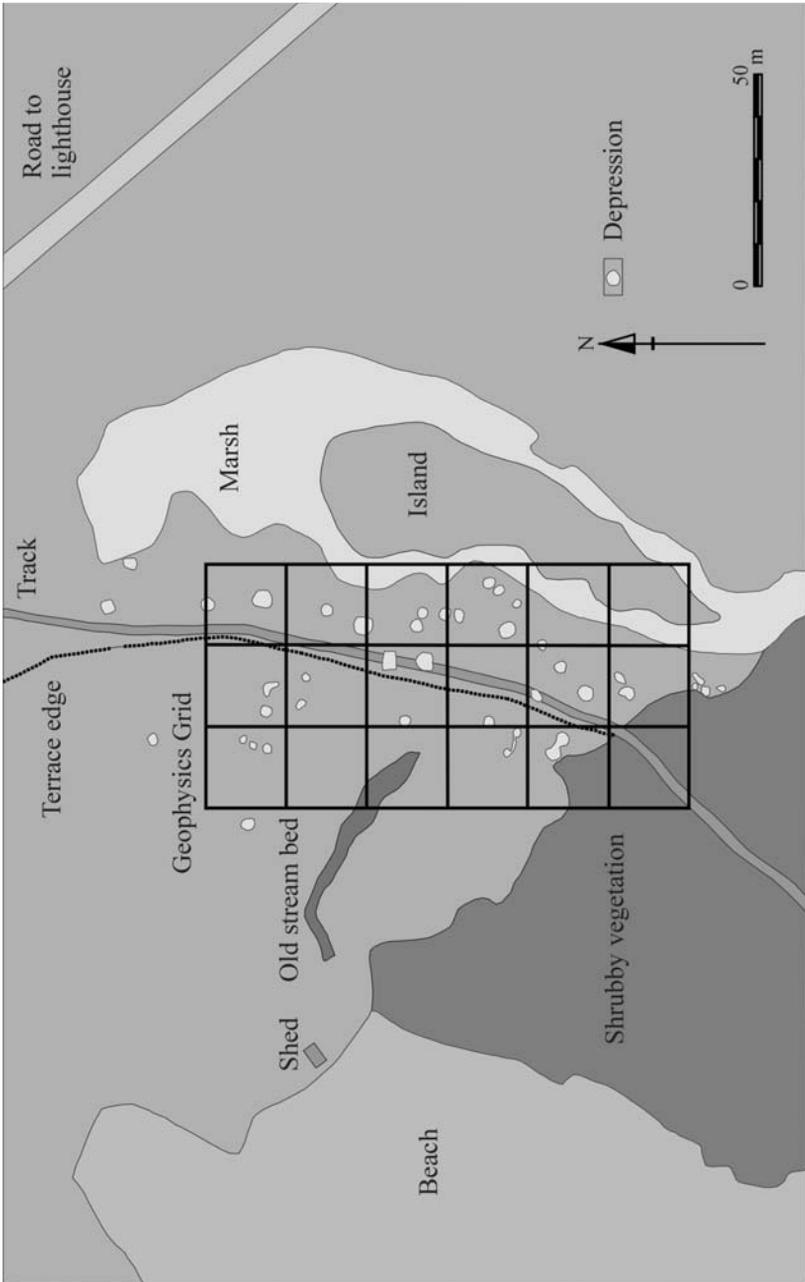


Figure 2. Surface features and location of geophysics grid at Point Riche.

imately 2 metres behind the dwelling, and a heating platform, consisting of a semicircle of fire-burned cobbles and flat rocks, was identified near the entranceway. The other excavated depression (Feature 1), despite being clearly defined on the surface, turned out to be a shallow amorphous pit masked by frequent undulations in the limestone substrata (Renouf 1985). No architectural elements were identified and it was therefore suspected that the feature was not a dwelling at all, but merely a natural depression containing midden material. Similar natural depressions, which related to the drainage pattern of the limestone bedrock, could be seen on the exposed bedrock nearer the beach. Renouf (1992) interpreted Point Riche as a seasonally occupied base camp, where the occupants hunted the massive harp seal herds that migrated past the site every spring.

Although Renouf considerably advanced our understanding of the Dorset Palaeoeskimo occupation at Point Riche, a number of questions remained unresolved. One of these questions concerned the number and distribution of Palaeoeskimo dwellings at the site. The excavation of Feature 1 had made it apparent that not all the depressions containing artefacts were Palaeoeskimo dwellings. A sixth season of fieldwork was therefore planned in 2001 to address this, as well as other questions relating to the Palaeoeskimo occupation of the site. The fieldwork included a reassessment of the number of dwellings with the production of an accurate site map, and the excavation of a third depression to gain more data on dwelling architecture and associated artefact distributions.

THE GEOPHYSICAL SURVEY

The two principle goals of the geophysical survey at Point Riche were to identify a Palaeoeskimo dwelling with well-preserved architectural features for excavation, and to discriminate between those features that were Dorset dwellings, and those that were natural features or historic building foundations. Two approaches, magnetometry and resistivity, were chosen. The surface features of the site were mapped using a total station theodolite and a 120-metre by 60-metre geophysics grid was established and orientated to encompass as many of the surface depressions as possible (Figure 2).

THE RESISTIVITY SURVEY

The resistivity survey was conducted with a Geoscan RM15 Soil Resistivity meter. Readings were logged at 1-metre intervals along traverses spaced 1 metre apart within each 20-square-metre grid. Because of the tight time schedule (a single day), only the twelve easternmost squares of the survey grid were surveyed. The raw data were processed in Geoplot 2 and converted into images in the grey scale format.

The grey scale format divides a given range of readings into a set of number classes, each with a predefined scale of grey (Ovenden-Wilson 1997). An increase in tone corresponds with an increase in number class. The images were interpolated to smooth the graphics data between sample points.

THE MAGNETOMETER SURVEY

Two magnetometer surveys were conducted at Point Riche. The first, which encompassed the entire survey area, logged readings at 1-metre intervals along traverses spaced 1 metre apart within each 20-square-metre grid. The results of this survey were disappointing, as the interval between readings proved to be too wide to pick up the subtle nature of the archaeology. To improve the resolution, readings were logged every 0.25 metres along parallel traverses spaced 0.50 metres apart within each 20-square-metre grid. The additional time required for a close interval survey meant that the surveyed area had to be reduced to the eight easternmost grid squares. Fortunately, this 120-metre by 40-metre area was centred over the greatest concentration of depressions. The raw data were processed in Geoplot 2 where they were converted into images in the grey scale format. Processing included: 1) “de-spiking” to remove many of the readings that most likely resulted from modern metal objects in the ground, 2) “Zero mean traverse” to remove striping effects in the graphics that often occur in fluxgate gradiometer data, and 3) “interpolate X and Y” to smooth the graphics data between sample points.

IDENTIFYING A DEPRESSION SUITABLE FOR EXCAVATION

Of the two geophysical techniques used at Point Riche, the magnetometer survey proved to be the most useful in identifying a suitable depression for excavation. The results of the resistivity survey (Figure 3) were disappointing, with no archaeological features detected. This was due to drastic changes in soil moisture across the site, which ranged from exposed bedrock to a waterlogged marsh within a distance of 20 metres. Such variable and rapid changes in soil moisture, which has a direct relationship with the electrical resistance of the ground, masked any of the more subtle changes in electrical resistance that might have been expected from the archaeological features associated with Palaeoeskimo dwellings.

The results of the magnetometer survey were more successful, although the identification of archaeological features was at the extreme end of the detection limits of the instrument. Additionally, not all the depressions could be evaluated as they lay outside the survey area, or fell close to old excavation areas that contained a large number of buried metal grid pegs. These grid pegs produced such large anomalies that they obscured large areas of the survey (Figure 4:E).

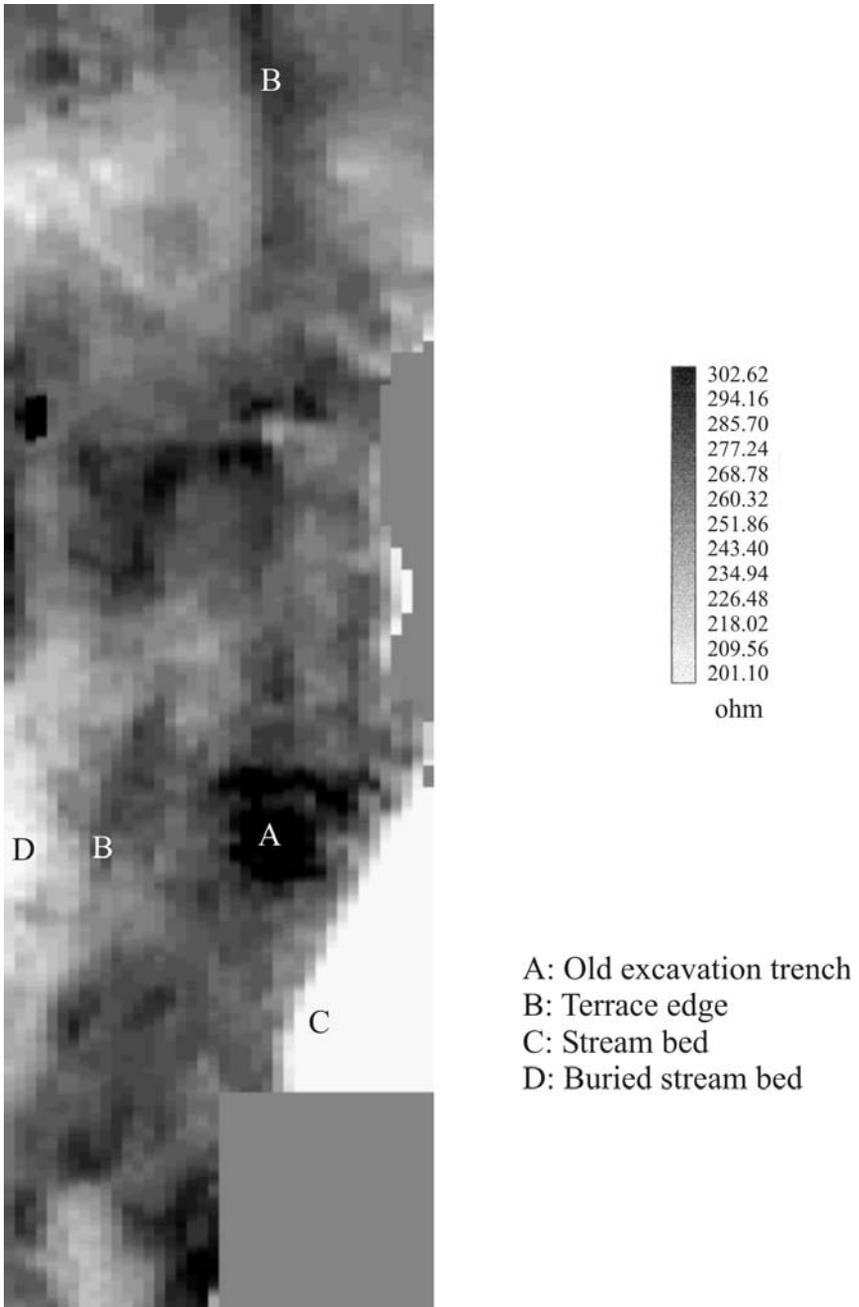


Figure 3. Results of the resistivity survey.

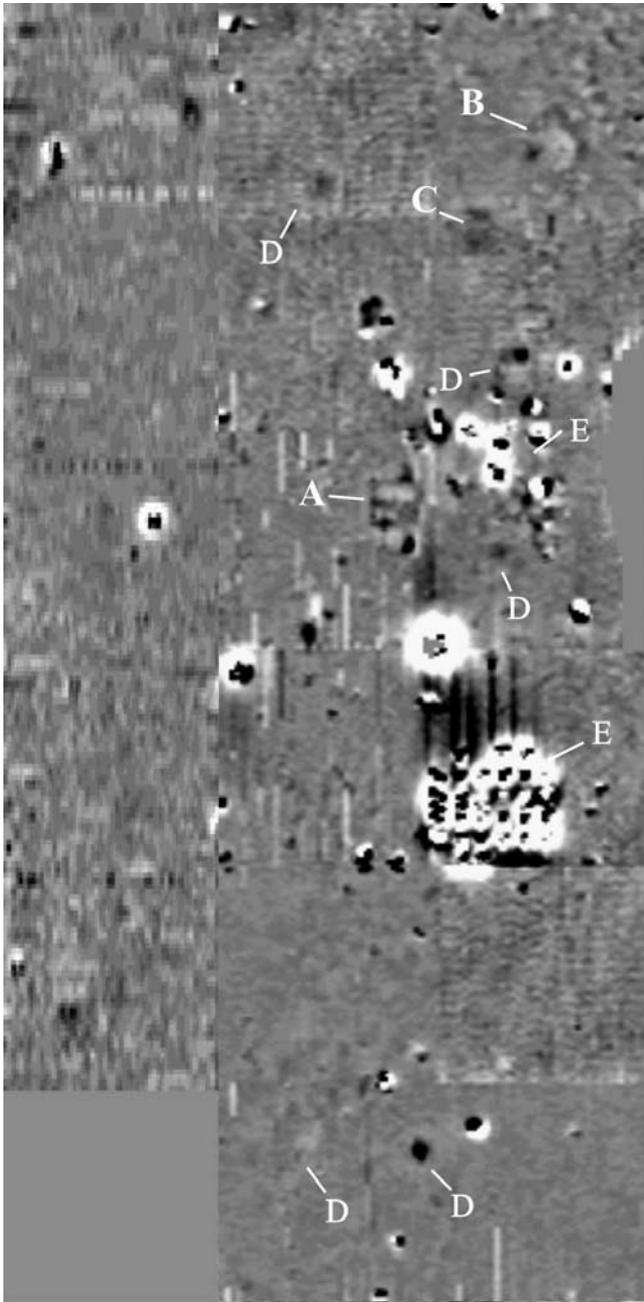


Figure 4. Results of the close interval magnetometer survey. Note: the western six grids are added from the broad interval survey.

The results of the magnetometer survey showed a round area of negative magnetism surrounded by a semi-circle of positive magnetism (Figure 4:B and Figure 5) in the top right-hand corner of the survey. Not only did the location of this anomaly corresponded with a well-defined surface depression, it also showed distinct similarities to House Feature 8, excavated in 1991 by Renouf (1992), which consisted of a central depression surrounded by a limestone gravel bank on three sides. As none of the other depressions had such clear anomalies, it was suspected that this depression was the most likely to have well-defined architecture. On this basis, it was chosen for excavation. The excavation did indeed reveal a Palaeoeskimo dwelling, House Feature 30, with architecture very similar to that indicated by the magnetometer results (Figure 6). It consisted of a central depression 3.60 metres long, 3.10 metres wide, and 0.60 metres deep, surrounded by a horseshoe-shaped earth platform that averaged 1.60 metres wide.

MAPPING THE PALAEOESKIMO DWELLINGS AT POINT RICHE

Although no clearly definable dwellings were identified in the resistivity survey, comparison of the results with the surface features recorded in the topographic survey showed some of the depressions to correspond with areas of very low resistance. As low resistance is indicative of wetter, more conductive deposits, it is probable that these depressions were the result of solution hollows in the limestone bedrock, or buried streambeds, rather than cultural activity. Both of these natural features were present elsewhere on the site and produced similar low resistance anomalies in the survey (Figure 3:D). The location of these low resistance features contrasted with the location of many of the other depressions, including those confirmed to be houses through subsequent excavation. House depressions were situated on the driest part of the site that ran parallel to and approximately 10 metres east of the terrace edge (seen as the high resistance black line running north-south in Figure 3:B). This indicated that the Dorset Palaeoeskimo deliberately avoided the wetter areas when selecting a dwelling location.

A number of archaeological features were identifiable in the magnetometer survey. The clearest was a rectangular anomaly just north of centre (Figure 4:A and Figure 7). Its regular shape clearly identified it as a historic building consisting of three rooms. This anomaly coincided with a surface depression which, on appearance alone, was indistinguishable from the other depressions.

Also visible was a number of Palaeoeskimo dwellings. The clearest of these was the depression (House Feature 30) that was subsequently excavated (Figure 4:B and Figure 5). The advantage of having followed the survey with excavation is that it allowed some of the anomalies to be ground-truthed. Ground-truthing links the characteristics (e.g., shape and strength) of an anomaly to a particular archaeological feature type. Anomalies with similar characteristics to the ground-truthed

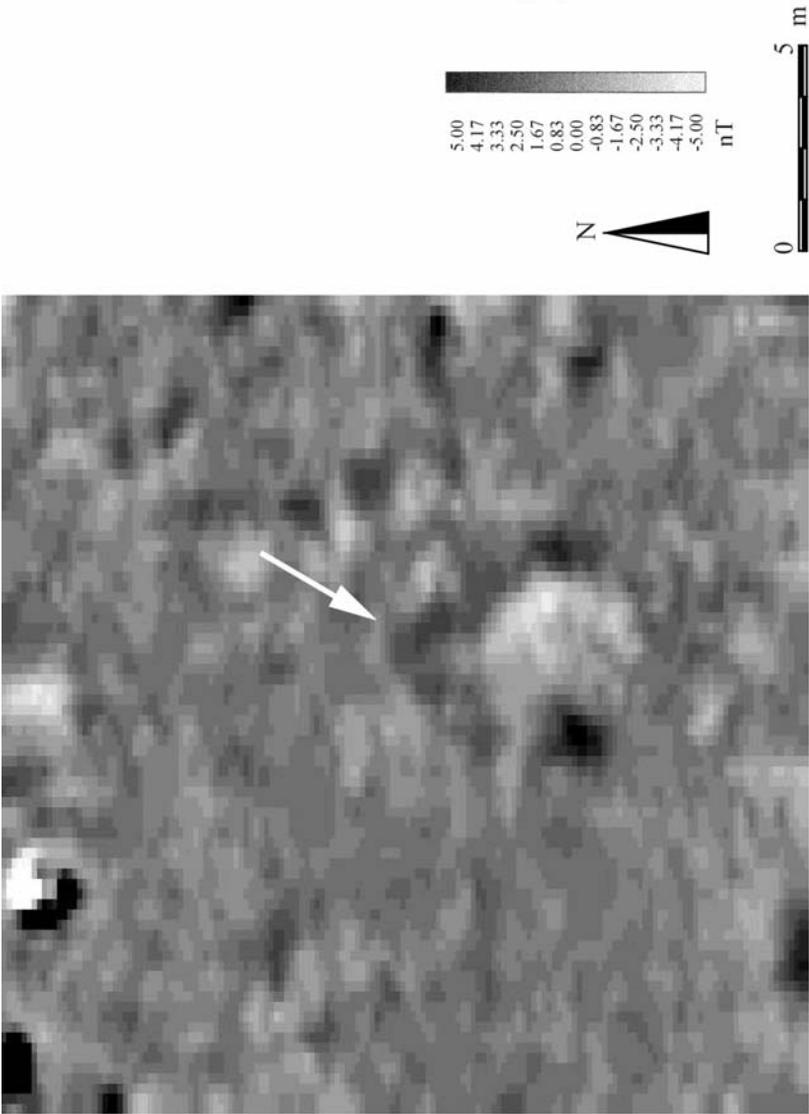


Figure 5. Detail of the magnetometer survey showing House Feature 30.

example can then be assumed to result from similar archaeological features. For example, the depression that was confirmed to be a Palaeoeskimo dwelling through excavation (House Feature 30) showed up as a round anomaly surrounded by a “halo.” Round anomalies that are surrounded by haloes are, therefore, likely to be other Palaeoeskimo houses with similar central depressions and platforms.

The results of the magnetometer survey showed haloes around five of the other depressions (Figure 4:D), although none were as clear as House Feature 30. Three of these anomalies differed from House Feature 30 in that they had negative rather than positive magnetic haloes around their depressions. It is probable that this resulted from the different building materials used to construct their house platforms. House Feature 30’s platform, which produced a positive magnetic signal, was constructed predominantly from clay-rich earth (Figure 6:F45). House Feature 8’s platform, however, was made from limestone gravel (Renouf 1992: 51). In House Feature 30, the section of the platform (Figure 6:F40) constructed from limestone rocks and turf produced a negative magnetic signal. The negative magnetic haloes around the unexcavated dwellings therefore indicates that the platforms around these dwellings were probably constructed from gravel banks similar to House Feature 8 rather than the earth banks used in House Feature 30.

The same three anomalies also differed from House Feature 30, in that they had positive magnetic anomalies in the centre of their depressions. This is almost certainly the result of the depressions being used as convenient refuse pits after the houses were abandoned. This practice has been documented in contemporary Inuit populations at Minguotok, Frobisher Bay (Henshaw 2000: 64), and demonstrated archaeologically at Phillip’s Garden (Renouf 1987: 27). Geophysical survey at Phillip’s Garden (Eastaugh 2002) showed these refuse deposits to have magnetic signatures identical to those at Point Riche.

Also identifiable in the magnetometer survey was a sub-rectangular area of positive magnetism (Figure 4:C) approximately 4 metres southwest of House Feature 30 (Figure 4:B). Unlike the dwelling depressions, there was no surface indication that corresponded with this anomaly, and it was tentatively interpreted as a diffuse midden associated with House Feature 30. However, upon excavation it turned out to be an activity area relating to the Groswater Palaeoeskimo, another Arctic-adapted culture which inhabited Port au Choix prior to the Dorset, between 2950 and 1820 cal BP (Renouf et al. 2000: 107). It consisted of a spread of burnt rocks and charred seal fat with many flakes and stone tools, including harpoon endblades, scrapers, burin-like tools and bifaces. This feature may be a temporary dwelling, as the shape and size of the anomaly is consistent with excavated examples of Groswater Paleoeskimo dwellings from Phillip’s Garden East (EeBi-1) and Phillip’s Garden West (EeBi-11) (Renouf 2002: 48-56).

Other features in the magnetometer survey appeared as circular areas of positive magnetism, which varied between .5 metres and 2 metres in diameter. As none of these anomalies were subsequently excavated, it was difficult to establish what

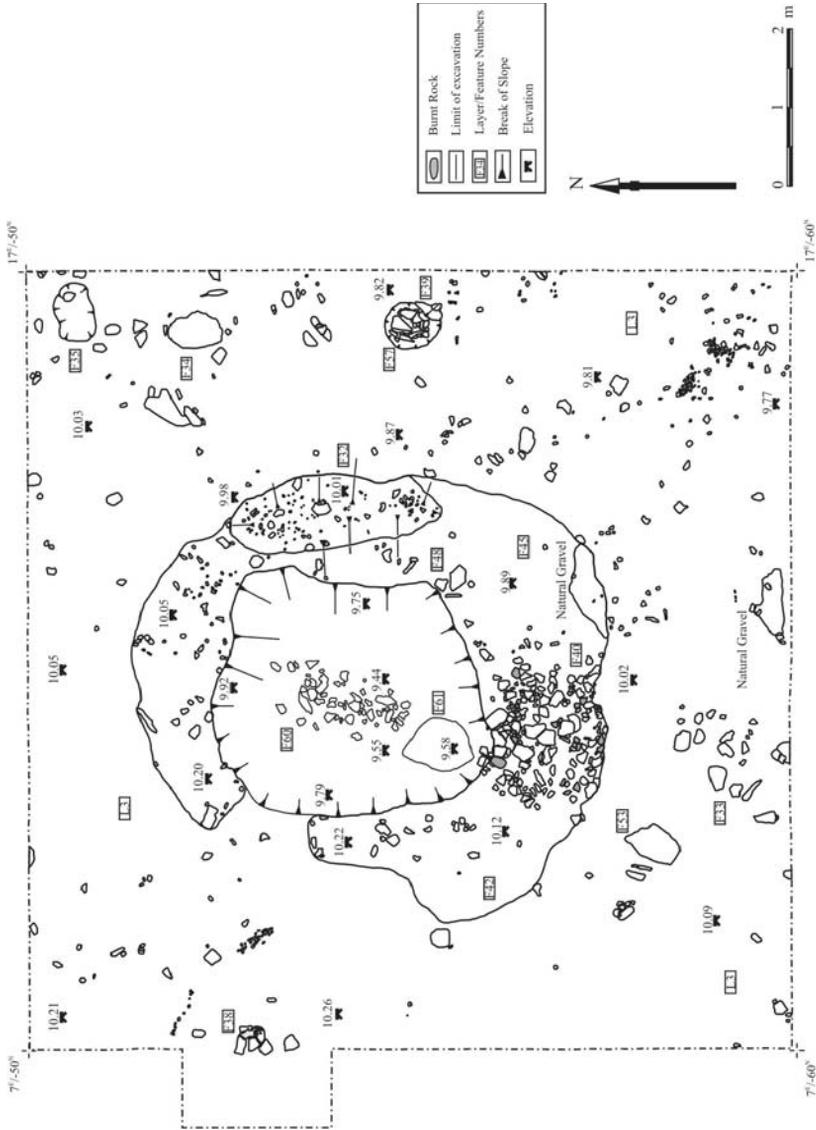


Figure 6. Excavation plan of House Feature 30. F40 is a stone platform and F45 is the clay-rich earth that comprises the built-up platform area.

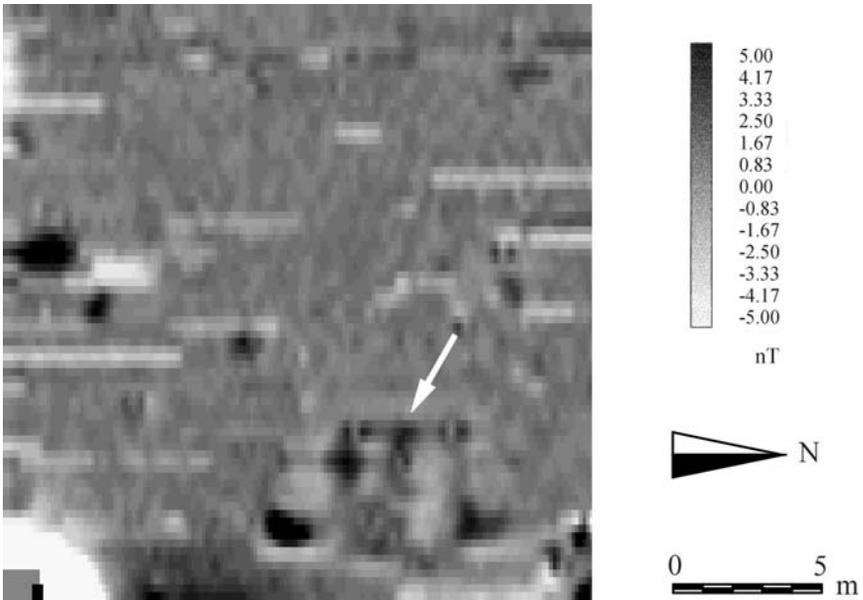


Figure 7. Detail of the magnetometer survey showing a rectangular historic structure.

they represented. Their shape and size suggested that they were probably small external pits and/or areas of burning such as hearths. More extensive excavation at Phillip's Garden (Renouf 1985, 1986, 1987, 1991, 1992, 1993) has revealed both of these feature types on Dorset Palaeoeskimo sites in the area.

Figure 8 presents a revised map of the main Dorset Palaeoeskimo features at Point Riche. It includes depressions associated with magnetic haloes and those shown to be dwellings through excavation. It also includes the small anomalies from the magnetometer survey believed to be refuse pits and/or hearths. The map excludes depressions thought to be natural solution hollows (based on the resistivity survey), and those depressions that appeared highly amorphous in the topographic survey. Depressions that lay outside the survey area, or were masked by the metal anomalies but fall on the same alignment as the positively identified dwellings, are included but labelled undetermined. The map shows up to seventeen dwellings that run north-south parallel to and approximately 10 metres east of the terrace edge. This is an ideal location, as it places the houses just behind the terrace ridge, which not only provides protection from the prevailing wind, but is also the driest part of the site (as demonstrated by the resistivity results). It also provides access to fresh water in the stream 10 metres to the east, as well as providing a clear vantage point out to sea. The pits concentrate away from the dwellings, approximately 10 metres to the west and just over the terrace edge.

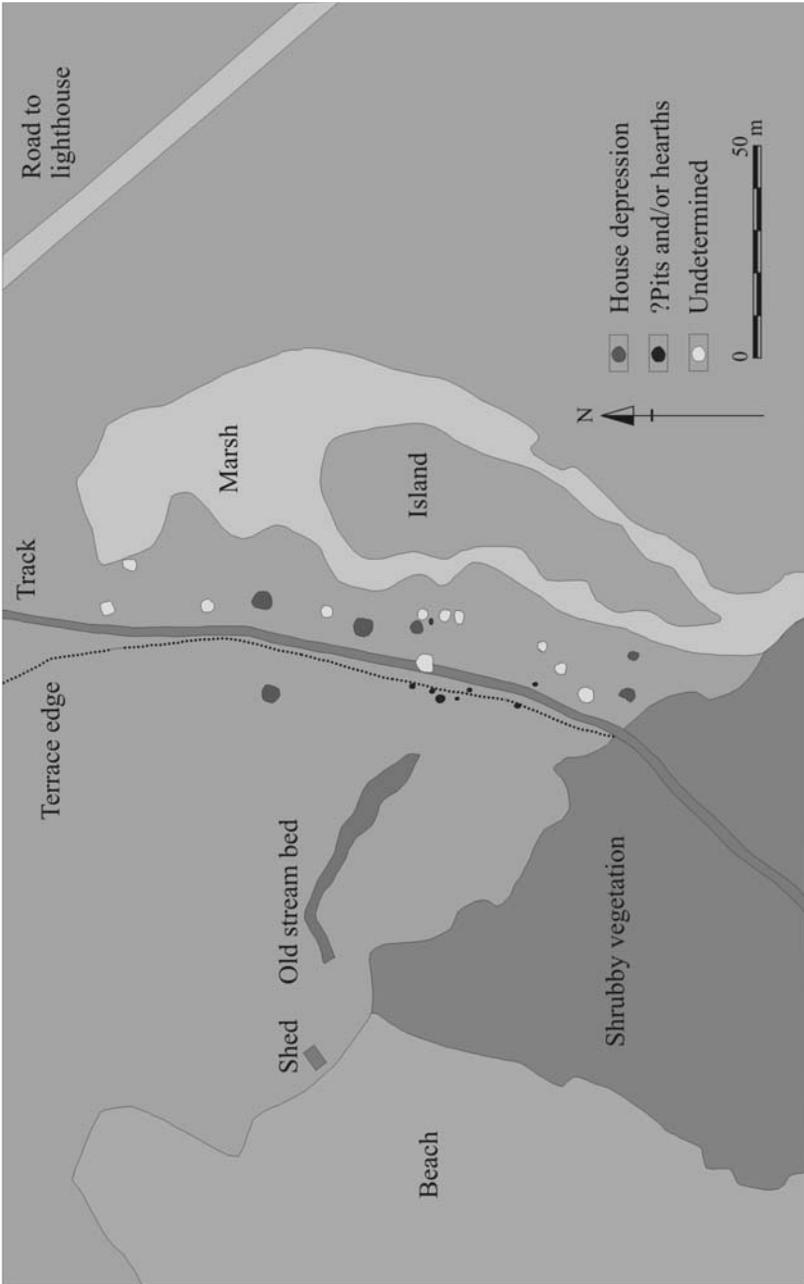


Figure 8. Map of probable and confirmed dwellings at Point Riche.

CONCLUSION

This paper has introduced two of the more common techniques of geophysical prospection to archaeological research. The magnetometer and resistivity surveys at Point Riche provided a means to map the number and distribution of Palaeoeskimo house depressions among the many surface features at the site. It also facilitated the identification of the most suitable depression for excavation thereby increasing the efficiency of the field season. Of the two approaches, magnetometry proved to be the most suitable to the local conditions of the site, although even this approach was at the extreme end of the detection limits of the instrument. Magnetometry was more successful at identifying cultural features including five Palaeoeskimo dwellings, an historic structure, a Groswater Palaeoeskimo activity area and a number of small features which are probably refuse pits. However, it was badly affected by the large quantity of iron grid pegs present on the site. The resistivity survey, while not successful in identifying cultural features, did provide a means of identifying many natural solution hollows. This in itself is instructive as it demonstrates the benefits of combining the two techniques in an integrated survey.

Acknowledgements

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Note

¹Dates are expressed in the text in calibrated calendar years before present (cal BP) as either a one-sigma probability age range or a median probability single age.

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