LATE PREHISTORIC SETTLEMENT AND SOCIETY IN SOUTHEASTERN SCOTLAND

by

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ABSTRACT

ALICIA L. WISE: Late Prehistoric Settlement and Society in Southeastern Scotland
(Under the direction of Carole L. Crumley.)

A study of protohistoric human ecology and societal response to change in cultural and natural environments was undertaken in the Scottish Borders. Specific objectives of the research program were to:

1) Collate archaeological and paleoenvironmental evidence,
2) Conduct targeted geophysical survey and excavation to fill some major gaps,
3) Analyse this evidence in order to look for patterns in site distributions,
4) Develop a paleoclimate model,
5) Construct an historical model of change through time, and
6) Present a preliminary explanation based on anthropological principles.

New information about the construction and layout of many native sites was gained through geophysical survey. Settlement pattern analysis supplied the first assessment of settlement evidence in central Tweeddale gathered in general surveys that took place in the 1890s and the 1950s. This analysis provided a bridge from site-specific detail to a regional framework informed by anthropological and other social theory. Fieldwork elucidated the nature of both native and Roman archaeology.

There is evidence for indigenous cultural maintenance despite the expansion of the Roman empire. There appears to have been little contact between the Roman military and the local population, and what contact there was may have been relatively peaceful. Stability in the face of expanding empire was partly due to embededness in the landscape and a resilient subsistence strategy well adapted to the changing maritime climate.

In loving memory of Tom Hargrove

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This research would not have been possible without a wide variety of colleagues and friends. All of my advisors at UNC worked very hard keeping track of me and reading drafts, especially Carole Crumley who has been an ideal supervisor. Access to data collected by members of the Newstead Research Project was essential and thanks are due Rick Jones, Simon Clarke, Kate Clark, Paul Cheetham, and John Dent.

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LIST OF ABBREVIATIONS

BADC	British Atmospheric Data Centre
CRM	Cultural Resource Management
CUCAP	Cambridge University Collection of Aerial Photographs
EBM	energy budget model
GCM	global climate model
Km	kilometers
m	meters
MNE	Minimum Number of Elements (MNE)
NISP	Number of Identifiable Specimens
NMR	National Monuments Record
NMRS	National Monuments Record of Scotland
NMS	National Museum of Scotland
nT	nano tesslas
RCAHMS	Royal Commission on the Ancient and Historical Monuments of Scotland
SMR	Sites and Monuments Record

I. INTRODUCTION

1.1 General Research Aims

The study presented in these pages grew from a very general question – what happened to the indigenous population when the Roman army invaded southern Scotland almost 2000 years ago? Many themes entwined in the research that ensued including archaeological methodology, theoretical perspective, maritime climates, settlement, ecology, computer applications in archaeology, Celtic and Roman interactions, and the nature of proto-historic colonialism.

Two general aims emerged as central to the archaeological study of past populations in southern Scotland. The first was to understand the protohistoric human ecology, and the second was to understand the ways native society responded to changes in cultural and natural environment.

A general literature view of past approaches to these questions in archaeology follows in the next two sections, and this discussion leads directly into following sections about the chosen study region and my specific research program.

1.2 Approaches to human ecology in archaeology

The earliest anthropological writings about the relation of people and their environments were generally descriptive, and any interpretation fell into two broad categories.

The first was *environmental determinism* in which the nature of the environment was thought to directly result in the cultural expression of people inhabiting that environment (Wissler 1929). The second was *environmental possibilism* in which the nature of the environment was thought to limit certain kinds of cultural expressions, but the ability of cultures to adapt to a range of environments and historical circumstances was recognized (Boas 1948, Forde 1934).

The work of Julian Steward moved beyond these two interpretive schools, and for the first time demonstrated ways in which the general interaction between cultures and environments could be studied (Harris 1968). Steward's interests were not on the physical environments in which cultures were found, but rather on human beliefs about the range of resources available in an environment. Steward worked with the idea of the "culture core" as the basic feature of cultures, and defined this core as behaviors dealing with the techno-economic foundation of a society including social, religious, and political features. These basic features of cultures occurred with similar functional interrelationships resulting from local ecological adaptations and similar levels of socio-cultural integration (Steward 1973). Through careful description of the culture core and environment in specific societies, and extensive cross-cultural comparison, Steward noted that band-level social organization in a variety of environments was related to similar underlying ecological structures (Steward 1936, 1969). Band organization was thus interpreted as the most effective kind of social organization for certain environments.

Steward's approach to cultural ecology is widely recognized as a significant milestone in the study of humans and their environment (Netting 1986), although he has been criticized for suggesting the universality of the relationships between social organization and ecology he recognized (Harris 1968). His ideas have a particularly strong bearing on the practice of American archaeology today because Steward was one of the first anthropologists to draw on archaeological evidence in the formulation of his theories (Steward and Murray 1977).

In archaeology, attention has turned from description of past environments to analysis of diachronic changes in environments and how these changes affected societies (Butzer 1982). Collected under the name *human ecology*, new questions were asked of the archaeological record. The nature of spatial and temporal variability in environmental change was studied to establish a sense of the predictability and variability of the environments in which people lived. Landscapes surrounding archaeological sites were examined to understand what subset of the total environment was actually utilized in order to gain some perspective on human use of the environment. The goal of archaeology was conceived as study of the interrelationship between culture and environment, emphasizing archaeological research "directed toward a fuller understanding of the human ecology of prehistoric communities" (Butzer 1964:5).

With the rise of new archaeology, interest in cultural ecology took a decidedly functional and economic turn. Interest in rational decision making in the past led to an increased use of statistics for spatial analysis to understand site locations in terms of minimizing costs of obtaining raw materials and this led to advances in the methodology and theory of spatial analysis (Johnson 1977, Kintigh and Ammerman 1982, Watson *et al.* 1971).

In Britain, Butzer's human ecology and the empiricism of new archaeology carry on today in the school of environmental archaeology. Environmental archaeologists specialize in applying methods used to reconstruct past environments (Bell & Walker 1992, Bowden *et al.* 1981, Chambers 1993, Goudie 1992, Harding 1982), but formal testing of derived hypotheses in specific regional contexts has been confined mainly to periods for which historical documents exist (Lamb 1981; McGhee 1981; McGovern 1994; Parry 1978, 1981) and only recently has the term *ecology* actually been applied to this endeavor (O'Connor 1998). Perhaps because of this lack of concern with the theoretical underpinnings of their discipline, British environmental archaeologists have focused their attention on data collection resulting in a solid and thorough body of paleoenvironmental evidence.

Another strand of research in Britain that can trace its roots through Butzer is landscape archaeology. Here a combination of survey techniques including aerial photography and geophysics, strong environmental research, scalar analysis, and spatial analysis (Hodges 1987) have led to compelling discussions of the extensive remains of prehistoric ritual monument and settlement landscapes. Thanks to Butzer's sympathy with the argument that it is human perception of environment that is more important than the actual environment (Butzer 1982), landscape archaeology has been a fruitful ground for successful integration of processual and post processual analysis (Wagstaff 1987) despite some rejection of the concept of nature (Shanks and Tilley 1987, Tilley 1994). In North America many of the same concerns and interests have manifested in research on archaeological regions (Crumley and Marquardt 1987, Ebert 1992).

Also in North America, an extension of Butzer's work exists in the school of historical ecology where the traditional dichotomy between culture and nature is challenged (Ingerson 1994), and a dialectic relationship between these two spheres is demonstrated (Crumley 1994) while the emphasis on scale is retained (Crumley 1993). Interpretation of diachronic evidence about people and their environments in terms of dialectical relationships between culture and nature is promising in archaeology. These include refinements in our understanding of human evolution (Winterhalder 1980), new ability to incorporate information obtained from environmental modeling (Wise and Thorme 1996, Wise in press a), new interpretive frameworks for events observed in the archaeological record (McGovern 1994), and new predictive ability with which to contribute to current political discussions about the impact of humans on their environments (Crumley 1994a). Relatively recent calls in the British literature for precisely this sort of research (McGlade 1995), suggest that there is also a new opportunity to unite British and North American approaches to the study of humans and environment.

1.3 Approaches to the study of change in the archaeological record

Earlier this century studies of change in the natural sciences came to be dominated by Darwinian theories of evolution, but in the social sciences Herbert Spencer's theories of social evolution were more prominent. Darwin's brand of evolution centered on the individual and on the individual's success in reproducing. Spencer emphasized the social aggregate as the unit of selection and

> attempted to demonstrate scientifically that nature, particularly human nature, inexorably moved toward perfection, which in the case of man he interpreted as complete adaptation to the social state, a consummation in which evil and stupidity, both inadaptations, would be finally replaced by freedom from social coercion and by expansion of individual rational capacities (Richards 1987:287).

For Spencer the terms *evolution* and *progress* were interchangeable and he struggled with the question of how a more moral society could be produced through unilinear evolutionary processes. Adopting Lamarckian principles of the inheritance of acquired characteristics, Spencer believed that the practice of moral living would lead to more developed moral senses. He blamed the poor for their unfortunate social positions and believed that poverty was a cure for moral diseases inherited from parents. For this reason he criticized the Victorian government for institutionalizing welfare programs designed to ease the burden of Britain's poor. Spencer instead advocated a decrease in government involvement in welfare reform and an increase in individual charitable donations because he believe that it was only through the daily practice of moral acts by individuals that society could evolve.

Evolutionary thinking and debates about the mechanisms of change were popular in anthropology as well as sociology. Particularly influential on archaeology were debates on whether all innovations were independently invented (Tylor 1871), or whether new ideas developed just once and then population migration caused them to spread into new areas (Morgan 1877). This debate over the originality of ideas is more understandable when viewed in its intellectual context. Migration of populations was one of the only explanations for culture change offered in the Old Testament and "this alone was enough to insure its predominance down to the middle of the 19th century, and in some quarters down to the present day" (Adams 1978:1). Adherence to migration/invasion hypotheses was also often the result of racist attitudes, conscious or unconscious, in which indigenous peoples were believed to have been too primitive to innovate and too barbaric to peacefully adopt outside ideas.

For the first half of the 20th century this migration/independent invention debate gripped archaeology (Renfrew 1979a) as similarity in the function, morphology and style of material culture in widely separated areas was noted. For European archaeologists, the two foci for this debate were the origins of collective megalithic chamber tombs and the origins of metallurgy. In the New World archaeologists puzzled over the origins of pyramid architecture and the mysterious mound builders.

Migration hypotheses were more widely accepted than the idea of independent invention, though both schools were eventually softened and blended into a general interest in the diffusion of ideas (Childe 1951). No longer were population movements envisioned as the only mechanism by which diffusion might operate (Adams 1978). It is now accepted in archaeology that diffusion occurred between individuals as well as groups and therefore operated at different rates, at different scales, and to different degrees within sites and between sites (Davis 1983). Note, however, that diffusion is not a cause of the spread or adoption of cultural traits, but only a way of referring to processes that are engendered by a diverse range of cultural and environmental factors.

Julian Steward, father of cultural ecology, capably combined data from archaeology, ethnography, and ethnohistory to describe the changes which took place within cultures through time in particular locales. Although he accepted that the diffusion of ideas or particular material traits into new cultural contexts could cause change and acknowledged the possibility of independent invention of traits within a group or groups, Steward believed these were not the only mechanisms of cultural change. For Steward diffusion was a process that could hasten culture change or result in parallel development, but it wasn't an ultimate cause of change (Steward and Murray 1977). The ultimate cause of changes were the complex interactions between ecology, technology, and economics within cultures.

Cultural ecology was formulated in opposition to social evolution (Steward 1955) which was criticized for being culturally biased and overly concerned with apparent 'progress'. Steward broadened the anthropological study of change in human groups by looking both inside and outside social systems for causes of processual change. He documented three trends in anthropological discussions of evolution - unilinear, universal, and multilinear - and strove to undermine the assumption of a single universal progression to human evolution he perceived in the works of Gordon Childe and Leslie White. For Steward evolution was not a goal-oriented process. He did believe there was general progress through time to systems of greater socio-cultural integration, greater complexity, and (after Herbert Spencer) greater heterogeneity, but he did not believe that the forms this progression would take in different areas or at different times would be identical.

Steward's three categories of evolutionary study were not mutually exclusive (Harris 1968) and were rejected by White as inaccurate characterizations of his work (White 1967) although this was due to some extent to a failure to distinguish between discussions of the specific evolution of a culture and general principles of cultural evolution (Sahlins and Service 1960). White also rejected Steward's central idea that environmental factors played an important role in evolution, and instead treated technology as the determinant of society and ideology. His basic law of evolution linked the rate of evolution to energy harness and efficiency (White 1943).

This interest in economy and process was especially influential in New Archaeology as focus shifted to forms of diffusion based on economic processes including exchange (Earle 1982) and trade (Renfrew 1979b). A tradition of attributing cultural similarities to migration/invasion still, however, remains with us (Adams 1978, Armit 1990a, Armit 1990b, Renfrew 1979a). This is especially true for explanations of changes in settlement morphology or pattern as these changes are more likely to be attributed to population migration. Changes in the style of objects are more likely to be explained as a process of adaptation after exchange or trade.

Other current approaches to the study of change are embedded in Darwinian evolution theory (Durham 1991, Dunnell 1980, Rindos 1985). Strategies for using Darwinian evolution in archaeology include analogy, where cultural selection is seen as analogous to natural selection, and direct application, where both cultural selection and natural selection are invoked as causes of change in frequencies of traits (Dunnell 1980). A strong reaction to Darwinian ideas has developed, partly to do with long-standing debates such as the creativity and free-will of people.

Barnett (1953), a social geographer, argued that ideas are never new, and that innovation is simply the new combination of pre- existing ideas. This idea resonates well with post processual thinking in archaeology where the social context of culture change has come into focus. Archaeologically this has been expressed by identifying profiles of potential adopters of innovations through discussion of relative rank, education, literacy, wealth, experience, ethnic identity, gender, and social mobility (Davis 1983), studying the individual and social contexts in which diffusion mechanisms like trade, exchange, migration, and invasion act (Earle 1982, Earle and Ericson 1977), and analysis of the symbolic value of material goods in the past and how this might influence uptake and dissemination (Hodder 1986).

1.4 Selection of Study Region

In the last two sections, past archaeological approaches to the study of human ecology and social responses to change were reviewed. These themes played a prominent role in selection of a study region in which to undertake research. Exploring human ecology requires access to a critical mass of archaeological and environmental data for a single region, while exploration of social responses to change requires a region where evidence suggests both cultural and environmental changes.

The most efficient strategy for gaining access to appropriate regional data was to become involved in an established research project in a country with a long history of archaeological research and relatively liberal policies on access to data. My pre-existing interests in maritime climates and the interaction of Celtic and Roman peoples made research in Britain a good option. Wide consultation in Britain and the United States identified the Newstead Research Project directed by Rick Jones of Bradford University as the closest fit. Conveniently, that project needed someone with experience in the application of Geographic Information Systems in archaeology, and so the benefit was mutual.

The goals of the Newstead Research Project were to study settlement and society from 1000 BC to AD 1000 in a 25 km^2 zone around the Roman fort of Newstead and the key question asked was the degree to which Natives assimilated to Roman systems during the 1st-3rd century occupation of Newstead (Jones 1990a). Extensive paleoenvironmental research undertaken in southern Scotland and northern England showed that widespread deforestation also occurred at the end of the prehistoric period (Dumayne *et al.* 1995; Tipping 1994, 1997).

Figure 1.1 Map of Great Britain showing the Scottish Borders

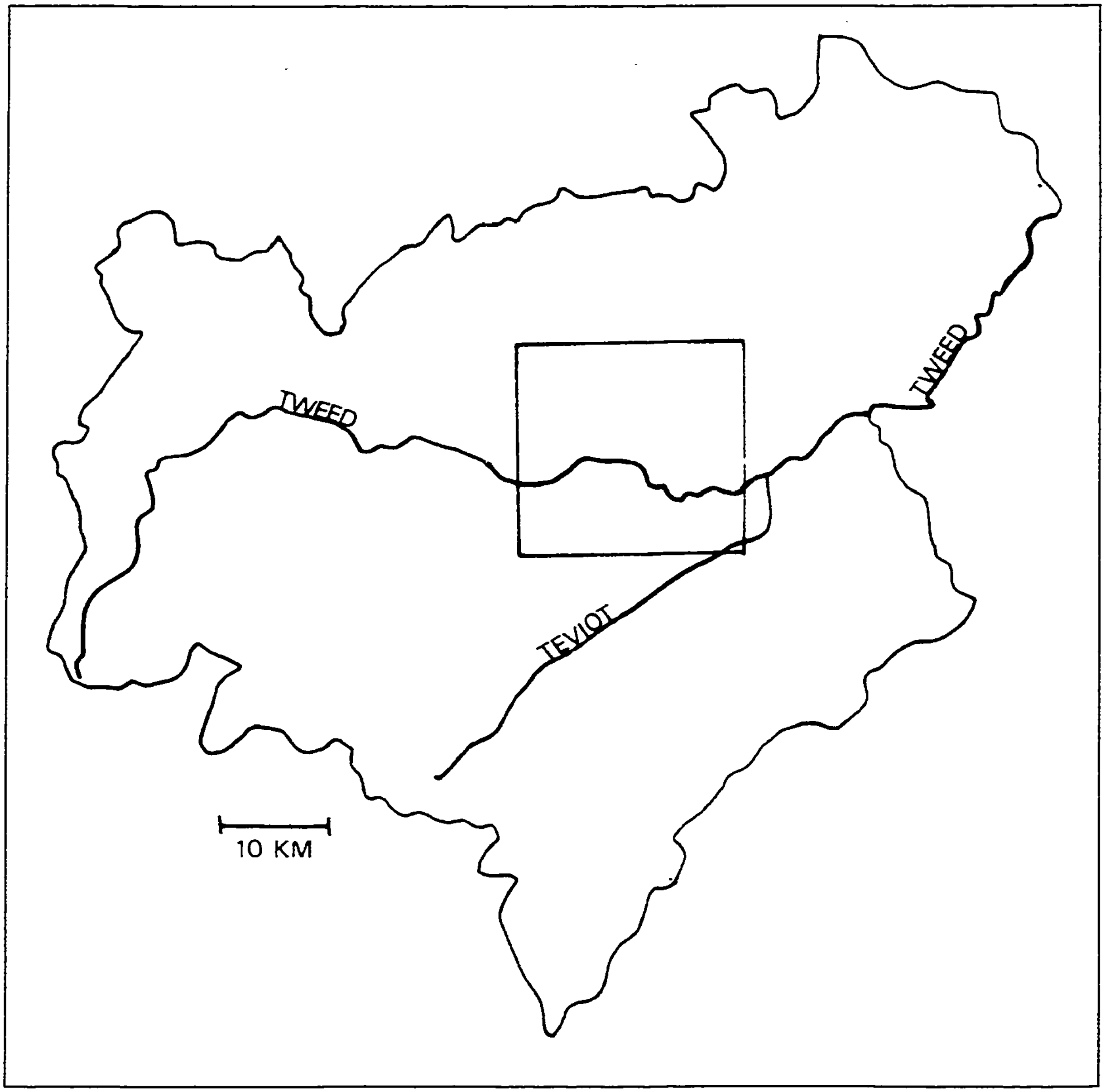

Figure 1.2 Map of the Scottish Borders showing the Study Area

1.5 The Study Region

The Tweed Valley lies in the Scottish Borders (see figures 1.1 and 1.2) midway between Hadrian's Wall to the South and the Antonine Wall to the north. Roman forts line these walls and dot the major Roman Road, Dere Street, which winds its way north and east between them. These forts sit in a landscape covered with non-Roman settlements. Although historical texts, like the *Agricola* by Tacitus, tell us that in southern Scotland Romans encountered some hostile and some friendly tribes, archaeological evidence for tribes or tribal divisions is unsurprisingly nebulous.

The landscape of the study region is very diverse, straddling the lowland Berwickshire coastal plain to the east and the Southern Uplands to the west. It is demarcated by the catchment of the Tweed River and its tributaries and bounded to the north by the Lammermuir Hills and the Cheviot Hills to the south.

1.6 General Archaeological Background

For at least 150 years the prehistoric and Roman archaeology of the Scottish Borders has commanded attention (Christison 1895, Craw 1921, Curle 1911, Jeffrey 1855, Tait 1885). Two of the most enduring issues that have been researched in this region focus on the nature of Roman and Native interactions, and the meaning of the dramatic settlement evidence which is apparent all across the landscape.

A strong research program from antiquarian times, and early adoption of Worsaae's three-age system, means that a great deal of evidence has been collected within temporally-defined research frameworks. Archaeological studies of culture change and settlements have therefore differed dramatically depending on the temporal period which most interested the individual archaeologist. Furthermore, traditional geographic divisions in the practice of archaeology (Armit and Ralston 1997) mean that research on these questions has been carried out differently by archaeologists working north and south of the border between England and Scotland, and differently in the four regions of Scotland (Piggott 1966). In the last decade, however, developments in landscape archaeology have begun breaking down the traditional boundaries between temporal periods, and renewed integration of evidence is underway via diachronic regional studies (Jones 1990a).

Quite formidable challenges face archaeologists who work in the region. The majority of available evidence comes from cropmarks[1] recorded in aerial photographs. This means that hundreds of settlements are known, but archaeologists are uncertain of their exact dimensions and morphology, and usually have no information with which to assess site phasing or occupation dates. It also means that whole classes of potential settlements, for example unenclosed settlements, may have been missed as they are less likely to appear as cropmarks.

Geophysical survey is more useful than aerial photographs in gaining detailed information about settlements in the region, and has been carried out successfully on approximately 50 sites during the Newstead Research Project. For such sites there is sometimes evidence available about sites phasing, dimensions, and morphology, however dates are still unknown for the settlements. Unfortunately excavation of settlements known through cropmarks or geophysical survey is no guarantee of secure dating evidence due to an almost complete absence of artifacts from many settlements, and the flat radiocarbon calibration curves c. 2000 years ago (e.g. Harding 1982).

More misleading in some ways is the fact that there is an exception to the absence of artifacts on sites in the region. Roman sites have abundant artifacts that can be fairly closely dated, and this attraction has sometimes diverted attention away from the study of native settlements.

Another interesting feature of the archaeological record in the region is that there is a complete absence of some classes of settlement that are relatively common in neighboring areas. Most notable among these are a lack of unenclosed platform settlements which are

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[1] Cropmarks are patterns in vegetation caused by underlying archaeological features.

common further east, south, and west and the lack of field systems which are common in the Cheviot Hills to the south (Topping *et al.* 1989). The absence of these classes of settlement suggests that there may be a bias in settlement preservation due to the intensive cultivation of land in the study region, and the subsequent destructive ploughing of archaeological sites.

1.7 Relating Archaeology of Study Region to General Research Aims

Given the few artifacts found on Native sites, the lack of absolute dates, the existence of few relative dates for any but Roman sites, and possible biases in the preservation of evidence in the landscape, research on the late prehistoric native population may seem like something of a challenge. There are several reasons, however, for hope.

First, work by other archaeologists in northern England and southern/central Scotland suggests that detailed analysis of settlement patterns can produce information about social structure. For instance, Steve Driscoll (1991) examined medieval settlements and was able to identify thanages, a type of medieval political unit, not listed in historic documents. He did this by examining the spatial layout of known thanages, and determining that they were characterized by a regular combination of features: a church, central meeting place usually in the form of a prehistoric mounds, and cemetery. Using this information (and narrowing his search by examining only those areas with place names suggesting they were inhabited at approximately the correct time period) he was able to find combinations of these features in other parts of the region.

Another example of the use of settlements to study social structure comes from the work of Leslie Macinnes (1989) on prehistoric settlements north and south of the Firth of Forth. In these two areas she noticed many similar patterns of Iron Age settlements and also noted differences in the frequency with which Roman artifacts were found at Iron Age sites. These goods were more frequently located at dun[2], crannog[3], and broch[4] sites than they were

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[2] Thick-walled circular stone towers.

at unenclosed, palisade-enclosed, or bank/ditch-enclosed sites. Presumably the more substantially built sites were somehow differentiated from the others economically and/or socially and thus enjoyed different sorts of relationships with Romans and their goods.

Second, inhabitants of southern Scotland were not thoroughly romanized. This means that evidence of traditional settlements and their locations remain for archaeologists to examine, but that we know some degree of face-to-face contact occurred. No villas were built in the area and very few Roman artifacts like amphorae or coinage have been found on sites other than those constructed by the Roman military. These factors make the archaeological record of protohistoric Southern Scotland different from any other part of Europe.

Study of protohistoric human ecology and consideration of ways native society responded to cultural and environmental changes in this region must be based on study of the rich native settlement record. Historically there have been a variety of approaches to the study of the settlement evidence in the Scottish Borders. Initially, settlement evidence was interpreted by direct correlation with Roman textual evidence. This was a contorted exercise as the existence of tribal groupings identified in texts is extremely difficult to support from the available archaeological evidence. Interpretation focused on hillforts as central tribal places in hierarchical settlement systems, and rather tautological reconstruction of relationships between Romans and Natives ensued. For example, Traprain Law was identified as the Votadini capital because it lay in roughly the correct area (Hill 1987). Texts reported that the Votadini were Roman allies, and this was confirmed archaeologically because why else would the Romans have allowed the maintenance of a strong fortified fort in this territory in the absence of any Roman outpost (Hanson and Maxwell 1983)? The Selgovae, whose capital was described as lying farther south and has been identified as Eildon

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[3] Timber roundhouses built on wooden platforms in lakes.

[4] Tall round stone towers with internal staircases. Very common in the north and west of Scotland, but rare in the Scottish Borders.

Hill North, were graced with the auxiliary fort of Newstead which was "well placed for the control of the Scottish Lowlands" (Wilson 1967:18). This was accepted as archaeological support for the texts which reported that the Selgovae remained hostile to Rome and sacked Newstead just after 100 AD. In the last ten years archaeologists throughout Europe have distanced their interpretations of the material record from the images presented in classical texts (Blagg and Millett 1990a, Jones 1990b, Millett 1990). Rather than using the archaeological record to verify the details presented in those documents, it is viewed as an independent source of information more rich in its preservation of non-elite and non-Roman lives.

After modern excavations began, but before the introduction of radiocarbon dating, settlement forms were assumed to be temporally diagnostic (Piggott 1966) based on a sequence recorded at the site of Hownam Rings (Piggott 1950). The settlement seriation was based on the belief that defensive structures around settlements had increased through time, and had then abruptly ceased at the time of Roman expansion. Thus settlements were undefended in the early Iron Age (roughly 2800 BP), became encircled first by wooden palisades and then by earthen banks and ditches through the middle and later Iron Age, and then reverted to being unenclosed in the Romano-British period. Subsequent excavation has confirmed that some of the sites used to argue this case were occupied contemporaneously, and the chronologic sequence suggested by Piggott has not been supported (Hingley 1992).

Post processual approaches have now become prominent in British archaeology, so settlements are now approached for information about the individuals who lived within and are seldom treated as a source of evidence about wider social phenomena such as kinship. Detailed fieldwork projects have continued, and appreciation for the diversity of these settlements has increased as a result, however in the Scottish Borders no attempt has been made to relate the results of this new fieldwork to regional settlement patterns or paleoenvironmental evidence.

It remains to be determined if different classes of settlements appear in any pattern on the landscape, whether any gaps in settlements are due to biases in archaeological practice, how the landscape itself dictates to any extent the location of sites, and whether these patterns reflect meaningful underlying social structure. Climate changes, soil changes, and vegetation changes in the last 3,000 years may have been a factor and the changing nature of the landscape itself, and the positions of these sites within it, is one important component of settlement patterning that has not yet been examined.

1.8 Research Objectives

My research aims in the Scottish Borders were to study protohistoric human ecology and the ways native society responded to changes in the cultural and natural environments. Specific objectives of the research program in the study area were to:

1. Collate archaeological and paleoenvironmental evidence,
2. Conduct targeted geophysical survey and excavation to fill some major gaps,
3. Analyse this evidence in order to look for patterns in site distributions,
4. Develop a paleoclimate model,
5. Construct an historical model of change through time, and
6. Present a preliminary explanation based on anthropological principles.

No single theoretical perspective was adopted at the outset of this research, but an openess to both processual and post processual strategies was. This rather eclectic approach worked well as it provided a flexible framework for dealing with patchy data. Historical ecology and phenomenology were explicitly engaged when writing this text, but the research process itself led me to think of the application of method and theory in a heterarchical way. The settlement evidence in central Tweeddale can be analyzed at a variety of scales (e.g. regional, local, site) and the choice of method and theory varied with the scale of analysis. Human organization in the past also operated at a variety of scales (e.g. tribal, familial, individual) and different theoretical approaches were more informative in analysis and explanation at particular scales.

1.9 Overview of Chapters

Chapter 2 provides an overview of the archaeological record in the Borders and the research design. This is followed in Chapter 3 by results from geophysical survey, settlement pattern analysis and excavation in the region. Chapter 4 is a discussion of these results and a comparison of the evidence from the study region with neighboring regions. A review of paleoenvironmental evidence from the Scottish Borders is presented in Chapter 5 with a new paleoclimate model for central Tweeddale. Finally, the project aims and objectives and main results are woven together for a conclusion in Chapter 6.

1.10 A note about the term native

From the outset, the terminology available to describe the indigenous population of Scotland in the Roman period has plagued me. Traditionally, the identity of these people has been filtered through Roman texts which tell us that two tribes occupied what is now the Scottish Borders -- the Votadini and the Selgovae. With increasing scepticism in archaeology about the direct application of historical texts to interpretation of the archaeological record, both these tribal names have been rejected. An increasing number of British archaeologists would challenge *Celtic* as a word to describe the indigenous population, partly because the term is heavily politicised and problematic today. The term *native* is frequently used in the literature to describe the indigenous population, but this term is unwieldy and archaic. Native is also not a very illuminating term as it simply defines the population in terms of what it was not rather than helping us get to grips with what was actually going on. In Chapters 2-5 of this dissertation the terms *native* and *indigenous population* are used interchangeably for convenience, but the ways in which we identify past populations are discussed further in Chapter 6.

II. SETTLEMENT OVERVIEW AND RESEARCH DESIGN

2.1 Introduction

The late prehistoric archaeological record in southeastern Scotland has sometimes been dismissed as a relatively poor focus for study. There are large numbers of archaeological sites, and even the most careful and extensive excavations of these rarely produce artifacts on which detailed analysis of past lifeways can be based. Instead of relying on artifacts, archaeologists in the region have also focused their attention on the morphological classification and culture history of the settlements themselves. These strategies have ultimately proven frustrating and limiting, and have contributed to a marginalization of settlement studies generally and devaluing of the late prehistoric archaeological record in particular. Also frustrating the development of Iron Age studies in Scotland has been a traditional focus on exploring provinces defined in Roman texts (Clarke 1980) rather than organizing research in topographically or archaeologically defined regions.

Desktop assessment of previous research and targeted data collection from geophysical survey and excavation undertaken for this Ph.D. dissertation form the basis for reevaluation of prehistoric and protohistoric settlements in the central Tweed valley. Careful evaluation of settlements, based on evidence gleaned from aerial photography, geophysical survey, and excavation has led to the discovery of patterning at specific spatial scales. Settlement clusters at scales of 2 km^2 provide evidence of past social organization and social behavior, and suggest the importance of kinship in structuring protohistoric settlement, society and space. It is in these areas that the key to understanding past human relationships, responses to ecological change, and cultural change and stability lie.

In this chapter a literature review of settlement studies in the Scottish Borders is followed by the research design for, and an overview of, work undertaken for this doctoral research. In Chapter 3 the results of settlement analysis and fieldwork are presented, and in Chapter 4 these results are analyzed and discussed.

2.2 Regional Archaeological Sequence Literature Review

2.2.1 Mesolithic

The evidence available for the Mesolithic in central Tweeddale consists of large lithic scatters (Lacaille 1940). Interpretation of these scatters is made easier by the excavation of three Mesolithic sites (Mulholland 1970) and an enthusiastic population of local amateur archaeologists who have been especially active in collecting evidence from this period. It is fair to say, however, that relatively little attention has been paid to the Mesolithic period in the Scottish Borders (Finlayson and Edwards 1997). A survey of Mesolithic sites in Upper Tweeddale currently underway by Historic Scotland should hopefully improve this situation in the near future.

2.2.2 Neolithic

Even less information is available about the Neolithic period in the Borders (Barclay 1997). There appears to be some continuation of the lithic industries from the Mesolithic period, and a variety of ceremonial sites are also attributed to this period including henge monuments, standing stones, some cairns, and some cists (Scottish Borders Council 1997).

Artifacts play an important role in the archaeological record for the Neolithic, and pottery vessels and jet[5] objects have been recovered during excavation and surface survey.

2.2.3 Bronze Age

In the Bronze Age large hillforts appeared on the landscape (Rideout *et al.* 1992) in addition to ritual monuments such as cairns (Jobey 1982a). A total of 8 hillforts adorn the tops of very steep and high hills in the region, and each is marked by impressive ranks of concentric ditches and banks. The best known is the 16 hectare hillfort on Eildon Hill North where more than 200 hut circles have been identified through aerial photography (Owen 1992). The Dunion is a 6 hectare hillfort lying to the west of Eildon Hill North. There is evidence of a small Bronze Age occupation phase at this site, although the excavators are at some pains to discredit these early radiocarbon dates (Rideout 1992c, 1992e). The other hillforts in the region are those at Hownam Law (9 hectares), Yeavering Bell (5 hectares), Rubers Law (3.5 hectares), White Meldon (3.5 hectares), Hirsel Law (3.5 hectares), and Whiteside Rig (2.5 hectares) most of which are known primarily or solely through interpretation of aerial photographs (Welfare 1980).

Another closely related class of defensive hillforts are promontory forts in which ditches and banks mark defensive perimeters on one or two sides and cliffs, streams or rivers mark the remaining boundaries. No promontory forts have been excavated in the study region, but due to their similarity in position and construction they are grouped with hillforts here to show their possible relation to Bronze Age occupation. It is important to note that excavations at Braidwood promontory fort to the north in Midlothian suggests that promontory forts may also date to the Iron Age (Piggott 1957-1958, Stevenson 1948-1949).

Though no examples exist in the study area, unenclosed platform settlements also date to this time period and also extend into the Iron Age (Jobey 1982a, Jobey 1983). These

[5] Jet is a hard black lignite that can be carved and polished.

settlements generally consist of between 2 and 12 circular huts constructed on earthen platforms carved into hill slopes (Feachem 1963). Usually the hut platforms are arranged linearly along a contour line, but occasionally clusters of hut platforms are tiered. The best studied unenclosed platform settlement is probably that at Green Knowe, partly because it has been excavated more than once and partly because it has produced a large quantity of artifacts and burnt wood for radiocarbon dating. Artifacts include coarse hand-built pottery, saddle querns, lithics, a jet pendant and ring fragments, an amber bead, and fragmented bone including ox teeth and an antler fragment (Jobey 1982a).

Burial practices in the Bronze Age included cremation with occasional inhumation of the cremated remains in ceramic vessels. The single Bronze Age burial in the study region was recovered during excavation at Cauldshiels Hill homestead (Dent forthcoming) and unfortunately the remains were in extremely bad condition.

Homesteads such as Cauldshiels Hill existed alongside the hillforts and promontory forts in the Bronze Age, generally containing 1-3 hut circles. This settlement class appears to have originated in the Bronze Age, but its use continues until the medieval period in southern Scotland. Homesteads are the dominant feature of the prehistoric archaeological record in the Borders, and serve as the focus for Iron Age studies in particular.

2.2.4 Iron Age

The majority of Iron Age sites in the study region are homesteads (Freer 1892) though this settlement form began in the Bronze Age and continued through to the Medieval period. Homesteads are generally located 150-300 m above sea level on eastern or southeastern slopes of hills. These locations are generally not the most defensible positions, however they sometimes command wide views, and all are situated near permanent water sources. Homesteads are generally characterized by 1-5 round hut circles enclosed by one or more ditches and banks. In the past these sites were defined as small hill forts, and the ditches and banks were interpreted as defensive features. A variety of functions, ranging from cattle corrals to symbolic markers of social prestige, have subsequently been attributed to these ditches and banks (Hanson and Slater 1991, Harding 1982, Hill 1989, Hingley 1990, Hingley 1992, Macinnes 1982). Five of these homestead sites have since been excavated in the last 10 years. Each has produced very few artifacts - only a few beads and a few undiagnostic stone objects in total.

The Hownam sequence of homestead development (Piggott 1950) suggested that homesteads evolved in a standard way from enclosures surrounded by wooden palisades, to single stone-walled enclosures, to enclosures surrounded by multiple stone walls, and finally to open settlements.

Piggott followed her influential excavation at Hownam with additional excavations designed to test the Hownam sequence and to date each phase in the sequence more closely (Piggott 1951, Piggott 1952). This sequence was gradually refined (Feachem 1963, Feachem 1977, Hill 1982a, Hill 1982b, Jobey 1978, Rivet 1966) to include an unenclosed phase at the start of the sequence and both unenclosed settlements and small enclosed homesteads at the end of the sequence. The Hownam sequence has been one of the most influential in the history of Iron Age studies in this region, but is no longer accepted as representative of the archaeological record throughout the Tyne-Forth province. This is for a variety of reasons. A great degree of complexity generally exists in all of the settlements, in their transformations from one form to another, and there is contemporaneity of the different settlement forms (Harding 1982). Introduction of radiocarbon dating (Mackie 1969) and a theoretical move away from invasion and diffusionism also caused a major reassessment of settlement evidence (Hill 1982a). The use of stone enclosures after timber enclosures seems to be a feature peculiar to Northumberland (Ralston 1979). Unenclosed settlements appear to date to the early Iron Age in Peebleshire and upper Clydesdale, and these settlements appear never to have passed through enclosed phases (Feachem 1963).

Quite a lot of effort has also gone into classifying the huts and house platforms located within the settlements that date to the Iron Age (Hill 1982a). It has been asserted that changes in these structures might be chronologically diagnostic because they would have carried a great deal of social meaning and therefore would have been conserved features. The sheer number of huts and houses to be studied makes easy analysis impossible, and although a few house styles have been demonstrated (Hill 1982a) it is entirely unclear how widespread their distribution was or how deep their social meaning.

The Iron Age is marked by a wider variety of settlement classes than the Bronze Age, including the remains of lowland brochs. Two of the three brochs in the Scottish Borders are in the study region and these date to the Late Iron Age/Roman Period (Dundas 1866, Hunter 1949, Macinnes 1984a, Piggott 1951).

Unlike areas further south in Britain, and in Europe, hillfort occupation is not a dominant feature of Iron Age occupation in this region. Two hillforts in the region have been excavated. Two percent of Eildon Hill North has been excavated, and so far no area has been clearly shown to date to the Iron Age (Owen 1992). Evidence from the Dunion with its 66 hut circles, indicates that it was occupied in the Iron Age (Proudfoot 1992, Rideout 1992a, Sanderson 1992) as well as the Bronze Age but the precise nature of the later occupation is unclear.

Antiquarian reports suggest the presence of an Iron Age souterrain[6] site at Newstead, but unfortunately the site was destroyed early in the 20th century and can not be confirmed by modern excavation techniques. The descriptions of the souterrain available to us today suggest that the stones were carved and appeared to have been robbed out of the Roman fort at Newstead (Curle 1913, Hogg 1951). This would, of course, suggest a post-Roman date for the structure if it could be confirmed although this class of site is generally associated with the Iron Age in other parts of Scotland.

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6 Souterrains are subterranean stone-lined L-shaped chambers. Souterrains are quite common in the archaeological record for northeastern parts of Scotland, but are extremely rare in the Scottish Borders.

One enigmatic feature of the landscape, often presumed to date to the Iron Age, is the Catrail and similar series of earthworks. These earthworks are linear ramparts extending across the landscape, sometimes appearing to connect networks of settlements (Jobey 1976) and sometimes appearing to bound areas containing no clear archaeological evidence.

As mentioned previously, it is rare to find very many artifacts on even the most extensively excavated Iron Age site. One possible explanation for this would be the systematic spreading of refuse on fields with acidic soils and modern ploughing fragmenting remains beyond recognition. Another possible explanation is that the population may have relied heavily on less durable and very biodegradable objects (e.g. baskets rather than pottery). Particularly challenging for archaeologists is the fact that even when objects are recovered they are not often more chronologically sensitive than 500 or 1000 years. Although the majority of Iron Age objects found on rural settlements are not chronologically sensitive, assemblages of them appear to be (Cool 1982). Excavation reports are thus filled with detailed descriptions of quern fragments, smoothed stones, disintegrating coarse wear sherds, spindle whorls, flint objects, and shale objects.

Even though Iron Age objects are rarely recovered from settlements, they are commonly found in hoards and during surface survey. Recent work on the contents of hoards in Scotland (Hunter 1997) has shed new light on the chronological and significance of artifacts in the Iron Age. Hoards containing iron objects were once thought to be Roman in origin (Manning 1972) as the indigenous population during the Iron Age was considered ironically incapable of producing iron objects. As yet unpublished metallographic and radiographic research by Andrew Hutcheson (cited in Hunter 1997) suggests that the iron objects found at the Roman fort of Newstead differ from the iron objects found on the native hillfort at Traprain Law. This is the first clear evidence of an independent local iron working tradition, and suggest that many hoards containing ironwork date to the Iron Age and are native in origin (Hunter 1997).

Burial evidence from the Iron Age is extremely sparse, partly because the soils are very acidic and what little bone or ash may have been deposited is often not preserved. There also appears, however, to have been a tradition of depositing the dead in ways that are not recoverable by contemporary archaeological techniques -- perhaps in bogs, lochs, or rivers -- or perhaps by practicing rituals of excarnation (Carr and Knusel 1997). A very small number of inhumations, dated to the Iron Age by grave goods, are known in Southern Scotland. These include a cist internment at Burnmouth in Berwickshire with an iron knife and two bronze objects, an internment in West Lothian with a bronze bracelet, an internment in East Lothian with an iron brooch, and an internment in Midlothian with an iron ring head pin and brooch (Welfare 1980). The only Iron Age internment in the study region is that of an adult woman without grave goods in the outer ditch of the broch at Torwoodlee (Piggott 1951). None of these remains have been well enough preserved to permit analysis.

2.2.5 Roman Period

The Roman advance into the Scottish Borders under the Roman commander Agricola was rapid, and it is thought that all of southern Scotland may have been conquered in the years AD 80 and 81 (Hanson 1980, Hanson and Breeze 1991). Forts and fortlets were established spaced with roughly one day's march between each. Besides the main line of Roman forts built along the North/South running Dere Street, a smaller East/West line of fortlets was established in the Tweed Valley (Hanson 1980). Roman forts were generally located in strategic positions where supplies such as food, metal, and labor were readily available (Johnson 1989:85). These fortifications appear to have been largely abandoned by AD 90 shortly after Agricola himself was recalled to Rome (Hanson 1980) and all Roman outposts north of the Tweed appear to have been abandoned by AD 105. In 138 AD when the Emperor Hadrian died, his wall had been under construction for 15 years and was still being modified (Breeze 1980).

The next Roman advance into Scotland was under the command of Lollius Urbicus, and this lasted from the late 140s to somewhere between 160 and 207 (Hanson and Breeze

1991). It is during this time that the Antonine Wall was built between the Forth and the Clyde.

A third short Roman incursion occurred in 208 and 209 under the command of the Emperor Septimius Severus. The Emperor's death appears to have resulted in the abandonment of this campaign as his son and heir, Caracalla, rushed from Britain to Rome to secure his inheritance (Hanson and Breeze 1991).

Changes to native economies, settlement patterns, and social organization collectively known as "romanization" (Millett 1990) in southern Britain and Gaul, are not recorded in the archaeological evidence from Scotland (Hingley 1992). Several suggestions have been made to explain Rome's failure to conquer Scotland including the overpowering strength of the native population, the overwhelming topography and poor climate conditions. It has been suggested that incorporating Scotland into the empire wasn't economically viable because the native infrastructure was not sufficient to supply the army with food or taxes (Groenman-van Waateringe 1980, Jones 1991). Another factor might have been internal Roman politics (Breeze 1988). Despite suggestions that there was no imperial policy for provinces, that governors could do as they pleased (Millar 1982), and the long time lag in communication guaranteed virtual autonomy, there are some passages in *The Agricola* that suggest Emperors took a direct interest in the Scottish frontier (Breeze 1988). It is also though that natives played a role (Blagg and Millett 1990a, Haselgrove 1990).

The Agricola, written by Tacitus, is the primary source that covers the indigenous population of Scotland during the 1st century advance of the Roman army (see Hanson and Breeze 1991for overview). The text is a biography of the author's father-in-law who was the Roman commander of Britain in the late 1st century. Tacitus tells us the Roman army imposed conscription and taxation on the native population and introduced them to new concepts of land ownership, architectural styles, education, language, dress, bathing, eating, and religion. These new concepts were in contrast to their traditional religion, rituals, language, and behavior which were very similar to the natives of Gaul. Tacitus states that the indigenous political structure consisted of small warring factions led by rival chiefs, either male or female, with wealth and status based in horses. Tacitus tells us that the social relations of the Celts assisted Roman expansion as the groups were organized into tribes each of which interacted differently with the Roman army. Some tribes are described as embracing the *pax Romana*, sometimes after the Roman army purchased peace, but others resisted.

Because Tacitus was a colorful writer who provided lots of detail about the "barbarous" ways of the indigenous population, this text has captured the imagination of many archaeologists trying to understanding the nature of native and Roman interactions (e.g. Breeze 1989, Hanson 1987, Mattingly and Handford 1948, Maxwell 1989). Working from this text, a variety of reasons have been advanced for the rapid first advance of the Roman army into lowland Scotland. It has been suggested that the natives did not unite, thus conveniently producing divided opposition (Clarke 1958), that the natives could not unite because they lacked any political centralization (Frere 1978), or that an earlier campaign had "taken their edge off" and taught them to respect Rome's military power (Birley 1953, Hanson 1980). It has been suggested that the second northwards advance may have been caused by native disturbances (Steer 1964), internal Roman politics (Birley 1974), or the need for a new Emperor to gain a military reputation (Breeze 1980). However, we just don't know the reasons.

This text and others have been used most of all, however, to identify native groups occupying different parts of southern Scotland (Maxwell 1983). Roman documents suggest that the response to Roman incursion by varied greatly between native groups. A tribe called the Selgovae continuously rebelled, the Damnonii and Votadini tribes accepted Roman overrule readily, and the Romans had to purchase peace with the Maeatae because they used extremely effective guerrilla tactics (Maxwell 1989, Piggott 1982).

Attempts to identify these tribal groups archaeologically have not been very successful, however. Votadini territory was bounded by Hadrian's wall to the south and the Antonine wall to the north, and was located on the eastern coast of present-day Scotland

(Hogg 1951). The Selgovae tribe, with whom the Votadini seem to have had a hostile relationship, bordered their territory to the west (Hanson and Maxwell 1983, Wilson 1967).

A small number of Roman sites in the study region have been investigated, and it is this handful of sites that is the most prominent feature of the archaeological record. The best known Roman site is the fort at Newstead, identified as the Roman *Trimontium* on General Roy's map of 1793 for its proximity to the three Eildon Hills (Curle 1911, Owen 1992). Newstead is a large fort surrounded by extensive annexs on every side (Clarke and Wise, in press; Curle 1911; Jones *et al.* 1990, 1991, 1992, 1993; Richmond 1950) and noted for its deep wells filled with ritual deposits (Jones and Clarke 1994a, 1994b) such as parade helmets and disarticulated skeletal material (Curle 1911). Dere Street, the major Roman thoroughfare, runs through Newstead and the fort was probably established to control the point where Dere Street crosses the Tweed river.

Occupied in the 1st and 2nd centuries AD, and perhaps later as well, Newstead was abandoned at several points in this period and was probably never occupied for longer than 40 years at a time (Maxwell 1983, Richmond 1950). Extensive evidence for metalworking and other industrial activities has been recovered from Newstead (Jones *et al.* 1991). Recent excavation suggests that the fort may have hosted periodic markets in its annexs, particularly the south annex (Jones *et al.* 1993), and may thus have served as a focus for regional interactions between Natives and Romans. This is supported by the recovery of a variety of objects identified as native in origin including brooches, torcs, fibulae, glass, bone spoons, and wooden bowls (Curle 1913).

There are currently only two convincing examples of direct reuse of native Iron Age settlements by Romans. A small Roman fortlet at Cappuck, 11 miles southeast of Trimontium, appears to have been constructed over a palisade-enclosed native homestead (Richmond 1951). In the Roman period these palisade bedding trenches were filled with white clay, and subsequent building in no way respected the alignment of the palisade enclosure. In the Cheviot hills to the South there is evidence that the native settlement at

Woden Law was abandoned, perhaps in the Roman period but perhaps before, and was subsequently surrounded by a series of Roman earthworks. This has been interpreted as a Roman training ground for hillfort sacking techniques (Richmond and St. Joseph 1982). A six day excavation on Eildon Hill North (Steer and Feachem 1952) resulted in the suggestion that a Roman signal station was built over the hillfort. At that time the hillfort was thought to date firmly to the Roman Iron Age, but as previously mentioned a gap in occupation at this site between the Bronze Age and the Roman period is now recognized (Owen 1992).

2.2.6 Romano-British?

Roman sites are marked by both distinctive architecture and abundant diagnostic ceramics (Hartley 1972) and metal objects. The study of relationships between Romans and Natives has often led archaeologists to search for native settlements with deposits of Roman objects. This search has generally proven futile for homestead sites and difficult to interpret for other settlement classes (Curle 1932a, 1932b).

A comprehensive review of Roman objects from non-Roman contexts in Scotland (Robertson 1970) was based on some excavated material but mostly material collected during surface survey. Her findings suggest that a wide range of high status Roman objects, including bronze vessels, brooches, coins, glass, and samian pottery, did routinely pass into Native hands. Robertson also argues that these objects may be the product of two-way relationships as coin assemblages on Native sites mirror those found at Roman sites and because Native objects have been recovered from Roman sites. At Newstead Roman fort, for example, she follows Curle (1911) in recording numerous indigenous objects including bronze terrets, wheels, swords and sword-guards (native identification challenged by Manning 1972), horn tools, weaving combs, spindles and spindle whorls, glass armlets, a brass torc, beehive querns, stone discs and lamps, and wooden dishes.

More recently it has been argued that the distribution of coins in all periods reflect the distribution of other artifacts, and therefore the presence of coins does not indicate acceptance of a monetary economy (Macinnes 1989). Possible mechanisms by which Roman material arrived on native sites include gifts, booty, exchange, trade, and tribute payments.

In general, 2nd century Roman material is found in larger quantities and over a wider area than 1st century material (Macinnes 1989).

Roman objects are found at numerous native sites, though rarely at homesteads. At the hillforts of Eildon Hill North and Traprain Law, Roman artifacts have been found in votive deposits (Hingley 1992, Rideout *et al.* 1992). Melon beads recovered from Roman forts have been recovered at Dod Law; Roman brooches are rarely found in native contexts north of the Humber River but one has been found at Doubstead in Northumberland and another at Dod Law (Allason-Jones 1989). Ring head pins are found in both native and Roman contexts between Hadrian's Wall and the Antonine Wall (Allason-Jones 1989). Roman objects are found at all 3 lowland brochs in the Scottish Borders (Curle 1913, Macinnes 1989, Robertson 1970) and the presence of Roman objects at broch sites has been used to suggest Roman trade with native elites inhabiting brochs.

Roman objects were also incorporated into hoards and votive deposits (Herkes 1996). Originally the natives were thought too backward for ritual hoarding (Manning 1972) and all hoards were thought to be Roman (Hunter 1997). Recent metallographic studies of iron found at Newstead and in hoards demonstrate that there was a native ironwork tradition and this native ironwork was deposited in ritual hoards before the Roman invasion. Later Roman objects were incorporated into hoards as just another "component in a pre-existing tradition of openness to exotic influences" (Hunter 1997:122).

An interesting insight into relationships between Romans and Natives comes from examination of plant remains. In the Scottish Borders native sites as Chester House, Dod Law, and Murton have produced grain assemblages characterized by a mixture of emmer wheat, barley, and a tiny amount of spelt wheat (van der Veen 1989) which suggests it may have been extremely difficult for the indigenous population to grow a crop surplus. Because the Roman army in the Borders would have required a relatively large amount of grain for provisions, and can also have been expected to tax the native population in kind, this botanical evidence suggests that the land and local community did not have the carrying capacity to support a large invading force.

An increasing number of scholars feel comfortable with the statement that the relative lack of evidence for close contact indicates that the Roman invasion into Lowland Scotland had relatively little impact on the native population (Fulford 1985, Macinnes 1989). The very lack of a pronounced social hierarchy and economic infrastructure may have been a hindrance to Roman military expansion (Jones 1991) and thus passively contributed to the failure of Rome's colonization ambitions.

2.2.7 Post-Roman and Anglian Periods

The end of the Roman period is hazily understood, and gives way after an unclear transitional period to the "dark ages" and Anglian period. The archaeological record for the region in this time period is strikingly different than any period that came before, largely as a result of the establishment of monasteries, estates, and shires when this region became incorporated into the Kingdom of Northumberland (Smith 1984). Melrose, and the very heart of the study region, was a monastic center and served as the focus of an extensive agricultural estate. Other ecclesiastical centers included Coldingham, Jedburgh, and Peebles.

In general, many gravel river terraces in the eastern Tweed valley appear to have served as foci for settlement in the Anglian period. Secular buildings from this period generally have three distinct forms. The first are rectilinear timber halls (Reynolds 1980) that appear to be associated with Anglian settlements. The second are tower houses that were constructed as parts of a defensive system along the Tweed and its major tributaries. These tower houses are generally inter-visible, and are found only along the major waterways (Smith 1984). The third settlement form consists of curvilinear homesteads which continue from the Bronze Age right through the Roman period (St. Joseph and Maxwell 1984), the

Anglian period and beyond. To stress settlement continuity right through the Roman period, Smith in fact pointedly refers to these sites as "Brito-Roman" on occasion (Smith 1984) rather than the more standard "Romano-British". Smith (1984:182) writes:

> The pattern of rural settlement which emerges is of two broadly distinct types, both of which, to differing degrees, owed much to the constraints and prevailing traditions of a surviving native population. In the low-lying parts of the region the pattern is one of dispersed, nucleated settlements, surrounded by tracts of arable, with outlying pasture, meadow, and woodland. In the uplands the impression is one of extensive grazings, scattered vills and isolated farmsteads, some perhaps with a small area of cultivated ground in their immediate vicinity.

Noting that Anglian placenames are more common in the eastern lowlands of the Scottish Borders (Nicolaisen 1964), and Gaelic and Scandinavian placenames predominate the uplands to the west, Smith (1984) suggests that Anglian settlement in the east involved new individuals taking over established landuse patterns and pre-existing places. Such continuity of place was often accompanied by discontinuity of actual settlement forms in the east, but greater continuity of settlement forms is evident in the west (Smith 1984). For example at the Dod, an Iron Age homestead was overlain by a replacement homestead in the 12th or 13th century. In the eastern lowlands, however, adoption of pre-existing landuse patterns and social places did not always mean respecting their form and boundaries. At Sprouston, for example, Smith (1991) notes that native settlement patterns were not respected and he suggests this was a conscious strategy of the English colonial forces who recognized the social importance of pre-existing places.

Traditional homestead construction, and successive re-occupation of places, continued in the Scottish Borders even after 973 when all land north of the Tweed River passed into the Kingdom of Strathclyde and from there into the united Scottish Kingdom (Yeoman 1991).

2.3 Research Design

As outlined above, my research aims in the Scottish Borders were to study protohistoric human ecology and the ways native society responded to changes in the cultural and natural environments. Specific research objectives were to collate relevant evidence, fill gaps in this evidence through survey and excavation, look for settlement patterns, develop a paleoclimate model, construct a model of change through time, and present a preliminary explanation based on anthropological principles.

2.3.1 Data Sources for Collation

2.3.1.1 Archaeological Evidence

Archaeological data for the Scottish Borders are available in published site reports, the extensive archives held by the National Monuments Record of Scotland (NMRS), the holdings of the National Museum of Scotland (NMS), the artifacts collected by local avocational archaeologists, and the unpublished results of recent archaeological projects.

A significant amount of archaeological data have been collected in the last 10 years by members of the Newstead Research Project, and these data are not yet available in the NMRS. The Newstead Research Project is quite unusual in Scotland, having relied extensively on rectification of existing aerial photographs for the region, and undertaking geophysical surveys on 40 prehistoric sites in the area. Rick Jones, director of the Newstead Research Project, kindly agreed to allow me access to project data for dissertation research in exchange for analyzing the results of the 40 geophysical surveys of sites around the Roman fort at Newstead.

Parallel to this extensive survey program has been intensive excavation at the Roman fort of Trimontium and exploratory excavation of five native homesteads presumed to be late Iron Age in date. Geophysical survey took place at each of these five sites prior to excavation, and information gained greatly assists in the identification and interpretation of features in the geophysical survey of unexcavated sites.

2.3.1.2 Archaeological Evidence from Nearby Regions

In order to fulfill the objective of anthropological interpretation, evidence needed to be contextualized with reference to a broader area. For this reason, a literature review was conducted to identify comparable archaeological evidence in neighboring regions. The regions selected for comparison include the Manor Valley, the Bowmont Valley, the Solway Firth, and northern Northumberland. Each of these comparison regions is discussed further in Chapter 4, but a brief description of each is offered below.

The Manor Valley provides a good control sample because it has small homesteads, a hillfort, and topography fairly similar to that in the region around Eildon Hill North. It has also been relatively well studied.

The Bowmont Valley has been the focus for a long term settlement and environmental study directed by Roger Mercer and Richard Tipping. This region makes a very interesting comparison for the study area because of the great variation in evidence despite the relatively small distance separating the two areas.

The Solway Firth has traditionally been the focus of intermittent study, but recent intensive work by the Royal Commission for the Ancient and Historical Monuments of Scotland has provided an exciting new synthesis for late prehistoric settlement in the region.

Late prehistoric and Romano-British sites in Northumberland were extensively studied by George Jobey and his students in the latter half of the 20th century, and this corpus of work provides an unparalleled settlement database for comparison.

2.3.1.3 Paleoenvironemtnal Evidence

Paleoenvironmental data are also available from a variety of sources including published articles and archives. The key archives containing Scottish climate data are the Britsh Atmospheric Data Centre (BADC) and the Met Office archive in Edinburgh. The St. Mary's Mill archive in Selkirk also contains historical records of the Scottish Borders, including texts related to the environment.

2.3.2 Fill Gaps through Survey and Excavation

Fieldwork was undertaken to fill some of the remaining gaps in basic knowledge about the settlements of central Tweeddale. With the help of grants from Sigma Xi and the Society of Antiquaries of Scotland, I directed a geophysical survey at Oakendean House, co-directed a geophysical survey and excavation of the northern annex at Newstead fort, and co-directed the first excavation of a rectilinear homestead in the Borders at Lilliesleaf. These sites were chosen both because they had been targets of the Newstead Research Project and because they provided unique opportunities for better understanding the settlement record in the region. The results of this fieldwork are presented in Chapter 3.

Attempts were made to collect new paleoenvironmental data for the region, but these have so far been unsuccessful. Coring was attempted at Lilliesleaf as a way for retrieving pollen samples from the site of Lilliesleaf, however the ground was too rocky. Sediment samples taken during the excavation of Lilliesleaf were to be analyzed by a pollen specialist, but no funding was available for this activity. Prominent paleoenvironmental scholars in Scotland view paleoenvironmental evidence from archaeological sites as suspect (Tipping 1994, 1997), and prefer evidence sampled from bogs, lochs, or other 'regional' sites. This perhaps contributes to the current situation in which it is difficult to obtain funding to carry out analysis that would be normal on archaeological sites in other parts of the world.

2.3.3 Analysis

The first stage in analysis of the settlements of central Tweeddale was collation of relevant information in an Access database. The database contained information about site location, size, and shape; artifact distributions; and roadways. Not all of this information was available for each site as sites that have been excavated are better known than those known through geophysical survey alone, and those sites known through geophysical survey are better known than those identified only in aerial photographs.

The second stage was processing and subsequent analysis of geophysics images from the Newstead Research Project. Contors software, written by John Haigh of Bradford University, was used for display and initial processing of all data. Each grid was balanced in Contors then further processing was done with Grid software written by Armin Schmidt, also of Bradford University. After processing, printouts of each survey were made at two scales: 1:2500 and the largest scale that could be displayed on a single page of A4 paper. Using the printouts and screen displays, drawings were made showing the major features of the images. These drawings were then used to interpret the images, and a final interpretive drawing was produced for each site. In order to facilitate comparison of the geophysics data with other geospatial information about the settlements, each geophysics survey was exported from Contors using Armin Schmidt's Grid program and imported into Arcview GIS software.

Analysis of settlement evidence in the area began in earnest with exploratory data analysis using paper and digital maps, and continued with linking of the database to an Arcview Geographic Information System (GIS). Information contained in, or generated via, the GIS included settlement elevation, position on hillside, distance to water sources, and intervisibility with other sites; soil types, geology, vegetation, and modern climate. A settlement classification was devised, distribution maps were generated, and some quantitative analysis done.

2.3.4 Paleoclimate Modelling

Rather patchy environmental data relevant to the Scottish Borders were available at local, regional, and global scales. Reid Bryson, Emeritus Professor of Climatology at the University of Wisconsin, developed a preliminary model while I studied with him in Madison in 1994. Further development of this model was a good way of integrating available information, and is a new method for the study of human ecology. This is discussed further in Chapter 5.

2.3.5 A Historical Model of Change

Chronological control is poor for the prehistoric and protohistoric archaeological record of Southern Scotland, and interpretation has often focused on sites rather than on regions. The multiscalar focus of human ecology demans analysis at both regional and site level through time. For this reason, a historical model of change through time has been developed based on analysis carried out for this research. It is accepted that this is an attempt to begin writing a story about the past in this area, but this story will need further development. The data collated, produced, analyzed, and modelled herein provide a good grounding to a lifetime's study of the Scottish Borders.

2.3.6 Explanation

Explanation based on anthropological principles was a key objective of my research. This is a perspective too often missing from archaeological interpretation of sites in Britain, and one that a background in American anthropological archaeology enabled me to contribute. It would be heartening to see more attempts to synthesize archaeological information in order to develop an integrated understanding of what it meant, and how it was, to be human in prehistoric and protohistoric Britiain.

III. RESULTS

3.1 Introduction

Analysis of geophysics, settlement patterning analysis, and fieldwork in the Scottish Borders contribute to improved understanding of this region in prehistory, of human responses to change in general, and to methodology. Results from each of these aspects of research are prefaced in this chapter by a short literature review.

3.2 Geophysical Survey

3.2.1 Background

Geophysical survey was a key strategy of the Newstead Research Project for studying Roman and native interactions in and around Trimontium (Clark 1996). The fort itself was intensively surveyed for 4 years, and the surrounding region was surveyed extensively with 40 native enclosures recorded by at least one and often both techniques (see Appendix 1).

Two complementary geophysical techniques were applied in the region. *Resistivity* which is particularly useful for detection of ditches and stone structures such as masonry foundations and road surfaces, and *magnetometry* which is particularly useful for the identification of burnt features. This includes buildings destroyed by fire, industrial workings, kilns, or magnetized material associated with ditch or well fills. Resistivity survey was carried out using either a Geoscan RM-4 or RM-15 resistance meter in twin probe configuration generally at a setting of 1 ohm. Sample spacing was 1 m, with transects recorded in a zig-zag pattern. Magnetometry survey was carried out using a Geoscan FM-18 fluxgate gradiometer generally with a setting of 0.1 nT. Sampling was carried out in parallel transects south to north.

Processing and interpretation of survey data for the five native settlements excavated during the Newstead Research Project were undertaken during the life of the project. The rest of the survey data were largely left unbalanced and unprocessed until I began working on them. Using Contors software data I iteratively explored the data, chose parameters and scales for displaying each result set, and produced an interpretive drawing for each site. Each interpretive drawing in Appendix 1 is thus based on more information than can be displayed in any of the images produced from the dataset.

3.2.2 Data Collection and Analysis

An overview of the collection and analysis of geophysics data from the Newstead Research Project follows. Illustrative examples from the sites of Avenel Haugh and Whitrighill accompany this text.

During the Newstead Research Project the NMRS description for each site in a 10 x 15 km window around the Roman fort at Newstead was copied down by hand, and entered into a project database. This database was then used to identify suitable sites for geophysical survey.

Table 3.1 Sample NMRS entry for Avenel Haugh

Type of Site	Settlement
	Linear Cropmark
NMRS Number	NT53NW 33
Location	Map reference: NT 516 369
	Parish: Melrose
	Council: Scottish Borders, The
Archaeology Notes	NT53NW 33 5167 3697
	Listed among several sites where resistivity and magnetometer surveys were made, and plans produced. R Jones (*et al.*) 1991.
Collection Summary	Photographs: 7
	Drawings: 0
	Manuscripts: 0
	Other Material: 0
Bibliography	Jones, R {F J} {*et al.*} (1991 b) 'The Newstead project', University of Bradford, Archaeological Sciences 5th annual report, 1990-1, 15.

For some sites the NMRS holds a great deal of descriptive text, reflecting the fact that the site may have been studied for more than 100 years. For Avenel Haugh, the NMRS entry reflects the fact that the site was known only as cropmarks in seven aerial photographs prior to the geophysical survey undertaken by the Newstead Research Project. On the basis of the cropmarks alone it was classified by the RCAHMS as a "settlement" or "linear cropmark".

In order to qualify for geophysical survey during the Newstead Research Project sites generally had to have aerial photographs, and had to be classified either as a late prehistoric settlement or a settlement of uncertain but pre-modern date. Armed with copies of oblique aerial photographs for each site from the NMRS archive members of the Newstead Research Project team produced rectified interpretations of cropmarks (see Figure 3.1).

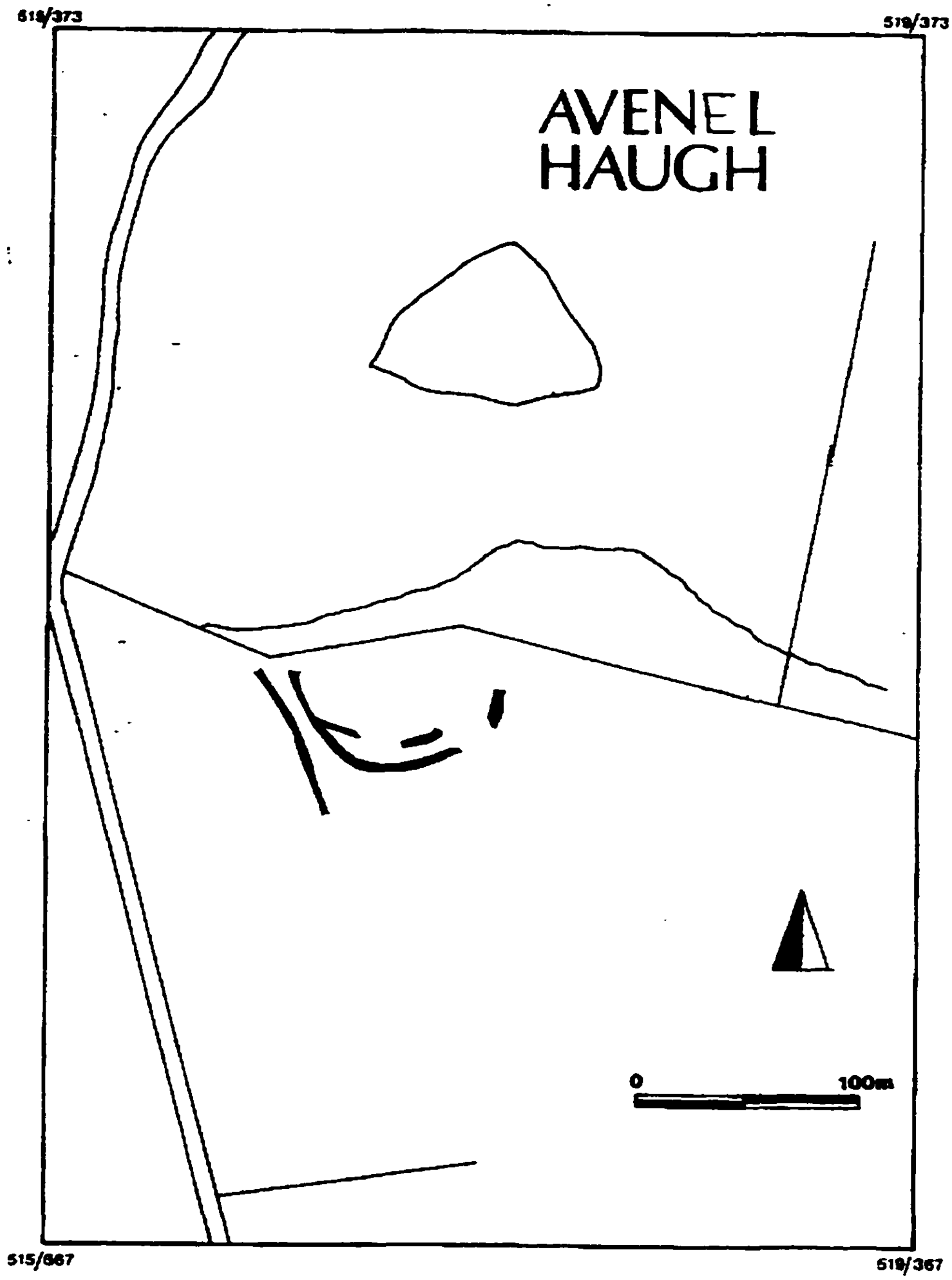

Figure 3.1 Aerial photograph interpretation for Avenel Haugh

In the field further assessment of native sites for which there were aerial photograph rectifications was undertaken during site visits. Any sites identified as being under pasture or barley stubble were suitable candidates, provided that no horses were in pastures. Sites that lay under young barley, wheat, or other crops were not ideal as crops would have been damaged and the farmers would have required compensation. Sites that were inaccessible were equally impractical.

The owners and tenants of suitable sites were visited and, if permission was granted and a convenient time could be arranged, a geophysical survey team of 4-6 people would visit the site.

Once on site, the field crew established a 20 x 20 m grid over the survey area using identifiable control points on the aerial photograph to estimate the rough location of the cropmark. The resistivity and magnetometer surveys were then carried out, with the field crew making notes (see Table 3.2) about special conditions, as appropriate. The grid was marked with brightly colored tent pegs, tomato canes, or bamboo. While grids were being surveyed their lines were marked by colorful ropes marked in 1 m increments.

Table 3.2 Crew notes from Avenel Haugh

1990	In September the field was undersown with barley stubble and the enclosure site appeared to have been eroded on the north side by the small burn. Kate Clark, director of the field crew, reported that the burn runs through a steep gully and that the field corner to the west of the site is very low lying and appears to have been marshy before field drainage.
1991	In September the field was being used for pasture. Both fluxgate gradiometer and electrical resistivity surveys were done. 19 and 24 grids respectively were completed. Fewer magnetometry grids were done because the southeastern portion of the survey area was crossed by an overhead power line supported by a steel pylon which would have interfered with magnetometer readings.

At the end of each day, or when the memory on either machine became full, data were transferred from the geophysical survey equipment to a small portable Amstrad field computer using Contors software written by John Haigh at Bradford University. Very hazy dot density displays of the data were possible with the Amstrads, and this information was used to refine the survey boundaries to ensure that major site features were covered.

Back at field headquarters data were transferred to a full-sized PC where they could be better displayed, basic statistics could be calculated and grids could be balanced. The precise placement of grids were drawn (see Figure 3.2). A rough set of crew notes was compiled and preliminary interpretation of geophysics evidence was done for the handful of sites chosen to be excavated.

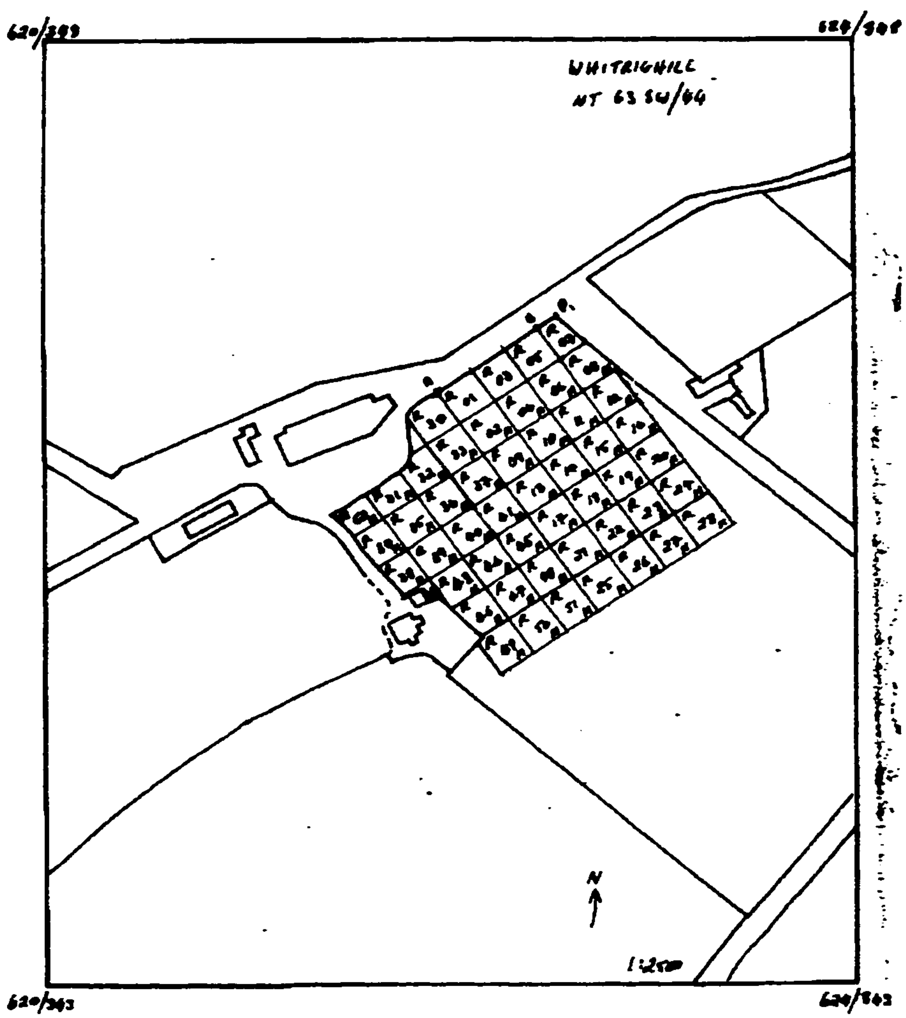

Figure 3.2 Grid location for Whitrighill survey

Final analysis of the geophysical data involved processing the data to remove errors such as striping, doing exploratory visual data analysis to identify features and determine how best to produce "portraits" of each site, and then printing one to five representative images from each survey. Uncut data were generally printed at the largest possible scale (see Figure 3.3) and at a standard scale of 1:2500 (the largest scale at which all sites can be displayed). Site "portraits" were next printed at the largest possible scale, at a scale of 1:2500, and at a scale of 1:1000.

Figure 3.3 Sample image of resistivity data from Avenel Haugh at a scale of 1:1000. Note that white represents areas of relatively high resistance and black represents areas of relatively low resistance.

Geophysics interpretations were next drawn at a scale of 1:1000 (see Figure 3.4) and a table containing a short text description of each feature was produced (see Table 3.3).

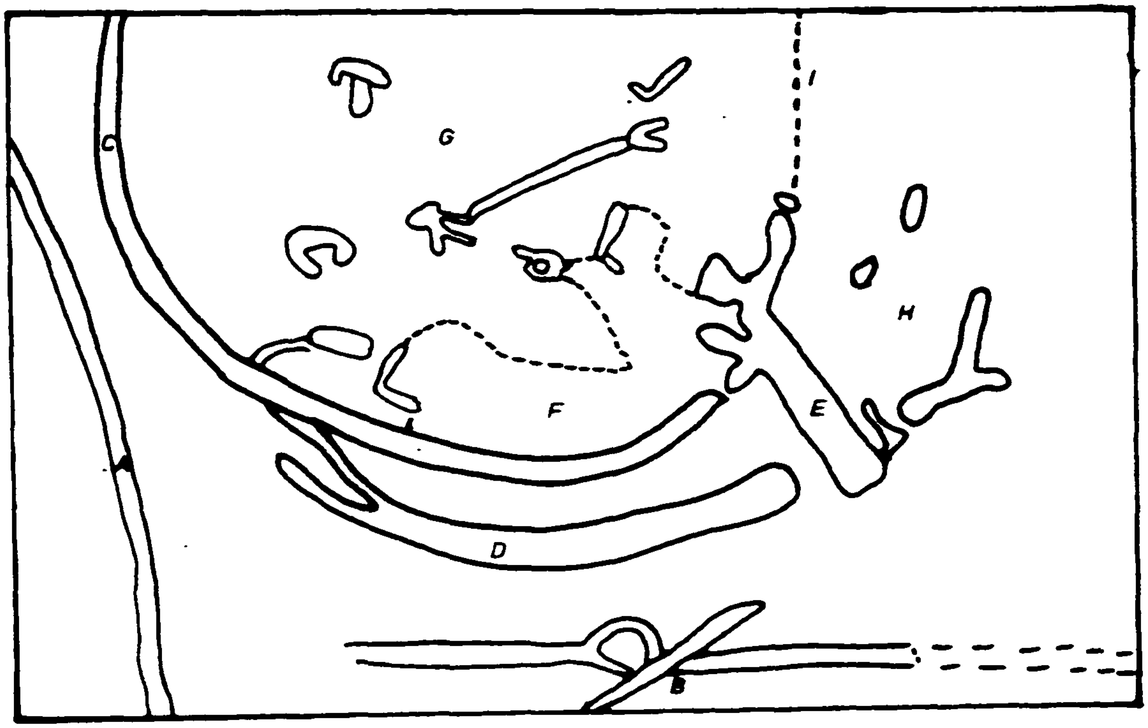

Figure 3.4 Geophysics interpretation for Avenel Haugh at a scale of 1:1000.

Table 3.3 Features identified through geophysical survey at Avenel Haugh.

Feature	Technique	Interpretation
A	Resistivity	Linear earthwork running north/south, of uncertain relation to the enclosure
B	Resistivity	Linear earthwork running east/west, of uncertain relation to the enclosure
C	Resistivity	Enclosure inner ditch
D	Resistivity	Enclosure outer ditch (or possibly a re-cut line if enclosure was single-ditched)
E	Resistivity	Enclosure entrance.
F	Resistivity	Yard area
G	Resistivity	Series of resistivity anomalies representing internal settlement features. Some of these features appear to be curvilinear and others appear to be rectilinear.
H	Resistivity	Three lines marking possible courses for the enclosing ditch or ditches.
I	Resistivity	Possible line of enclosing bank.

Finally, an interpretive report pulling together all available information about the site was produced. The full report for Avenel Haugh is included in Appendix 1 for interested readers.

3.3 Key Results from Interpretation of Geophysical Data

1. Geophysical evidence was used to inform the choice of native enclosures to excavate during the life of the Newstead Research Project, and in this way fundamentally shaped archaeological knowledge of the region. Geophysical data produced new information about the construction and layout of many native sites as the level of detail, and the precision of rectification, is greater than could be obtained from oblique aerial photographs. Appendix 1 contains detailed analysis of each site, and key conclusions for each are listed in Table 3.4.

Table 3.4 Summary of key conclusions from geophysical surveys of regional sites

Avenel Haugh	The enclosure at Avenel Haugh had at least one surrounding ditch, possibly two, and appears to have been reshaped and restructured through time. If the enclosure was only single-ditched, then this suggests that the enclosure was expanded at some point in its history to provide more space in the yard area adjacent to the site entrance.
Bemersyde Hill Curvilinear Homestead	Through survey and subsequent excavation we know Bemersyde Hill Curvilinear Homestead to be a triple-ditched circular enclosure of roughly 80 m by 60 m internal size and with an external diameter of roughly 195 meters. The enclosure was surrounded by a hollow-way and the ditches appear to vary in size. The main site entrance was to the southeast with a small secondary entrance to the south. Numerous internal geophysics anomalies suggest the possible presence of at least 4 roundhouses plus a variety of other structures.

	To truly elucidate the relationship between Bemersyde curvilinear and sub-rectangular enclosures, more survey work needs to be done to the south of the existing surveyed area.
Bemersyde Hill Rectilinear Homestead	The southwestern section of this enclosure's ditch curves to fit the line of the outermost eastern ditch of the curvilinear enclosure. This suggests that they were either constructed about the same time or that the rectilinear enclosure came later.
Bemersyde Moss	Evidence for a variety of internal features was recovered, some distinctly curvilinear and a couple somewhat rectilinear, suggesting this as an interesting and relatively preserved site at which to carry out future excavation. It would be interesting to try and verify the presence of rectilinear structures via excavation and to collect, if possible, dating evidence to determine whether this curvilinear homestead was occupied during the Roman period.
Birchgrove	No evidence for the homestead at Birchgrove was recovered via geophysical survey.
Bogle Field	As one of a cluster of enclosure sites nestled around the Roman fort at Trimontium, Bogle Field is a candidate for further exploration on the basis that it may contain information about Roman and Native contact. On the basis of geophysical survey it seems possible that intact archaeological features and contexts would be uncovered through excavation and that both curvilinear and rectilinear internal features might be recovered. Bogle Field is currently classed as a Roman site and in fact shares a NMRS number with the Roman fort at Newstead. Unless excavation is undertaken to evaluate whether this site is in fact Roman, it would benefit from being given its own number.

Bowden Moor	The site itself has probably not yet been geophysically surveyed, but as it sits amidst an extensive series of earthworks it is worthy of further study.
Butchercote Promontory Fort	The continuing existence of the ditches of this fort, given extensive ploughing and near-surface bedrock, suggests that the ditches may have been carved into the bedrock.
Butchercote Rectilinear Homestead	This enclosure appears to have been reshaped at different periods, suggesting a multiphase occupation. Evidence for reshaping of the northeast corner is particularly clear from the geophysical evidence. Overall, the odd shape of Butchercote, and the multiple lines of ditch around the enclosure, lead one to wonder if originally this site may have been curvilinear. There is evidence for structures within the enclosure, and the geophysics data suggest that these structures may be both curvilinear and rectilinear. This site would be interesting to excavate. Relatively good site preservation is suggested by the quantity of internal geophysics signals, and the possibility that this site began as a curvilinear homestead and was later restructured into a rectilinear enclosure is intriguing.
Cairneymount	Geophysical survey at Cairneymount provided evidence for the continuing presence of the homestead ditches and spread from the banks in advance of excavation. No clear evidence for internal structures was detected via geophysics despite the clear cropmark on aerial photographs. Excavations carried out on this site as part of the Newstead Research Project (Dent 1993) confirmed the presence of two inner ditches, an intervening bank, the entrance, and at least three ring-groove roundhouses with medieval pottery and

	spindle whorls.
Cauldshiels Hill	Excavation undertaken by the Newstead Research Project after the geophysical survey revealed evidence for a rock-cut enclosing ditch with an entrance to the east surrounded by a complex sequence of entrance structures. One circular house platform was discovered in the fort's interior, and this was also cut into the bedrock. Finds included whetstones and fragments of a saddle quern, suggesting an Iron Age date for the fort. A burial with beaker was discovered during the excavation, and suggests that the site was also used during the Bronze Age.
Chester Knowe	The geophyscial data collected during the 1993 survey is now missing, and all that is left is a poor printout of the magnetometry data
Chesterlee Cairneymount	This oval enclosure appears to be Medieval as its morphology would be unusual in prehistory.
Clint Hill	The resistivity evidence suggests there may be an earthwork running north to south just west of the enclosure and curving to respect the line of the enclosure's ditch.
Clint Mains	The clarity of internal features recorded during geophysical survey, as well as the hint of multi-phased ditch construction, makes this an important site for further investigation. It warrants excavation in order to test hypotheses about the temporal relationship of ring grooved and ring ditched houses.
Craigsford Camp Plantation	Geophysical survey produced evidence suggesting that a second rectilinear enclosure overlies the northwest portion of the well-preserved curvilinear enclosure.
Drygrange Mains	The survey produced evidence for two overlapping enclosures. Although there is some evidence for internal curvilinear and rectilinear structures, the presence of opposing entrances suggests that the enclosure may also have been a henge monument at some point in its history.

East Lodge	Evidence suggests that there is a rectilinear enclosure with internal curvilinear features adjacent to an earthwork running from north to south. There is a curvilinear feature overlying the ditch on the western side of the rectilinear enclosure, and a short ditch segment just slightly west and completely outside the rectilinear enclosure. These features may perhaps represent unenclosed settlement, or indicate multiple construction phases.
Easter Housebyres	No evidence for the enclosure was found during survey. This might mean that no trace of the site remains, however it is possible that the grid reference may be incorrect.
Eildontree Plantation	A smaller sampling interval may have been more successful in identifying remains of any timber hall that existed here. Evidence for a possible enclosure is interesting, though not completely convincing. The extensive modern field drains appear, however, to have disrupted a large area of the field and therefore relatively poor preservation of any archaeological remains can be expected.
Fens	Further investigation of Fens is warranted as there appears to be good preservation, and because there is only evidence for curvilinear internal features within this rectilinear enclosure.
Heckside 1	Evidence for the southern part of a double-ditched enclosure with internal features was recovered. There is also some suggestion of external features.
Heckside 2	This is one of the very few triple-ditched curvilinear enclosures surveyed in the region. Evidence suggests that it was constructed in multiple phases, and potentially re-shaped and re-sized.
Huntlyburn House	The double-ditched curvilinear enclosure is unusual in having an entrance in the northwest.
Kaeside	Survey confirms the presence of a double-ditched curvilinear enclosure.

Lilliesleaf	Two sherds of samian ware were recovered during survey. As a result this single-ditched rectilinear enclosure was excavated in 1996. Preliminary results from the excavation are presented later in this chapter.
Lilliesleaf, South	No evidence of this enclosure has yet been recovered.
Littledean	This promontory contains evidence for a heavily entrenched fort and medieval tower. With such a complicated series of defenses neatly enclosing the tower, it is likely that the ditches are contemporaneous with it. Curvilinear anomalies within the inner ditch suggest this enclosed an earlier promontory fort.
Oakendean House	This survey improved knowledge of the location of the rectilinear enclosure and western linear earthwork. The relationship between the enclosure and the earthwork, and these features with the curvilinear enclosure and eastern linear earthwork remain undefined. Further survey in all three fields seems appropriate given the complexity and potential archaeological importance of the site.
Quarry Hill	Despite the ravages of modern quarrying, a good deal of the enclosure remains intact. Both the ditches and internal features appear clearly in the geophysics data suggesting relatively good preservation.
Red Rig	Evidence suggests a disturbed site which was re-shaped through time. It is conceivable that this enclosure was transformed from a more curvilinear shape to a more rectilinear shape, but no evidence for clear corners was recovered and this hypothesis is speculative.
Redpath	This tiny rectilinear site appears to be an enclosure with some curvilinear structures. Its size would be unusual for a prehistoric enclosure, and suggests a post-Roman date.
Rink	Evidence for a single-ditched oval enclosure. No evidence for entrances or internal features was recovered.

St. Boswell's Green	Resistivity shows a faint line that corresponds with the northern portion of the enclosure. No evidence for an entrance or any internal features.
Souterrains	No evidence for the former position of the souterrains, or any suggestion of a surrounding enclosure. There are a series of poorly defined high resistance marks that may be associated with human activity in the area.
South Whitrighill	The results of this survey are unclear as animal tracks, field drains, and water pipes are numerous and over power any archaeological signals.
Third	There is evidence for multiple building phases, suggesting that the site may have been used over a relatively long period of time. This impression is enhanced by the presence of a modern farmhouse over the center of this archaeological enclosure. As an example, the convergence of the inner and outer ditches to the north of the enclosure suggests that they were not constructed simultaneously, and that the enclosure may have been expanded. The three round houses that overlie the inner ditch furthermore suggest that the expansion may have been due to increased population size and the need for more living space.
Turfford Burn	No evidence for the enclosure was found, although survey in a more moist year would be helpful. There appears to be an unrecorded standing earthwork in the adjacent plantation.
Whitrighill	The geophysical survey at Whitrighill provided useful detail, especially about the enclosure's interior, for planning subsequent excavation. Evidence suggests that the enclosure was built over multiple phases.

2. Importantly, the geophysics evidence suggests that 22 of the homesteads in the study region have been the focus of construction activity in more than one period. There

is evidence from these sites for multiple episodes of construction including ditch realignment and/or expansion.

Data used as evidence for multi-phase construction activity includes overlapping geophysical anomalies (e.g. roundhouses built over ditches, the two enclosures at Oakendean House), the presence of both curvilinear and rectilinear construction techniques, and the construction of external earthworks that respect the lines of settlements.

A particularly good example of multi-phase construction comes from the site of Third (see Figures 3.5 and 3.6 and Table 3.5) where it appears that the ditch from a single-ditched curvilinear enclosure was re-aligned to enable expansion of internal settlement space. Three roundhouses were then built over the line of the original ditch. At some point a rectilinear annex was constructed to the west and a curvilinear annex was constructed to the north.

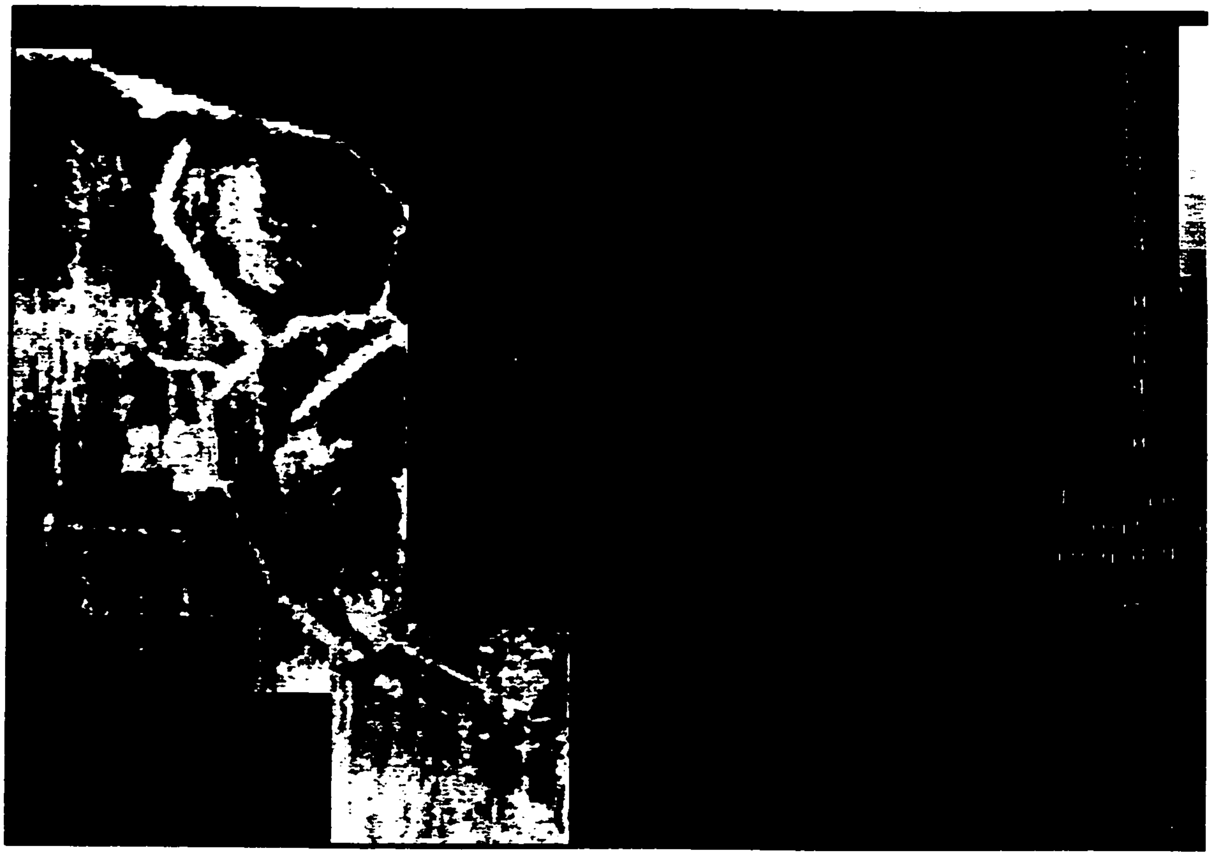

Figure 3.5 Resistivity image from Third

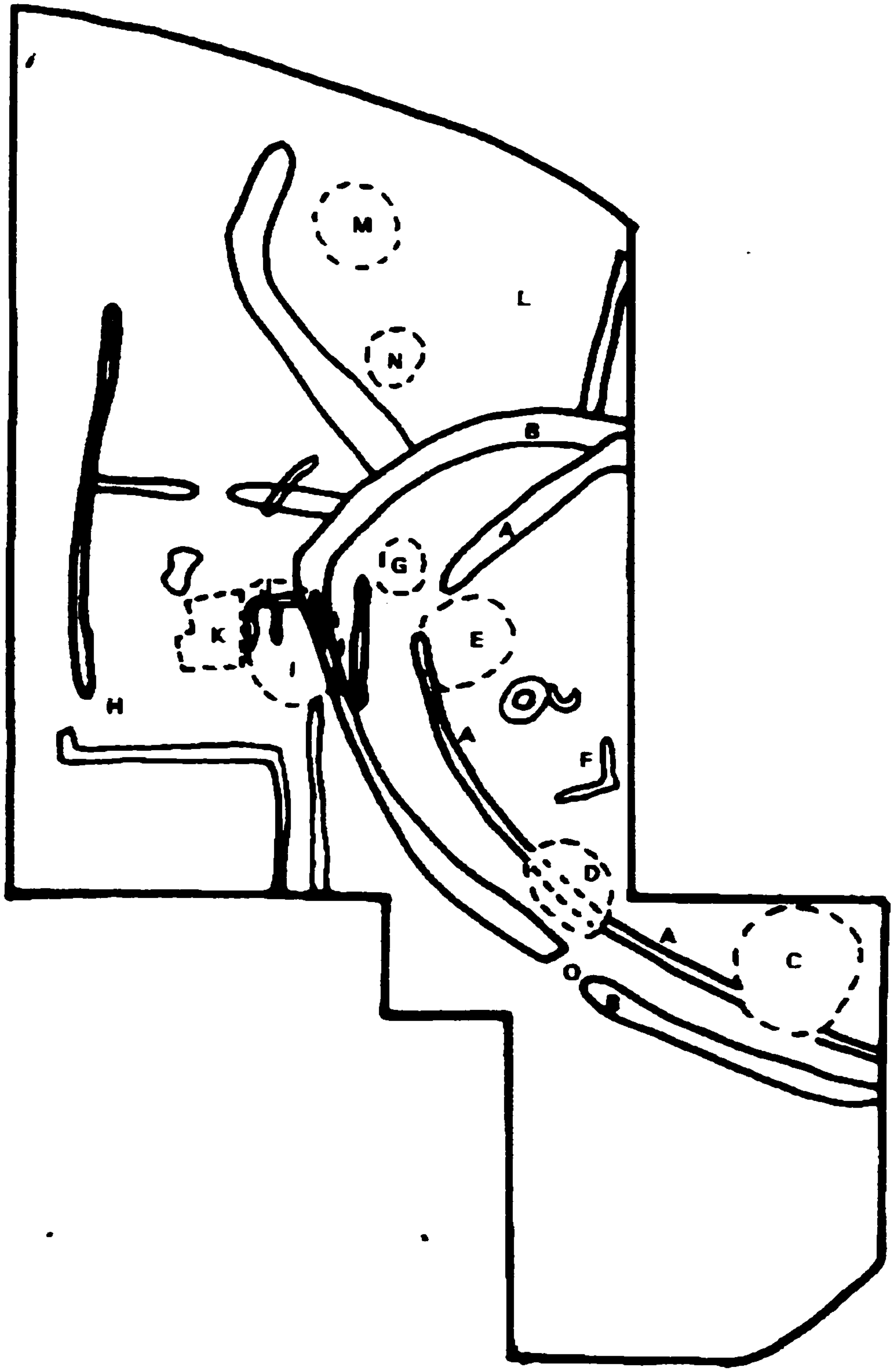

Figure 3.6 1:1000 interpetation of geophysical data from Third at 1:1000.

Table 3.5 Features identified during interpretation of Third geophysics data

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Inner Ditch
B	Magnetometry and Resistivity	Outer Ditch
C	Magnetometry and Resistivity	Possible roundhouse overlying inner ditch in south of enclosure.
D	Magnetometry and Resistivity	Possible roundhouse overlying inner ditch in southwest of enclosure.
E	Magnetometry and Resistivity	Possible roundhouse overlying inner ditch and blocking west passage from the innermost enclosure toward the west annex.
F	Magnetometry and Resistivity	Assorted curvilinear and rectilinear anomalies possibly representing internal structural features.
G	Magnetometry	Possible roundhouse between first and second ditches.
H	Magnetometry and Resistivity	Western annex.
I	Resistivity	Possible round structure in western annex.
J	Magnetometry	Possible square rectangular structure in western annex either underlying or overlying Feature I.
K	Magnetometry and Resistivity	Second possible rectilinear structure in western annex and lying west of Feature J.
L	Magnetometry and Resistivity	Northern annex.
M	Magnetometry	Possible round structure in northern annex.
N	Resistivity	Possible round structure in northern annex.
O	Magnetometry and Resistivity	Entrance

Of the 18 sites without clear evidence for multiphase construction, 12 did not provide enough geophysical evidence to argue convincingly for single-phase construction. The 12 sites include two that produced poor geophysics results overall (Birchgrove and Eildontree Plantation), four in which the enclosures were missed entirely during geophysical survey (Bowden, Easter Housebyres, South Lilliesleaf, and Turfford Burn), two in which only an edge of the enclosure was surveyed (Rink, St. Boswells Green), two that produced evidence for ditches hand-carved through bedrock (Butchercote Promontory Fort and Cauldshiels), and two for which data are missing (Chester Knowe and Mellerstain). The six sites which produced no clear geophysical evidence for multi-phase construction are Cairneymount, Chesterlee, Heckside 1, Kaeside, Quarry Hill, and Souterrains.

In general the widespread evidence for multi-phase construction suggests an investment in settlements and a degree of organic growth within them. These themes will be taken up in the next Chapter.

3. There is also evidence for the successive re-use of settlement locations often continuing to the present day. A particularly good example of this comes from Littledean (see Figure 3.7) where the location of a prehistoric promontory fort appears to have been re-used in the medieval period (for a tower with up to seven lines of defense) and modern period (as a farmhouse occupies the site today).

Figure 3.7 Magnetometry survey of Littledean. Note that white represents areas of relatively high magnetism, and that black represents areas of relatively low magnetism.

The definition of location re-use used here was the presence of other archaeological or modern features within 250 m of a site. 34 of the 40 enclosures had such evidence, the exceptions being Butchercote Promontory Fort, Chester Knowe, Chesterlee, Craigsford Camp Plantation, Quarry Hill, and Turfford Burn. Many of the 34 sites with evidence for location re-use were near sites of more than one period (e.g. there were nearby early prehistory features such as tumuli or standing stones as well as medieval and modern features).

The degree of location re-use seems to suggest great social investment in particular places, and this is another theme taken up in the next Chapter.

4. The patterning of internal curvilinear and rectilinear features is another piece of interesting information that comes from close analysis of the geophysical data. I was curious to know whether there was a correlation between enclosure morphology and internal structure morphology. Fourteen sites produced no evidence for internal structures. Of the 26 remaining sites, 17 sites appear to have only curvilinear internal features (14 of these are curvilinear enclosures and 3 of these are rectilinear enclosures), 1 site appears to have only rectilinear features (this is a rectilinear enclosure), and 8 appear to have both curvilinear and rectilinear internal features (2 of these are curvilinear enclosures, 3 of these are rectilinear enclosures, and 3 of these can be classified as both curvilinear and rectilinear enclosures). The general trend is, therefore, for curvilinear enclosures to have curvilinear structures but for rectilinear sites to have either curvilinear or rectilinear structures (see Table 3.6).

This last category, sites that have both curvilinear and rectilinear enclosures and internal structures, requires further clarification. At Drygrange Mains it was not clear which enclosure morphology went with which internal structure morphology, and therefore the evidence is inconclusive for the question being addressed. At South Whitrighill the evidence is equally inconclusive. At Third, however, the curvilinear enclosure produced only evidence for internal curvilinear features while the rectilinear annex produced both curvilinear and rectilinear internal structures. Evidence from Third therefore supports the broad trend for curvilinear enclosures to contain evidence for curvilinear structural features, and for rectilinear enclosures to contain evidence for either curvilinear or rectilinear structural features. Indeed, with the evidence from Third it is fair to say that rectilinear enclosures more often then not have rectilinear structures and curvilinear structures.

Table 3.6 Comparison of enclosure and structure morphology

	Curvilinear Structures Only	**Rectilinear Structures Only**	**Curvilinear and Rectilinear Structures**
Curvilinear Enclosures	Bemersyde Cairneymount Cauldshiels Chester Knowe Clint Mains Craigsford Heckside 1 Heckside 2 Huntlyburn Kaeside Littledean Mellerstain Quarry Hill Whitrighill		Bemersyde Moss Chesterlee Drygrange ??? South Whitrighill ??? Third
Rectilinear Enclosures	East Lodge Fens Redpath	Bemersyde	Bogle Field Butchercote Drygrange ??? Lilliesleaf South Whitrighill ??? Third

5. Previously unrecognized construction patterns have become apparent through comparison of geophysical survey data from this region. For example, many rectilinear sites appear to have small gaps near the ditch corners perhaps to allow a walkway across the ditches. Excavation at Lilliesleaf (discussed later in this chapter) has confirmed the careful construction of such a gap.

6. Analysis of these geophysical data also points to ways in which future field practice could be improved. There is clearly a need to survey the entirety of each site with both methods, if practical, even when no obvious features appear in initial displays. There is often very subtle information that can be teased out of the data from one relatively unresponsive geophysical technique to confirm (or contradict) the evidence from another more responsive technique.

Similarly, there is clearly a need to extend survey boundaries beyond the site boundary when possible to explore the possibility of external or unenclosed settlement evidence. The geophysical survey at Lilliesleaf, for example, suggests the possible presence of a curvilinear structure to the east of the enclosure. The recovery of samian sherds from this same area again supports the possibility of unenclosed settlement evidence.

Finally, a finer sampling interval than 1 m would be extremely useful in resolving construction details for these enclosure sites. It would also introduce the possibility of detecting more ephemeral features such as field systems or timber-framed buildings.

7. Finally, the response of geophysical techniques was sometimes good even when the background geological conditions precluded the "sensible" use of magnetometry and resistivity. For example, granite bedrock often is used as an argument against geophysical survey but at Butchercote Promontory Fort (see Appendix 1) the ditches carved into this bedrock show up well against the noisy geophysical background. This means that in the context of regional analysis, geophysical methods may be worthwhile even when background conditions are not ideal.

A great deal of useful information has been derived from analysis of geophysical data collected at 40 settlements in the Borders region. The last point in the list of major results, that geophysical methods are useful in the context of regional analysis, provides a nice segue into discussion of settlement pattern analysis in the Scottish Borders.

3.4 Study of Settlement Patterning

3.4.1 Background and Methods

Settlement pattern analysis complements and contextualizes geophysics data with a higher level of analysis focusing on the region rather than the site. In this chapter a brief literature review of settlement pattern analysis and interpretive frameworks in archaeology is followed by a description of the methods used in this research, and a summary of major results.

A revolution occurred in the 1960s with the advent of settlement archaeology (Chang 1967, Trigger 1967). Archaeologists gained a widespread appreciation for the fact that landscapes, and the settlements and communities within them, are structured (Gaffney *et al.* 1995, Hodges 1987, Kolb and Snead 1997).

The advent of settlement archaeology changed our understanding of virtually every aspect of late prehistoric archaeology in the United Kingdom because:

> The best preserved body of data is undoubtedly the physical evidence of Iron Age settlements. Many thousands are known and of these hundreds have been examined by excavation, some of them on a comparatively large scale. The settlement evidence from Britain is fuller than that from any other country in Europe (Cunliffe 1991).

The importance of settlement studies is largely due to the initial efforts of David Clarke who reassessed the Iron Age settlement of Glastonbury in England (Clarke 1972a:801). Clarke's analysis of spatial relationships embodied in the settlement and its wider context remains inspiring. His first principle -- that there is almost always some patterning to be found and understood in settlements -- is still a bedrock for archaeologists today. Clarke's study also has the honor of being one of the first examples of quantitative assessment of such patterns.

The blossoming of archaeological quantification in the late 1960s and 1970s led to renewed focus on sampling strategies, typologies, and analysis of every imaginable kind of patterning (Hodder and Orton 1976, Parsons 1972). This included patterns of artifacts within sites, but also included an explosion of quantitative techniques for analyzing the distributional patterns of settlements and their spatial relationships. The search for settlement patterns originally focused on households (Flannery 1976, Foster 1989, Lightfoot 1995, Oswald 1997, Trigger 1967) and settlements (Clarke 1972a, Trigger 1967) but gradually expanded to encompass communities (Flannery 1976, Kuna 1991, Lightfoot 1995, Neustupny 1991), microregions (Kuna 1993), and regions (Crumley and Marquardt 1987, Flannery 1976, Marquardt and Crumley 1987). There was also discomfort with the idea of aggregating evidence at any of these levels and thus attempts to do distributional archaeology without defining "sites" at all (Ebert 1992). More abstract patterns were identified through rigorous application of quantitative techniques (Gaffney *et al.* 1995) and these underpinned concurrent expansion in research on prehistoric economies and environments.

In the settlement archaeology literature of the late 1960s three primary scales of analysis were used: individual structures, settlements, and settlement distributions (Trigger 1967). In the literature of the late 1980s and early 1990s, there is discussion of three more general scales of analysis: continental, regional, and site specific (Crumley and Marquardt 1987, 1990; Farley *et al.* 1990; Madry and Crumley 1990; Savage 1990). Flexible and efficient multiscalar research in archaeology, desirable in reconstructing social and environmental processes at work in the past, is rare because of the enormous amounts of data that must be collected and managed.

Besides enormous quantities of data, there are other practical reasons for the rarity of effective multiscalar research. These research projects are extremely expensive in terms of money, time, and energy (Madry and Rakos 1996). Frequently micro scale studies are too expensive to justify. As a result, top-down modeling is often the default mode for spatial analysis in archaeology and choice of scale is based on the lowest common denominator of source material.

Another barrier to multiscalar research is a lack of methodologies to assist in quantitative assessment about what the effective scales are for variables in a given region (Bian and Walsh 1993, Wise 1993). Effective scale is any scale at which pattern may be recognized and meaning inferred (Crumley 1979).

The literature in archaeology, geography, soil sciences, and geology are filled with affirmations about the importance of scale. Studies of scale seem to be most highly developed in the field of geography where it is a major concern of researchers interested in cartography and remote sensing applications. A quote from two photogrammetrists illustrates this widespread concern with scale:

> The choice of an appropriate scale, or spatial resolution, for a particular application depends on several factors. These include the information desired about the ground scene, the analysis methods to be used to extract the information, and the spatial structure of the scene itself. (Woodcock and Strahler 1987:311)

Scale is recognized for having important effects on all phases of research from data collection through analysis and presentation. The results which are obtained depend on the scale or scales at which data are analyzed. Analysis is dependent on scale because the patterns which are available for interpretation vary with the scale at which data are presented. These patterns in turn frame the explanations that are explored. This holds true not only for biophysical, but also for sociocultural studies of landscape.

A brief overview of the major methods for studying settlement patterning, at any scale, follows below.

3.4.1.1 Distribution Maps

Creation of distribution maps is the primary method used to represent settlement patterns (Hodder 1977a), but distribution maps have a variety of drawbacks. First, it is extremely easy to conflate different phases of occupation in a synchronic distribution map (Dewar 1991), especially when no artifacts are available to provide some degree of temporal control. Second, it is extremely easy to miss information out of a distribution map and fairly difficult to realize when this has happened (Groube 1981). Activity patterns in the past are not the same as depositional patterns from those activities and the depositional patterns generally are not equal to the patterns recovered from the field by archaeologists (Ebert 1992). Finally, the variety of potential errors in distribution maps create a remnant settlement pattern (Rouse 1972) and it is often difficult to establish how this relates to the settlement patterns actually created and experienced by people in the past.

Archaeologists have tried to develop quantitative and qualitative techniques to reduce the error incorporated into distribution maps. Such techniques include the assumption of constant rates of settlement establishment and abandonment in each phase and numerical methods of calculating average establishment and abandonment rates (Dewar 1991), synchronic filtering when artifacts allow some degree of chronological control or diachronic filtering by settlement class (Groube 1981), fieldwork to test blank areas in distribution maps to test for missing settlements (Groube 1981), and rigorous application of random sampling in field survey projects (Hodges 1987).

3.4.1.2 Statistics

Four goals for interpretation of the patterns recorded on distribution maps include 1) recognizing random scatters, clustering, and alignment; 2) identifying the spatial limits of any identified clusters; 3) recognizing co-variation in the spatial arrangement of multiple artifact/settlement types; and 4) identifying the spatial limits of any identified multitype clusters (Carr 1984). Luckily, after achieving the best possible distribution maps for a study area, archaeologists have recourse to a variety of techniques for identifying patterns in their data.

Heuristic analysis is one approach combining the rigor of statistical analysis with knowledge drawn from experience and contextual knowledge. First proposed in the early 1980s (Kintigh and Ammerman 1982) this is a strategy that foreshadowed the rise of Bayesian statistics in the 1990s. In heuristic analysis four basic kinds of patterning -- clustered, uniform, linear, or random -- are sought and once identified are described in great detail. Then geographical, cultural, and archaeological knowledge is employed to explain the patterns that have been recognized.

Parametric statistical techniques routinely used in the interpretation of site distributions include cluster analysis (Kintigh and Ammerman 1982), correlation analysis (Esquivel *et al.* 1999), principal components analysis (Esquivel *et al.* 1999), and various regression techniques including trend surface analysis where the spatial coordinates are treated as independent variables (Warren 1990).

The popularity of these statistical techniques amongst archaeologists interested in the analysis of settlement patterns does not mean that these techniques are the only, or even the most, appropriate. Few can be anything more than exploratory techniques for spatially distributed information because spatially distributed information is often auto-correlated and thus violates underlying parametric assumptions. If autocorrelation is present, techniques that require an independent variable must also be used with care to explore data.

A special class of spatial statistics was specifically developed by soil scientists (Webster 1985) to allow formal analysis while avoiding biases inherent in spatial datasets. Spatial statistics have rarely been used explicitly in archaeology (Aldenderfer 1998, Kvamme 1993, Schieppati 1985, Wise 1993). Spatial statistics are useful for both exploratory analysis of geographically distributed data, and for confirmatory analysis of hypotheses being tested

(Rogerson and Fotheringham 1994). In other disciplines these statistical techniques are frequently linked to the design of sampling strategies and the interpolation of sample information. A number of spatial statistics are designed for analysis of spatial dependence and heterogeneity. These include spatial regression, Moran's I, Geary's C, semivariance analysis, and fractal analysis (Bailey 1994, Bian and Walsh 1993, Getis 1994, Wise 1993). The first three techniques are methods for exploring spatial autocorrelation in attribute data. Semivariance is calculated to determine those scales at which variables are spatially correlated. Fractal analysis is used to quantify the degree of spatial dependence between two variables. Spatial statistics are not only useful in identifying and quantifying the strengths of relationships, but are also useful in analyzing the role choice of scale plays in the process of pattern identification and analysis.

3.4.1.3 Geographic Information System (GIS)

Geographic Information Systems (GIS) is the name given to a class of software that link relational databases to mapping tools. The database in a GIS contains information about attributes relating to an entity (e.g. an archaeological site) tied to particular spatial co-ordinates, and the mapping tools can be used to display and manipulate the entities.

The use of GIS in archaeology has flowered in the 1990s since publication of early exploratory research (Allen *et al.* 1990, Lock and Moffett 1991, Wansleeben 1988). Today GIS are well-established in the United States for use in predictive modeling for CRM. In the United Kingdom GIS are also well-established for archaeological information management in SMRs and NMRs. Some standard GIS analytical tools, for example viewshed calculation and cost-surface analysis, are also widely accepted. There has, however, been a well-publicized lack of theoretical breakthroughs as a result of the introduction of GIS in archaeology (Gaffney *et al.* 1995, Wheatley 1993, Wise in press b). In general, GIS are quite expensive to construct and are generally only justified for relatively large regional projects (Kvamme 1991, Kvamme and Jochim 1989, Limp *et al.* 1988) where analysis of settlement patterns and/or predictive modeling is necessary.

Advances in archaeoinformatics including GIS are positive developments toward facilitating effective multiscalar research. A GIS environment is the best currently available for multiscalar regional analysis because of the in-built tools for manipulating and transforming data at a variety of scales.

3.4.2 Explanatory Models

Once method has been applied to data, and patterns emerge, explanation is the next hurdle. The task of interpretation remains as statistics and automated computation mediate between data and theory (Orton 1999), but do not replace the need for models and theory.

Unsurprisingly, explanatory frameworks for settlement patterning go through fashions. Models drawn from economic geography, for example, were particularly popular in the 1970s and 1980s. A quick overview of some influential explanatory models follows. These are grouped into 4 classes - demographic, economic, environmental, and socio-political - though it is recognized that these classes all overlap and often need to be approached heterarchically to achieve the deepest possible understanding (Crumley *et al.* 1987, Marquardt and Crumley 1987).

3.4.2.1 Demographic Models

One angle for explaining settlement patterns is to explore the demographics of the population inhabiting them. For stratified societies, rank size analysis is sometimes useful. For rank size analysis settlements are assumed to be arranged hierarchically according to population size (Johnson 1977). A first step in a convincing rank size analysis is, therefore, demonstration that the society was sufficiently integrated and interdependent to necessitate hierarchical organization.

Where this assumption can not be made, for example where no settlement hierarchy is present, socio-political models are generally a more useful starting place. Where demography is of particular interest, however, there are techniques for using settlement numbers to estimate population size, and from there to work toward a model of expected settlement distribution (Kuna 1991).

3.4.2.2 Economic Models

One long-popular import from geography is Christaller's central place theory (Hodder 1972) which is based on von Thunen's model of diminishing returns around social centers (Hodges 1987). These geographical models have their roots in Weber's recognition that modern settlements are often located to minimize energy expenditure and ensure least-cost for access to raw materials and markets (Clarke 1977b, Hodges 1987). For analysis using central place theory a settlement pattern is compared with a regular hexagonal pattern. Hexagonal geometry decreases distance between outlying settlements and central places for the largest number of nearest neighbors (Groube 1981, Hodder 1972, Hodges 1987, Johnson 1977). Assuming that the area is topographically uniform and that the population is distributed evenly throughout, tightly-integrated market economies should theoretically produce hexagonal settlement patterns. Other geometric patterns, for example thiessen polygons, suggest other socio-economic models for society (Hodder 1972).

Recognition that settlements are, and were, frequently not located to maximize benefits or minimize energy expenditure unless produced by fully commercialized societies (Steponaitis 1978) has been influential and has opened the way to new understanding of the cultural behaviors which influenced choice of settlement locations in the past.

More attention has been paid in the 1990s to particularistic study of settlements than syntheses of broad socio-cultural patterns through the study of settlements generally, and there has been a backlash against many popular models from the 1980s (Hodges 1987). Widespread acceptance that beliefs pattern behavior, and therefore the archaeological record, have led to a search for systematic patterning that particularly reflects past beliefs (Renfrew 1981). For example, there have been attempts to relate settlement form and location to cosmology (Parker Pearson and Richards 1994) and a wide variety of other social and ideological factors.

3.4.2.3 Environmental Models

Where the economic or socio-political underpinning of a society is not known, environmental models are often a useful starting point. For example, catchment analysis is one approach for understanding the economic potential of an area around a settlement (Johnson 1977) or around a group of settlements. Catchments, traditionally circular and of pre-determined radii (Chisholm 1962) determined either by physical distance (Ellison and Harriss 1972) or temporal distance (Gaffney *et al.* 1996), are increasingly of irregular shape to reflect the diversity of the landscape in which a settlement is located (Hunt 1992). Once the catchment is determined, the natural resources available to humans living within are quantified.

Catchment models are too rigid and arbitrary for some tastes, and a more free-form approach is exploratory data analysis in which settlement patterns are compared to the distribution of natural resources, landscape features such as soil types, or trade routes with the goal of detecting ordered relationships between some or all of these variables (Groube 1981).

3.4.2.4 Socio-Political Models

Geometric patterning of settlements is one characteristic of stratified societies (Morrill 1970). Settlements in unstratified, loosely stratified, or heterarchically arranged societies are often patterned in less uniform ways. Exploration of settlement patterning can therefore lead to interesting insights into the nature of socio-political organization.

For proto-stratified societies, one approach is to concentrate research on boundary areas between different distributions of settlement classes. The degree of pattern overlap can sometimes indicate whether centralized or non-centralized forces are controlling the expression of settlement forms or their locations (Hodder 1977b).

Another approach is to use first principles to model the settlement patterns expected with a variety of socio-cultural systems (Smith 1976, Johnson 1977). This technique has been especially informative for teasing out the reasons that settlement hierarchies do or do not appear in the archaeological record. For example, central place theory with its underlying assumptions of minimization of energy and risk is not always applicable to pre-modern non-market based societies (Johnson 1977). Also influential have been models based on heterarchical, rather than hierarchical, organization (Crumley 1979, Ehrenreich *et al.* 1995).

In summary, there are many explanatory frameworks for settlement patterns and which are appropriate in any given circumstance depends on the nature of research questions. An articulate and concise summary of this situation is that:

> Archaeology essentially consists of three inter-connected dimensions: settlement systems, production-distribution systems and cognitive systems. These three dimensions constitute the material-culture record. The optimum approach to this record is not to study a single site, or a single site and its wider/regional implications, but instead to examine the structure of regions in levels of analysis appropriate to implementing either Smith's [sociocultural] models or, for example, central-place theory. This necessitates comprehending the relationship between regions, between the constellation of

settlements that make up a region (i.e. communities), and between the units that make up communities. (Hodges 1987:128)

3.4.3 Data Collection and Analysis

Data sources for the settlement patterning analysis were listed in chapter two, the most important of which was the National Monuments Record of Scotland (NMRS) archive. Some useful information about the regional settlements also came from the National Museum of Scotland (NMS) collections database. Other sources of information included aerial photographs, geophysics data, 1:63,360 Soil Survey of Scotland soil maps, 1:50,000 Soil Survey of Scotland land capability for agriculture maps, geology maps, 1:250,000 and 1:625,000 Bartholomew digital maps, Ordnance Survey 1:25,000 Pathfinder and 1:50,000 Landranger maps, and site visits.

3.4.3.1 Site Selection from the NMRS

The first stage in analysis of the settlements of central Tweeddale was selection of a subset of archaeological sites recorded in the study region by the NMRS. For these purposes the study region was defined as Ordnance Survey mapsheet numbers NT 42-44, 52-54, and 62-64. Settlements selected included those described by the following keywords:

settlement
enclosure
enclosure (possible)
fort
enclosures
enclosures (possible)
earthwork
linear cropmarks
ring-ditch
timber building
timber building (possible)
linear feature
homestead
hut circle

ring-ditch (possible)
burial
mounds
fort, promontory
fort, broch

Not every archaeological site classified in those categories was selected, however, because many of the settlement classifications in the NMRS are not exclusively used to describe late prehistoric sites. A thorough search through all information held by the NMRS about each settlement classified in these ways was necessary to narrow the selection down to late prehistoric and protohistoric sites. For example, *timber building (possible)* is a term equally likely to classify a 19th century farmstead as a late prehistoric homestead. Where additional information was available that securely dated a site to the medieval, post-medieval, or modern periods it was removed from further analysis.

3.4.3.2 Site Selection from the NMS

After selecting data from the NMRS with which to work, the information provided by the National Museum of Scotland (NMS) was examined. This was less useful for the purposes of settlement pattern analysis than anticipated. One barrier to use of NMS information in the settlement pattern analysis is the fact that, unsurprisingly, the retrieval location for objects was rarely known in detail and the overall level of georeferencing was poor. Another reason is that objects in the NMS database are recorded by material type (e.g. bronze, ceramic) and these materials are often not chronologically diagnostic. It was not within the scope of this project to examine the artifacts directly to confirm or refine the available information.

In the end, NMRS information about Roman objects, which could be readily identified, were included in this analysis as were finds classified by broad material terms that suggested prehistoric activity (e.g. flint). For the purposes of the settlement pattern analysis this produced an overall feel for the parts of the landscape used in prehistory, but did not produce detailed information directly comparable to the aerial photographic and archival evidence available from the NMRS.

3.4.3.3 Database Construction

During the life of the Newstead Research Project information about regional sites was held as an Ingres database. Sadly the original project database became corrupted and unusable before my involvement with the project, and it was necessary to construct a new settlement database. This was done using Microsoft Access software.

In total 29 variables about 1884 sites were included in the database. The variables included details about each site, its location, and its relationship to nearby water sources (see Table 3.7).

Table 3.7 Variables in project database

	Variable	Source
Site	Name	NMRS
	Number	NMRS
	Sub-Number	NMRS
	Protection Status	NMRS
	Class	NMRS
	Report	NMRS
	Morphology	Aerial photographs and geophysics data
	Maximum Internal Diameter	Aerial photographs and geophysics data
	Transverse Diameter	Aerial photographs and geophysics data
	Number of Ditches	Aerial photographs and geophysics data
	Number of Ramparts	Aerial photographs and geophysics data
	Artifact Type	NMS
	Artifact Description	NMS
	Artifact Period	NMS
Location	Map Number	NMRS
	East Grid Reference	NMRS
	North Grid Reference	NMRS
	Land Class	1:50,000 and 1:250,000 maps
	Soil Class	1:63,360 maps

	Soil Group	1:63,360 maps
	Drainage	1:63,360 maps
	Elevation	1:25,000 and 1:250,000 maps
	Location	1:25,000 and 1:250,000 maps
	Slope	1:25,000 and 1:250,000 maps
	Aspect	1:25,000 and 1:250,000 maps
Water sources	Distance	1:25,000 maps
	Name	1:25,000 maps
	Type	1:25,000 maps
	Direction	1:25,000 maps

Some of the variables, for example site name, are self-explanatory and come straight from the NMRS. Since the NMRS Canmore database became available online at http://www.rcahms.gov.uk/ in 1998 it has been possible to routinely ensure that the most up-to-date information about each site is being used.

Morphology Classification

As described in Chapter 2 it was my original intention to create a complex morphological classification scheme which captured subtle variation in the form of sites in the Scottish Borders. This was unfortunately a doomed undertaking, and in the end I have rejected complexity in favor of a two-class system. Each settlement is classified as either curvilinear or rectilinear depending on its overall shape and the straightness of its component ditches (see Table A2.1 in Appendix 2).

Diameter Measurements

In the few cases where rectified cropmarks and/or geophysics data allow measurement of internal diameter, a "maximum internal diameter" is recorded for the widest part of the enclosure and a "transverse diameter" is recorded for the widest part of the enclosure perpendicular to the maximum internal diameter. Relatively few sites are known in enough detail to complete these calculations, so the measurements are of relatively limited benefit to regional settlement pattern analysis.

Ditch and Rampart Counts

Where rectified cropmarks and/or geophysics data allow sensible counts of ditch and rampart numbers this information is recorded in the database. Again, relatively few sites are known in enough detail to complete these calculations, so the measurements are of relatively limited benefit to regional settlement pattern analysis.

National Grid References

The east and north national grid references for each site downloaded from the NMRS had to be converted to their full numerical form (i.e. NT could not be used as the initial code to indicate the 100 km map square) to be useful for analysis.

Location

I was interested in whether there might be discernible patterns, correlated with site class or morphology, to the location of a settlement on its hill. Accordingly, the location of each settlement on a 1:25,000 Pathfinder map was recorded as being one of the following locations:

- hill shoulder
- hill side
- hill top
- promontory
- ridge shoulder
- ridge side
- ridge top

Slope and Aspect

These two variables are difficult to discern from 1:25,000 maps and though this is the method I used at the beginning I quickly moved to deriving slope and aspect information from the 1:250,000 digital Bartholomew data that was available. Only information derived from the 1:25,000 maps is included in the database as the digital map data allowed calculation on the fly.

Water Variables

The four water variables record information about the 4 bodies of water nearest each settlement including distance if less than 1 km. The definition of "bodies of water" used is very broad and includes everything from springs to creeks to primary rivers.

3.4.3.4 Distribution Maps

Distribution maps were created by connecting the Access database to Arc/View GIS software using Microsoft's Open Database Connectivity (ODBC) protocol. The background for each distribution map is derived from the 1:250,000 Bartholomew digital mapping data (see Figure 3.8). A scale of 1:250,000 is fairly small, so keep in mind that local detail is lost with such a background coverage.

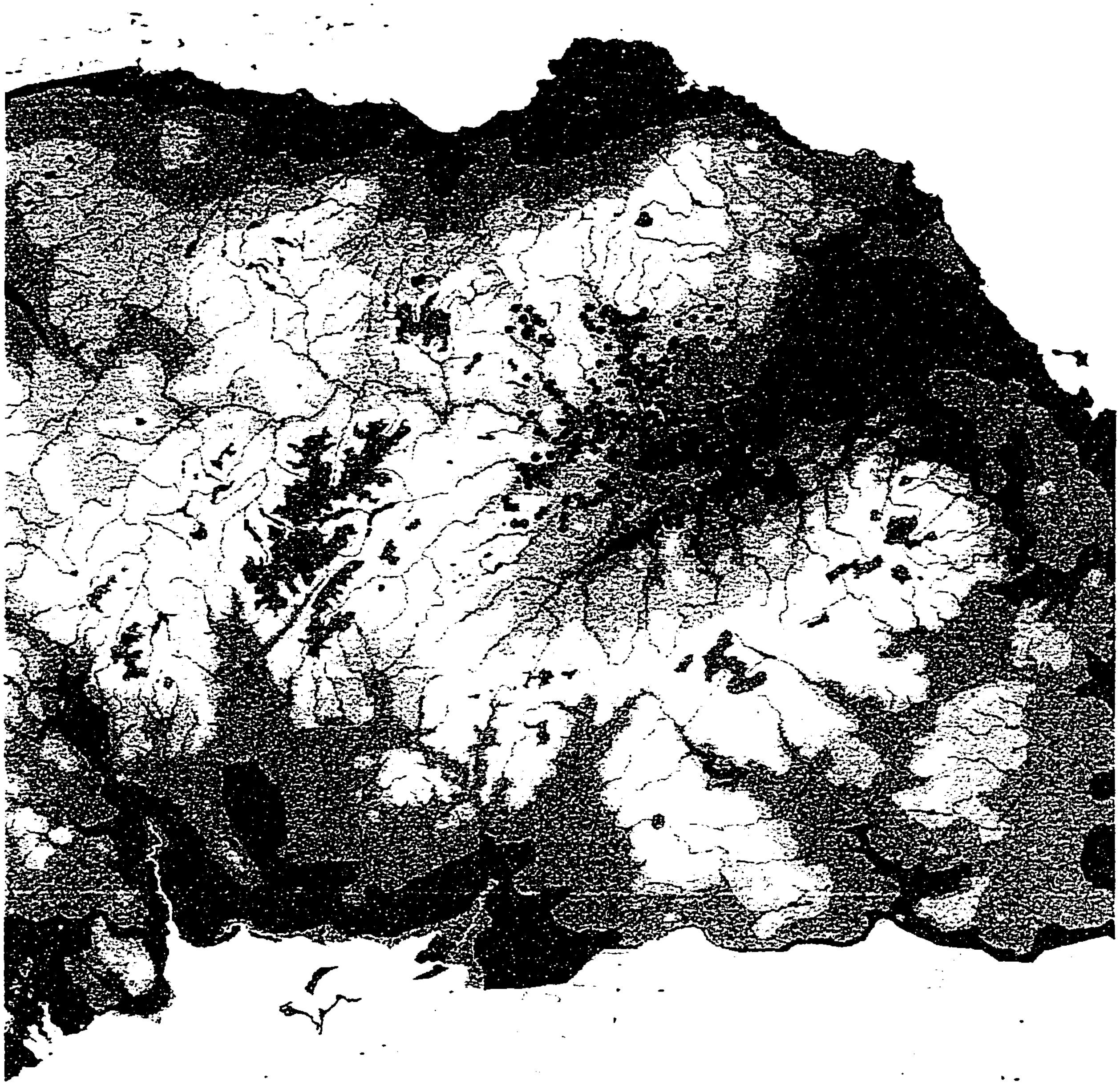

Figure 3.8 1:10,000 map of southeastern Scotland. The study region is shown as the cluster of blue symbols representing settlements. Primary rivers are shown as red lines, lakes are shown as blue polygons, and the bands of color represent a combination of elevation and landcover with red being coastal plains and green being upland pasture or forest.

A distribution map was produced for each class of settlement in the database: brochs, crannogs, cup and ring marks, hillforts, homesteads, promontory forts, Roman forts, souterrains, and standing stones. In addition, distribution maps were produced for each of the two settlement morphology classes: curvilinear (see Figure 3.9) and rectilinear. Finally distribution maps were produced for each class of material held in the NMS: bronze, copper, flint, glass, gold, iron, Roman, silver, and stone.

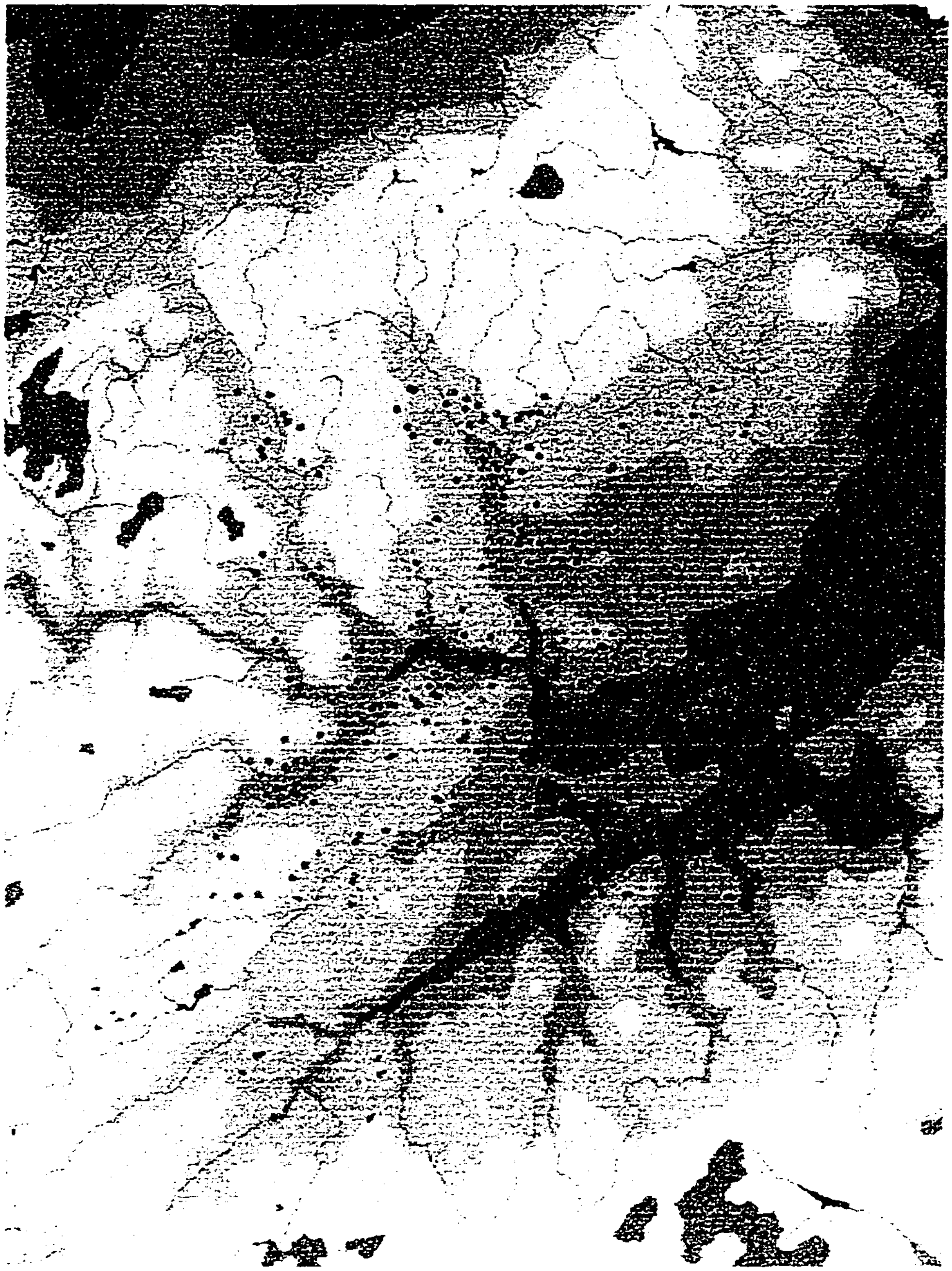

Figure 3.9 1:2,500 distribution map of study area showing location of all curvilinear settlements.

3.4.3.5 Exploratory Data Analysis with GIS

GIS such as ArcView are computerized mapping programs that allow three dimensional display of information. These software packages are especially useful when the quantity and complexity of available data make distributions too unwieldy for analysis using conventional maps. The GIS systems used for this research were Arc/Info and Arcview, each coupled to the settlement database held in Microsoft Access and to 1:250,000 Bartholomew digital mapping data.

Broad settlement patterns in the core region were explored in the following ways:

1. Settlement locations known through aerial photography and geophysical survey were plotted on 1:25,000 and 1:250,000 scale base map sheets by class and morphology, as described in the previous section.

2. Next settlements, grouped by class and morphology, were iteratively displayed at different scales with different coverages of landscape characteristics including topography, soils and water.

3.4.3.6 Quantitative Analysis

The statistical software used for this research was primarily SPSS 9.01, although some simple statistical calculations were also done in Arcview GIS software. The techniques most useful for analysis included simple crosstabulations and hierarchical cluster analysis.

3.4.4 Key Results from Analysis of Settlement Patterns

Settlement pattern analysis was useful in moving from the site-specific detail of the geophysics information to a regional framework, and enabled a search for evidence of larger socio-cultural groupings (e.g. tribes, kinship groups) as well as broad economic patterns (e.g. resources, trade networks). Key results are presented below.

1. Morphological classification of settlements confirmed that all hillforts and promontory forts were curvilinear, but homesteads occurred in both curvilinear and rectilinear forms (see Table 3.8).

Table 3.8 Settlement morphology

	Curvilinear	**Rectilinear**
Broch	2	0
Crannog	2	0
Hillfort	14	0
Homestead	237	33
Promontory Fort	5	0
Roman	0	1

Note that Table 3.8 probably underestimates the number of curvilinear homesteads, and overestimates the numbers of hillforts. This is because the definition between the two depends mostly on the site's landscape position (i.e. hillforts are at the pinnacle of hills) and only secondarily on the size of the site (i.e. hillforts are much larger than homesteads) even though this is the more diagnostic characteristic.

Also note that a surprising number of sites identified as rectilinear (Bell Hill, Bewlie, Birchgrove, Blackchester, Bloomfield, Caddonlee, Castle Hill, Castleside Hill, Child Knowe, Corby Linn, Eden Burn 1, Eden Burn 3, Fens, New Greenhill, Redpath, Redpath Dean, Redpath Park, St. Boswell's Green, and West Morriston) may in fact be curvilinear. This possibility is suggested by a close look at the aerial photographs for these sites which suggest that they have rounded corners and straight-ish sides. This is similar to the morphology of the homestead at Ridgewalls, Cairneymount as it appears in aerial photographs and geophysical survey. When excavated this homestead was found to be curvilinear. The number of rectilinear homesteads is therefore likely to be overestimated, and the number of curvilinear homesteads slightly underestimated.

It was not possible to test the counts in Table 3.8 with a Chi-Square procedure as too many boxes have fewer than 5 observed cases. Instead a Crosstabulation producedure was run in SPSS using Kendall's tau-b (see Table A2.2 for output) which supports the idea that the observed counts are significantly different at the .05 level.

2. Different spatial patterns appear to have been associated with each of the major classes of native settlement.

Some of these differences are inherently part of the definition of the settlement classes. For example, crannogs consist of roundhouses built on wooden platforms over water and unsurprisingly their distribution is limited to lochs and mosses. Hillforts, by definition, are large settlements on the very tops of hills and their distribution is limited to the tops of prominent hills. Promontory forts are, by definition, constructed at the ends of promontories and are protected by natural features (e.g. cliffs, rivers) on three sides.

Neither the broch settlement class nor the homestead settlement class is defined by landscape position, so closer examination was required. Both the brochs in the study area are located on relatively low-lying hills, and there appears to be little to distinguish their distribution from those of homesteads in the region except possibly median elevation. Homesteads were located between 50-450 m above sea level with a median of approximately 200 m. The median elevation for the two brochs in the study region is approximately 300 m (see Figure 3.10). As this figure is based on the elevations of only 2 brochs, and the elevations of both are within the range recognised for homesteads, the difference may not be significant.

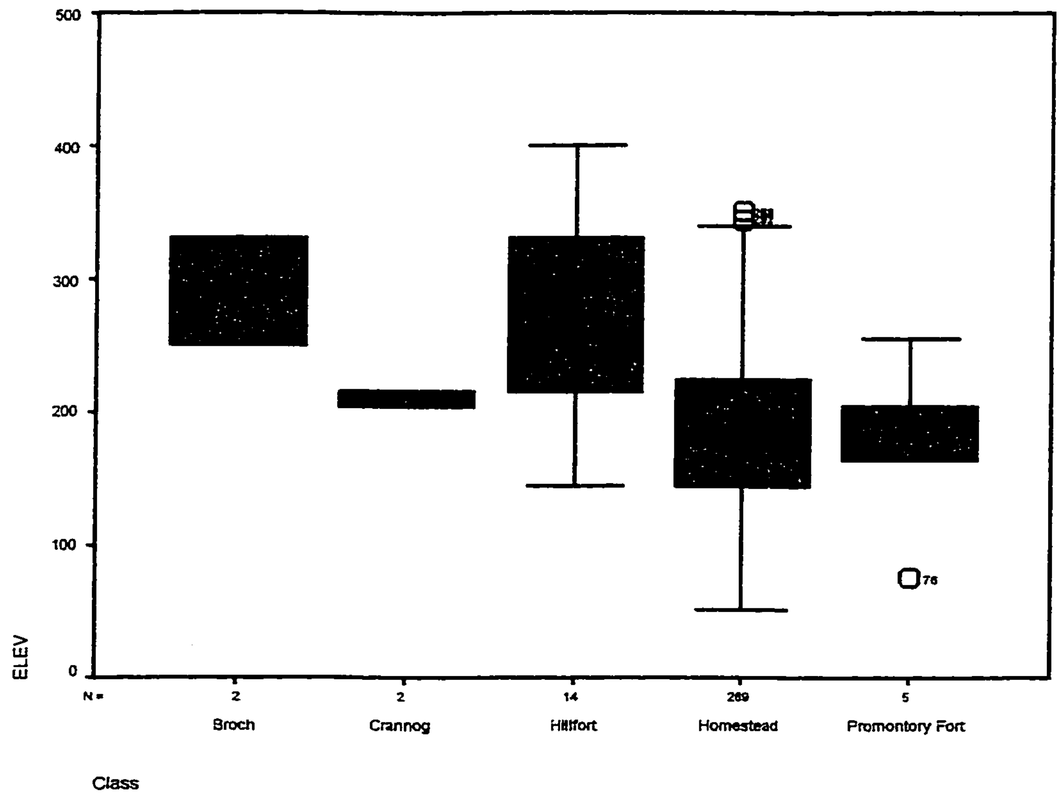

Figure 3.10 Boxplot of elevation for each settlement class summarizing the median, quartiles and extreme values. Caution should be used when interpreting this boxplot because of the low number of cases in the broch, crannog, hilfort, and promontory fort settlement classes and the large number of cases in the homestead settlement class.

It is perhaps worth noting explicitly that no settlements in the region are located at an elevation less than 50 m above sea level. This is partially because there is limited low-lying land in the study region, but appears to be a trend characteristic of late prehistoric settlements in Britain (Cunliffe 1991). It is possible, however, that a class of low-lying late prehistoric settlements remains to be discovered under alluvial sediments.

Initial exploration of the relationship between settlement class and the following variables proved unilluminating: distance to water, land class, and landscape position. The relationship between settlement class and distance to water quickly flagged up the fact that Scotland is a wet place and few locations are distant from some form of water. In future, study of the relationship between settlement class and particular categories of water (e.g. lochs, primary rivers) might prove more fruitful. The relationship between settlement class and land class parallels that for elevation presented above, and appears to reflect a correlation of elevation, topography, and modern farming practices. The relationship between settlement class and landscape position is again problematic because the definitions of crannogs, hillforts, and promontory forts partly contain this information. This leaves brochs, a class with a very small sample size, and homesteads, which are found in all landscape positions that were included in the classification.

3. Closer examination of homestead distribution was possible because of the large number of cases, and revealed further patterns. Some homesteads appear to be arranged in a linear pattern following main rivers such as the Tweed and its major tributaries, however the majority of homesteads were clustered together away from the major rivers.

A hierarchical cluster analysis was carried out in SPSS statistics software using the national grid references for each settlement as variables. A squared euclidean distance measure was used to classify the distance between settlements, and the nearest neighbor cluster method was used to group them.

This procedure clustered homesteads in a variety of ways based on the number of clusters the software package was asked to find. Experimentation revealed that some patterning was visible when the homesteads were clustered in 10-30 groups. There was only a limited amount of difference, however, in membership across these groups. Cluster membership for 10, 15, 20, 25, and 30 cluster runs was exported from SPSS to Arcview 3.1 and displayed with the goal of identifying finer patterning.

This linkage of the GIS software and the output from the cluster analysis proved fruitful. It was here that the relationship between some homesteads and major rivers was formally recognised. When all homesteads within one km of the Tweed or a major tributary were removed from the analysis, four strong clusters of 6-15 settlements became apparent along the Tweed River and Leader Water (see Figure 3.11). When all homesteads within 500 m of the Tweed or a major tributary were removed from analysis, an additional eight clusters of at least six settlements became apparent bringing the total number of clusters of 6-15 settlments to 12 (see Figure 3.12). Each cluster of settlements is approximately 2 km^2.

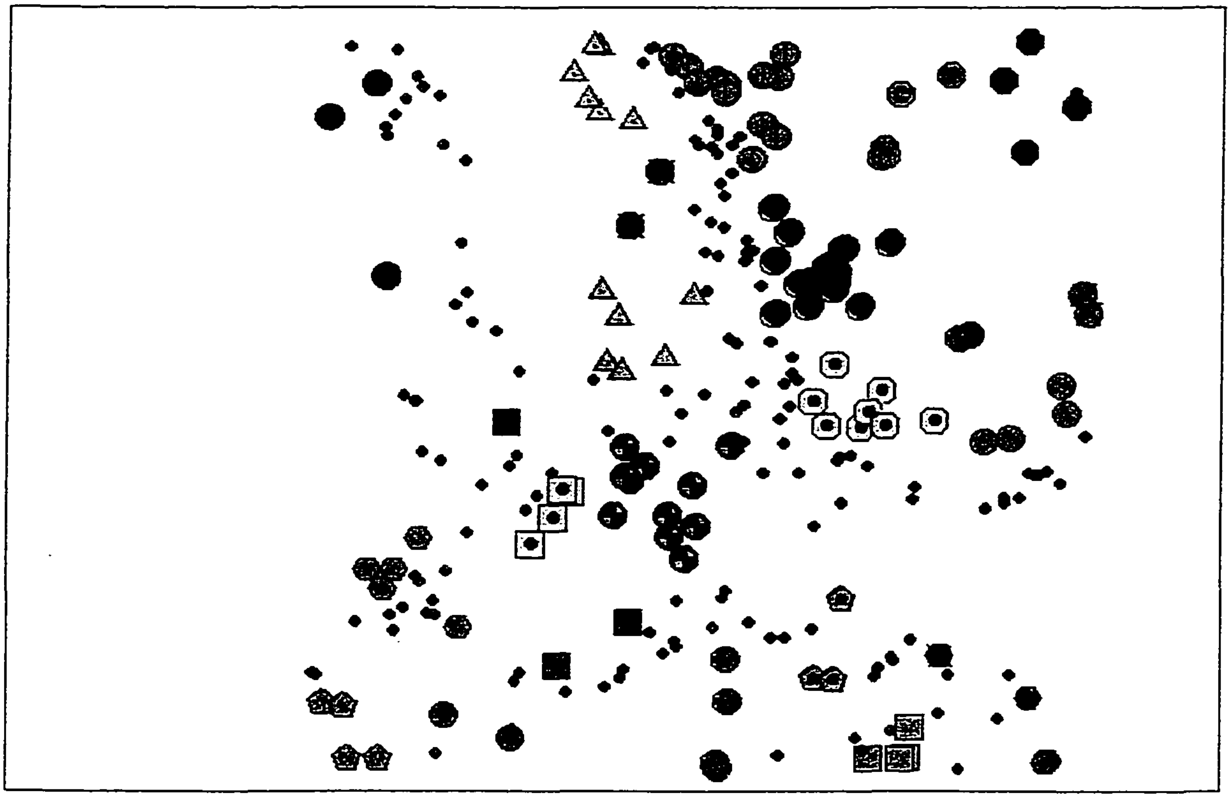

Figure 3.11 1:5000 map showing homesteads within one km of major rivers and settlement clusters. Small blue dots represent curvilinear homesteads within one kilometre of the Tweed and other major tributaries. Other symbols represent clusters of settlements.

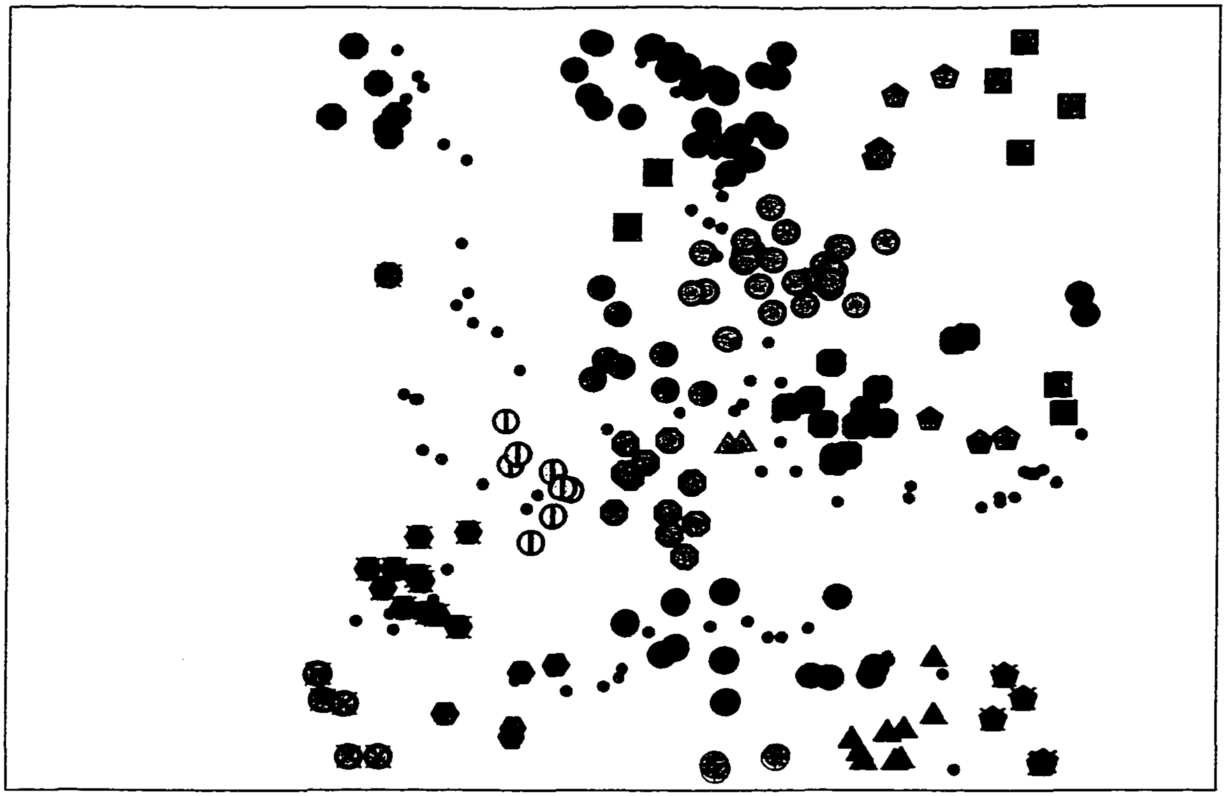

Figure 3.12 1:5000 map showing homesteads within 500 m of major rivers and settlement clusters. Small blue dots represent homesteads within 500 m of the Tweed and other major tributaries.

The reason for the difference in cluster results when settlements within 500 m or 1 km of major rivers are removed appears to be related to topography. Areas with relatively broad floodplains appear to have a more dispersed 'linear pattern' of settlements, and river areas with constricted floodplains (i.e. further up valleys) appear to have a more constricted 'linear pattern' of settlements. When membership of this linear settlement pattern is controlled it affects the number of sites available for cluster analysis, and thus the clustering pattern visible.

This use of cluster analysis and visual display of data in a GIS proved valuable in interpretation, and identified 2km^2 as one effective scale of analysis for the region. It should be stressed that these techniques were only used as exploratory methods, and do not 'prove' that the identified clusters were significant in the past. Interested readers can see the data and cluster assignments for homesteads in Appendix 2 (Tables A2.4 and A2.5).

4. Next the distribution of rectilinear homesteads was compared to the curvilinear homestead clusters. At first no pattern was really discernible (see Figure 3.13) though it did seem striking that some clusters had many rectilinear homesteads and others had none. At this stage I decided to revisit the settlement evidence for each of the rectilinear homesteads.

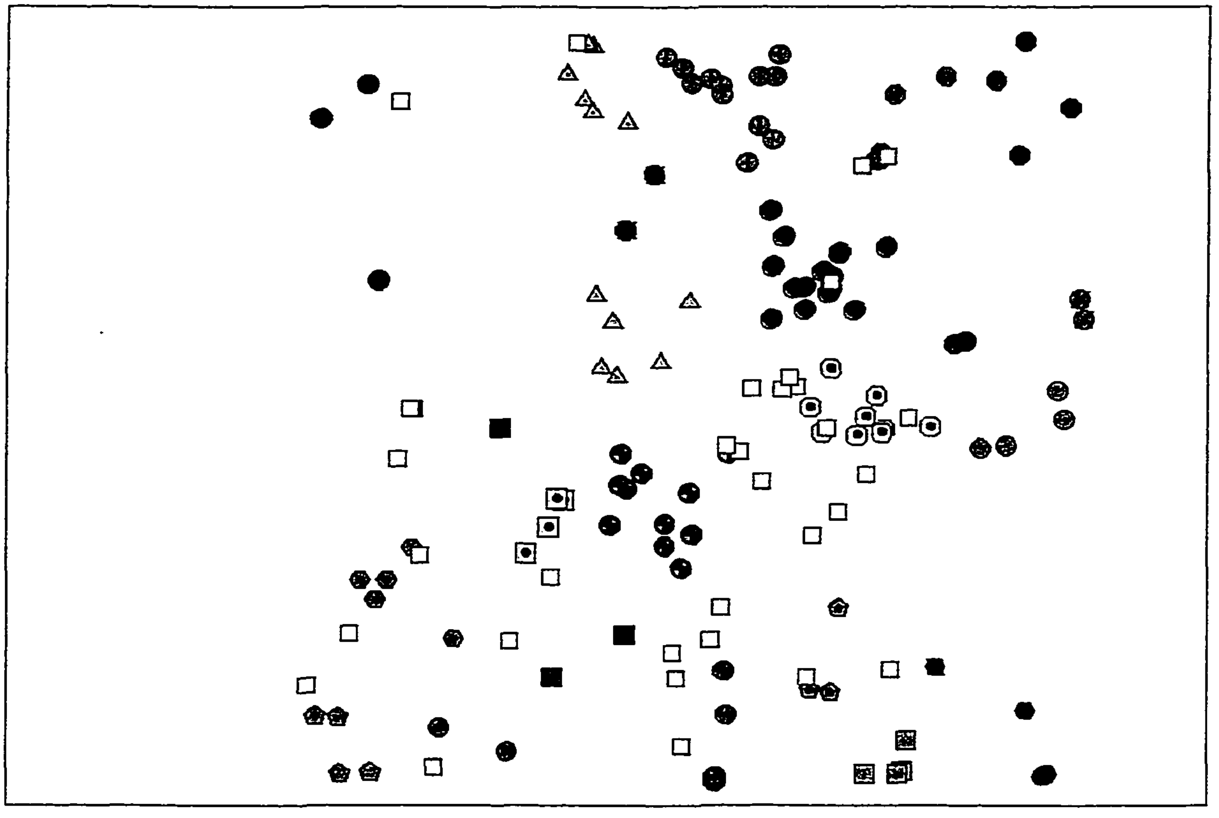

Figure 3.13 1:5000 map showing rectilinear homestead distribution and curvilinear homestead clusters. Rectilinear homesteads are shown as yellow squares.

As mentioned in section 1 above, 19 sites identified as rectilinear are likely to be curvilinear on the basis of close examination of aerial photographic evidence. When these homesteads were removed from analysis, a more interesting pattern of rectilinear homestead distribution appeared (see Figure 3.14).

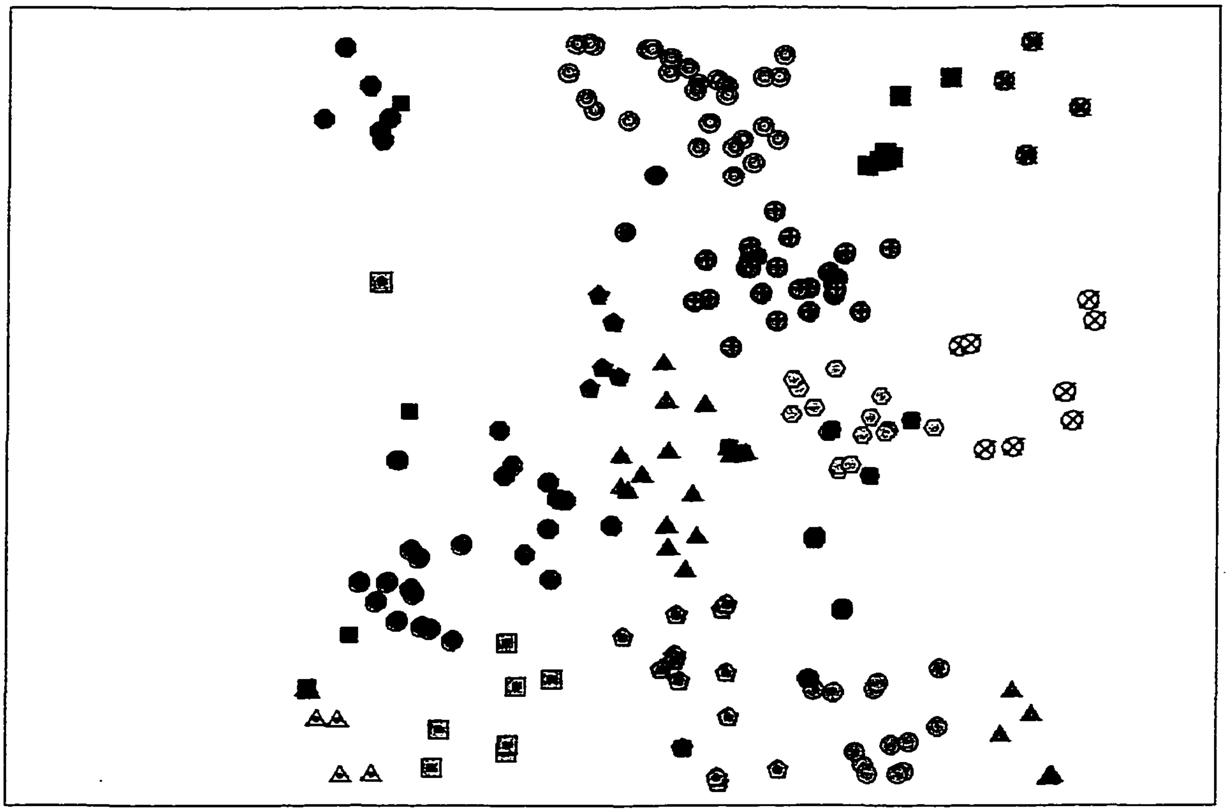

Figure 3.14 1:5000 map showing rectilinear homesteads with curvilinear homestead clusters. Black squares (and the one yellow square) represent rectilinear homesteads. The clusters are formed from curvilinear homesteads 500 km or more from a major river.

Clusters of curvilinear enclosures appear to be associated with no, or a very limited number, of rectilinear homesteads. Eight clusters have no rectilinear homesteads, six clusters have a single rectilinear homestead, one cluster has two rectilinear homesteads, and one cluster has three rectilinear homesteads.

5. Three field visits (see Table 3.9) were made to clusters identified through this settlement analysis. Though this was a very subjective way of trying to understand the outcome of the cluster analysis, it did seem that the character of each cluster was slightly different from others. This instilled a degree of confidence that the identified settlement patterns might in some way reflect information about past human behavior.

Table 3.9 Visit notes from clusters identified during analysis

Cluster Name	**Description**
Bemersyde Loch	14 curvilinear enclosures, one rectilinear enclosure, one hillfort, and one promontory fort (see Figure 3.15) lie within 2 km of the loch. Loch appears to serve as focus of settlement cluster.
Cauldshiels Loch	Curvilinear homesteads, no rectilinear homesteads, and numerous earthworks. Loch does not appear to serve as focus for settlement cluster.
Eildon Hills	More widely spaced than other clusters. Contains a great diversity of settlement classes including one hill fort, 12 curvilinear homesteads, rectilinear homesteads, two souterrains, a variety of standing stones, and the large Roman fort with annexs (see Figure 3.15).

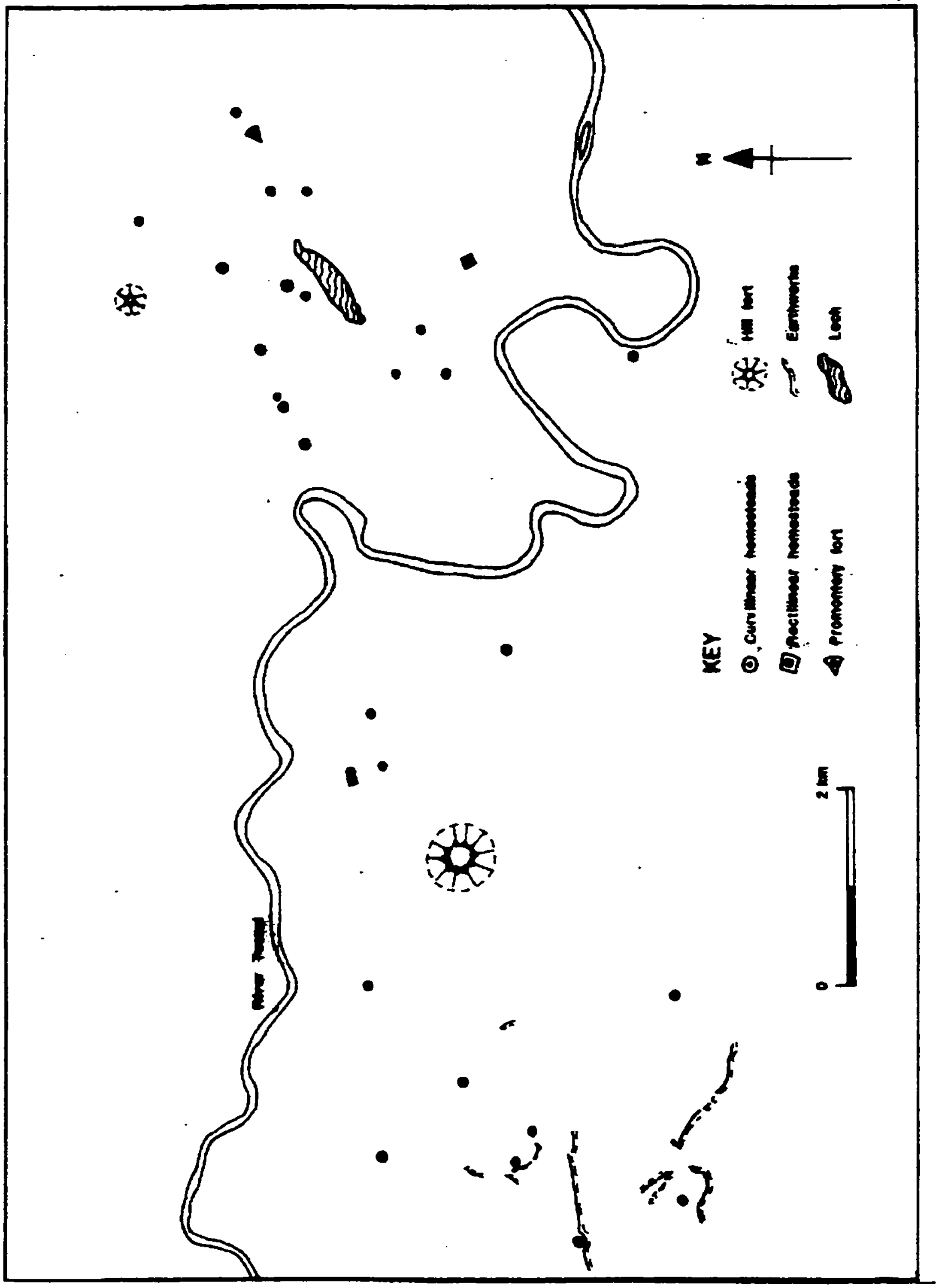

Figure 3.15 Illustration showing the character of clusters around Bemersyde Loch (north of the Tweed) and Eildon Hills (south of the Tweed).

6. In southeastern Scotland future settlement pattern analysis could be improved if native settlements were systematically categorized by approximate shape, landscape position, and size. The classification systems currently in use at the NMRS and elsewhere mixes and matches these 3 characteristics in an unsystematic way and as a result may occlude meaning.

In the future it would be interesting to explore further the relationship of settlement patterns to background landscape features at different scales. More work could also usefully be done to assess gaps in the distribution maps to check and control further for sampling bias (e.g. in aerial photography coverage).

Spatial statistics are being incorporated with every new release of GIS software designed to automate spatial analysis (Fotheringham and Rogerson 1994) and in this way are gradually spreading into archaeology. Unfortunately, however, the ArcView software I was licensed to use did not include any spatial statistics modules and no funding was available with which to purchase appropriate external software. Future analysis of autocorrelation and semivariance would be helpful, and may in fact be useful in identifying other effective scales for analysis.

3.5 Fieldwork

Homestead clusters emerged as an intriguing pattern in the settlement pattern analysis. The precise relationship of curvilinear and rectilinear homesteads within clusters was of particular interest, as was the general nature of rectilinear homesteads, so a program of fieldwork was undertaken in the region to explore these issues. Another goal of fieldwork was to continue trying to collect information about native and Roman interactions through recovery of stratified diagnostic artifacts. Accordingly, geophysical survey was undertaken at Oakendean House where two homesteads - one curvilinear and the other rectilinear -

overlap. Excavation was undertaken at the rectilinear homestead at Lilliesleaf, Hillhead North. Both geophysical survey and excavation were undertaken in the field north of the Roman fort at Newstead as this was the only area around the fort not explored by the Newstead Research Project.

3.5.1 Oakendean House

Aerial photograph cropmarks for Oakendean House (NT 563 338) show a number of enclosures and linear earthworks. The two features of central interest are two abutting double-ditched enclosures. The eastern enclosure is circular and the western enclosure is rectilinear, thus offering archaeologists one of the only opportunities to better understand the relationships of these settlement types in the Borders region of Scotland.

Two linear earthworks run north to south across the enclosures: the easternmost earthwork bisects the curvilinear enclosure and the westernmost earthwork passes just west of the rectilinear enclosure. The earthworks have been tentatively identified as earthworks associated with marching camps of the Roman fort at Trimontium (e.g. Maxwell 1989) but more recent work suggests that these ditches may be associated with field systems surrounding the fort itself (Clarke and Jones 1994).

In December 1995 a team directed by the author carried out geophysical survey at Oakendean House. Survey was undertaken to try and determine the relative stratigraphic position of the two homesteads, and to attempt to define areas where excavation might be most fruitful.

The fields at Oakendean House were only free of crops for a short window in late November and early December. Snowfall during the survey period limited the amount of ground that could be covered, and the few results that were obtained were poor (see Appendix 1). It would appear that this potentially important site has been severely damaged by modern ploughing, although more extensive geophysical survey during more favorable times of the year would be necessary to conclusively support this suggestion.

3.5.2 Newstead Fort: North Annex

In 1996 the area north of the fort was the least known of any part of the military complex. All information about this area of Newstead derived from James Curle's 1908 excavation. No detailed account of his trenches survives, but later excavations have shown that he generally excavated in narrow parallel trenches set 1.5 m to 3 m apart (Clarke and Jones 1996, Clarke 1997). In the field north of the fort Curle discovered a series of ditches that comprised the north defenses of the fort itself and eleven pits (Curle 1911). These pits included some of the deepest and most artifact-rich discovered within the complex (Curle 1911).

Unfortunately the majority of archaeological deposits likely to have been encountered in the north part of the site would have been difficult to recognize using Curle's trenching techniques. With the exception of one small building with a stone foundation near the fort's northwest corner (Curle 1911), no accompanying structures were discovered. Furthermore, in contrast to the three other extramural areas in which Curle excavated, no evidence for the line of the annex defenses was recovered.

Subsequent research has consistently overlooked the area to the north of the fort. Elsewhere fieldwalking by local amateurs and cropmarks from aerial photography provide a good indication of the layout of the site, but the field north of the fort lies under permanent pasture and is not as responsive to these techniques. Richmond excavated two trenches at Newstead in 1947, which revised the phasing of the fort's defenses, but added nothing to our understanding of the area to the north of the fort (Richmond 1950). More recently the Newstead Research Project, directed by Dr. R. F. J. Jones of Bradford University, recovered a substantial body of information about the character of the fort and its surrounding annexs (Jones 1989; Jones *et al.* 1990, 1991, 1992, 1993; Jones and Gillings 1987). However geophysical survey, though extensive over the complex as a whole, was never undertaken in the north field. Similarly, excavation outside the main body of the fort was confined to the east and south annexs (Clarke and Jones 1994, Jones *et al.* 1993).

In 1996 a team directed by the author, Simon Clarke, and Abigail Tebbs undertook fieldwork in the scheduled area north of the Roman fort at Newstead (NT 571 346). The objective of the field season was threefold. First, geophysical survey of the entire area north of the fort to define defensive lines and occupation areas. Second, limited excavation of potential features revealed by the geophysical survey in order to assess their character and date. Third, excavation in the depression northeast of the Roman fort to confirm the presence of an amphitheater. A detailed excavation and survey report is forthcoming (Clarke and Wise, in press), but a summary of key findings from the geophysical survey and excavation is provided here.

3.5.2.1 Geophysical Survey

In 1996 resistivity and magnetometry (David 1995) surveys were undertaken in the area north of Newstead fort. Resistance meters are particularly useful for detection of ditches and stone structures such as masonry foundations and road surfaces. Magnetometers are particularly useful for the identification of burnt features such as buildings destroyed by fire, industrial workings, kilns, or magnetized material associated with ditch or well fills. Previous work undertaken at Newstead suggested that all of these features were likely to be encountered in the field north of the fort.

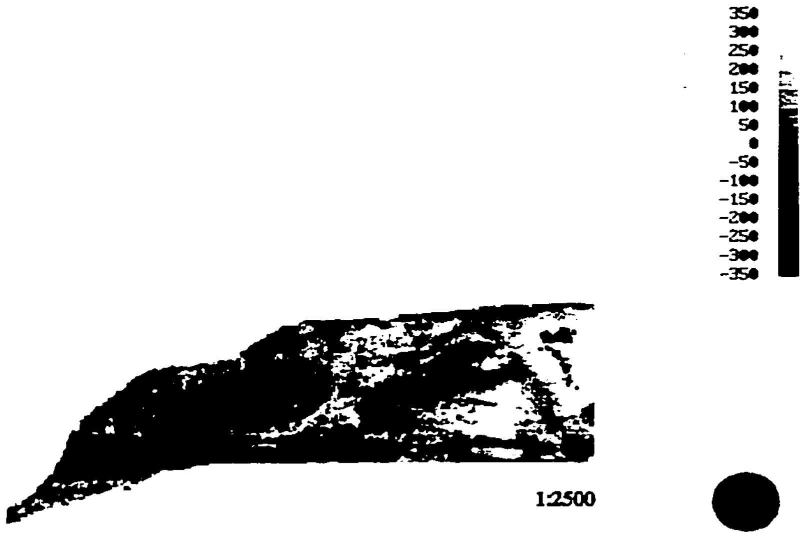

Figure 3.16 Resistivity data from 1996 Newstead field season

Resistivity survey (see Figure 3.16) was carried out using a Geoscan RM-15 resistance meter in twin probe configuration at a setting of 1 ohm. Sample spacing was 1 m, with transects recorded in a zig-zag pattern. In the north field, the resistivity survey produced fewer results than the magnetometer survey. This poor response was probably due to the overall dryness of the soil at the time of the survey. An additional factor in the north of the field was the depth of soil overlying archaeological features. Excavation at trench 6 (see Figure 3.16) indicated substantial soil creep downslope, burying features at the foot of the slope more deeply than can be detected using a resistance meter in 0.5 m spacing twin probe array. A wider probe array might have improved detection, but unfortunately the slope is too steep for safe use of such equipment.

Interpretation of a variety of data printouts and images derived from the resistivity survey resulted in identification of only the largest ditch features associated with the fort and west annex (see Figure 3.16, Figure 3.17, and Table 3.10). In one sense, features A to I provide little new information as they are only a very partial plan of the north defenses of the fort. On the other hand they do correspond accurately with earlier excavations (Curle 1911) making it very likely that fort plans are reliable, and not simply a schematic interpretation

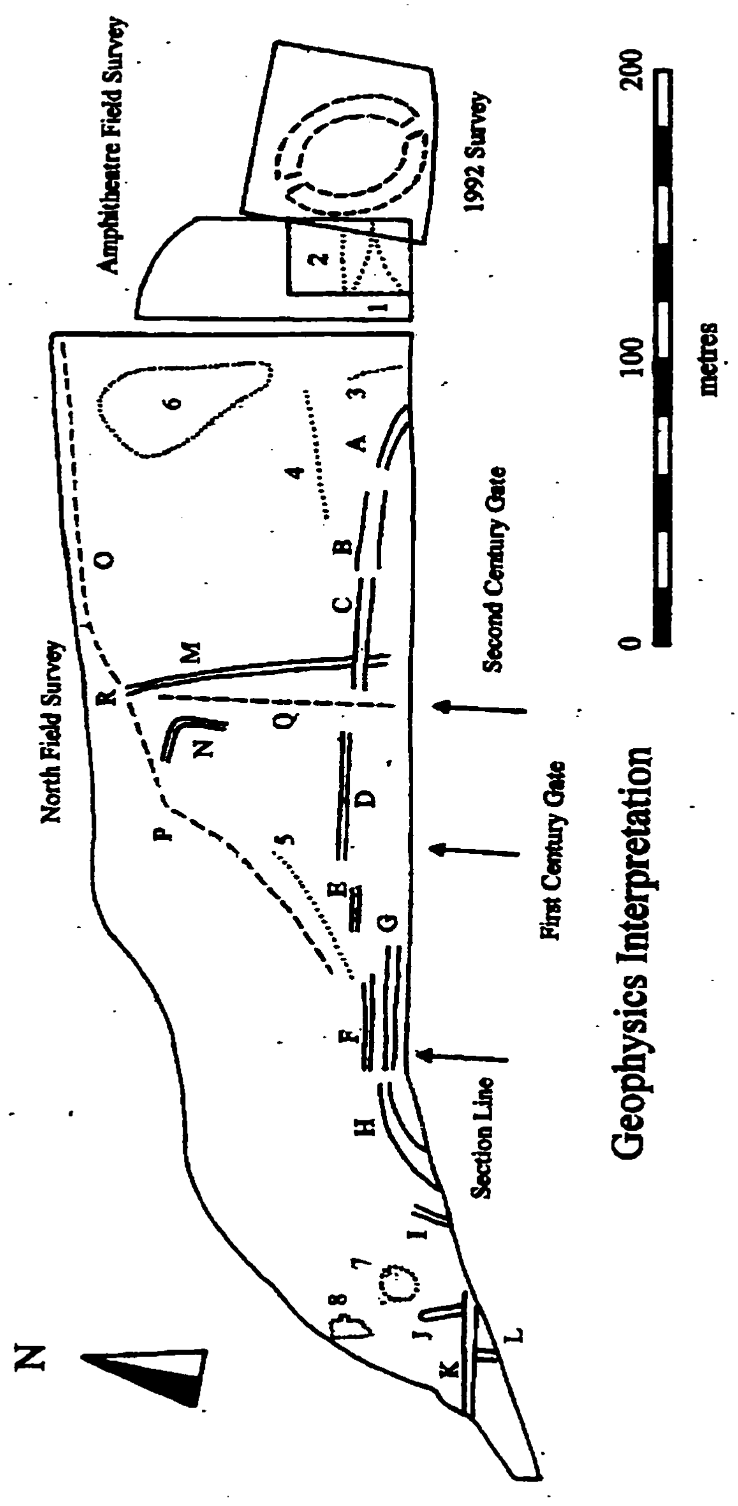

Figure 3.17 Interpretation of geophysics data from 1996 survey at Newstead (drawn by Simon Clarke).

Table 3.10 Features identified during the 1996 geophysical survey north of Newstead fort (see Figure 3.17)

Feature	Technique	Interpretation
A	Resistivity	Outer ditch at the fort's northeast corner, second century
B	Magnetometry and Resistivity	Fort's outer ditch, second century
C	Magnetometry	Fort's outer ditch, second century
D	Magnetometry and Resistivity	Fort's outer ditch, second century
E	Magnetometry	Fort's outer ditch?, second century
F	Resistivity	Fort's middle ditch, second century
G	Resistivity	Fort's narrow inner ditch, second century, but overlying first century ditch
H	Resistivity	Wide inner ditch at the fort's northwest corner, first century
I	Resistivity	Outer ditch at the fort's northwest corner, second century
J	Resistivity	North-south ditch, part of west annex defenses, first century?
K	Magnetometry and Resistivity	East-west ditch, part of west annex defenses, second century?
L	Resistivity	North-south ditch, an extension to the ditch that cuts the mansio foundations (Curle 1911).
M	Magnetometry	North-south ditch, probably first century north annex defenses.
N	Magnetometry	Minor ditch, north and east sides of a small enclosure
O	Magnetometry	Possible east-west track indicated by topography and ribbon of archaeological features
P	Magnetometry	Possible northeast to southwest track indicated by a series of short lengths of ditch, either side of a possible road
Q	Magnetometer	North-south road line through break in second century defenses associated with intensive industrial or domestic occupation.
R	Magnetometry	Ditch terminus?, possible entrance to the north annex
1	Resistivity	Area of animal trampling by modern field gate.
2-5	Resistivity	Animal tracks
6	Resistivity	Poor probe contacts due to geology / dryness
7	Magnetometry	Electricity pylon / transformer
8	Unsurveyed	Area overgrown with nettles

based on excavation in other parts of the complex. The other features detected by resistivity J, K and L are entirely new discoveries relating to the west annex.

Magnetometry survey was carried out using a Geoscan FM-18 fluxgate gradiometer with a setting of 0.1 nT. Sampling was carried out in parallel transects running south to north. The survey was more successful than the resistance survey. As well as the fort's defenses the magnetometer detected the line of defense around a previously unknown north annex and evidence for settlement occupation north of the fort (see Figures 3.17 and 3.18).

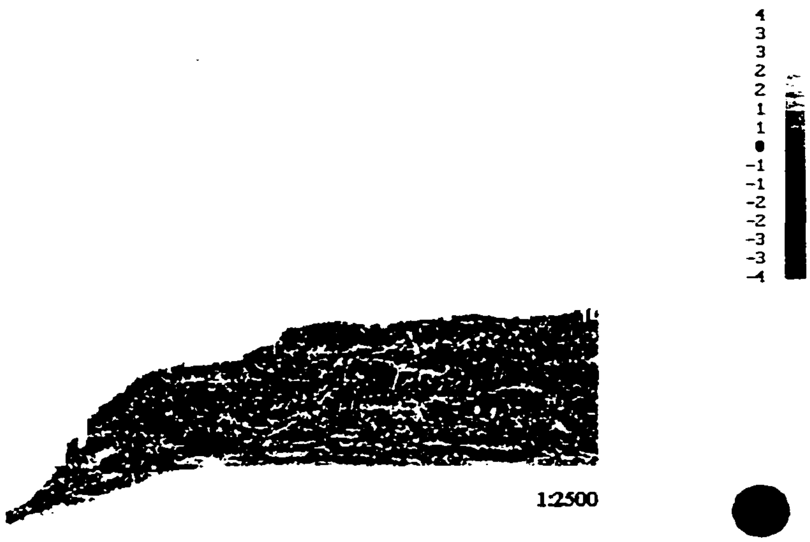

Figure 3.18 Magnetometry data from 1996 Newstead field season

In the field north of the fort the magnetometer provided extensive evidence for settlement. Features B, C, D and E are parts of the outermost ditch of the second century fort defenses. The fact that they show up in the gradiometer survey, in contrast to the other fort ditches, suggests they may contain cultural debris and this in turn suggests proximity to occupation areas. Note that the west annex defenses visible in the magnetometer data (the eastern part of feature K) were adjacent to the bathhouse and burnt debris from the bathhouse probably fill the ditches and produce the strong magnetic signals. Feature M represents the eastern defenses of the north annex. The anomaly is not particularly prominent on this plot because a de-striping program has been run. However, on some plots the line of the ditch can be seen to extend almost to the field edge, and to be overlain by feature C. Feature N, though visible as a strong anomaly, proved in excavation to be a much smaller ditch, perhaps defining a building or animal enclosure (see below).

There were so many other minor features visible on the gradiometer plots (see Figure 3.18) that it is necessary to interpret the general character of clusters of anomalies. The most subtle cluster of anomalies is feature O, which perhaps represents occupation adjacent to the line of a road. Closely associated with this are a group of features aligned roughly southwest to northeast which suggest another road line running from the fort's northwest corner to a possible gap in the north annex defenses (feature R). Feature Q represents a strip of intense magnetic activity, probably occupation debris, extending along the projected line of the second century main road.

In spite of the poor response with the resistivity survey over the majority of the field the geophysical survey clearly benefited from the use of both techniques. As expected, both the magnetometer and resistivity surveys revealed evidence of the fort's northern defensive ditches. These had already been identified, however geophysics confirmed the reliability of Curle's plans and substantiated Richmond's conclusion that the outermost ditches related to the second century defensive system (Richmond 1950).

More importantly, two previously unknown defensive works were clearly identified in the 1996 geophysical survey. In the extreme west of the survey area resistivity showed a single east-west ditch running from the northwest corner of the fort's outer ditches to the field edge. This probably represents the northern boundary of the west annex. A north-south ditch (feature L), known from excavation immediately to the south (Curle 1911), is also visible and meets the first ditch at right angles. Cut through the first century "mansio" foundations, the ditch represents a reduction in the area enclosed within the west annex, probably in the later second century.

The other newly discovered defensive feature was a wide north-south ditch running from just east of the second century fort's north gate to the edge of the scarp above the River Tweed. It appears to represent the western defenses of a previously unknown north annex, bounded on the north and east by the natural scarp slope and to the south by the fort and west annex. Though not clear from Figure 3.18 this feature appears to underlie a second century fort ditch suggesting a first century date for the annex.

The final evidence provided by geophysics is for minor ditches and general occupation noise located in a broad band either side of the projected line of the road leaving the fort's more easterly north gate. As the gate was dated to the second century it seems probable that the detected occupation was of a similar date. Comparable geophysics evidence from the south annex was found on excavation to have been associated with small timber strip buildings in which people engaged in a range of domestic and industrial activities (Jones 1989, Jones *et al.* 1993, Clarke 1995).

3.5.2.2 Excavation

The relationship of the north annex boundary ditch to the spread of occupation activity was of central importance during excavation north of the fort. For this reason a trench was excavated across the ditch line (trench 5), while two additional trenches examined areas just to the west (trench 7) and just to the east (trench 6), i.e. just inside and just outside of the enclosed area (see Figure 3.19). A final small trench, placed to explore one anomaly on the geophysical survey (trench 8), proved that the geophysical anomaly in question was caused by underlying geology.

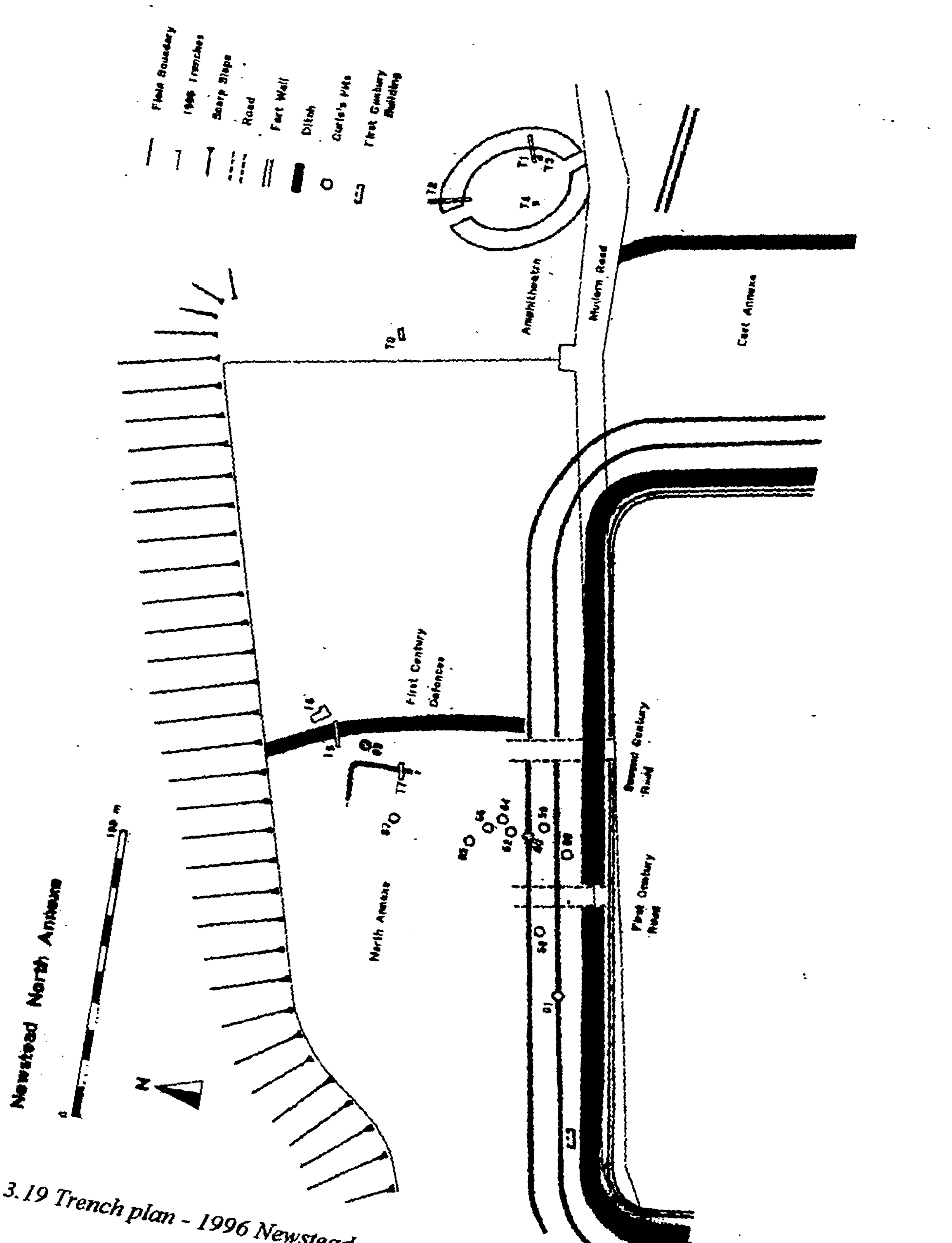

Figure 3.19 Trench plan - 1996 Newstead excavation (drawn by Simon Clarke)

The north annex defenses consisted of a wide, relatively shallow ditch fronting a rampart constructed from up-cast material. The ditch was just over 4.5 m wide and 1.2 m deep. The accumulation of a substantial overburden (up to 0.5 m) allowed the survival of unusually good evidence for the rampart. This was fronted by a timber retaining wall or palisade, behind which a substantial dump of silty sand had been deposited. The full width of the rampart was not exposed.

The date of use for the north annex defenses is somewhat problematic. The rampart, which would have produced the clearest dating for the defense construction, produced no datable finds. The lower fill of the ditch was virtually sterile, in marked contrast with the upper fill, which was extremely rich in finds. Evidently the palisade was deliberately dismantled, and its timbers burnt and rampart cast down, while the ditch was in a relatively clean condition. At least one sherd of pottery from the lower ditch fill was of second century date, but this may have originated in the upper fill as the whole area has been extensively burrowed by rabbits, and the dating of this feature is therefore somewhat insecure. A probable date can be put forward on the strength of three pieces of evidence. First, geophysics evidence from further south suggests that the ditch was overlain by the outer most (i.e. second century) ditches of the fort itself. Second, occupation appears to have spread over the defensive line, implying that it had gone out of use, at least by the later second century. Finally, the design of the north annex defenses, consisting of a single large ditch, most closely resembles Newstead defenses of the first century date especially those surrounding the first century fort, the inner south annex, and the inner east annex. However, a construction date in the early part of the second century occupation remains possible. Certainly the line of the north annex ditch survived for some time during the second century, as a shallow linear depression accumulating debris.

Trench 7 examined an area just inside the north annex defenses and was intended to provide evidence for the character of contemporary occupation. The 1 x 5 m trench was positioned to section a strong linear feature known from magnetometer survey to run north and south for at least 20 m before swinging sharply to the west. This proved to be a v-shaped ditch, 2 m wide and 1.1 m deep, cut into underlying boulder clay. No occupation deposits survived outside the ditch, modern ploughing presumably having truncated the archaeological sequence. The ditch itself was dated to the second century by its fill. Although some residual first century material was present, it seems likely that most of the magnetic noise identified by geophysics in the north annex enclosure (particularly feature Q) relates to second century occupation. First century enclosed settlement must have existed to have required the construction of pits 59 to 67 (Curle 1911, Clarke 1997), but its character cannot be ascertained from the 1996 evidence.

Just to the east of the north annex defenses, in the irregular 4 x 6 m excavation area of Trench 6, evidence for a complex structural sequence was recovered. Artifacts recovered from the structures suggest a second century occupation, therefore this settlement appears to be extra-mural, post-dating the north annex defenses. The earliest building event was the construction of a flat terrace cut into the hillside to create a building platform. The most southerly part of the platform was occupied by a shallow east-west gully at least 3 m long, 100 mm deep and 0.75 m wide, which probably acted as an eves drip. The full extent of the platform was not exposed. Relatively little can be stated with confidence about the building which occupied it. However the short length of eves drip is enough to suggest a rectilinear form, post-holes indicate a timber superstructure, while the absence of tile implies a thatch or shingle roof. A second building platform, located immediately uphill (to the south), was probably contemporary. A single post-hole provides the only evidence for the occupying structure. Judging by the level of debris which accumulated over the terraces, the buildings may well have been abandoned for some time before the second major structural event. This was the construction of a post-in-trench fence-line or wall, running down the slope (north-south). Immediately to the west and parallel to this ran a shallow ditch or gully.

3.5.2.3 Conclusions

Considering the extremely limited size of the trenches in the north annex field, an impressive finds collection was recovered including 613 sherds of pre-modern pottery. Excavation in 1996 within the defended area of the north annex uncovered only a few sherds of first century pottery. Although first century ceramics were present these would appear to represent residual material that tell us very little about the character of occupation within the first century north annex. Nevertheless the area included a series of deep shafts, probably wells, noted by Curle in 1908 (Curle 1911). The absence of resistivity anomalies in this area suggests that any buildings were made of wood rather than stone. The absence of magnetic noise implies that domestic and industrial debris were not allowed to accumulate. This is in marked contrast with occupation in the fort itself and the second century south annex. First century occupation in the south annex and second century occupation in the east annex, both of which seem to have been "clean" settlement environments, may provide close parallels to the north annex.

The assemblage was dominated by forms and fabrics from the second century. The character of the assemblage was therefore primarily the product of second century occupation of the area. 10.4% of the ceramic assemblage was samian ware. Roman glass, mostly from simple vessels, was present in significant quantities (9 sherds). There was also a single fragment from a window pane. Iron work was also relatively plentiful (113 objects), mainly of nails, but also including personal items such as a buckle and tools such as a mason's chisel and a leather worker's awl. Fragments of bronze (7 pieces) were also fairly common for the size of the assemblage. Too much should not be read into the discovery of a single silver coin, but the over all impression is of a relatively rich artifact assemblage. Animal bone, charcoal and coal were also quite common.

More can be said about the second century occupation, which supplied the bulk of the finds collections and some structural evidence. Because of the small scale of excavation the assemblage is relatively small and therefore should not be over-interpreted. Nevertheless some general comments can be made. First, finds were very plentiful and it must be inferred that this was an environment in which debris, including animal bone, was not systematically removed. The relatively low proportion of the 613 sherds of pottery made up by samian (just 10.4%) suggests a community of modest means, though the glass and metalwork suggests wealth. The overall impression is of a civilian community, similar to that encountered in the South Annex in 1989 and 1993, heavily engaged in industrial activities and trade (Clarke 1995).

The evidence for relatively dense second century settlement in this steep-sloping and north-facing area suggests some strong imperative for settling on this side of the fort. A possible explanation for this dense northern settlement is that there was a lack of space in other areas of the fort during the second century, though excavations in the south annex suggest that this area at least was not fully occupied. A better explanation for the dense northern settlement is likely linked to proximity to the road leading north from the fort toward the, still undiscovered, location of a bridge or ford across the Tweed.

The 1996 discoveries at Newstead are useful additions to our understanding of one of Scotland's most important Roman period sites. They prove that, during its first century occupation, all of Newstead's extramural settlements were defended. In the second century, in contrast, settlement in the field north of the fort appears to have been open. It is likely that some of these annexs functioned to protect settlements possibly civilian in character. However the open nature of the north field sets it apart from the other communities outside Newstead fort and invites the suggestion that it had legally independent vicus status. The population appears to have adopted Roman construction techniques and lifestyle not accepted in settlements away from the fort itself.

3.5.3 Lilliesleaf

In 1998 a team directed by the author and Simon Clarke excavated a rectilinear homestead at Lilliesleaf (NT 543 255). The enclosure had been recognized for some time from cropmarks. In the 1980s and early 1990s fieldwalking and metal detecting at and around the site also provided a steady stream of Roman period material and this raised the profile of the site enough for it to be included in the Newstead Project's program of geophysical investigation. In 1993 both resistivity and magnetometer survey were undertaken at the site, the latter providing more useful results. Preliminary data plots (see Figure 3.20) indicated that the enclosure was sub-rectangular, approximately 65m by 70m, with two opposing entrances, aligned east-west. Faint positive anomalies in the northern half of the enclosure also suggested the presence of two ring ditches with diameters in the region of 15m (Jones *et al.* 1993, see Appendix 1). Excavation in 1998 was designed to investigate one of these interior anomalies and a part of the enclosure ditch, to assess the character of occupation and confirm that the site was indeed comparable in date to Newstead Roman Fort just 10 km to the north.

Figure 3.20 Magnetometer survey of Lilliesleaf

A detailed excavation report for this site is in preparation (Clarke and Wise, forthcoming) and post-excavation analysis is continuing, but key preliminary findings are summarized below.

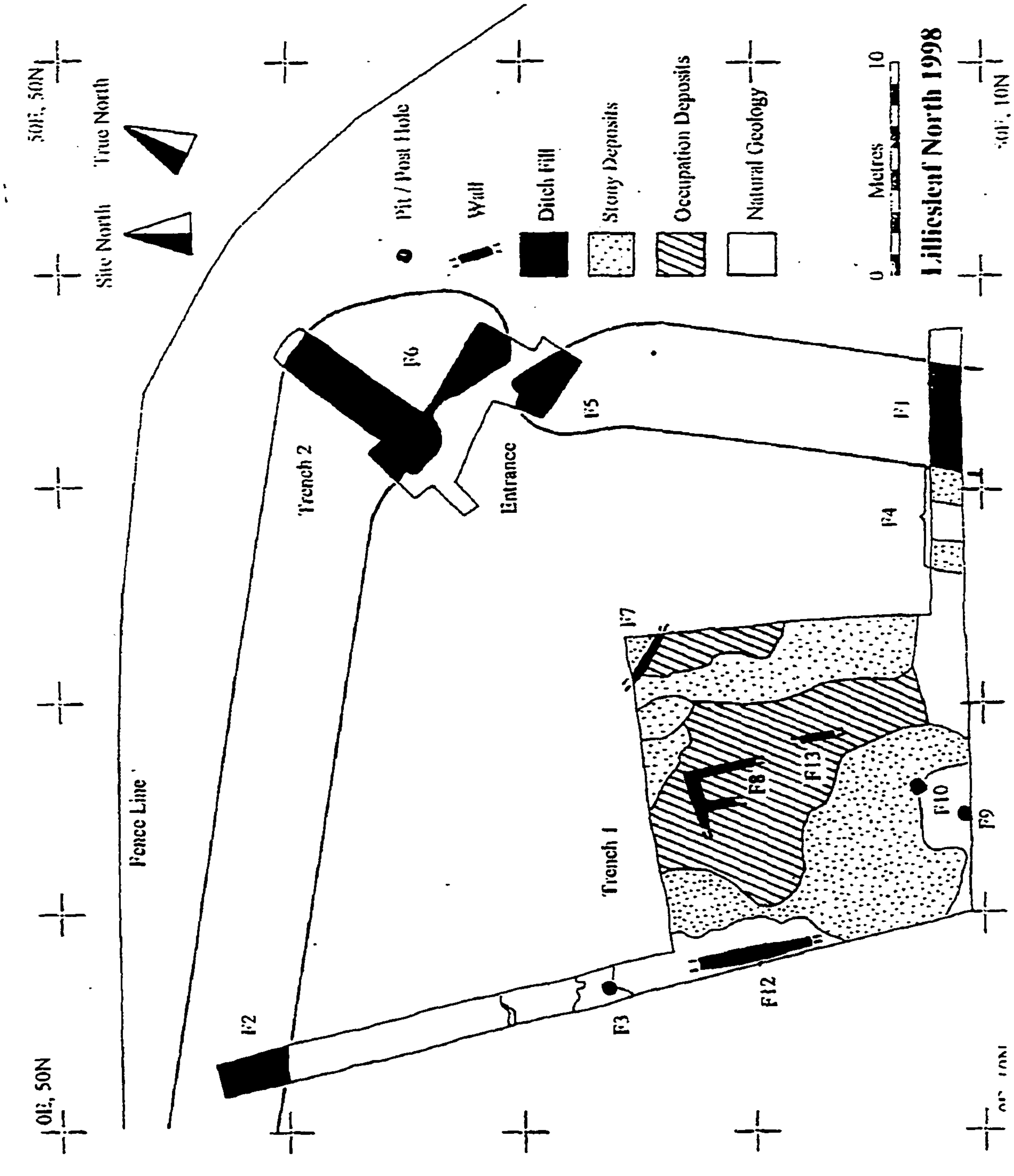

Figure 3.21 Trench plan for 1998 Lilliesleaf excavation (drawn by Simon Clarke).

3.5.3.1 The Excavation Area

Because the site was under cereal crop, the 1998 investigation had to be confined to the quarter of the settlement enclosure closest to the field corner (see Figure 3.21). The main excavation area, a machine stripped trench 14 m x 16 m, centered on the more easterly (and less convincing) of the two possible ring ditches identified through geophysics. Two 1.5m wide extensions projected from this area to intercept the enclosure perimeter. A second rather irregular L-shaped trench, 11m by 9m, was stripped by hand at the enclosure's northeast corner.

3.5.3.2 The Enclosure Ditches

On the eastern side the enclosure ditch (F1) proved to be just under 5 m across and 1.25 m deep (to the bottom of the plough soil, which was .3 m deep at that point). The ditch was cut into a natural geology of silt, containing occasional boulders and was a shallow U-shape in profile. Just inside the ditch were two thin spreads of rubble, which may represent all that remains of a rampart (F4). They suggest a bank 4.5 m across at its base, possibly with an earth or turf core, but with no berm to separate it from the ditch and no trace of palisade or retaining framework. Elsewhere a solid geology of siltstone was encountered immediately below the plough soil. This would have presented a formidable disincentive to ditch construction and appears to have resulted in an enclosure ditch of more modest proportions. The partial section of the north ditch (F2) suggested that the ditch's full width was started, but then abandoned in favor of a more shallow scoop. Within this scoop the ditch proper was probably only 3.5 m wide and 1.1 m deep, with a V-shaped profile.

Excavation in Trench 2, at the enclosure's northeast corner, was intended mainly to sample the ditch fills in order to investigate the possibility of differential deposition of cultural material. An unexpected bonus was the discovery of a break in the ditch's circuit, just south of the corner. As the ridge between the two sections of ditch (F5 and F6) was formed in part by soft silt geology it is assumed that this was a deliberate feature intended to act as a pathway in and out of the site.

Each portion of the enclosing ditch had different fills. At the enclosure corner (F6) strata consisted entirely of natural silting with virtually no cultural material and little to distinguish the ditch fill from natural geology. Five meters to the southeast, the ditch terminus (F5) south of the newly discovered postern gate was filled with a dark charcoal rich layer. It was possible to excavate only a small part of this, but it yielded significant quantities of animal bone, metal working slag and a large rim fragment from a gray ware jar. This differential deposition may imply that "rubbish" in the ditch terminus was part of some sort of structured deposition. While ritual or symbolic activity is quite likely in such a location it cannot be regarded as proven on the strength of present evidence, and we await post-excavation analysis of the material from this context. Both the other ditch sections also contained significant quantities of animal bone. F1 also produced a large part of a thick walled, hand-made, native jar.

It is worth noting that the density of cultural material seems to have increased markedly in the later ditch deposits. All the demonstrably Roman material comes from relatively late in the stratigraphic sequence. During most of the Roman period the ditch may therefore have been no more than a relic feature, the settlement no longer effectively enclosed.

3.5.3.3 The Settlement Interior

The settlement's interior turned out to be more complicated than anticipated. The main trench was intended to investigate a possible roundhouse suspected from geophysical evidence. From experience elsewhere in the Borders we had expected to find a ring ditch for post-in-trench construction or a hut platform made of packed earth or a cobble spread.

Instead the positive magnetic anomaly originated from a saucer-shaped depression up to 1m in depth, overlain by a sequence of occupation deposits and rough gravel surfaces.

The depression itself seems to have been created by the cutting of a building platform into the hillside (F11). This platform or terrace could only be partially investigated in the three weeks available. Its full extent was not exposed, and the nature of the building or buildings for which it was constructed was not identified. Even the shape of that building was uncertain, although given the shape of the overlying occupation deposits a curvilinear form must be strongly suspected.

The uppermost building sequences, however, were rectilinear in form. In the northeast corner of the trench a .5 m high dry stone wall seems to have formed the edge of a rubble platform (F7). Only 3 m of this structure was exposed, but it appears to represent the footings of a rectilinear building set into the corner of the enclosure's rampart. The stone wall (context 37) tapered from .5 m wide at its base to just .2 m at its top, suggesting that the building's superstructure may have been a timber frame resting on a sill beam. Overlying the early hut platform (F11) were dark, organic rich layers separated by a rough spread of cobbling (F14). These contained a bronze brooch, iron nails, Roman pottery and glass vessel fragments, fuel ash slag and animal bone. Cutting these deposits were a series of rectilinear features, probably representing several buildings. Features 8, 12 and 13 represent discontinuous lengths of post-in-trench walls (not necessarily from one building), aligned northwest to southeast. Iron nails, though far less common than at Newstead (see Clarke 1995), suggest changes in construction technique as well as building shape. Several isolated post-pits were also recorded (features 3, 9 and 10). These have no stratigraphic relationship to other features or datable finds, so cannot be assigned to a phase.

3.5.3.4 Faunal Remains

The faunal assemblage from Lilliesleaf was highly fragmented and much of it could not be identified to element or species. Poor preservation has also been noted at other sites in the region including Eildon Hill North (McCormick 1992) and Dryburn Bridge (Triscott 1982), and acidic soil is probably responsible. The enclosure at Broxmouth, located in an area of higher soil pH to the northeast of the study region, produced a large assemblage in good condition with over 15,000 identifiable bone fragments (Barnetson 1982).

Only 95 bones from Lilliesleaf could be identified to element and species or size category. The presence of many single teeth and tooth fragments suggest that the jaws may have been destroyed leaving only the more resistant teeth. Differential fragmentation of bones from various species probably affects their representation in the assemblage. For this reason the minimum number of elements (MNE) and the number of identifiable specimens (NISP) were calculated to provide an estimate of species representation not affected by fragmentation (see Table 3.11).

Table 3.11 NISP and MNE values for the identified bones from Lilliesleaf North.

	NISP		MNE	
Species	**Number**	**Percent**	**Number**	**Percent**
Cattle	57	60.0%	27	48.2%
Equid	7	7.4%	3	5.4%
Large Herbivore	17	17.9%	16	28.6%
Caprine	6	6.3%	3	5.4%
Sheep	1	1.1%	1	1.9%
Medium Herbivore	3	3.2%	3	5.4%
Pig	2	2.1%	1	1.9%
Roe Deer	2	2.1%	2	3.6%
Total	95		56	

Although the sample size is small, cattle appear to have been the most important animal in the economy of Lilliesleaf and the representation of species is similar to the faunal assemblages from Broxmouth (Barnetson 1982), Dryburn Bridge (Triscott 1982), and Edinburgh Castle (Driscoll and Yeoman 1997).

It has been suggested that the equids at Dryburn Bridge could have been either horse or pony (Triscott 1982). The equid remains from Lilliesleaf consisted mainly of fragmented teeth, but the presence of a small second phalanx could indicate that ponies were among the animals kept.

Although the sample size is too small to study the body part representation and age of death of cattle in detail, cattle seem to be represented by the whole skeleton. The only evidence for butchery practices comes from cut marks on the posterior side of a horse or cow mandible and a chop mark on a scapula also from a large herbivore. The limited data available on epipyseal fusion (see Table 3.12) suggests that a least a significant proportion of the cattle were slaughtered at approximately the time when they where reaching the end of their growth. This suggests that these animals were kept as a source of meat rather than primarily providing traction or milk, although it is possible that the bones of animals kept for meat were more likely to become incorporated into the domestic refuse.

Table 3.12 Epipyseal fusion of cattle bones from Lilliesleaf.

Fusion Age	Number Unfused	Number Fused	Indeterminate	Percent Unfused
Total <7-10 months	0	2	3	0%
Total <12-18 months	0	3	1	0%
Total <24-36 months	0	1	1	0%
Total <36-48 months	3	0	4	100%

3.5.4 Conclusions

Lilliesleaf is a single ditched rectilinear enclosure. On the eastern side it is enclosed by a u-shaped ditch just under 5 m across and 1.25 m deep. Just inside the ditch were two thin spreads of rubble, which may represent all that remains of a rampart. This suggests a bank 4.5m across at its base, with no berm to separate it from the ditch and no trace of palisade or retaining framework. On the northern side the site is enclosed by a v-shaped ditch 3.5 m wide and 1.1 m deep cut into solid siltstone geology.

At the enclosure's northeast corner there is a break in the ditch's circuit, just south of the corner. As the ridge between the two sections of ditch was formed in part by soft silt geology it is assumed that this was a deliberate feature intended to act as a pathway in and out of the site.

Each section of the ditch had different fills. At the enclosure corner strata consisted entirely of natural silting with virtually no cultural material and little to distinguish the ditch fill from natural geology. Five meters to the southeast, the ditch was filled with a dark charcoal rich layer yielding significant quantities of animal bone, slag and pottery. Both the other ditch sections also contained significant quantities of animal bone and some pottery (including one large piece of native pottery).

The settlement's interior was more complicated than anticipated. A positive magnetic anomaly known from geophysics turned out to have originated from a saucer-shaped depression, overlain by a sequence of occupation deposits and rough metalled surfaces, up to 1m in depth. The depression itself seems to have been created by the cutting of a building platform into the hillside. Overlying the early platform were dark, organic rich layers separated by a rough spread of cobbling. These contained a bronze brooch, iron nails, Roman period pottery and glass vessel fragments, fuel ash slag and animal bone. Cutting these deposits were a series of rectilinear features, probably representing several buildings.

Preliminary analysis of evidence suggests that at Hillhead, Lilliesleaf the enclosure ditches were already filling with debris by the Roman period. Although it is not possible to suggest accurate dates for initial occupation and subsequent abandonment at Lilliesleaf it is now clear that at least part of the occupation period was contemporary with the Roman Fort at Newstead. The style of discard at Lilliesleaf differed significantly from curvilinear enclosures in the region in that large quantities of cultural material was recovered from both the enclosure ditches and the settlement interior (Wise, 2000). This relative wealth of artifacts and ecofacts is more closely comparable to deposits at the lowland brochs (Macinnes 1984a) and the extramural occupation outside Newstead Fort (Jones *et al.* 1991, 1992, 1993) although small quantities of Roman period material were associated with traces of rectilinear structures at the curvilinear enclosure at Bemersyde Hill (Jones *et al.* 1990).

3.6 Key Fieldwork Results

1. Fieldwork undertaken for dissertation research unfortunately revealed nothing about the relationship of curvilinear and rectilinear homesteads in the study region. This is because the Oakendean House geophysical survey results were poor, largely because the site was only available for survey in December when the frozen ground was not conducive to geophysical techniques. In future if Oakendean House became available earlier in the year it would be well worth surveying again as the overlapping curvilinear and rectilinear cropmarks are compelling.

2. Much greater success can be claimed in elucidating the nature of rectilinear homesteads in the study region. The excavation at Lilliesleaf was extremely successful, and produced a great deal of interesting information. Key results include:

- Recovery of a relatively large assemblage of native and roman objects suggesting that assemblages at rectilinear homesteads may have more in common with the assemblages at brochs than they do with the assemblages at curvilinear homesteads.

- The single rectilinear ditch at Lilliesleaf appears to have been slighted before the availability of Roman objects and this process continued through the Roman period. This strongly supports the idea that the ditches do not primarily function as defensive features for the protection of homestead inhabitants, and instead have a symbolic or ritual function.

- Both curvilinear and rectilinear structures were found during excavation of the interior of the Lilliesleaf rectilinear homestead.

3. Geophysical survey and excavation north of Newstead fort show that:

- North of Newstead fort in the 1st century was a defended north annex. Just west of this annex were a series of wells perhaps associated with timber structures but not associated with many metal objects or burnt features.

- By the second century there was relatively dense occupation of even the steepest slopes north of the fort. These settlements were occupied by people, possibly civilians, with access to Roman glass, iron, bronze, tools, coins, and samian pottery.

3.7 Conclusion

The results presented in the above sections on geophysics, settlement pattern analysis, and excavation contribute to a better understanding of the region in prehistory. They create a picture of settlements re-shaped and re-structured over time, patterned in groups and along waterways, with differential access to Roman objects. In the process of gathering this information, interpreted further in the next chapter, contributions have been made to the methodology of geophysics and settlement pattern analysis. Noteworthy in this respect are the iterative interpretation of geophysics data displays, and the coupling of cluster analysis and exploratory visualisation in a GIS.

IV. DISCUSSION

Analyzing sites known through such diverse methods as excavation, surface survey, geophysical survey, and aerial reconnaissance leads both to an enormous quantity of data and different sample sizes at varying scales. Eight sites in the study region have been excavated, 41 have been geophysically surveyed, and hundreds are known through aerial photography. The interpreter's challenge is to weave together a coherent narrative about the people who formerly lived in this region which reflects both the strengths and limitations of available multiscalar data.

4.1 Gaps in Archaeological Knowledge

One important issue is to what extent patterns identified in the settlement record reflect past human practices and to what extent they reflect bias in archaeological practice and/or preservation.

We can feel fairly confident that most remaining brochs, hillforts, homesteads, and promontory forts in the region have been identified by air. The region has been extensively photographed and, except for the heavy alluvial soils immediately adjacent to the Tweed, generally produces good cropmarks. There appears to be no correlation between known settlement locations and landscape features such as soil type that influence cropmark development.

The poor cropmark response in the alluvial sediments along the Tweed is, however, a real bias in the recovery of settlement information. This is exacerbated by the fact that towns and villages have been constructed along the Tweed from the Anglian period to the present day. Places such as Galashiels and Melrose either obscure or have destroyed remains of any earlier settlement along the river itself. For this reason it is likely that the linear arrangement of homesteads along the Tweed and its major tributaries is somewhat understated, and that there may have been additional homesteads in or around modern riverside towns.

There is another possible bias in our understanding of settlements in the region. It is possible that entire classes of settlement exist that are not susceptible to identification by aerial photography. Unenclosed settlements with one or two houses, for example, would probably be difficult to identify from cropmarks alone (Driscoll and Yeoman 1997). The heavy glacial sediments in the area, and the scarcity of artifacts in even the most well-equipped prehistoric site, make other forms of site identification (e.g. shovel test transects, surface survey) unlikely to produce settlement evidence. At the present time there seems little that can be done to address this possible bias. The most promising approach, admittedly high-risk, would be removing the topsoil from a long strip of land - perhaps in advance of road construction - and carefully studying any interesting features.

Another important issue is that sample sizes vary greatly with the different classes of available evidence. Hundreds of aerial photographs have been examined to create a morphological classification of homesteads, and the large sample size leads to confidence in interpretations based on this classification. Only one rectilinear homestead has been excavated in the region and, while it produced a great deal of detailed and interesting information, the small sample size makes general interpretation of the settlement class based on this evidence less convincing.

A final issue is the relatively arbitrary way in which the study region was selected. Its boundaries were chosen on the simple basis of being a standard distance from the Roman fort at Trimontium. Boundaries were not chosen to reflect any apparent difference in the archaeological record or any apparent environmental difference. In one sense this is a strength as it means the study region was chosen fairly randomly (but see Plog 1976 for a discussion of potential problems with random regional sampling). It is difficult to test how representative the study region is, however, because the surrounding area is not well studied. The best comparisons available for the study area are nearby areas that have received high levels of archaeological attention, for example the Bowmont Valley and the Manor Valley (see below). More work is needed to identify the effective scale for regional sampling in southern Scotland.

In conclusion, the striking wealth of settlement evidence for the region masks underlying deficiences in available data. Structured filling of gaps in the data, informed by thorough understanding of sampling, spatial analysis, and previous work, is needed. The synthesis of data here presented points a way forward in which each settlement class would warrant a slightly different approach. For brochs no further work appears required at the present time. This is because Leslie Macinnes has laid the interpretive groundwork admirably, and there has been a modern excavation at Edin's Hall, a broch just west of the study region. No crannogs or promontory forts have to date been explored through excavation, and it seems high time to address this gap. Interpretation of hillforts either comes from excavations on Eildon Hill North or excavations in other areas. It would be useful to explore other hillforts in the region in more depth, and compare these to Eildon Hill North. Work at Traprain Law would also provide useful data to compare with that from Eildon Hill North. Homesteads are the most intriguing class of settlements, and a great deal of further work could be done to expand and refine the work presented here. Only one rectilinear enclosure has to date been excavated, and it is important to understand how representative it is. From the geophysics data it appears that diachronic evidence may be available in some of the curvilinear sites, and no opportunity to collect relative or absolute dates should be ignored. For homesteads of both morphological classes more work could be usefully done to look for and explore external features. Finally, the cluster and linear patterns suggested here need to be formally tested. No two homesteads from any cluster have to date been excavated and compared, nor has an excavation taken place on one of the homesteads arranged along the Tweed or its major tributaries.

4.2 Interpretation

The interpretations in this chapter are aimed between uncontroversial, bland, statements closely tied to the evidence and overly imaginative statements drawn from the air. Unless archaeologists engage in some speculative discussion about the nature of past peoples and societies, draw on evidence, utilize their imaginations, *and* think creatively about research frameworks for exploring ideas we run the risk of polarizing into those who provide the (dull) facts and those who provide the (unprovable) ideas. The objective is to create a gentle blend of processual and post processual interpretation, drawing on the merits of each.

There are two clear boundaries to secure interpretation for the study region, and these boundaries are not crossed. First, any interpretation requiring absolute dates to be convincing is unworkable in this region, as there are very few such dates with which to work. Second, interpretations must rely on only minimal support from relative dates as the majority of these come in the form of objects associated with the Roman period or in longterm changes in native artifact assemblages (Cool 1982).

4.2.1 Settlement Distribution

Settlements in unstratified or loosely stratified societies are often patterned in less uniform ways than those in stratified societies (Morrill 1970). Exploration of settlement patterning can therefore potentially lead to insights into the nature of prehistoric socio-political organization.

4.2.1.1 Linear Pattern

As no homestead distributed in a linear pattern along a river has been excavated, there is little information available for interpretation. Instead it seems best to offer a variety of possibilities here, each of which would benefit from further investigation. It is recognized that the clustered and linear patterns may have had no temporal overlap, or if they did that the two patterns could have been either complementary or unrelated.

Some possible explanations for presence of the linear settlement distribution along waterways include:

- proximity to water-based resources such as fishing or trade routes,
- defensive positioning for maximum views down major waterways, or
- both of the above.

Possible relationships between the clustered and linear settlement distribution patterns therefore include:

- simultaneous occupation, perhaps with periodic movement between the two classes (e.g. seasonal movement to take advantage of fishing or pasture),
- simultaneous occupation with an embassy/defense function for some settlements and a farming function for others, or
- temporal differences marking two distinct settlement systems.

In conclusion it is important to reiterate that currently there is not enough information to understand the relationship between clustered and linear distributions of settlements. This is an area that would benefit from further work, and the scenarios above are offered to stimulate discussion and future research.

4.2.1.2 Cluster Pattern

The clustering of settlements in the study region provides better evidence for past social organization in the area. Given the lack of firm dating evidence for most of the sites, it might at first appear impossible to make a preliminary interpretation of the social behaviors underlying this settlement distribution pattern. What can be argued is that the 2 km^2 areas in which homesteads cluster were significant either to a relatively large group of people during a relatively short but intense occupation period (intensive occupation), or to a small group of people during one long occupation or recurrent occupation episodes (extended occupation).

To tease apart the evidence and decide whether intensive or extended occupation characterized the late prehistoric period in the study region, we need to try and determine whether all homesteads in single clusters were occupied simultaneously. Keep in mind that we have little dating evidence to draw upon and no two settlements in any single cluster have been excavated.

Geophysical survey of sites in the area shows that 22 settlements had multiple construction phases and that 34 sites were located in positions used in multiple periods. This suggests that individual settlements sometimes had extremely complex histories, and were occupied for relatively long stretches or perhaps were reoccupied multiple times. In other words, geophysics evidence supports the case for extended occupation of clusters.

Extended occupation of clusters is also supported by excavation evidence from Lilliesleaf rectilinear homestead where gradually (i.e. a scale of tens or hundreds of years) the building tradition changed from curvilinear to rectilinear, and the ditches filled with little effort to re-cut or clean them. This strongly suggests a settlement changed to fulfill the evolving needs of its inhabitants.

People in the study area therefore appear to have chosen particular parts of the landscape to serve as foci for settlement for extended periods. This connection to relatively focused parts of the landscape by relatively small groups of people suggests social organization based on extended families perhaps with matrilocal or patrilocal residence.

The description of this settlement distribution pattern as "clustered" is in fact a misnomer. Extended occupation of each cluster means that sequential homestead construction and abandonment occurred, potentially extending from the Bronze Age to the Medieval Period. Given this length of time, and the number of enclosures in each cluster, there may have been only one occupied homestead in each cluster at any given time. For inhabitants the settlement would therefore not have appeared clustered, but would instead have served as *the* settlement in a landscape of family memories.

The landscape of family memories may provide an important clue to the reason for stability in the native settlement system. The land itself was integral to society, being the physical heart of each settlement – the material from which homes were shaped, the material from which boundaries between social/natural and insider/outside were constructed. I suggest that the land was also a source, perhaps the source, of social identity and power. Social stability stemmed from strong family identity, embedded in the earthen fabric of settlements, reinforced by land tenureship, and embedded in symbolic and spiritual associations with the surrounding landscape. Social stability was thus the foundation of stability in the settlement system, the two reinforced each other, and in turn were reinforced by the landscape itself. The people, their social places, and the landscape itself would need to be disrupted before the bedrock of society was shaken.

4.2.2 Settlement Hierarchy and Social Stratification

It appears that the study area was populated by relatively independent and isolated extended family groups in late prehistory. However, the area may have been characterized by more hierarchical social organization earlier in the Bronze Age.

This suggestion is based on the length of time that particular settlement classes appear to have been in use, as explained in Chapter 2. Brochs were used for settlements from the late Iron Age and Roman period. Hillforts were occupied during the Bronze Age, sometimes with subsequent reuse for ritual purposes. Homesteads had a very long date range extending from the Bronze Age through the Medieval period. The occupation dates for promontory forts are unknown, and are therefore not considered further here.

This range suggests a native settlement hierarchy with hillforts and homesteads in the Bronze Age, but ending in the Iron Age with the decrease of settlement in hillforts. The appearance of the Roman military, with its regular network of forts and fortlets, imposed a rigid hierarchy over a relatively egalitarian landscape of homesteads. When the Roman hierarchy was withdrawn, the egalitarian homestead pattern continued. With the introduction of Anglian monasteries there was once again a settlement hierarchy in the region.

It could be argued that broch and rectilinear homesteads indicate a native settlement hierarchy in the Iron Age as well. Surface finds and excavation suggest that the character of rectilinear homesteads was very different from that of curvilinear homesteads. Inhabitants of rectilinear sites had greater access to Roman goods than inhabitants of curvilinear homesteads, and in this respect are similar to the inhabitants of the three brochs in the Scottish Borders. For broch sites the presence of Roman artifacts has been interpreted as an indication of social stratification (Macinnes 1984a).

However, evidence suggesting that settlements were alone in a landscape of family memories may throw new light on our understanding of both rectilinear enclosures and brochs. It is plausible that the rectilinear class of homestead represents a short-lived stylistic phase in the historical development of landscapes of family memories. This invites reinterpretation of brochs as well. Perhaps rather than being elite residences, brochs are also a relatively short-lived settlement form emerging in parallel with the rectilinear homesteads during the period that Roman artifacts were available in the region. Given the even scattering of homesteads and brochs, this suggests relatively ubiquitous access to Roman objects throughout the study area.

It also reinforces the idea that the development of broch and rectilinear homestead settlement classes is worthy of further consideration. After all, why would people who had lived in curvilinear homesteads for a millennium suddenly dabble with two new settlement forms and then revert back to curvilinear enclosures? Were they coerced into accepting new settlement forms? Did they carefully choose the new settlement forms for their own reasons, perhaps borrowing them from political allies further north and south? Rectilinear settlement forms were widespread in parts of Northumberland (see below) and in the Romanized south, while brochs were widespread in the west and north of Scotland. Simultaneous emergence of these settlement classes may represent relatively short-lived social responses in a period of temporary acute social upheaval.

In southern Scotland there are relatively few 1st century Roman objects on native sites, but 2nd century Roman objects are much more common on native sites (Robertson 1970, Macinnes 1984b, Macinnes 1989). Macinnes used this evidence to suggest that Roman objects became less prestigious in the 2nd century, and were replaced by brochs and crannogs as status markers (1984). While this scenario is certainly possible, it does require quite close dating evidence to support the argument and now needs to be expanded to include rectilinear enclosures.

Instead the presence of Roman artifacts at some sites may simply mark the settlement in a landscape of family memories occupied when Roman objects were available. If correct, this would point to a new interpretation for the distribution of Roman artifacts. Instead of marking elite households, the presence of Roman objects would simply mark occupation during the time that Roman goods flowed in the region. This would provide a powerful analytical basis for de-coupling the interpretation of Roman artifact distributions from questions about direct interactions between natives and Romans. In fact, there may have been little regular contact between the Roman military and the local population.

4.2.3 Natives and Romans at Newstead

The nature of relationships between native inhabitants of the region, the inhabitants of the fort's annexs, and the "Roman" inhabitants of the fort itself has been significant throughout history of research at Newstead. The existence of civilian settlement outside the fort at Newstead was first suggested by Curle (1913) who imagined native people living as serfs in the fort's annexs, toiling away for their Roman masters. The potential presence of native residences in and around the fort annexs has proven an especially enticing topic for subsequent research.

Settlement evidence from fieldwork north of the fort suggests that in the 1st century Newstead had a defended north annex. Just west of this annex were a series of wells perhaps associated with timber structures but not associated with many metal objects or burnt features. This is comparable with evidence of settlements in the more extensively excavated south annex where small rectilinear timber strip buildings were thought to be civilian in character (Jones *et al.* 1993). However there is nothing to positively demonstrate that the structures in either the north or south annexs were built or inhabited by the local indigenous population. By the second century there was relatively dense occupation of even the steepest slopes north of the fort. These settlements were occupied by people with access to Roman glass, iron, bronze, tools, coins, and samian pottery. There are mixed signals, however, as to the cultural identity of the 2nd century inhabitants.

Unlike the building traditions in evidence at native settlements in the region, the extra-mural structures at Newstead are exclusively rectilinear. The choice of living on a north-facing slope would have been quite alien to the native population with their strong tendency to orient homes to the east and south (Parker Pearson and Richards 1994), an architectural trend thought to relate to the importance of the sun (Oswald 1997). There are however some similarities between native settlements and the inhabited area north of the fort. For example, both the native building traditions in evidence at other settlements in the region and the extra-mural structures at Newstead are constructed of timber and are located on platforms constructed on slopes.

The annexs at Newstead appear characteristic for a *vicus* -- or self-governing village inhabited by camp followers, merchants, and natives -- as these often contained a standard style of elongated timber strip house (Saddington 1989) and rarely reflected the architectural traditions of indigenous populations. It has been argued that all forts in Britain had *vici*

(Sommer 1984), and there is no real reason to suspect that Newstead differed from other forts. In the end there would have been nothing to stop natives inhabiting the annexs even if they were not directly responsible for constructing the houses found there, so it is not too surprising to get mixed signals about the cultural identity of inhabitants. Some impact on the surrounding regional settlement pattern would be expected, however, if a large number of native inhabitants relocated to such a village. No evidence for radical re-structuring of the settlement patterns is in evidence, so it is likely that any native inhabitants were from other regions.

It is more likely that the indigenous regional population visited Newstead on a seasonal or periodic basis when it may have served as a base for merchants (Snape 1989) catering for the needs of both native inhabitants of the region and the Roman military. Occasional trade with at least some natives took place, as demonstrated by the recovery of Roman artifacts from brochs (Macinnes 1984a) and rectilinear homestead enclosures such as Lilliesleaf. However, it remains unclear who brokered this exchange, where it took place, or how representative inhabitants of sites with access to this exchange system may have been (Macinnes 1989).

Based on interpretation of new settlement evidence, the answer may be that most, if not all, people in the region had access to the exchange system focused in the annex markets at Newstead. This picture of a stimulating multi-cultural environment, with ample opportunity for exchange of goods and information is at odds with more bloody beliefs about the nature of native and Roman interactions.

4.3 Comparison with Neighboring Regions

Distribution of native settlements in southern Scotland is uneven with concentrations of native sites in Kirkcudbrightshire, Nithsdale, Annandale, Eskdale, Liddesdale, the Lothians and Stirlingshire, Peebleshire and Upper Lanarkshire, the Tweed basin below Peebles, around

Penmanshiel, the Bowmont valley, around Coldingham Loch, and at Buncle Edge (Christison 1895).

In this section a broad overview of several well-studied areas is offered to enhance and provide context for discussion of the study region. A list of the settlement forms found in each is followed by a discussion of any settlement pattern evidence that is available. As these regions have generally not been studied with this aim, data are infrequent in published reports.

4.3.1 Bowmont Valley

The Bowmont Water drains the Cheviots, eventually flowing into the Glen and Till before joining the River Tweed. In its valley is a group of native settlements, nestled in a 3.5 mile long and 1 mile wide area approximately 15 km southeast of Kelso (Christison 1895). Settlements are located in the bottom of the valley, on hilltops, and on the valley sides just below the ridges. Christison also noted that some of these settlements are connected by "intrenched lines" by which he appears to mean that there are connecting ditches or earthworks running between sites.

Selected excavations (Piggott 1950, 1951) and extensive field survey (Mercer 1984, 1985, 1986, 1987; Mercer and Tipping 1988, 1994) suggest that the Bowmont Valley includes palisade enclosures with ring-groove houses, a unique rectangular palisade with ring-ditch houses, homesteads with ring-ditch houses, hillforts, promontory forts, scooped enclosures, and unenclosed platform settlements. There are no brochs or crannogs in the area, and it is not clear whether there are any rectilinear homesteads.

4.3.2 Manor Valley

There is good preservation of settlements, and clear patterning, in the Manor Valley near Peebles (about 25 km west of Newstead). This area, largely known through aerial photographs and survey of standing remains (RCAHMS 1967, Smith 1990), has prominent hillforts surrounded by homesteads, tower houses and medieval nucleated villages (Yeoman 1991). Settlements were regularly spaced, and normally separated by a stream, rivulet, or other topographic feature. Homesteads were located on hillsides near the boundary between arable land and pasture (Smith 1984) and nucleated villages were located in the valley bottom (Smith 1984, Yeoman 1991). There are 13 modern farms in the Manor Valley, and these are thought to correspond with a system, described in 10th century manuscripts, in which 13 upland vills were attached to a single manor house (Smith 1984). The 10th century was important here as this area was part of the frontier of the Kingdom of Northumberland.

This appears to be an orderly area in which settlement was gradually transferred from the highest to the lowest elevations. The linear arrangement of sites closely follows the course of the Manor Water, and is reminiscent of the linear pattern of homesteads in the study area.

4.3.3 Northumberland

The large English county of Northumberland has been analyzed at many scales. At the largest scale, rank-size analysis of settlements in and around the Breamish Valley, South Rothbury, Yeavering, and northeast County Durham suggests the:

> existence of different Iron Age social formations within northeast England. In the upland zone, the picture is seemingly one of highly autonomous, isolated groups with a low level of interdependence and integration. There is little differentiation in site size and no evidence for any form of settlement hierarchy. ... The implication is rather that these sites represent the residences of extended family groups and that any display of status or small scale raiding took place between peers without altering the balance of power. (Ferrell 1997:233)

Within this region are several well-studied micro-regions with distinctive settlement patterning. For example, just north of Alnham is undisturbed moorland where 6 unenclosed platform settlements, 6 palisade enclosures, 8 burials, 6 rectilinear enclosures, and 2 hillforts lie in an area of approximately 4 km^2 (Gates 1983).

Other examples come from the numerous excavations undertaken by George Jobey. For example, excavations in advance of Kielder reservoir construction suggest that there were between 17 and 27 rectilinear enclosures (Jobey and Jobey 1988). The enclosures, located along a 20 mile stretch of the River Tyne, were spaced roughly 0.4 to 0.8 km apart and in this respect were similar to rectilinear settlements excavated further down the Tyne valley (Jobey 1963). Excavation at 4 enclosures in the Kielder catchment - Belling Law, Gowanburn, Kennel Hall Knowe, and Tower Knowe - suggest that there may have been a slight population increase in this region during the Romano-British period (Jobey 1974, Jobey 1977, Jobey and Jobey 1988) and that there was continuity of settlement through the post-Roman period (Jobey 1982b). Particularly noteworthy in this evidence is the fact that rectilinear homesteads were the norm in later prehistory, and that these were spaced in a regular pattern.

There are a wide variety of settlement classes in Northumberland. Particularly characteristic of the area are unenclosed platform settlements which appear to date from the Bronze Age to the Middle Iron Age (Gates 1983). There are approximately 90 unenclosed platform settlements, some with associated field systems (Topping 1989), and each with 1-12 houses. 50% have only one house and most have fewer than 6 houses making these unenclosed platform settlements somewhat smaller than those in Peebleshire or Lanarkshire. Unenclosed platform settlements are widely scattered and separated by empty landscapes.

4.3.4 Eastern Dumfriesshire

Extensive fieldwork in Eastern Dumfriesshire from 1990-1996 by teams from the RCAHMS have significantly improved our understanding of the area, adding over 1000 new sites to those already known (RCAHMS 1997). Settlement classes in the region include unenclosed settlements, palisade enclosures, forts (defined differently than in the study region as they are classified by construction material and are distinguished from homesteads after a rather subjective assessment of the greater defensive qualities of their enclosing features), homesteads, and scooped settlements. ^{14}C dates suggest that palisade enclosures began in the early 1st millennium BC and continued into the post-Roman period. Rispain Camp (NX 429 399), the type site for rectilinear homesteads in the region, has three radiocarbon dates of the late Iron Age (Haggarty and Haggarty 1983) is double-ditched and contains curvilinear structures. The field teams noted that "virtually every type of later prehistoric settlement that has been sampled by excavation has produced evidence of early timber-built phases" (RCAHMS 1997:155). Settlement patterning suggests that homesteads were regularly spaced at 1 km intervals in some parts of the region (Cowley, in press).

There is a regional pattern in the distribution of rectilinear enclosures which are very numerous both in the south on the Solway plain and in Annandale to the west but are relatively rare in Eskdale to the east. There are occasional hints of potential settlement clustering (e.g. RCAHMS 1997:142) but the scale at which distribution maps are reproduced is not detailed enough for certainty.

Upper Annandale and Upper Eskdale are discussed as special case studies. Settlements in Upper Annandale were inter-mixed with linear earthworks that appear to have enclosed large areas or perhaps field systems. There is also some evidence to suggest that the settlement system contracted at the end of the Bronze Age and re-expanded at the end of the Iron Age (RCAHMS 1997).

In Upper Eskdale "the pattern of settlement that emerges at this time [late prehistory] comprises a series of enclosures of different sizes strung out at intervals along the sides of the White Esk valley" (RCAHMS 1997:78). The field teams suggest that there my have been a hierarchical settlement pattern in the White Esk valley in prehistory composed of unenclosed settlements, enclosed settlements ranging in size from 0.03 to 0.2 hectares, and the large hillfort at Castle O'er. They also note, however, the extreme uncertainty of dating for the settlement classes as a whole and individual settlements in the White Esk valley.

Interestingly, there is evidence for unenclosed settlement overlying the defenses at the Bronze Age hillfort of Castle O'er. It is thought that this part of the region was controlled by the Brigantes during the Roman period, a tribe described by Roman authors as extremely hostile to the empire. One other particularly unusual discovery in the region is for a late prehistoric ritual enclosure preserved under peat at Over Rig. Interestingly, this ritual enclosure appears to be located in a gap in the otherwise regular settlement pattern (RCAHMS 1997:85).

4.3.5 Solway Basin

The native settlement pattern varies north and south of the Solway basin. Settlements north of the river are relatively few in number, more defended, and with fewer field systems (Breeze 1989). South of the Solway are 183 sites in 690 km^2. 73% of these are curvilinear enclosures, 18% are sub-rectangular enclosures, and there is an average area of 3.77 km^2 per site (Jones and Walker 1983). North of the Solway there are only 82 sites in 800 km^2. 96% are curvilinear and 3.6% are sub-rectangular, with an average area of 9.75 km^2 per site (Jones and Walker 1983). No clear hierarchical settlement pattern has been found in either area (Jones and Walker 1983).

4.3.6 Other Areas

There are occasionally relevant snippets in publications from other regions. At the midway point between Elginhaugh and Inveresk Roman forts in East Lothian there are 16 curvilinear enclosures, 3 rectilinear enclosures, and 4 palisade enclosures within a 4 km radius (Maxwell 1983). In Upper Clydesdale 7 enclosures and an unenclosed platform settlement with 13 huts are located within a 4 km radius of the Roman fort at Crawford (Maxwell 1983). Clusters of hut platforms and settlements have been noted on the Isle of Arran (Alexander 2000). The late prehistoric settlement pattern in southeastern Scotland appears to compare closely with the settlement pattern in late prehistoric Cornwall and Devon

(Cunliffe 1991). At Glenachan Rig in Peebleshire there is a cluster of 3 earthworks and 3 homesteads, one of which dates to the Bronze Age and another is medieval (Feachem 1958/59). A cluster of 20 forts including contour forts with stone wall defenses, and promontory forts with ditches and ramparts were noted in the Gillies Hill excavation report (Rideout 1992f).

Finally, clustering in the late prehistoric settlement record appears to be a more widespread phenomenon. Diachronic settlement clusters or "community areas" of 4-8 km^2 are features of the late prehistoric and Roman period settlement record of Bohemia in the Czech Republic (Kuna1991).

4.3.7 Summary and Ways Forward

What is immediately obvious, though surprisingly little has been made of it, is that classes of settlement vary quite substantially between regions in southern Scotland and northern England. While it has been suggested that enclosure forms would be more responsive to social, economic, and environmental changes than house forms (Hill 1982a, Mercer and Tipping 1994), it is also true that settlement class may also reflect these and other aspects of cultural behavior.

Interpretation of settlement class has often stopped at claims of functional adaptation to local topography, attempts to define a single developmental sequence, or assumptions of inherent defensibility. More work is needed on the social factors that lead to both the adoption of specific settlement forms (e.g. brochs, crannogs, hillforts, homesteads, palisades, promontory forts, scooped houses, unenclosed platform settlements) and the maintenance of so many different settlement forms.

Notable are the striking differences among areas within regions suggesting that the appropriate level of analysis in southeastern Scotland and northeastern England is sub-regional or micro-regional. Unfortunately, appropriate dimensions for sub-regions or microregions are not clear from evidence currently available. I would suggest that 20 km^2 (the size of the present study area) is too small, but that entire river catchments are too large. This is an important issue for further exploration.

Finally, it would be helpful to have more settlement work from key areas. For example, settlement pattern studies in the area around Traprain Law would be extremely valuable.

4.4 Conclusion

Gaps in archaeological knowledge exist despite the striking wealth of settlement evidence for the region. Structured filling of gaps in the data, prioritized by settlement class, is needed. Priorities for this work are suggested above for brochs, crannogs, curvilinear homesteads, hillforts, promontory forts, and rectilinear homesteads.

Further exploration of the linear settlement pattern identified through settlement pattern analysis is warranted. Initial hypotheses to explain this pattern include seasonal settlements located to benefit from fishing or water-based trading routes, and/or settlements commanding views down major rivers and serving an ambassadorial or defensive function.

Evidence from excavation, geophysical survey, and settlement pattern analysis suggests that parts of the landscape were occupied for extended periods. This connection to relatively focused parts of the landscape by relatively small groups of people has been used to suggest that social organization was based on extended families perhaps with matrilocal or patrilocal residence. Extended occupation of homesteads means that sequential homestead construction and abandonment occurred, potentially extending from the Bronze Age to the Medieval Period. Given this length of time, and the number of enclosures, there may have been only one occupied homestead in each $2km^2$ area at any given time. For inhabitants the settlement would therefore not have appeared clustered, but would instead have served as ***the*** settlement in a landscape of family memories.

It is important to stress here that it is the $2km^2$ effective scale that requires further testing. Even if the cluster pattern itself is a by-product of analysis, and homesteads are in fact randomly distributed, there is still evidence for extended occupation of this landscape.

The presence of Roman artifacts at some homesteads may simply mark the settlement in a landscape of family memories occupied when Roman objects were available, rather than marking elite households. This is a new interpretation for the distribution of Roman artifacts in this region, and provides a reason to further de-couple the interpretation of Roman artifact distributions from questions about direct interactions between natives and Romans. There may have been little regular contact between the Roman military and the local population, and what contact there was may have been relatively peaceful.

These results for the region can not, however, be extrapolated for a broader area in southern Scotland or northern England. A review of settlement pattern evidence from regions such as Northumberland and the Solway Firth demonstrates clear variation between this study region and others. Further work is needed to identify the effective scale or scales of regional analysis, and it appears this will lie somewhere between $20km^2$ and entire river catchments. More work is also needed on the social factors that led to both the adoption of specific settlement forms (e.g. brochs, crannogs, hillforts, homesteads, palisades, promontory forts, scooped houses, unenclosed platform settlements) and the maintenance of so many different settlement forms.

It was suggested above that social stability was the foundation of stability in the settlement system, the two reinforced each other, and in turn were reinforced by the landscape itself. The people, social places, and the landscape itself would need to be disrupted before the bedrock of society was shaken. This is a nice segue into Chapter 5, where environmental evidence for the region is presented and analyzed.

V. ENVIRONMENT

As introduced in Chapter 1, the general aims of this research are to understand the protohistoric human ecology of the region, and the ways native society responded to changes in cultural and natural environment. In this chapter available paleoenvironmental evidence is collated and analyzed, a paleoclimate model is developed, and this information is used to contextualise the archaeological evidence in terms of late prehistoric human ecology.

5.1 Introduction

Climate change has been a major theme in Scottish prehistory since Stuart Piggott published an influential paper on climatic deterioration during the first millennium BC (Piggott 1972). In this paper he established climate patterns that have been repeated in the literature, for example that periods of climatic deterioration were characterized by cold wet weather and that climatic optima were characterized by warm, dry weather. About the same time it was also suggested that a relatively warm, dry climate dominated Europe from roughly 300 BC – AD 300, and this "Roman Climatic Optimum" (Denton and Karlen 1973) was thought to facilitate Roman expansion into northern Europe.

We now know that colder climates usually bring drier conditions, as there is less heat to fill rain clouds through evaporation, and that warm climates are generally more moist (see Crowley and North 1991, Wright *et al.* 1993 for good introductions to paleoclimatology). We also know that regular changes in the amount of incoming solar radiation play out differently in terms of regional climate, and therefore an understanding of climate change requires both global contextualization and detailed regional analysis. There is no single broad-scale climate feature that dominates European climate (Crumley 1993), and for this reason detailed regional analysis is especially important.

Solar radiation is the main external source of energy input to earth's environmental system. It interacts with a variety of internal mechanisms and feedback loops on earth to produce our climate. Examples of some of these internal mechanisms and feedback loops include the melting of glaciers and polar ice caps, the introduction of aerosols into the atmosphere as the result of dust storms or volcanic eruptions, the introduction of sulphate and carbon to the atmosphere from slash and burn agriculture.

There are regular changes in the earth's orbit called Milankovitch cycles that affect the seasonal and spatial distribution of solar radiation. The earth's orbit is ever so slightly eccentric, rather than purely elliptical, and changes approximately every 105,000 years. The tilt of earth's axis changes approximately every 41,000 years, and the time of the equinoxes changes approximately every 21,000 years (Wright 1993). Variations in the Milankovitch cycles and properties of land, atmosphere, oceans, ice sheets, and biota affect how and where incoming solar energy is absorbed or reflected. Gasses and particles in the atmosphere may reflect solar energy back to space or prevent heat escaping from earth's surface to space. The reflectivity of the ground surface, or albedo, changes with land cover. For example, snow reflects much more energy to space than green forest canopies.

The different thermal properties of earth's oceans and continents result in different parts of the climate system reacting to changes in global variables at different time scales. Careful global contextualization and regional analysis is therefore essential before climate change can be considered as a viable explanation for archaeological patterns. Following this strategy would help to ensure that climate change does not continue to be over-enthusiastically applied in archaeological explanation (Coles and Mills 1998, Harding 1982, McGhee 1981).

5.2 Paleoenvironmental Evidence

Linking the global context and detailed regional data together is no easy task. It is difficult to marry sources of data at different scales, and there is a gap between regional methods and global explanatory frameworks. Further challenges stem from the inter-disciplinary nature of paleoenvironmental research, for example archaeologists need information about the paleoenvironment of their sites while environmental scientists prefer their paleoenvironmental data to be collected from places untainted by human 'interference'.

5.2.1 Holocene Global Context

Broad patterns of global climate are recognised for the Holocene. In the early Holocene the earth generally had warmer and wetter summers than today. In eastern North America and western Europe, for example, there was broad latitudinal displacement of vegetation zones, suggesting that the summers were c. 2° C higher than today (Crowley and North, 1991). In the late Holocene the global climate became cooler and drier with an average overall temperature decline of 1-2° C. Evidence for this comes from ice, peat, and ocean cores (Bell and Walker 1992, Dansgaard *et al.* 1982).

It is very difficult to say much more than this about the global context with confidence at present. Although much could be written about detailed datasets that are available, as soon as these are compared difficulties emerge because each dataset reflects a different spatial and temporal scale. This is the case whether we examine oak sequences in England, Germany, and Ireland (Baillie 1993 and 1998); study detailed records of lake level changes in Europe (Street-Perrott *et al.* 1989); or further the understanding of global Holocene climate in other ways.

Paleoenvironmental evidence presents a confusing body of evidence to interpret and synthesize. The ultimate cause of the changes recorded in bodies of environmental evidence are rarely obvious, though the proximal causes sometimes are. Annual tree ring growth, for example, is affected by temperature and precipitation. The cause of temperature and precipitation fluctuations, however, is not recorded in the tree ring evidence, and it's that ultimate cause of change that is most useful in understanding past environments.

In general, it is difficult to relate evidence for paleoenvironmental change to ultimate causes because of:

- Feedback between parts of the environmental system,
- Lag times in response obscuring cause and affect,
- Spatial and temporal discontinuities in the paleoenvironmental record, and
- Difficulty obtaining absolute dates.

Confusingly, the proximal causes of change suggested by various sources of evidence may point in different directions. For example, how are we to interpret a region in which tree rings suggest high precipitation for ten years but evidence from lakes suggests that water levels were falling and that it therefore may have been drier? Environmental scientists often need an independent way of testing different explanatory hypotheses to understand the complex system and ultimate causes behind environmental evidence. This is where modeling can be useful, and why it will be explored further later in this chapter.

The results from the PAst Global changES (PAGES) project should also improve our understanding of global Holocene climate. This project is part of the International Geosphere-Biosphere Programme (IGBP) which coordinates international scientific efforts with the aim of developing paleoenvironmental databanks consistent enough to use for predictive climate modeling. The PAGES project is developing international consensus about best practice in collating and analyzing data from cave and spring calcite, coral, sediment, insects, pollen, glaciers, documents, ice cores, lakes, molluscs, gases in ground water, ocean cores, packrat middens, soil, plant macrofossils, sea level variations, tree rings, and treeline movement. Researchers involved with PAGES are actively building bridges between more than 20 internationally important palaeoenvironmental databases that are structured uniquely and hold different kinds/scales of data. In the process scientists are identifying gaps and biases in available data, and are undertaking programmes of work to reconcile these (Anderson 1995).

Noteworthy progress has been made in understanding changes to the African and Asian monsoon belt (Kroepelin 1994); demonstrating a correlation between European vegetation and North Atlantic circulation change (Huntley and Prectice 1993, Ruddiman and Mix 1993); and collating evidence from three global transects, the Arctic, Antarctic, and Pacific (PAGES 2000). Results from the Europe to Africa transect will be presented at a major international conference in Autumn 2001, and should revolutionize our understanding of the past and present European environment.

5.2.2 Regional Paleoenvironmental Evidence

Against this backdrop of on-going revolutionary change in our understanding of the global paleoenvironment, much work has happened in the last 10 years to consolidate our understanding of the late prehistoric environment in southern Scotland.

5.2.2.1 Pollen

In Scotland pollen is the primary source of evidence about the past environment (Tipping 1994). Archaeological deposits sometimes contain pollen representing the local environment (Dimbleby 1985), however caution is necessary in the interpretation of pollen samples taken from archaeological sites because the local pollen signal may overwhelm the regional pollen signal (Edwards 1991, Tipping 1994) and control for contamination of sites and samples is difficult. The best sources of pollen for paleoenvironmental research are sites with regional catchments and good temporal resolution (Tipping 1994), although pollen samples taken off-site may not show clear evidence of human activity especially if this was localized.

Pollen evidence suggests that Scotland's forests in pre-glacial times included oak, hazel, spruce, pine, silver fir, and larch (Anderson 1967). After glaciation the native woodland of southern Scotland consisted of oak, hazel, and elm with some birch (Tipping 1994).

Pollen gathered from Blackpool Moss, just southwest of Eildon Hill North, contextualized excavations at the hillforts of Eildon Hill North and the Dunion (Butler 1992a). Of all the waterlogged basins tested between the two hillforts, Blackpool Moss was the only that appeared to contain layers dating to the late prehistoric period. The control sample taken from the top of the Moss contained a high proportion of local pollen, suggesting that samples from the core reflect past local environments in a catchment area with a radius of roughly 2 km for water-born pollen and a 5-10 km radius for airborne pollen.

Unfortunately no firm chronology could be established for the core, but results suggest an increase in agricultural activity in the area from the 2nd or 3rd millennium BC with a decrease in tree species - especially oak and elm. Interestingly hazel disappears entirely from the core in the Bronze Age during occupation of Eildon Hill North. In late prehistory there seems to have been a general mixed landscape of woodland, mire[7], pasture, and cultivated cereal fields.

In interpreting the Blackpool Moss core, Butler was able to draw on evidence from 9 other pollen cores including Din Moss (Hibbert and Switsur 1976), the Dod (Shennan and Innes 1987, Innes and Shennan 1991), Fellend Moss (Davies and Turner 1979), Kitchen Moss (Newey 1969), Linton Loch (Mannion 1978a), Side Moss (Newey 1969), Steng Moss (Davies and Turner 1979), Threepwood Moss (Mannion 1978b), and Upper Eddleston Valley (Newey 1969). Overall these cores indicate sequential clearance and regeneration of woodlands in late prehistory, with woodland clearance being slightly later in some areas (for example, the five northernmost sites). In all cases woodland was succeeded by an increase in pasture.

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[7] A mire is a bog or swampy place.

Pollen samples from excavation at the Dunion suggest that the surrounding area was dominated by ferns, grassland, and heath at the time the ramparts were constructed (Butler 1992c). Pollen was also sampled during excavation of Eildon Hill North. Of two samples taken from beneath the fort rampart one suggests there was either a light open woodland in the area or else the hilltop was cleared and the hillsides were wooded. The other suggests a nearby heathland (Butler 1992b). Charcoal evidence from Eildon Hill North also suggests an open woodland (Owen and Rains 1992). Pollen evidence from the excavated hut platforms suggest the presence of grassland, heathland, and woodland but it is unclear whether the variation is spatial or temporal.

There has also been pollen coring at Bemersyde Moss, but results from this work have not yet been published. Preliminary results suggest that there may be no deposits relating to the mid- to late-prehistoric periods (J. J. Lowe and R. Tipping, personal communication).

In summary, there is evidence for Neolithic woodland clearances for agriculture in southeastern Scotland. This was followed by near-synchronous regional increases in woodland clearance from c. 2000-1850 BC. These clearances were sometimes maintained for hundreds of years though they were generally small and localized (Tipping 1994). These woodlands may have been heavily managed in prehistory (Tipping 1994) with some evidence for coppicing (Boyd 1988, Coles and Coles 1986). After 500 BC there is again evidence for widespread, asynchronous, total woodland clearance though some areas were not cleared until the Roman period (Davies and Turner 1979, Dumayne 1993a, Dumayne 1993b, Dumayne-Peaty 1998, Dumayne *et al.* 1995, Lowe 1993, Manning *et al.* 1997, Tipping 1994, Tipping 1997, Turner 1979, Turner 1983).

Most of the regional pollen cores have unfortunately not been published, although similar data from other parts of southern Scotland have been (see Figure 5.1).

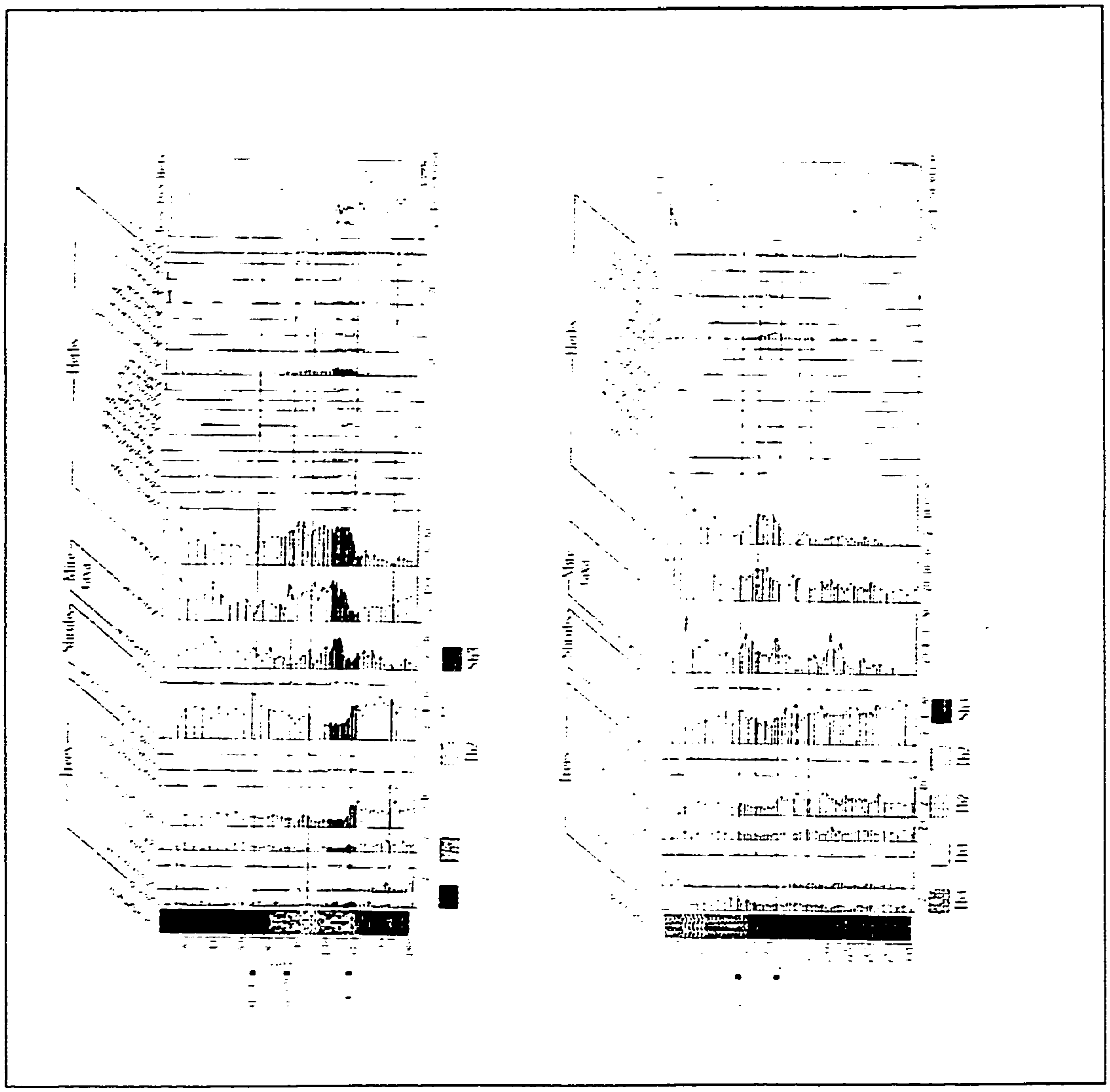

Figure 5.1 Evidence in pollen cores from Letham Moss (left) and Fannyside Muir (right) (Dumayne-Peaty 1998).

5.2.2.2 Other Plant Remains

Pioneering work on plant macrofossils (Van der Veen 1989, 1992) suggests that in late prehistory north of the Tyne there was a micro-scale intensive agricultural system, and that south of the Tyne there was a less intense but more widespread agricultural system with larger grain yields. This pattern was used to suggest that subsistence agriculture based on emmer wheat took place north of the Tyne, while south of the river surplus production of spelt wheat was possible. This pattern has interesting implications for interpretation of Native and Roman interactions, but on the basis of pollen analysis it has recently been argued that Van der Veen's pattern south of the Tyne may also have held true north of the river (Tipping, 1997). The course of this debate should be very interesting for both prehistorians and Roman archaeologists.

Wood from charcoal deposits at Edinburgh castle shows no variation in species composition from the Bronze Age through to Medieval contexts suggesting the same type of woodland was exploited but at low enough rates for regeneration. It was probably a mixed oak woodland as oak and hazel are dominant in the charcoal samples with some willow, alder, birch, elm, ash, and cherry.

Excavations at Edinburgh Castle also suggest that 6 row barley was consumed on site for the last three millennia (Driscoll and Yeoman 1997). In all phases grain and straw appear to have arrived on site separately.

5.2.2.3 Fauna

The extremely acidic soils make recovery of informative faunal assemblages quite extraordinary. For example, of 2357 animal bone fragments recovered during excavation at Eildon Hill North only 15 were identifiable. These include 10 fragments from two matching horse mandibles, and 5 fragments of cattle (McCormick 1992). Equally poor preservation was noted at Dryburn Bridge (Triscott 1982).

In the Roman Iron Age assemblage at Edinburgh Castle cattle were more numerous than sheep, and sheep were more numerous than pig (Driscoll and Yeoman 1997). A similar pattern has been recognized at Broxmouth (Barnetson 1982), Inveresk Roman fort, and Lilliesleaf (Clarke and Wise, forthcoming). Interestingly, this is different from the south of England where sheep routinely dominate and wool production is assumed. Wool production appears not to have developed in Scotland until the Medieval period (Driscoll and Yeoman 1997). Interestingly, at Edinburgh Castle the Roman Iron Age bone assemblage is in larger fragments than the Medieval bone assemblage and the difference does not appear to be taphonomic. This suggests that meat may have been more readily available to inhabitants in the Iron Age (Driscoll and Yeoman 1997).

5.2.2.4 Insects

Paleoenvironmental evidence from insects is rare in southeastern Scotland as remains are generally poorly preserved in the acidic soils. However, occasionally remains are found in waterlogged conditions. For example, beetle evidence from Doubstead enclosure near Berwick-upon-Tweed suggests that the settlement ditches were filled with a pleasant (for some beetles) combination of standing water and animal dung (Jobey 1982c).

5.2.2.5 Soils

Much of the study region is located on arable class 3 land (Bibby *et al.* 1982, Jordan 1992). The soils are a mixture of imperfectly drained brown forest soils of the Ettrick association and soils of the Yarrow association (Ordnance Survey 1959, Romans and Robertson 1983). These soils generally derive from greywackes and shales overlying glacial deposits (Butler 1992a). The drift geology is composed of boulder clay highly variable in character.

The river terraces of the Tweed have received some attention from geologists (Rhind 1968), but no detailed geomorphology research such as grain size analysis has been done on archaeological sites in the region.

5.2.2.6 Documents

Southeastern Scotland is a relatively productive agricultural area when compared to other parts of Scotland. It is, however, susceptible to local scale environmental fluctuations. This has been documented for the medieval period by correlations between the location of settlements, the types of crops that could be produced, and climatic variables such as the number of growing degree days, average wind speed, and temperature (Parry 1978, 1981). Settlements at high elevation in the medieval period were most at risk for crop failures. Lowland settlements were most buffered in the sense that they were less likely to experience consecutive years of crop failure.

Parry focused closely on oat crops that are limited by the wrong combination of elevation, aspect, slope, surface roughness, soil depth/acidity/moisture capacity, insolation, exposure, warmth, and wetness. He estimated the climatic conditions required for an average 1 in 3 crop failure rate and a 1 in 15 crop failure rate, hypothesizing that the former could destabilize farmers and the regional economy. He found documentary evidence to suggest that 15 settlements in the Lammermuir Hills were abandoned in the period leading up to 1600, 18 were abandoned from 1600-1750, 21 from 1750-1770, and 71 from 1770-1800. He did, however, note that figures for the last two periods are high because some farms appear "abandoned" when in fact they were amalgamated with neighboring farms. Parry evaluated a range of socio-economic factors that contributed to economic health and settlement stability including available technology, war, the strength of central government, disease, availability of land, fluctuation of demand, and shortage of supplies. He also examined soil degradation, but he concluded that the altitude at which oat crops could be cultivated in the Lammermuir Hills to the north of the Tweed river valley changed because of local climatic fluctuations (Parry 1978).

There are several justifiable critiques of Parry's work, but it has come to be routinely over-criticized in archaeological circles. He could have perhaps included more information about demographic changes in the population, broad economic trends, wars (Jobey 1977), etc.

in his model. He also made somewhat questionable statements about marginal agricultural systems being poorly adapted to their environments, and perhaps started from a theoretical position that would now be described as climatic determinism. There has also been the suggestion that his calculation of the limit to oat cultivation may have been 70 m too low (Duncan 1992), and his calculations would have been more convincing if done on pre-19th century oat species (Tipping 1994). Also, work in the Cheviot Hills suggests that the patterns Parry observed in the Lammermuir Hills did not hold true there (Tipping 1998).

These criticisms do nothing to change the fact that Parry developed a model in an unique, and I would argue valuable, attempt to relate socio-economic factors, settlement patterns, and climate change. Given appropriate care in the use of historical documents (Bryson and Padoch 1980) the data that Parry drew upon are sensible for generating models of economy, settlement, and climate.

5.2.3 The Environment in Prehistory

The global context for the late prehistoric environment was a broad shift from warmer and wetter summers in the early Holocene to cooler and drier conditions in the late Holocene. Regional evidence suggests there were mid-Holocene woodland clearances in southeastern Scotland to make way for pasture. This was followed by woodland regeneration and then near-synchronous regional woodland clearance from c. 2000-1850 BC. These clearances were small and localized but were sometimes maintained for hundreds of years. After 500 BC there is again evidence for widespread, asynchronous, total woodland clearance though some areas were not cleared until the Roman period.

It is very difficult to unpick whether anthropogenic factors, climate factors, or both contributed to changes in forestation. If trees are in a fragile state, human impact will either be negligible because clearances are occurring naturally anyway or devastating because it pushes the system over the edge (Tipping 1994). Possible causal climate factors include storminess, precipitation, or sea level change, and PAGES work on North Atlantic circulation will be essential for better understanding of the liklihood of these factors in the past.

Late prehistory appears to have been characterized by a general cycle of shifting climate, with people relying on a very mixed subsistence strategy including stock rearing, agriculture, hunting, gathering, and fishing (Jobey 1978, Jobey *et al.* 1987, Ralston 1979, Rideout 1992c). It is currently believed that regional farming may best be characterized as subsistence agriculture based on emmer wheat. It appears that herding of cattle and sheep was at least as important, and there is also some evidence for pig husbandry.

There are some avenues of research that have not yet been fully explored. For example, peat bogs could be direct sources of information about past local climates and environment (Barber 1982) given detailed studies with good absolute dating (Blackford 1993). A study of pollen assemblages from buried soils is ongoing at the University of Stirling Department of Environmental Science and may also provide useful information. To my knowledge no dendroclimatology has been done in southern Scotland, however archaeologists may need to pay particular attention to the fate of trees because "a growing body of evidence suggests that at times when tress suffered due to environmental downturns people also suffered" (Baillie 1993:13). The extension of isotopic studies also offers great potential (Whittington and Edwards 1997).

5.3 Climate Modeling

Climate modeling is essential for integrating sources of evidence at different scales. Construction of an appropriate regional model is an important first step in building a bridge from the global context to detailed regional datasets, and in implementing a historical ecology framework for study of late prehistoric Scotland.

5.3.1 Introduction to Modeling

The word model has lots of meanings, but in science a model is usually a simplified representation that allows better understanding of something complex in the natural world. Some of the earliest scientific models were physical. For example, models of the solar system were built by early astronomers trying to understand the way planets move in relationship to each other. These kinds of physical models are still used – many children learn that the planets in our solar system revolve around the sun by playing with just such models – but more abstract kinds of models are also now available to scientists.

Analogy is the process of arguing from similarity in some traits to similarity in other traits. Archaeologists use analogy, sometimes indiscriminately or unwisely (Ascher 1961) to construct explanatory models. The use of ethnographic analogy, or making arguments about the ways people would have lived in the past based on ethnographic observation of people from different cultures in the present, is particularly widespread in American archaeology as it is closely allied with anthropology. A relatively new kind of analogy has appeared recently in the archaeological literature and is based on the adaptation of ideas drawn from phenomenology. Here experiences obtained by interacting with ancient monuments in the present are used to argue by analogy for the ways people may have interacted with these monuments in the past (Tilley 1994).

Some models shape the questions we ask in archaeology and how we attempt to answer them. For example, French historians of the *Annales* school suggested that rural social history is structured in the short, medium, and long term. Relatively long term structures, for example the ecology of a region, are thought to affect medium and short term human relations therefore multi-temporal and multi-scalar regional analysis are advocated as the best ways of understanding social history. This has been successfully tested and adopted by archaeologists (Bintliff 1991, Crumley and Marquardt 1987).

Another main class of model, used in both archaeology and environmental sciences, is mathematical modeling. There are a range of types of mathematical models including deterministic models for which inputs and outputs are rigidly controlled, stochastic models in which probability is factored, dynamic models that accommodate change through time, and a variety of multivariate models. Stochastic and multivariate models are probably the most familiar to archaeologists as many of our most cherished statistical techniques (e.g. linear regression, variance analysis, multiple regression) are included in these categories.

Economic models are also frequently used in archaeology, and the precise kinds of economies being modeled range widely. Ways of modeling human economic behavior in our late 20th century global capitalist economy (e.g. supply and demand) are not appropriate for many populations studied through the archaeological record and for this reason other models have been developed. For example, economic models such as optimal foraging are frequently used to assist archaeologists studying those who live by hunting, gathering, and fishing (Winterhalder and Smith 1981). Population modeling has been with us since the late 18th century (Chapman 1988) and underpins much discussion of past economies as do models of kinship and socio-political organization drawn from anthropology (Clarke 1972a).

Computers are used to generate a wide variety of archaeological models, and there is an interesting debate in progress at the moment about whether computers enable us to model the past in new ways or whether they only allow us to apply older models to more data in a faster way. Predictive models of site location generated from the location of known sites, detailed modeling of the effort required to transport goods and people across landscapes, and modeling the intervisibility of sites are three classes of model commonly associated with the growing use of Geographic Information Systems (GIS) in Archaeology (Allen *et al.* 1990). That is not to say that these classes of models were never used before GIS existed (e.g. Butzer 1982, Clarke 1972b and Hodges 1987), but GIS is the tool that has made these models systematically accessible to archaeologists. Computers are also associated with the rise of models based on visualization (Miller and Richards 1995) and virtual reality (Gillings and Goodrick 1996). Maps are one very old form of creating visual models of the earth, but the development of relatively inexpensive desktop computing has introduced the ability to move through and interact with visual models.

What all of these models have in common is the ability to simplify some aspect or aspects of the complex world allowing study of dynamic systems or other things that cannot be effectively reproduced in a lab, experimented upon, or studied in the field. Models are often used to decrease the timescale required to observe complex interactions in nature, and thus make such systems more appreciable by, and accessible to, human study. Models are also used to facilitate the integration and testing of a variety of data.

Models may be useful at any stage of research, and intuition, experimentation and theory all have their roles in modeling. Models change from *a priori* to *a posteriori* types as the modeling process moves from enabling depiction of complex data to ordering them and then to explaining them (Hardisty *et al.* 1993). Creating models can thus be useful in moving projects through the process of researching minutiae and detail, and then on to the creation of broader explanatory frameworks.

However, modeling isn't enough on its own either. Every model has its limitations, and it is important for model creators to clearly communicate these and any assumptions underlying construction of the model. No model is complete until its been tested in the real world against fresh data and most models can be refined in terms of their accuracy, precision, range, or scale.

Climate models can help us answer questions about the ultimate causes of environmental change as well as determine its seasonality, pace, and scale. This is because climate itself results from interactions in the atmosphere, biosphere, cryosphere, and oceans as solar radiation, the primary source of energy, is input into this system. For this reason climate models provide a unifying backdrop for studying the Holocene environment (Wise and Thorme 1995).

There are two types of climate models in widespread use. The first are General Circulation Models (GCMs) and the second are Energy Budget Models (EBMs).

5.3.2 General Circulation Models

These complex, global-scale, three-dimensional dynamic mathematical models are based on physical principles like the law of thermodynamics. GCMs represent change in Earth's atmosphere and oceans in order to model broad scale climate systems including precipitation, temperature, wind circulation, and pressure on a scale of minutes or hours over time periods ranging from a few years to hundreds of years (Kutzbach 1985).

The various components of the climate system can be either initially specified or calculated during the model run. The affect and importance of the various forcing variables are monitored for each model. For example, using variable soil moisture values (where the calculations from T1 in the model produce the values for T2) rather than prescribed soil moisture allows more accurate modeling of past climates by enabling calculation of evaporation rates which influence earth's hydrology, temperature and circulation (Gallimore and Kutzbach 1989:177).

Calculating many variables makes the GCM more realistic, but also makes it more complicated to construct and expensive to run. A great deal of effort has been expended in the last few years to link atmospheric GCMs and oceanic GCMs with global models of surface variables such as biome distribution or soils (Foley 1994). GCMs were already so computer intensive, however, that these newer versions push the limits of currently available computing technology.

GCMs are especially useful in conjunction with paleoenvironmental studies of the recent past with relatively accurate time control. Discrepancies between simulations and field data can point to areas of weakness in the models, so systematic comparison of model output with field observations is extremely useful for fine-tuning models. GCM simulations of past global climates can be tested against the archaeological, geological, paleobotanical, paleozoological, and other records (COHMAP 1988, Kalkstein 1991, Wright *et al.* 1993).

What this testing tells us is that the accuracy of model output varies by region and variable. For example, there is good correlation between paleolake-level evidence and GCM runs for the last 18,000 years in Africa (Street-Perrott and Perrott 1993) though precipitation is the least accurately modeled component of climate in GCMs. The models seem to work best in the northern hemisphere, especially in the area of the north Atlantic. This is partly due to the greater concentration of land mass in the northern hemisphere, the greater amount of research which has been done on northern high latitude areas, and the greater quality and quantity of input records (e.g. sea ice).

5.3.3 Energy Budget Models

EBMs are easy to use, inexpensive mathematical models based on the laws of mass and energy conservation. They require some knowledge of climatology, mathematics, and physics to construct. These models calculate the temperature characteristics of the earth's atmosphere from information about the amount of incoming solar radiation reaching the Earth (Crowley and North 1991:7).

Zero-dimensional EBMs are the most simple models because they do not resolve differences at varying latitudes and longitudes and are based only on the assumption that on Earth there is a balance between incoming absorbed solar radiation and outgoing terrestrial radiation. One-dimensional EBMs are based on the additional piece of knowledge that the Earth receives more solar radiation at low latitudes than it does near the poles. As a result excess heat flows from equatorial regions to higher latitudes via the atmosphere and the ocean. Two-dimensional EBMs take geography and seasonal radiation changes into account for a more accurate depiction of global circulation patterns. Experiments run with two-dimensional EBMs yielded temperature results that measure up to those given by GCMs (Hyde *et al.* 1989).

One archaeological example of the application of an EBM is in the macrophysical model developed by Reid Bryson (Bryson 1984). The amount of solar radiation reaching the Earth provides the foundation of this model, as is the case with all GCMs and EBMs, but the macrophysical model also takes account of volcanic aerosol modulation of incoming radiation for the last 30,000 years. In addition modern climate information is added. This includes such variables as 30 year averages for annual rainfall, annual temperature, and annual wind direction/speed.

5.3.4 EBM for Southern Scotland

Professor Bryson was kind enough to create a macrophysical model of the paleoclimate around Newstead for this project. He began by plotting the 30-year monthly average precipitation (see Figure 5.2) and temperature. As no data were available for Newstead he worked with data from Aberdeen, Durham, and Renfrew, the three nearest climate stations for which he could gain data. Modern precipitation and temperature readings for each of these 3 climate stations were interpolated, controlling for elevation, to produce a model for monthly average precipitation (see Figure 5.2) and temperature (see Figure 5.3) around Newstead.

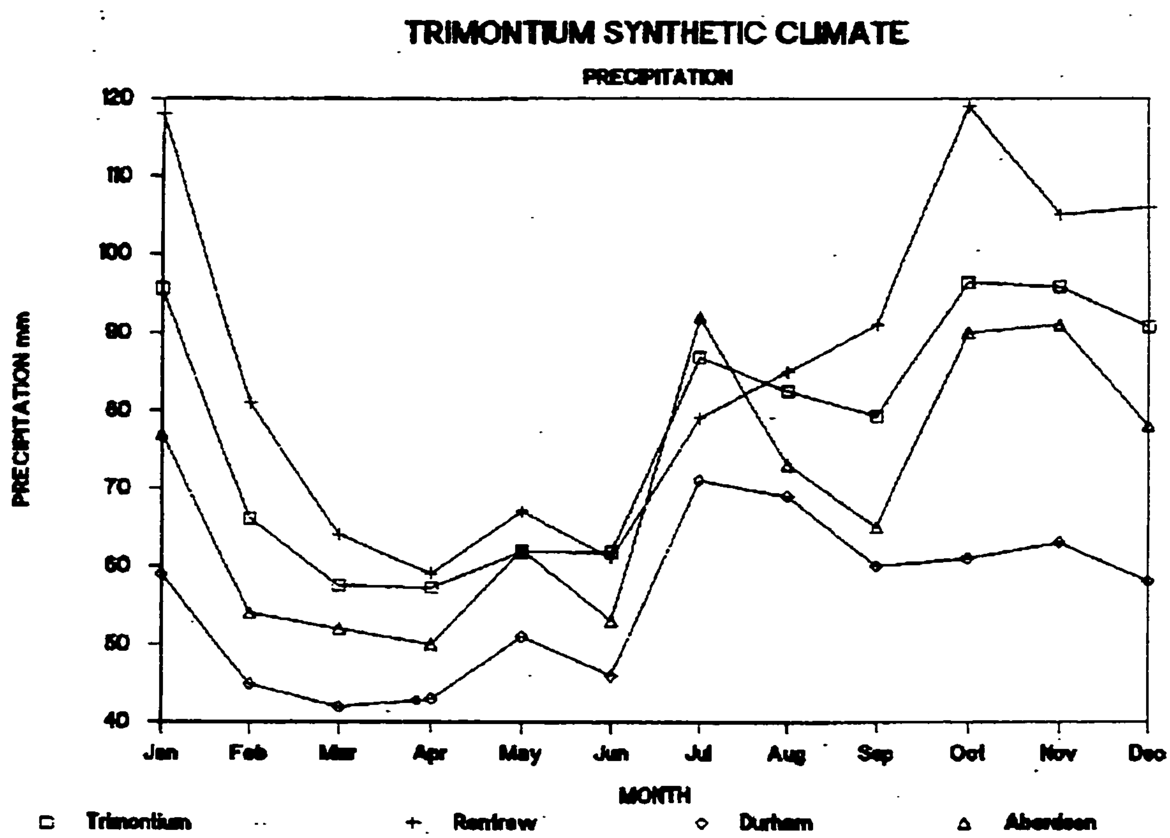

Figure 5.2 Modern climatic data. Graph showing 30 year average monthly precipitation values for Aberdeen, Durham, and Renfrew which were used to interpolate the average monthly precipitation for the area around Newstead (Trimontium).

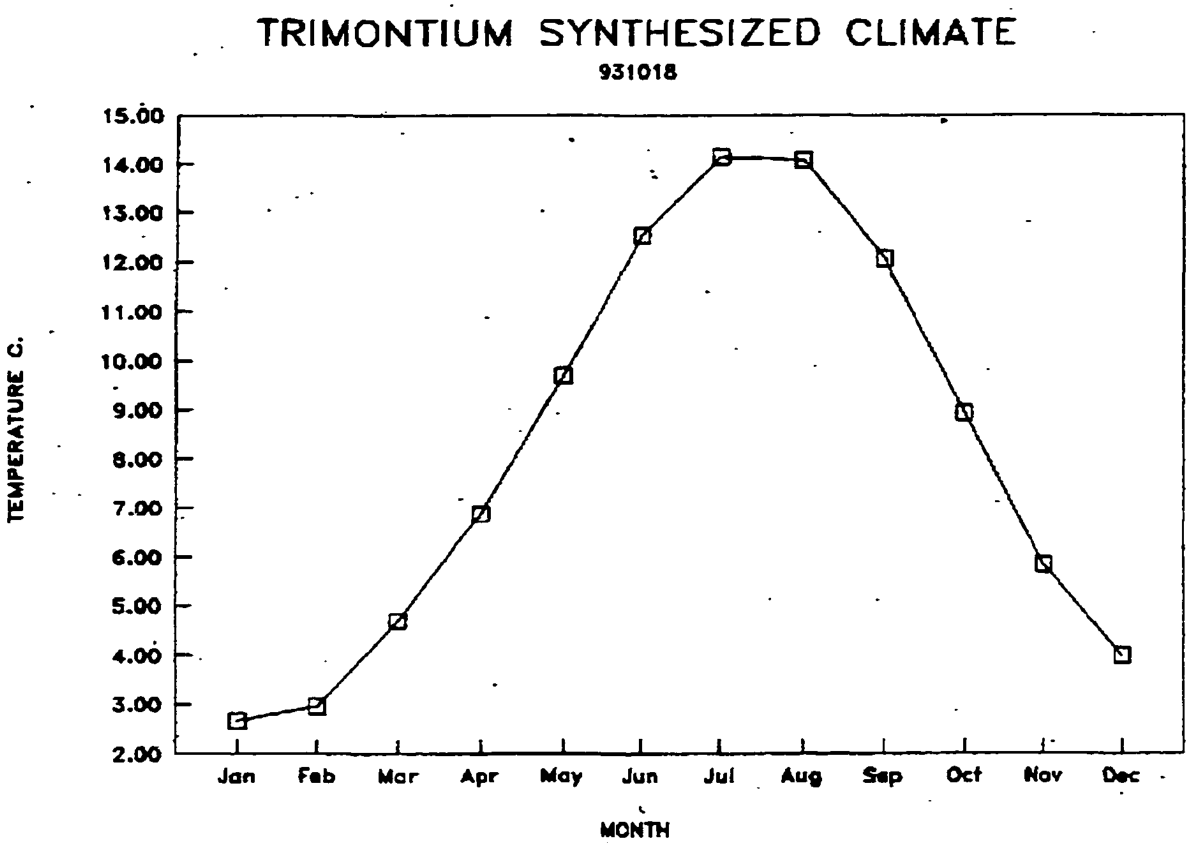

Figure 5.3 Temperature model. The monthly average temperature for the area around Newstead (Trimontium) based on interpolation of modern data collected in Aberdeen, Durham, and Renfrew.

The simulated annual average precipitation and temperature figures for Newstead were then combined with a simple model of fluctuations in incoming solar radiation during the Holocene to create a model of Holocene temperatures around Newstead (see Figure 5.4).

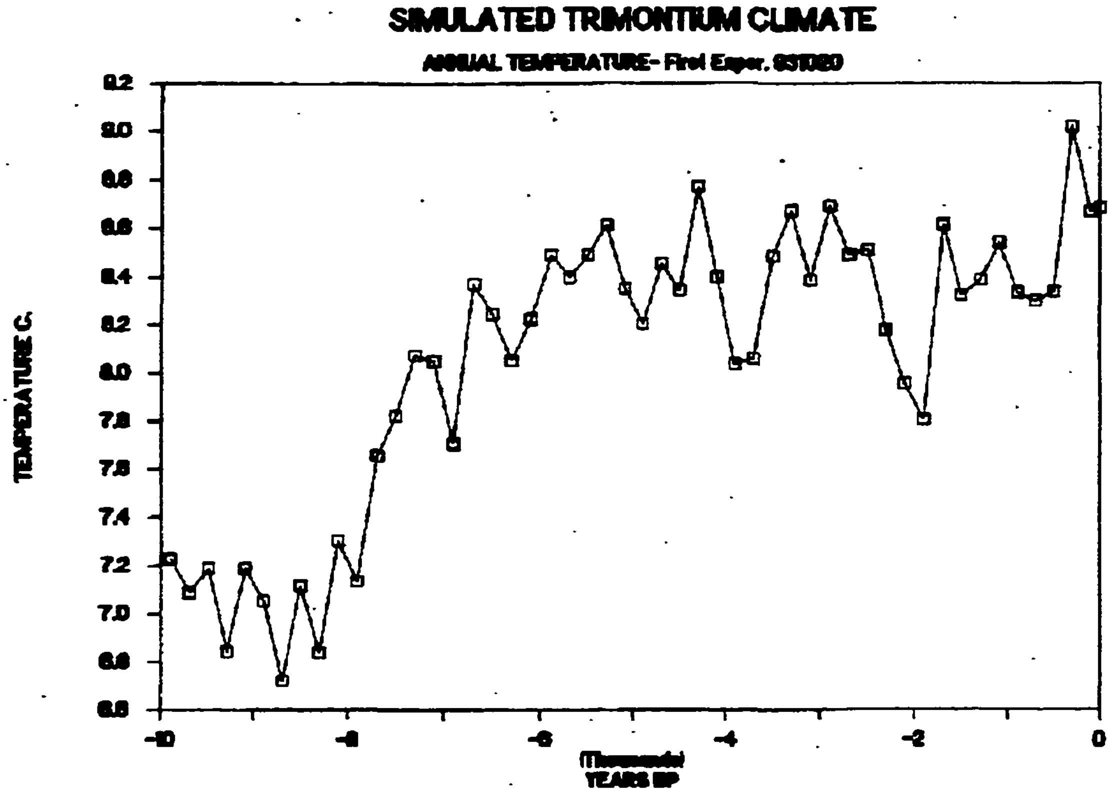

Figure 5.4 Temperature model for Holocene changes around Trimontium.

The general pattern presented in Figure 5.4 is of a cooler (and presumably drier) climate in the early Holocene, and a warmer (and presumably wetter) climate in the late Holocene. The transition between these regimes was marked, and appears to have taken place between 6,000 and 8,000 BP. Interestingly, this pattern is exactly the opposite of the global Holocene context.

The model suggests that there was regular climate fluctuation, with two notable dips in temperature at c. 4,000 and 2,000 BP. Although the model provides information on a different temporal scale from the pollen evidence, the dip in temperature around 2,000 BP is interesting given evidence for the near-synchronous regional increase in woodland clearance from 2000-1850 mentioned earlier. Further work is needed, however, to know whether temperature fluctuations may have been a significant factor in human woodland clearance especially as the woodland clearance that took place c. 500 BC coincides with one of the warmest periods in the model.

One important question to ask of this model is whether the modern climate stations used are appropriate proxies for Newstead. Since this macrophysical model was first created, the British Atmospheric Data Centre has put 43 large datasets online. These data include daily climate readings from stations near Newstead including Blythe Bridge, Bonchester, Galashiels, Glentress, Peebles, and West Linton. Modern data from these stations were examined and the pattern and range of average daily temperature from all 6 climate stations is very similar (see Figures 5.5 - 5.10), suggesting that the proxies are strong.

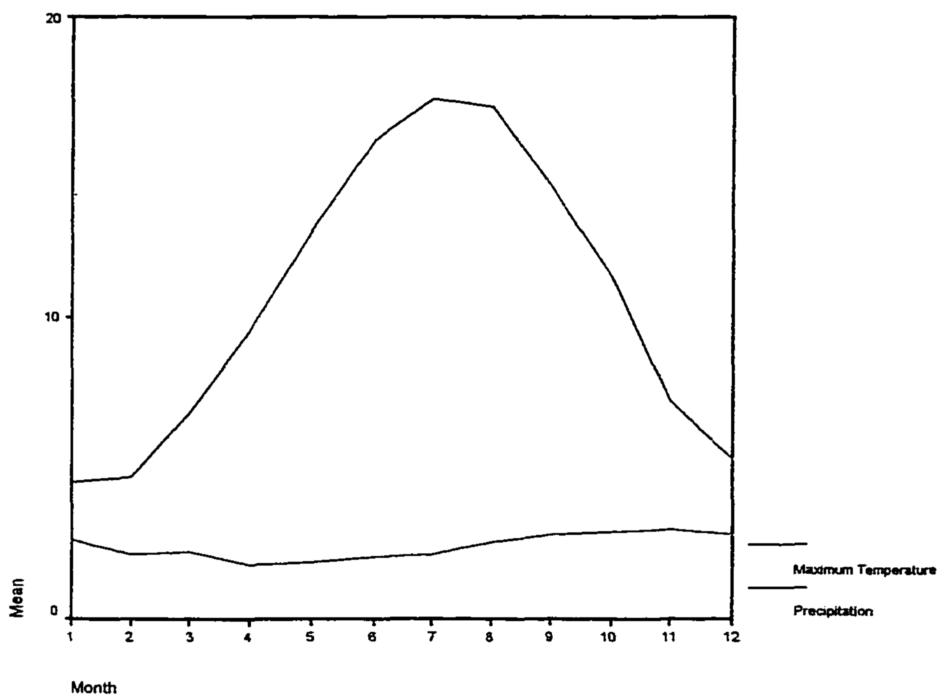

Figure 5.5 Blythe Bridge Climate Station, January 1959 - June 1998

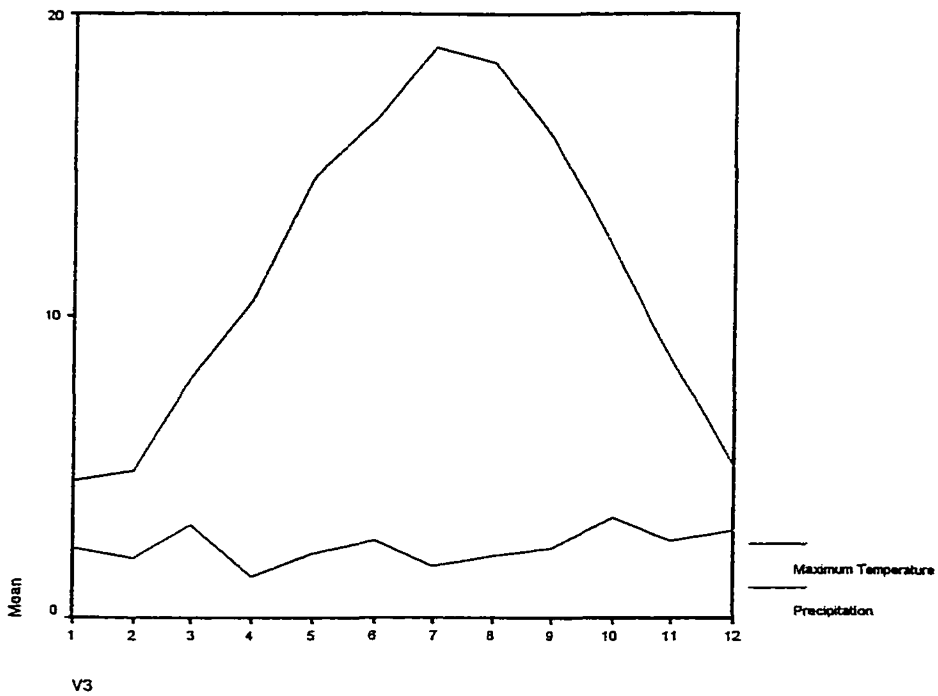

Figure 5.6 Bonchester Climate Station, October 1976 - December 1985

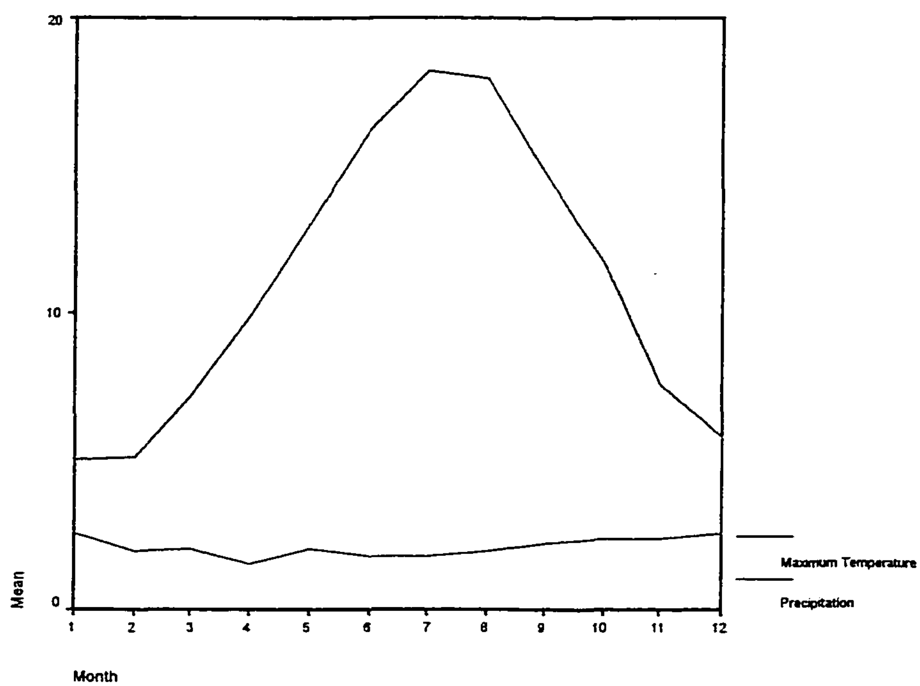

Figure 5.7 Galashiels Climate Station, March 1967 - June 1998

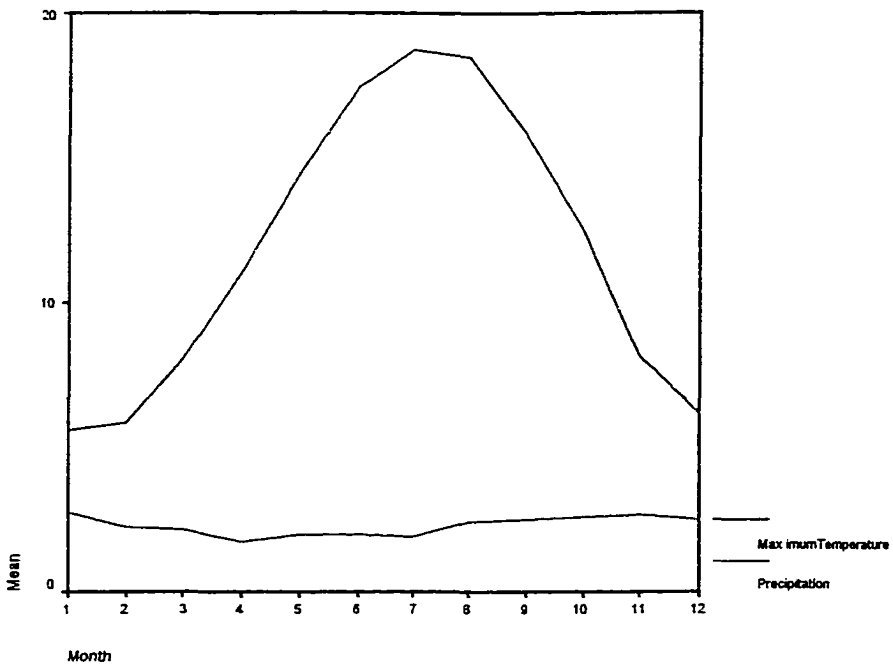

Figure 5.8 Glentress Climate Station, August 1959 - June 1998

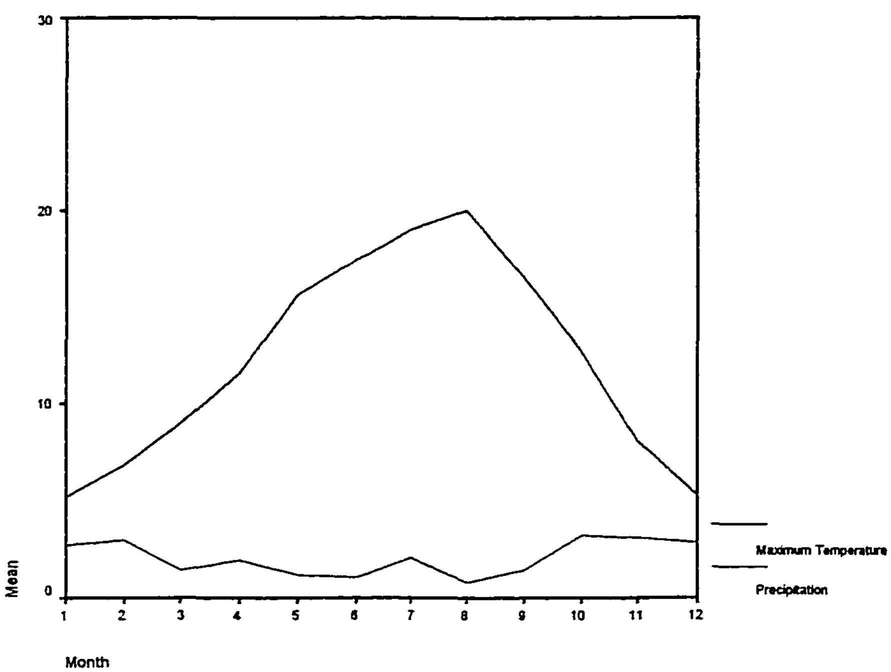

Figure 5.9 Peebles Climate Station, April 1959 - December 1961

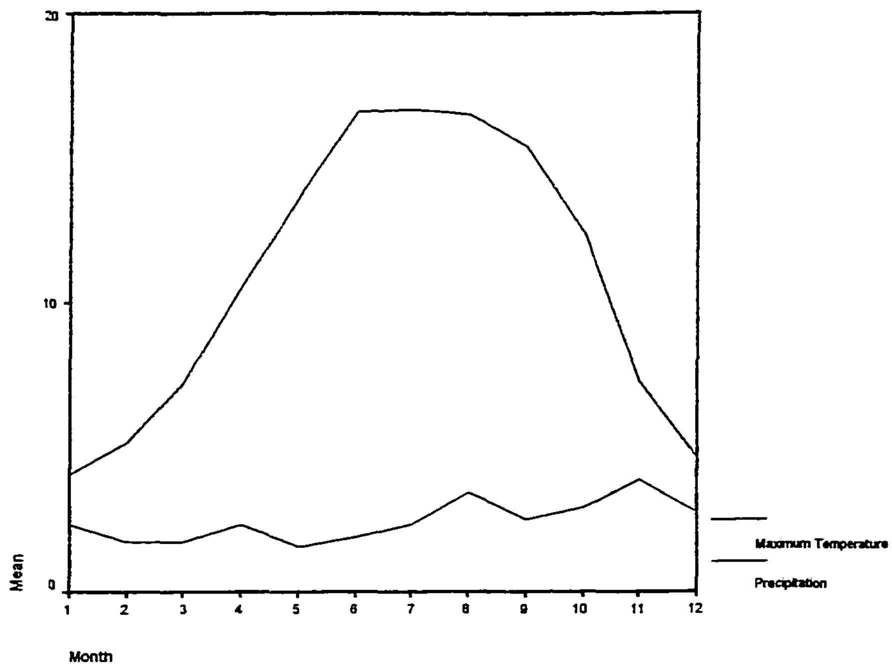

Figure 5.10 West Linton Climate Station, January 1959 - September 1964

It is much harder to assess how appropriate the modern precipitation data are as they represent average daily precipitation, and the model is based on average monthly precipitation. To rectify this, precipitation sums were totalled for each of the modern climate stations (see Figures 5.11 - 5.16). Note that in these figures it is the pattern of annual precipitation that should be compared to the model, and not the amount of precipitation.

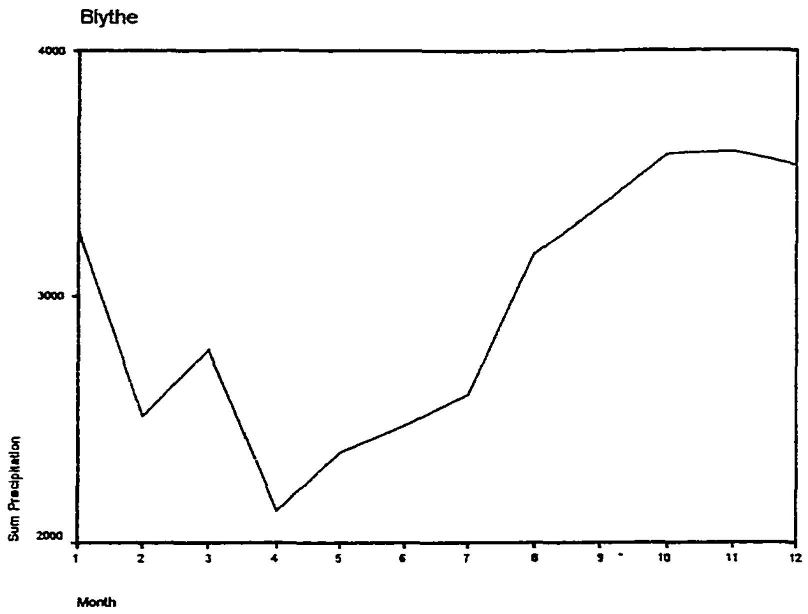

Figure 5.11 Annualized monthly precipitation from Blythe Bridge Climate Station, January 1959 - June 1998

Figure 5.12 Annualized monthly precipitation from Bonchester Climate Station, October 1976 - December 1985

Figure 5.13 Annualized monthly precipitation from Galashiels Climate Station, March 1967 - June 1998

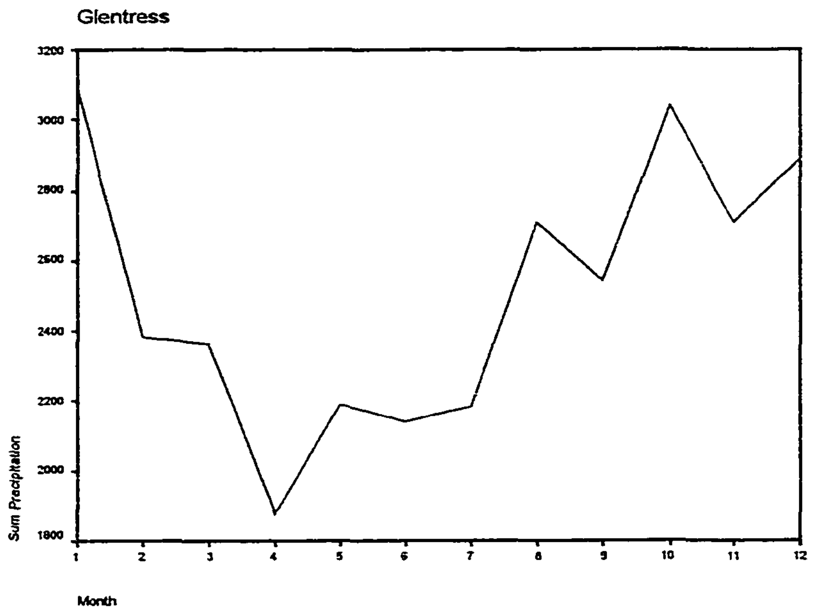

Figure 5.14 Annualized monthly precipitation from Glentress Climate Station, August 1959 - June 1998

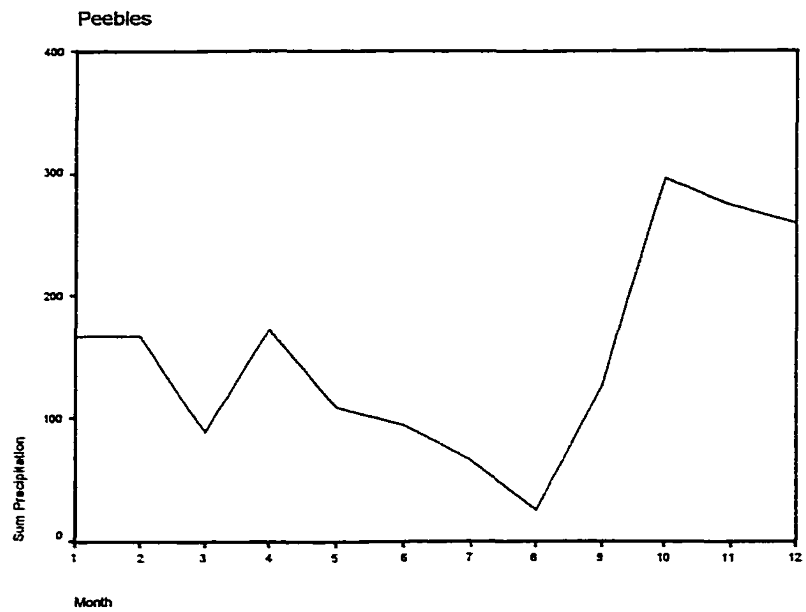

Figure 5.15 Annualized monthly precipitation from Peebles Climate Station, April 1959 - December 1961

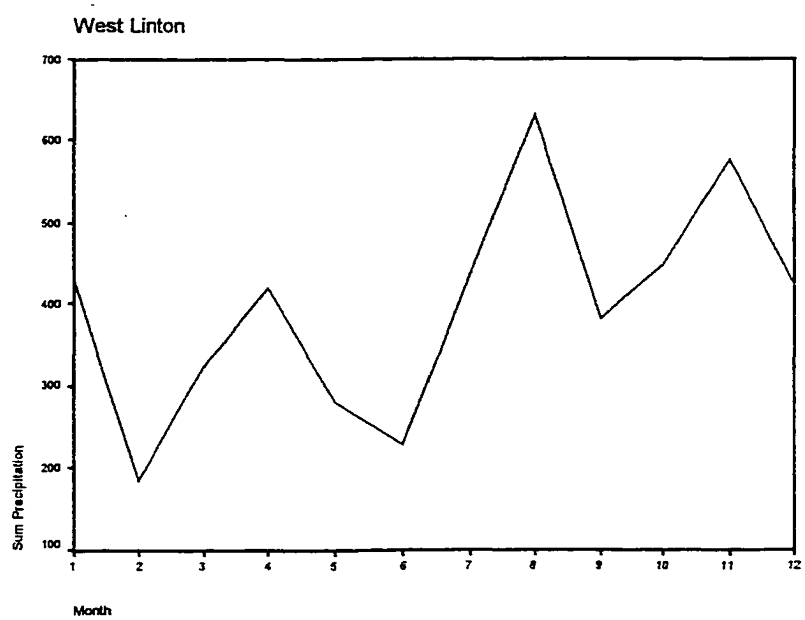

Figure 5.16 Annualized monthly precipitation from West Linton Climate Station, January 1959 - September 1964

The pattern of precipitation is generally similar to that in the model for all climate stations with annual lows in the early spring and increasing amounts of precipitation through the year. Interestingly, each climate station differs from the interpolated data in specific ways (see Table 5.1). This mismatch appears not to correlate with elevation so much as longitude, and suggests that the seasonal distribution of precipitation is affected by the clear annual trend for greater rain and snowfall in the west (see Figure 5.17) of Britain. Such dominant features of the modern British climate, caused by frontal movement from the Azores High to Icelandic Low which produce west-south-westerly winds (Manley 1970), are likely to have characterized earlier Holocene climates.

Table 5.1 Comparison of modern climate stations, and how their precipitation records compare to the proxies used in modeling.

	Elevation	**Comparison to Proxies**
Blythe	253	Greater precipitation in the autumn.
Bonchester	146	Greater precipitation in both spring and autumn
Galashiels	198	Greater precipitation in spring, less in autumn.
Glentress	165	Close match.
Peebles	197	Greater precipitation in the spring, and much less in the summer. Note that data is only available for 3 years.
West Linton	244	Greater precipitation in spring.

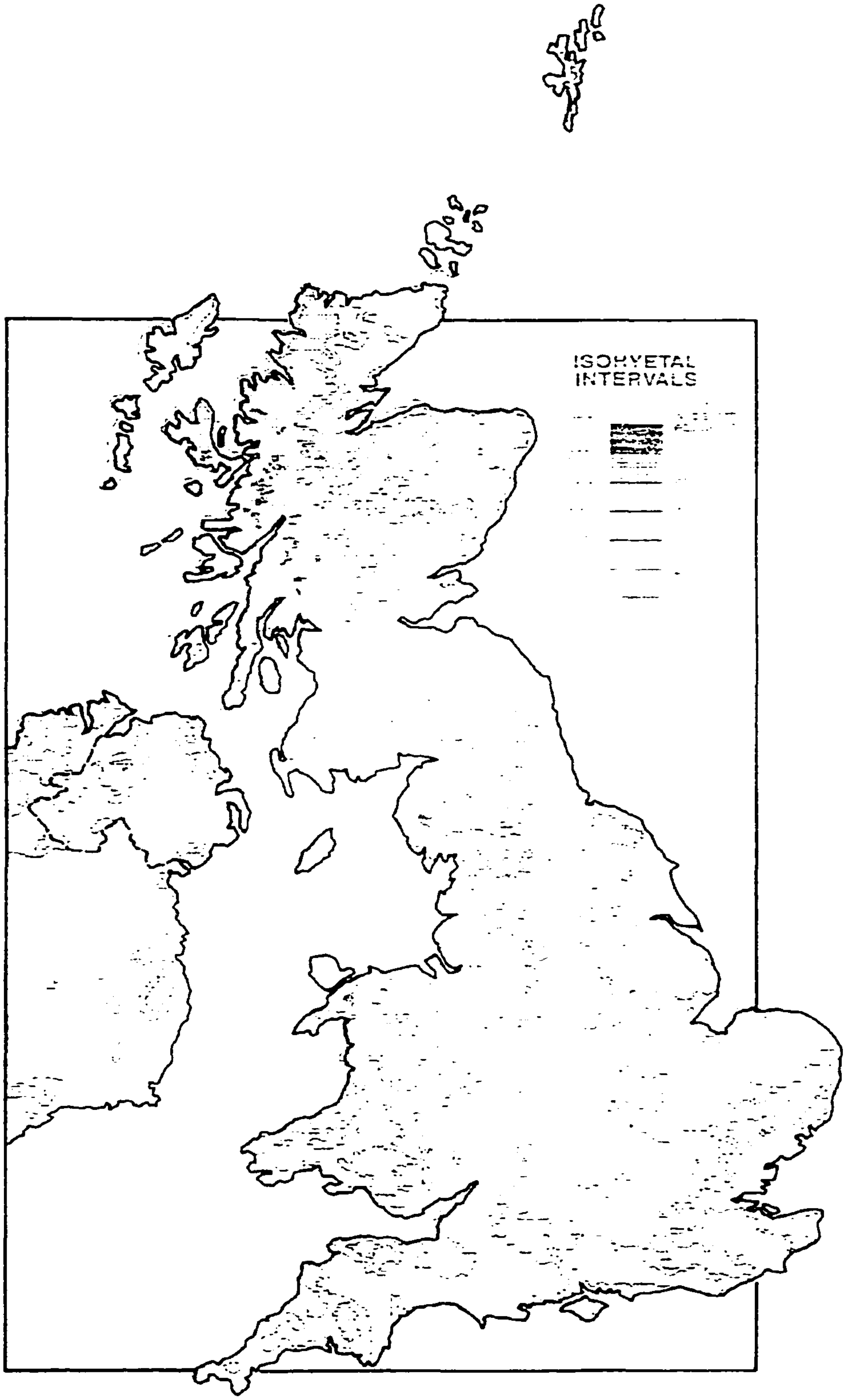

Figure 5.17 Map showing average annual rainfall in Scotland from 1941-1970

5.4 The Way Forward

5.4.1 Climate Models: a beginning?

Archaeologists and climatologists have a great deal of information to share. Climatologists have a sophisticated understanding of global climate and its regional expression. Adding climate variability on human timescales to our paleoenvironmental reconstructions will help make those reconstructions as dynamic as the environment itself.

For archaeologists the detail of daily or seasonal weather regimes might seem more informative than long term climatic trends. A quick short-lived climatic change, for example two or three years of flood or drought, could have had very serious consequences. Long term trends can, however, help archaeologists understand the variation people had to contend with in the past.

Rapid changes are the most difficult to learn about via global climate or energy budget models. Some sense of the range of variance, frequency, and magnitude of extremes can be obtained, but it is currently just too expensive to run GCM modeling experiments at fine enough resolution to answer human-scale questions. In fact, the reason no GCM data are presented here is that they are currently available only at 3,000 year intervals and unfortunately there have been no modeling runs for 2,000 BP.

Spatial scale is an important issue when determining how GCMs can be useful to archaeologists (Wise, in press a). GCMs are really not useful for determining what the climate was like at a particular spot on the ground in a particular century in the past. The map output created by GCM runs are difficult to relate precisely to particular points on the ground. GCMs are not going to replace detailed pollen core, paleo-lake level reconstruction, and other proxies for specific archaeological locales for a long time to come. Rather, GCMs can clarify some of the major reasons that climates changed across regions in the past. They also provide information about what past climates may have been like in those areas lacking proxy data. GCMs also provide important information on the seasonality and magnitude of past climate states. Changes from winter to summer precipitation regimes, for instance, are likely to be apparent from careful examination of GCM runs and in the past would have been especially important for agro-pastoralists.

Finer spatial resolution is offered by regional circulation models (Giorgi *et al.* 1993), which combine the physics of climate modeling with the detailed dynamics of weather forecasting. One application simulates the late glacial climate of the southwestern United States and demonstrates the contribution of both continental scale and local climate features (Hostetler *et al.* 1994). The horizontal resolution in this model is 60 km, and a similar model for Britain would be extremely helpful.

Archaeological evidence may be useful for fine-tuning models, much like paleo-lake level data or information from pollen cores, but the archaeological record is not a straightforward proxy climate indicator. Scale differences mean that we can often only detect general chronological correlations between climatological and cultural events, and rarely establish cause-affect relationships (Harding 1982, McGhee 1981).

The range of disciplines that are cross-cut in paleoenvironmental research is large: climatology, geology, botany, archaeology, chemistry, biology, and others. Interdisciplinary collaboration can lead to new understanding and piecing together previously disparate, but actually related, bits of information. However, communication across disciplinary boundaries is difficult, and this seems to increase exponentially when multiple disciplines are involved. Archaeologists need to articulate to those who study the paleoenvironment and those who do environmental modeling their need and desire for finer time resolution and spatial scales. It is important that archaeologists do not accept paleoclimatic reconstructions at face value, and instead understand the process by which the models are created.

Paleoenvironmental models can provide a "reality check" for the consistency of assertions made about the affects, or lack thereof, of climate change upon human populations. GCMs can provide information about why widespread environmental changes occurred in the past. They can be used to check the consistency of climate-based theories to explain evidence collected from the archaeological record. In areas for which no paleoenvironmental proxy data are available, GCMs can fill in puzzle pieces. The scalar resolution of current GCMs is not perfect for archaeological applications, but we can look forward to continuing improvement in this area. Also improving is the degree of realism with which natural processes are modeled. Finer time resolution is one aspect of GCMs that should improve in the next few years, but for finer spatial resolution we may need to look to a new breed of climate model.

It is likely that in the future more modeling will be undertaken directly by archaeologists, and it should be possible to incorporate greater spatial and temporal resolution in order to create models of greater complexity and realism. In particular a decreased reliance on linear mathematical models will be useful as will increased application of visualization and virtual reality models. Archaeologists interested in modeling the environment also need to embrace more post processual ideas and theories (Lock 1995, McGlade 1995, Wise in press b).

5.4.2 Future Paleoenvironmental Work

There is a great deal of high-quality paleoenvironmental research taking place in Britain. Efforts to align this work with global interpretive frameworks and historical ecology would be well repaid. Particular consideration of concepts such as patch, grain, stability, resilience, persistence, recurrence, predictability, constancy, and contingency would help bridge the culture/nature and regional/global gaps.

This framework suggests new archaeological questions that could usefully be addressed by environmental archaeologists or other environmental scientists working in the region including:

- what was the periodicity of occupation in different settlement classes, if any?
- what was the ecology of these settlements? (after Bell 1996, O'Connor 1998)
- what was the paleoenvironment around Traprain Law?
- is it possible to break down the culture/nature dichotomy in our thinking and writing about the paleoenvironment? (after Ingerson 1994, McGlade 1995).
- how did the process of deforestation affect subsistence strategies, production of goods such as iron, settlement locations, trade patterns, social relations, and land value?

For those managing and funding archaeological work there are some messages about the importance of:

- systematic and consistent sampling policy during all excavations, whether Roman or native, in order to develop an accurate picture of environment. (after Hanson and Breeze 1991, Hanson and Macinnes 1991)
- targeted excavation of sites with good organic preservation.
- phrasing dates in terms of the Holocene rather than archaeological episodes or phases to aid global contextualization of regional data.

5.5 Conclusion

Historical ecology appears to be the best theoretical framework for continued bridging of global Holocene contexts and detailed regional datasets. This is because it advocates collection of baseline environmental and cultural evidence, and applies this evidence to alleviating the impact of modern climate change through documentation of present and past regional adaptive strategies (Crumley 1993, 1994a, 1994b). The pursuit of historical ecology is best supported when human and environment relations are modeled at global, regional, and local scales using information drawn from archaeology, documents, ethnography, hydrology, pedology, topography, species distributions, climatology, etc. (Crumley 1993).

One of the themes in historical ecology is resilience, and a generally accepted principle of ecosystem studies is that "Systems that have experienced variation, that are spatially heterogeneous, and that are more complex (but lack high degrees of connectedness) are likely to be more resilient" (Winterhald 1994:39). Responses to environmental change depend on culturally transmitted knowledge about the environment and its fluctuations. If cultural knowledge does not adequately explain environmental fluctuations, and "if unstable conditions persist, traditional authority is challenged and new sociopolitical structures emerge that are more amenable to changes in population size, pattern of authority, and locale" (Crumley 1993:382).

Herein lies an additional way of understanding the regional archaeological evidence in southeast Scotland. It suggests that the native population had adequate information about their environment to cope with its regular fluctuations, and their diversified subsistence strategies were quite noteworthy in this respect. One hypothesis is that a highly mixed subsistence strategy was beneficial given the fluctuating marine climate. It is even possible that cultural memories about this adaptive strategy were consciously retained, and it has been suggested that a druid-like class may have performed such a function in prehistory (Crumley 1995).

VI. CONCLUSION

The most important archaeological results are those that tell us something about the people that lived in a study region in the past. The identities of those who lived in southeastern Scotland during late prehistory are discussed at the end of this chapter, after a summary of key results, discussion of methods used and theories applied, and an outline of priorities for future work.

6.1 Aims and Objectives

The aims of this project were to study protohistoric human ecology and the ways native society responded to changes in the cultural and natural environments. Specific objectives of the research program in the study area were to:

- Collate archaeological and paleoenvironmental evidence,
- Conduct targeted geophysical survey and excavation to fill some major gaps,
- Analyse this evidence in order to look for patterns in site distributions,
- Develop a paleoclimate model,
- Construct an historical model of change through time, and
- Present a preliminary explanation based on anthropological principles.

These objectives have been achieved. Strong aspects of the research program included the collation of large bodies of archaeological and environmental evidence, documentation of variability in site types, exploration of patterns in site distributions, and development of a regional paleoclimate model. These were used in turn to construct a preliminary historical model of change through time, and to develop a possible explanation for this sequence based on anthropological principles. Along the way innovative analytical techniques for geophysics and GIS data were developed.

There were clearly some weaknesses in the research program as well. Chronological control is poor for the region as a whole, and no contribution was made on this front. The settlement pattern analysis also sufferred through lack of appropriate analytical tools, especially access to spatial statistics software.

6.2 Key Results

6.2.1 Geophysics

Key results from interpretation of geophysical data went beyond identification of enclosures to be excavated during the life of the Newstead Research Project. Geophysical data produced new information about the construction and layout of many native sites (see Table 3.4 and Appendix 1). More than 20 homesteads in the study region appear to have had multiple construction episodes including ditch realignment and/or expansion. Data used as evidence for multi-phase construction activity included overlapping geophysical anomalies, the presence of both curvilinear and rectilinear construction techniques, and the construction of external earthworks that respected the lines of settlements. In general the widespread evidence for multi-phase construction suggests an investment in settlements and a degree of organic growth within them.

There is also evidence for the successive re-use of settlement locations, often continuing to the present day. The definition of location re-use used here was the presence of other archaeological or modern features within 250 m of a site. 34 of the 40 enclosures had such evidence. Many of the 34 sites with evidence for location re-use were near sites of more than one period (e.g. there were nearby early prehistoric features such as tumuli or standing stones as well as medieval and modern features). The degree of location re-use seems to suggest great social investment in particular places.

The patterning of internal curvilinear and rectilinear features is another piece of interesting information that comes from close analysis of the geophysical data. The general trend is for curvilinear enclosures to have curvilinear structures but for rectilinear sites to have either curvilinear or rectilinear structures (see Table 3.6).

Previously unrecognized construction patterns have become apparent through comparison of geophysical survey data from this region. For example, many rectilinear sites appear to have small gaps near the ditch corners perhaps to allow a walkway across the ditches. Excavation at Lilliesleaf confirmed the careful construction of such a gap.

Geophysics data provide greater detail than aerial photograph cropmarks, and both make valuable contributions to regional analysis. This value can be maximized through settlement pattern analysis to contextualize and complement regional survey data.

6.2.2 Settlement Pattern Analysis

This research provides the first assessment of settlement evidence in central Tweeddale since Christison's survey in the 1890s and the RCAHMS survey of 1956. Settlement pattern analysis was useful in moving from the site-specific detail of the geophysics information to a regional framework, and enabled a search for evidence of larger socio-cultural groupings (e.g. tribes, kinship groups) as well as broad economic patterns (e.g. resources, trade networks).

Morphological classification of settlements confirmed that all hillforts and promontory forts were curvilinear, but homesteads occurred in both curvilinear and rectilinear forms (see Table 3.8). Different spatial patterns appear to have been associated with each of the major classes of native settlement. Crannog distribution was limited to lochs and mosses. Hillfort distribution was limited to the tops of prominent hills. Promontory fort distribution was limited to promontories protected by natural features on three sides. However, there appears to be little to distinguish the distribution of brochs and homesteads in the region except possibly median elevation.

Some homesteads appear to be arranged in a linear pattern following main rivers such as the Tweed and its major tributaries, however the majority of homesteads appear to be clustered together away from the major rivers. Areas with relatively broad floodplains appear to have a more dispersed 'linear pattern' of settlements, and river areas with constricted floodplains (i.e. further up valleys) appear to have a more constricted 'linear pattern' of settlements. Clusters of curvilinear enclosures appear to be associated with no, or a very limited number, of rectilinear homesteads. Three field visits (see Table 3.9) were made to clusters identified through this settlement analysis. Though this was a very subjective way of trying to understand the outcome of the cluster analysis, it did seem that the character of each cluster was slightly different from others. This instilled a degree of confidence that the identified settlement patterns might in some way reflect information about past human behavior.

6.2.3 Fieldwork

Fieldwork clarified little about the relationship of curvilinear and rectilinear homesteads in the study region, but did elucidate the nature of rectilinear homesteads. Key results from the excavation at Lilliesleaf included recovery of a relatively large assemblage of native and roman objects suggesting that assemblages at rectilinear homesteads have more in common with the assemblages at brochs than they do with the assemblages at curvilinear homesteads. The ditch at Lilliesleaf appears to have been slighted before Roman artifacts became available and this process continued during the Roman period. This strongly supports the idea that the ditches do not primarily function as defensive features for the protection of homestead inhabitants and instead served social and symbolic functions.

Geophysical survey and excavation north of Newstead fort also produced evidence suggesting that in the first century there was a defended north annex. Just west of this annex were a series of wells perhaps associated with timber structures but not associated with many metal objects or burnt features. By the second century there was relatively dense settlement of even the steepest slopes north of the fort occupied by people, possibly civilians, with access to Roman glass, iron, bronze, tools, coins, and samian pottery.

6.2.4 Paleoenvironment

Late prehistory appears to have been characterized by a general cycle of shifting climate, with people relying on a very mixed subsistence strategy including stock rearing, agriculture, hunting, gathering, and fishing (Jobey 1978, Jobey *et al.* 1987, Ralston 1979, Rideout 1992c). It appears that regional farming may best be characterized as subsistence agriculture based on emmer wheat, that herding of cattle and sheep was at least as important, and there is also some evidence for pig husbandry.

The global context for the late prehistoric environment was a broad shift from warmer and wetter summers in the early Holocene to cooler and drier conditions in the late Holocene. Regional evidence suggests there were mid-Holocene woodland clearances in southeastern Scotland, followed by woodland regeneration and then near-synchronous regional woodland clearance from c. 2000-1850 BC, and widespread, asynchronous, total woodland clearance again at approximately 500 BC. It is not clear whether anthropogenic factors, climate factors, or both contributed to changes in forestation.

The resilience of the native population in southeast Scotland in the face of climate fluctuations and widespread deforestation suggests that they had adequate ecological information. The adoption of a diversified subsistence strategy seems especially effective in this context.

6.3 Method, Theory, and Ways Forward

6.3.1 Geophysical Survey

Analysis of these geophysical data also points to ways in which future field practice could be improved. There is clearly a need to survey the entirety of each site with both methods, if practical, even when no obvious features appear in initial displays. There is often very subtle information that can be teased out of the data from one relatively unresponsive geophysical technique to confirm (or contradict) the evidence from another more responsive technique.

Similarly, there is a need to extend survey boundaries beyond the site itself to explore the possibility of external or unenclosed settlement evidence. The geophysical survey at Lilliesleaf, for example, suggests the possible presence of a curvilinear structure to the east of the enclosure. The recovery of samian sherds from this same area again supports the possibility of unenclosed settlement evidence.

A finer sampling interval than 1 m would be extremely useful in resolving construction details for these enclosure sites. It would also introduce the possibility of detecting more ephemeral features such as field systems or timber-framed buildings. The finer sampling size could be limited to enclosure interiors if resources are tight, but should be collected whenever possible.

Finally, the response of geophysical techniques was sometimes good even when the background geological conditions precluded the "sensible" use of magnetometry and resistivity. For example, granite bedrock often is used as an argument against geophysical survey but at Butchercote Promontory Fort (see Appendix 1) the ditches carved into this bedrock show up well against the noisy geophysical background. This means that in the context of regional analysis, geophysical methods may be worthwhile even when background conditions are not ideal.

6.3.2 Settlement Patterning

There is richness in the settlement patterning evidence despite the fact that there are no accurate historic texts that describe the region, there are no significant artifact distributions to draw upon, and there are virtually no absolute or relative dates. This underlines the face that it is possible for archaeologists to gain insight into the past through settlement analysis alone. Patterning has been used as basis for new understanding of social organization in late prehistoric southeastern Scotland, and has generated a rich array of prioritised questions for future research.

The use of cluster analysis and visual display of data in a GIS was new and proved valuable in interpretation, suggesting 2km^2 as one effective scale of analysis for the region. This exploratory data method should be useful in other archaeological contexts.

In future settlement pattern analysis in Scotland could be improved if native settlements were systematically categorized by approximate shape, landscape position, and size. The classification systems currently in use at the NMRS and elsewhere mixes and matches these 3 characteristics in an unsystematic way and as a result may occlude meaning.

There are striking differences between regions in southeast Scotland and northeast England. It is currently not possible to tell the regional extent of the cluster and linear pattern observed in the study area or micro-region, but this would be interesting to investigate. 20 km^2 (the size of the present study area) appears to be too limited a scale at which to study this phenomenon, but entire river catchments would be too broad a scale. The answer lies nestled between. Future analysis of autocorrelation and semivariance would be helpful, and may in fact be useful in identifying other effective scales for analysis.

In future, study of the relationship between settlement class and particular categories of water (e.g. lochs, primary rivers) might prove fruitful. More work could also usefully be done to assess gaps in the distribution maps to check and control further for sampling bias (e.g. in aerial photography coverage). Finally, it would be helpful to have more settlement work from key areas. For example, settlement pattern studies in the area around Traprain Law would be extremely valuable.

6.3.3 Excavation

Further exploration of the linear settlement pattern identified through settlement pattern analysis is warranted. Initial hypotheses to explain this pattern include seasonal settlements located to benefit from fishing or water-based trading routes, and/or settlements commanding views down major rivers and serving an ambassadorial or defensive function.

Excavation of multiple sites within a single settlement cluster, a homestead from the linear pattern, and a promontory fort should be illuminating. It would also be helpful to have more settlement work from key places, for example the area around Traprain Law. The excavation of a small portion of the rectilinear homestead at Lilliesleaf has proven useful, and further investigation there appears warranted. Geophysics evidence also suggests good reasons for excavation at Bemersyde Moss, Bogle Field, Butchercote Rectilinear Homestead, Clint Mains, Fens, and Third.

Finally, it is quite critical to try for more absolute dates from each settlement class represented in the region.

6.3.4 Paleoenvironment

There is a great deal of high-quality paleoenvironmental research taking place in Britain. Efforts to align this work with global interpretive frameworks and historical ecology would be well repaid. Particular consideration of concepts such as patch, grain, stability, resilience, persistence, recurrence, predictability, constancy, and contingency would help bridge the culture/nature and regional/global gaps. This framework suggests new archaeological questions that could usefully be addressed by environmental archaeologists or other environmental scientists working in the region. Especially interesting here might be tests of the effectiveness of a diverse subsistence strategy given the suggestion that settlements were located in $2km^2$ clusters, although it is possible that the catchment area for settlements was bigger than this.

For archaeological funding bodies it will be important to support systematic and consistent environmental sampling policies, excavation of sites with good organic preservation, dating in terms of the Holocene rather than archaeological periods, and funding of data collection that will mesh well with the emerging framework for global environmental studies.

6.3.5 Historical Ecology

No single theoretical perspective was adopted at the outset of this research, but an openess to both processual and post processual strategies was. This rather eclectic approach worked well as it provided a flexible framework for dealing with patchy data. Historical ecology and phenomenology were explicitly engaged when writing this text, but the research process itself led me to think of the application of method and theory in a heterarchical way. The settlement evidence in central Tweeddale can be analyzed at a variety of scales (e.g. regional, local, site) and the choice of method and theory varied with the scale of analysis. Human organization in the past also operated at a variety of scales (e.g. tribal, familial, individual) and different theoretical approaches were more informative in analysis and explanation at particular scales.

Historical ecology appears to be the best theoretical framework for continued bridging of global Holocene contexts and detailed regional datasets. This is because it advocates collection of baseline environmental and cultural evidence, and applies this evidence to alleviating the impact of modern climate change through documentation of present and past regional adaptive strategies (Crumley 1993, 1994a, 1994b). The pursuit of historical ecology is best supported when human and environment relations are modeled at global, regional, and local scales using information drawn from archaeology, documents, ethnography, hydrology, pedology, topography, species distributions, climatology, etc. (Crumley 1993).

In the past, interpretation of settlement class has often stopped at claims of functional adaptation to local topography, attempts to define a single developmental sequence, or assumptions of inherent defensibility. More work is needed on the social factors that lead to both the adoption of specific settlement forms (e.g. brochs, crannogs, hillforts, homesteads, palisades, promontory forts, scooped houses, unenclosed platform settlements) and the maintenance of so many different settlement forms.

6.4 People in Late Prehistoric Southeast Scotland

The study region is associated in historical texts with the Selgovae tribe of Celts. The dense concentration of native forts around Eildon Hill North were thought to demonstrate that there was open hostility between Romans and the Selgovae (Hanson and Maxwell 1983). This understanding colored archaeological interpretation of the settlements in the region. For example, Torwoodlee broch is in Selgovae territory and it was suggested that the broch was destroyed by punitive forces after the natives raided Newstead fort for the Roman pottery recovered from the broch (Piggott 1951).

But before Roman expansion into southern Scotland was there a group that identified itself as Selgovan? Was this term one applied to a group of heterogeneous individuals by Roman historians? Was there a single tribe in the region, and were its members Celts? These and similar questions lead directly to consideration of approaches to the study of identity in archaeology.

As scholars in Britain debate the relevance of the term *Celtic* to any late prehistoric population on the island (James 1999), and American scholars set out research agendas for the chiefdoms and states which mark *Celtic* social organization on the continent (Arnold and Gibson 1995a, 1995b) it is increasingly acknowledged that this term is problematic. *Celtic* no longer can be used innocently to refer to some suite of pan-European cultural phenomena conveniently described in Irish texts and retained by some modern populations (Gwilt and Haselgrove 1997). It is an increasingly unhelpful term for archaeologists as it masks a tremendous diversity in archaeological evidence, ideology, social organization, subsistence practices, etc.

Similar debates are taking place in American archaeology with growing recognition that many ways of defining groups are embedded in western colonial experience. Classical anthropological groups, especially tribes, have been challenged in terms of cultural, spatial, and temporal cohesiveness as they were largely identities created for colonial convenience. Many approaches are based on assumptions of passive and unidirectional acculturation and are inadequate for considering multidimensional changes in multi-ethnic social environments (Lightfoot 1995). The synergy between American and European archaeology is unsurprising as Roman colonialism was the first example of western colonialism and its traces are still with us today (Bartel 1985).

New approaches suggest that archaeologists should search the archaeological record for multivariate self-identity groups (Jones 1997, Lightfoot 1995, Maceachern 1998) recognizing that social identities are complex, historically situated, and contextualized (Stark 1998) and that distribution patterns do not equal ethnic groups (Shennan 1989). In fact, it has been argued that ethnicity is a modern ideological construct (Maceachern 1998:111-112), so it is important to keep all options open.

Though we can not say if they thought of themselves as Celts or as Selgovae, the people living in the study region could have drawn on a variety of aspects of their culture in the construction of identities including settlement form and location, and interaction with their environment. Other areas which probably served as foci for self-identification (e.g. age, gender, language) unfortunately do not seem to be easily understood from the evidence currently available to archaeologists in the region.

6.4.1 Settlement-Based Identities

Evidence from excavation, geophysical survey, and settlement pattern analysis suggests that parts of the landscape were occupied for extended periods. This connection to relatively focused parts of the landscape by relatively small groups of people suggests that social organization was based on extended families perhaps with matrilocal or patrilocal residence. Extended occupation of homesteads means that sequential homestead construction and abandonment occurred, potentially extending from the Bronze Age to the Medieval Period. Given this length of time, and the number of enclosures, there may have been only one occupied homestead in each $2km^2$ area at any given time. For inhabitants the settlement would therefore have appeared as *the* settlement in a landscape of family memories.

Broch and rectilinear homestead settlement classes would then be short-lived styles, perhaps borrowed from native groups further north and south, in use at the time when Romans were present in the region. Given the even scattering of homesteads and brochs, this suggests relatively ubiquitous access to Roman objects throughout the study area. It is likely that the indigenous regional population visited Newstead on a seasonal or periodic basis when it may have served as a base for merchants (Snape 1989) catering for the needs of both native inhabitants of the region and the Roman military. Based on interpretation of new settlement evidence, it appears that most, if not all, people in the region had access to the exchange system focused in the annex markets at Newstead, producing a picture of a stimulating multi-cultural environment, with ample opportunity for exchange of goods and information.

The identities likely to emerge from this cultural environment are strong, independent, egalitarian, stable, and gendered (though we do not know whether this would have been male or female oriented).

6.4.2 Environment-Based Identitities

Physical spaces were strongly identified with social places in the past, and this continues right through to the present. Place name evidence suggests that all the major rivers in the region retain pre-Anglian non-Roman names (Nicolaisen 1964).

The land itself was integral to society, being the physical heart of each settlement – the material from which homes were shaped, the material from which boundaries between social/natural and insider/outside were constructed. I suggest that the land was also a source, perhaps the source, of social identity and power. Social stability stemmed from strong family identity, embedded in the earthen fabric of settlements, reinforced by land tenureship, and embedded in symbolic and spiritual associations with the surrounding landscape. Social stability was thus the foundation of stability in the settlement system, the two reinforced each other, and in turn were reinforced by the landscape itself. The people, their social places, and the landscape itself would need to be disrupted before the bedrock of society was shaken.

In fact the climate fluctuated throughout the Holocene and the environment changed as a result of this and deforestation. Still, the population remained resilitent, adopting a varied subsistence strategy. The data from numerous environmental studies suggest that prehistory was characterized by a general cycle of shifting climate, with people relying on a mixed subsistence strategy including stock rearing, agriculture, hunting, and fishing. There appears to be no evidence for individual or family specialization in these activities.

The symbolic meanings of earth, sun, and water appear to have been important in the past. A look through the Human Relations Area File suggests that the symbolic power of earth is cross-cultural relating to such diverse things as earth as foe, place body is deposited, reality (as opposed to the spiritual realm), magical substance, fertility, healing agent, deity, femaleness, building material, oven, something to be explained, life, storage facility, marking/staining agent, food. A cult of the sun has been suggested to explain the regular pattern of buildings being preferentially oriented to the southeast (Oswald 1997). Water seems to have been especially important as settlements were surrounded by water filled boundary ditches, and hoards were preferentially located on boundaries in wet places such as bogs and beaches (Hunter 1997).

A population resident in an area for a very long time would identify closely with particular parts of the landscape. It would not be unusual to find that members of such a population would fuse perception of themselves with perception of the land (Brookfield 1969), for example the Tiv of Nigeria perceive boundaries that divide group territories in terms of family lineages rather than in terms of physical landscape characteristics. "Where social organization and the territorial or ecological base are so deeply fused... it would be absurd to seek natural-human dichotomies in the perceived environment" (Brookfield 1969:68).

The identities likely to emerge from this cultural engagement with the natural environment are resilient, independent, embedded, bounded, and stable in the face of change.

6.4.3 Natives and Romans

Archaeologists assumed that Romans imposed their own cultural practices over pre-existing ones, with the assistance and support of the nobility, in a process known as "romanization" (Haverfield 1912, Millett 1990). Romanization was thought to be marked archaeologically by the establishment of long-distance trade networks for Mediterranean products such as oil and wine, and the reorganization of elite settlements into villa complexes, but much more complex range of relationships probably existed between Romans and Celts (Blagg and Millett 1990b, Wells 1992). Scottish archaeologists have also moved away from initial interpretations that the Roman military had a major impact on native populations (Armit and Ralston 1997, Edwards and Ralston 1997, Hanson 1997).

Romans were sometimes pawns in native political games. For example, it has been argued that in Roman Africa there is evidence for Roman style olive agriculture with water control systems with absolutely no other evidence for romanization (Grahame 1998). Natives, unsurprisingly, used the illusion of Roman friendship to manipulate indigenous social relationships and gain power, thus leading to the emergence of a native elite and increased political stability, thus leading to emergence of agriculture. A second example comes directly from Roman texts that tell of "princes" from Britain who traveled to Rome in order to win local political battles. In this way Dubnovellaunus and Tincommius went to Rome to visit Augustus, Adminius visited Caligula, and Dio visited Claudius (B. Hanson, personal communication.)

It has been argued that three types of contact generally characterized the Roman Empire (Bartel 1985, Bloemers 1989). The first was eradication or resettlement of the indigenous population, the second was segregation of the two populations leading to political equilibrium, and the third was integration of the population and subsequent acculturation (see Figure 6.1). This framework is similar to early classification of different outcomes in culture contact situations (Willey *et al.* 1965).

Table 6.1 Outcome of Roman contact with indigenous populations, after Bloemers 1989

	Colonialism (with settlers)	**Imperialism (no settlers)**
Eradication/resettlement	abrupt culture change	regional emptiness
Acculturation	slow indigenous culture change	slow indigenous change in economics
Equilibrium	settlement enclaves of two cultures	indigenous cultural maintenance

In southeast Scotland there is compelling evidence for indigenous cultural maintenance. There appears to have been little regular contact between the Roman military and the local population, and what contact there was may have been relatively peaceful. The native population was very strongly embedded in the cultural and natural landscape. Stability in the face of expanding empire was partly due to this embededness and a resilient subsistence strategy well adapted to the changing maritime climate.

> Assimilation, imitation, or assuming the role of rebellious exotic are not the only options and never have been. -- bell hooks

APPENDIX 1 - GEOPHYSICS EVIDENCE

Avenel Haugh Curvilinear Homestead

Description

The enclosure at Avenel Haugh (NT 5167 3697) sits just west of the Allan Water at 170 m above sea level on a southeast facing slope. To the north the site is bordered by a small burn. The NMRS records a possible tumulus just west of the earthwork enclosure.

Aerial photograph (RX/3964/CN) cropmarks suggest that the enclosure is double-ditched, half-circular, being bereft of its northern half, and roughly 100 m in diameter at its greatest extent. These cropmarks also show a gap in the southeastern portion of the enclosing ditches. Just west of the enclosure, a linear cropmark is visible running roughly northwest to southeast.

Avenel Haugh was visited by members of the Newstead Research Project (Jones *et al.* 1991) in September 1990. At that time the field was undersown with barley stubble and the enclosure site appeared to have been eroded on the north side by the small burn. Kate Clark, director of the field crew, reported that the burn runs through a steep gully and that the field corner to the west of the site is very low lying and appears to have been marshy before field drainage. In September 1991 a crew returned to do geophysical surveys at Avenel Haugh. At that time the field was being used as pasture.

Both fluxgate gradiometer and electrical resistivity surveys were done. In total, 19 and 24 grids respectively were completed. Fewer magnetometry grids were done because the southeastern portion of the survey area was crossed by an overhead power line supported by a steel pylon which would have interfered with magnetometer readings.

Interpretation

The fluxgate gradiometer produced disappointing results at Avenel Haugh, with no clear evidence for any of the features appearing as cropmarks in aerial photographs. The resistivity survey, however, produced excellent results with numerous identifiable features.

The homestead at Avenel Haugh was either enclosed by two ditches, or was single-ditched and expanded over at least two phases. Entrance to the site was gained from the southeast through a gap in the enclosing ditch or ditches. The enclosure was at least 83.5 meters wide internally. The innermost line of enclosing ditch corresponds with the two ditch sections visible as cropmarks on aerial photographs. Survey results indicate that this is one continuous 2 m wide ditch, however, which appears to run into the line of the outer ditch in the Southwest portion of the enclosure. The outer ditch (or re-cut line of the inner ditch, if homestead was enclosed by a single ditch) was roughly 3 meters wide. To the north and east of the entrance evidence for enclosing ditches is faint and disturbed, with two possible lines running parallel. Interestingly the linear earthwork to the west of the enclosure (feature A), appears to respect the line of the outer enclosure ditch and may therefore be later.

Table A1.1 Archaeological features identified from geophysical survey of Avenel Haugh.

Feature	Technique	Interpretation
A	Resistivity	Linear earthwork running north/south, of uncertain relation to the enclosure
B	Resistivity	Linear earthwork running east/west, of uncertain relation to the enclosure
C	Resistivity	Enclosure inner ditch
D	Resistivity	Enclosure outer ditch (or possibly a re-cut line if enclosure was single-ditched)
E	Resistivity	Enclosure entrance.
F	Resistivity	Yard area
G	Resistivity	Series of resistivity anomalies representing internal settlement features. Some of these features appear to be curvilinear and others appear to be rectilinear.
H	Resistivity	Three lines marking possible courses for the enclosing ditch or ditches.
I	Resistivity	Possible line of enclosing bank.

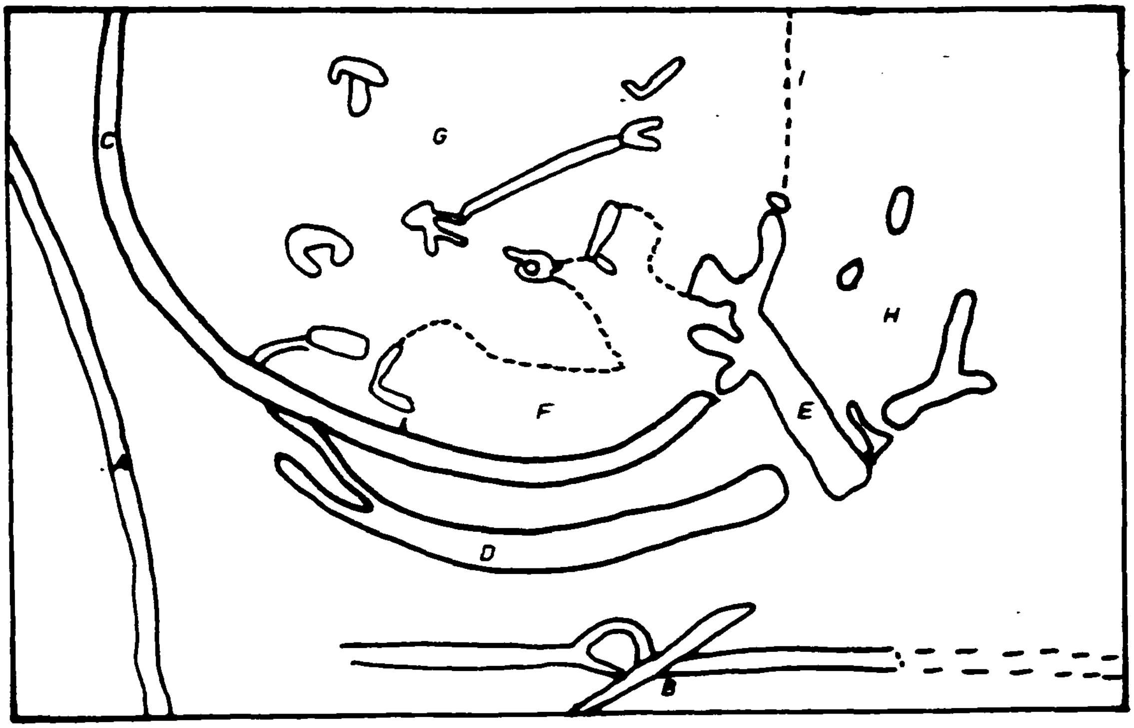

Figure A1.1 1:1000 interpretation of geophysics evidence from Avenel Haugh

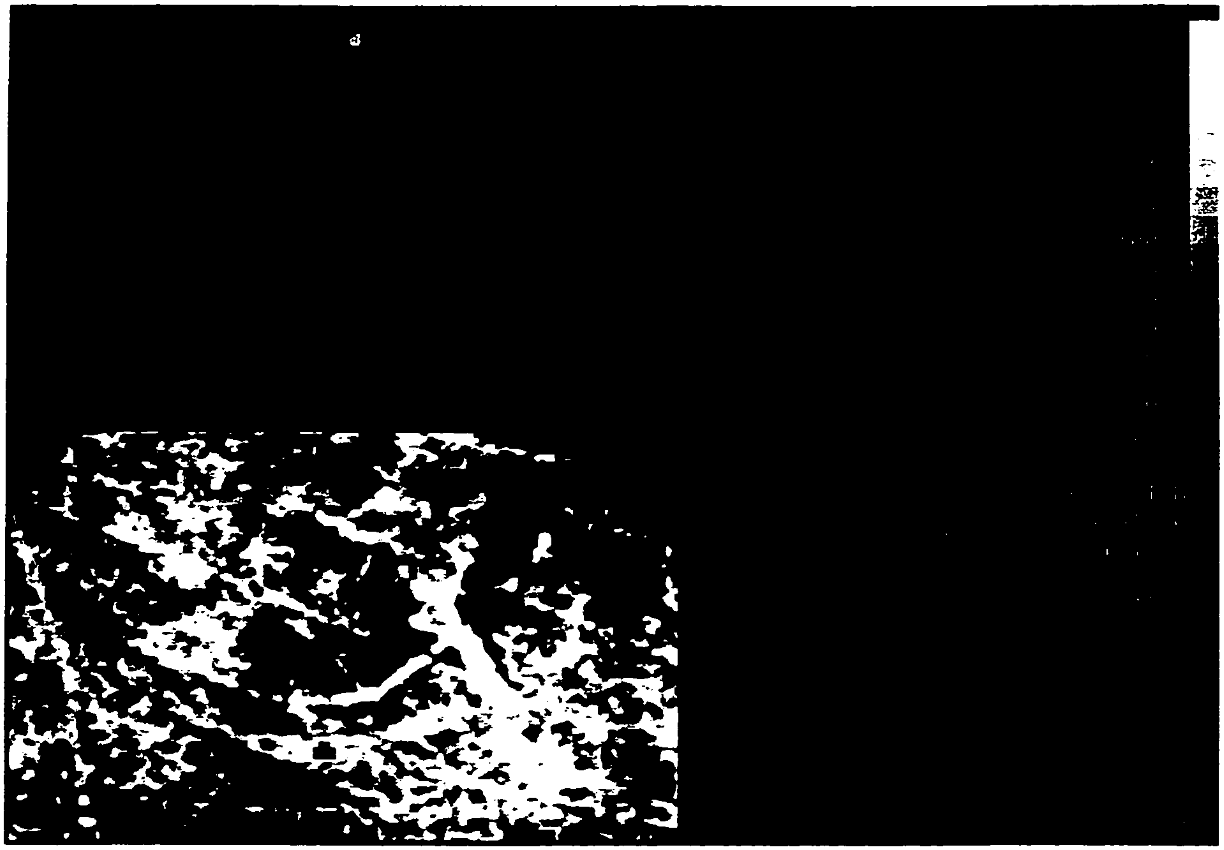

Figure A1.2 Resistivity image of Avenel Haugh (ahres5.tif) was produced from the resistivity data through spike removal, bicubic interpolation, and then cutting the range of data from 75 to 125 ohms. Scale is 1:1000.

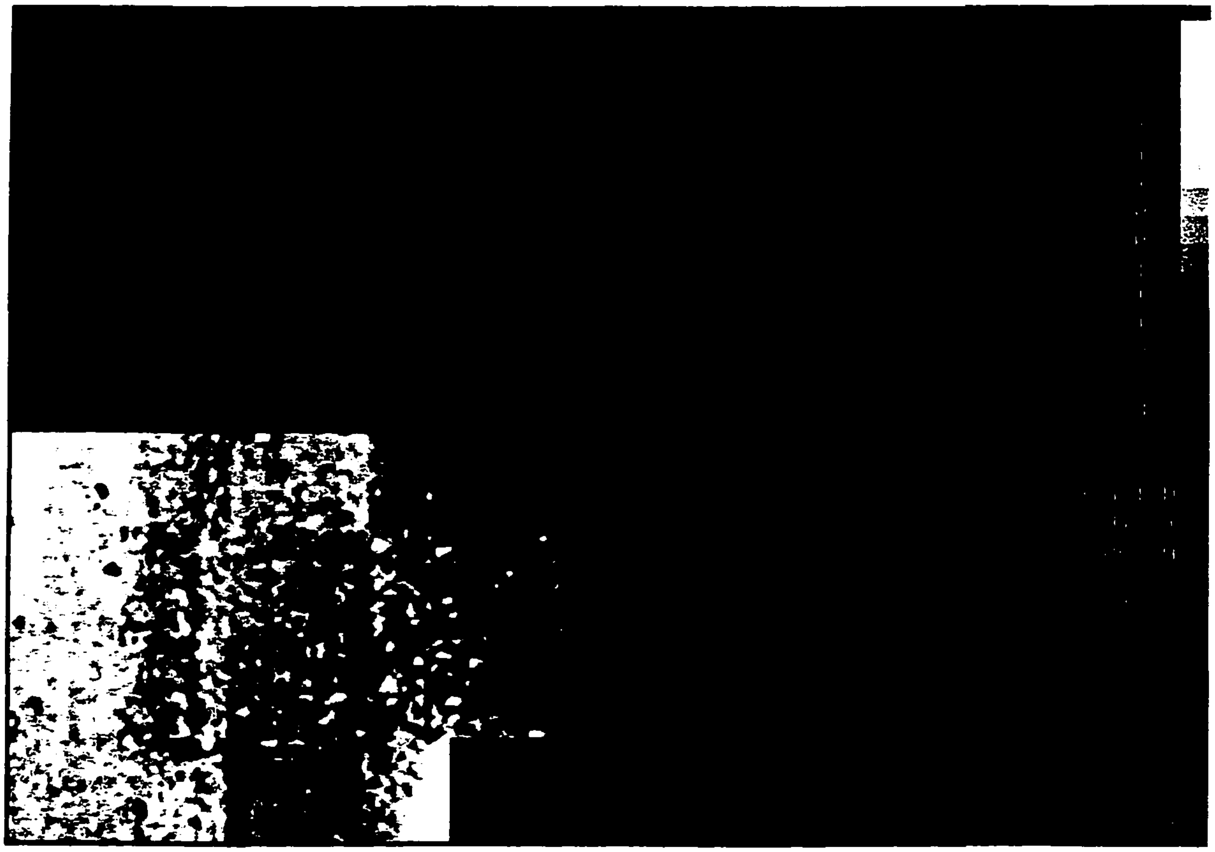

Figure A1.3 Magnetometry image of Avenel Haugh. This image of Avenel Haugh (Ahmag5.tif) was produced from the fluxgate gradiometer data through spike removal, bicubic interpolation, and a cut display of data points from -3 to 2.5 nT. Scale is 1:1000.

Conclusion

The enclosure at Avenel Haugh had at least one surrounding ditch, possibly two, and appears to have been reshaped and restructured through time. If the enclosure was only single-ditched, then this suggests that the enclosure was expanded at some point in its history to provide more space in the yard area adjacent to the site entrance.

Avenel Haugh may have been selected in the past as a site for this homestead for a variety of reasons including its defensibility, its proximity to water, its view, and its proximity to earlier archaeological remains (assuming the tumulus reported in the NMRS existed).

Bemersyde Hill Curvilinear Homestead

Description

The objective of this geophysical survey was primarily to more precisely locate the site on the ground in the absence of definitive aerial photographic evidence, and define its relationship with the sub-rectangular enclosure (Bemersyde Hill Rectilinear Homestead) immediately to the northeast.

This curvilinear enclosure (NT 5980 3435) lies just below, and to the east, of the summit of Bemersyde Hill and commands an extensive view northwards and northeastwards. A steep-sided hill shoulder runs out southeastwards to the point where the field drops down to substantially lower ground to the south. Towards the eastern field boundary the topography flattens as it approaches the base of the slope, forming a natural platform. The field is currently used for permanent pasture and has been re-seeded within the last 20 years. At that time the farmer noted what he describes as "filled-in wells" near the eastern field boundary but is unable to locate these precisely now.

Aerial photograph cropmarks suggest that the site is a multi-ditched sub-circular enclosure. Although the photographs are indistinct and without control points, a rectification was produced using the adjacent sub-rectangular enclosure as control. This rectification is likely to have produced a substantial distortion and this, with the ephemeral cropmarks, suggests that little confidence can be placed in the position, shape, dimension and nature of the site on the basis of the oblique photographic evidence alone.

Interpretation

The fluxgate gradiometer survey of this site produced no useful results, and was abandoned after only seven grids. The 83 grids of resistivity survey, however, produced clear and helpful results. Features identified include four ditches and three banks. A main entrance in the southeast was identified as was a secondary entrance in the south. The ditches appear as high resistance anomalies, and the banks appear as low resistance anomalies suggesting that ditches may be better drained than surrounding areas, even after in-filling. Several internal features are visible in this curvilinear enclosure and probably represent roundhouses and possibly other structures as well.

The curvilinear enclosure on Bemersyde Hill was excavated by members of the Newstead Research Project in 1990. Three trenches were excavated: first over a low-resistance roundish anomaly in the eastern portion of the enclosure's interior (feature 1), second through all four ditches on the western side of the site, and a third placed over the site entrance (feature L).

Table A1.2 Archaeological features identified from geophysical survey of Bemersyde Hill Curvilinear Homestead.

Feature	Technique	Interpretation
A	Resistivity	A disused field boundary.
B	Resistivity	Bank outside hollow-way.

C	Resistivity	Outermost ditch, identified as a hollow-way during excavation.
D	Resistivity	Outermost ditch, identified as a hollow-way during excavation.
E	Resistivity	Outermost ditch, identified as a hollow-way during excavation.
F	Resistivity	Third enclosing ditch of the enclosure.
G	Resistivity	Third bank of the enclosure.
H	Resistivity	Second enclosing ditch.
I	Resistivity	Second bank of the enclosure.
J	Resistivity	A short ditch segment forming the innermost ditch of the enclosure.
K	Resistivity	This appears to be a small entrance, though its relationship to the excavated entrance (feature 12) is not known.
L	Resistivity	Enclosure entrance.
M	Resistivity	This low resistance linear anomaly appears to be the result of modern ploughing practices.
N	Resistivity	This low resistance linear anomaly extends from north to south across the entire interior of the enclosure, but appears to be the result of modern field drainage.
O	Resistivity	Innermost ditch of the enclosure on its southeast side.
P	Resistivity	Innermost ditch.
Q	Resistivity	Second enclosing bank.
R	Resistivity	Second enclosing bank.
S	Resistivity	Second bank of the enclosure.
T	Resistivity	Second ditch of the enclosure.
U	Resistivity	Second ditch.
V	Resistivity	Third bank.
W	Resistivity	Third ditch.
X	Resistivity	Enclosing ditch of Bemersyde Hill Rectilinear Homestead.
Y	Resistivity	Possible roundhouse.
Z	Resistivity	Possible roundhouse.
1	Resistivity	Roundhouse identified through excavation.
2	Resistivity	Possible roundhouse.
3	Resistivity	Other internal structures.
4	Resistivity	Low resistance feature cutting second ditch and perhaps associated with the site entrance, the hollow way, natural topography.
5	Resistivity	Second ditch.
6	Resistivity	Third ditch.
7	Resistivity	Second bank.

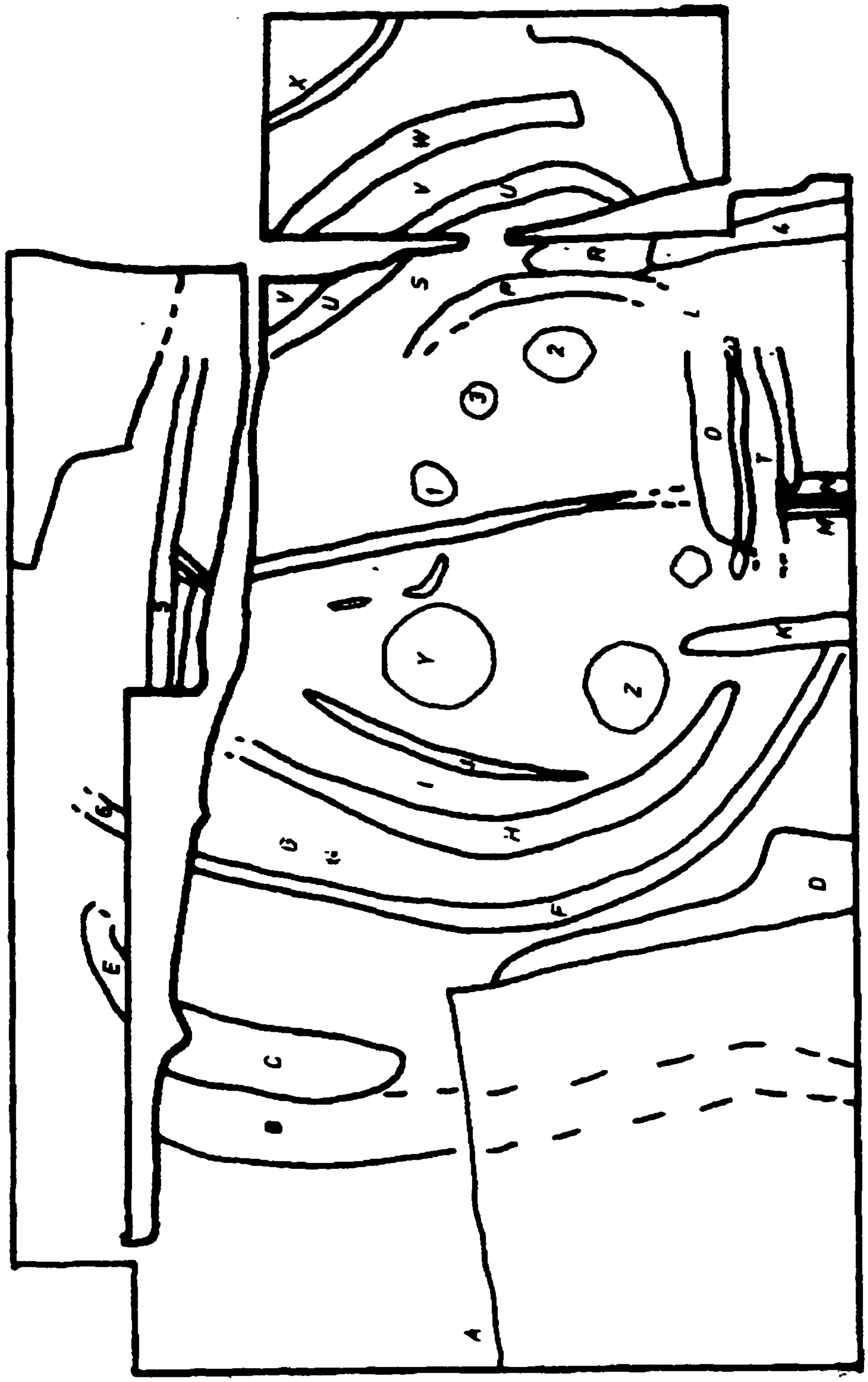

Figure A1.4 Interpretation of geophyysics evidence from Bemersyde Hill Curvilinear Enclosure

Figure A1.5 Resistivity image of Bemersyde Hill Curvilinear Enclosure. This image (BSCres3.tif) produced through spike removal, bicubic interpolation, and printing data points from 55 to 130 ohms at a scale of 1:1390.

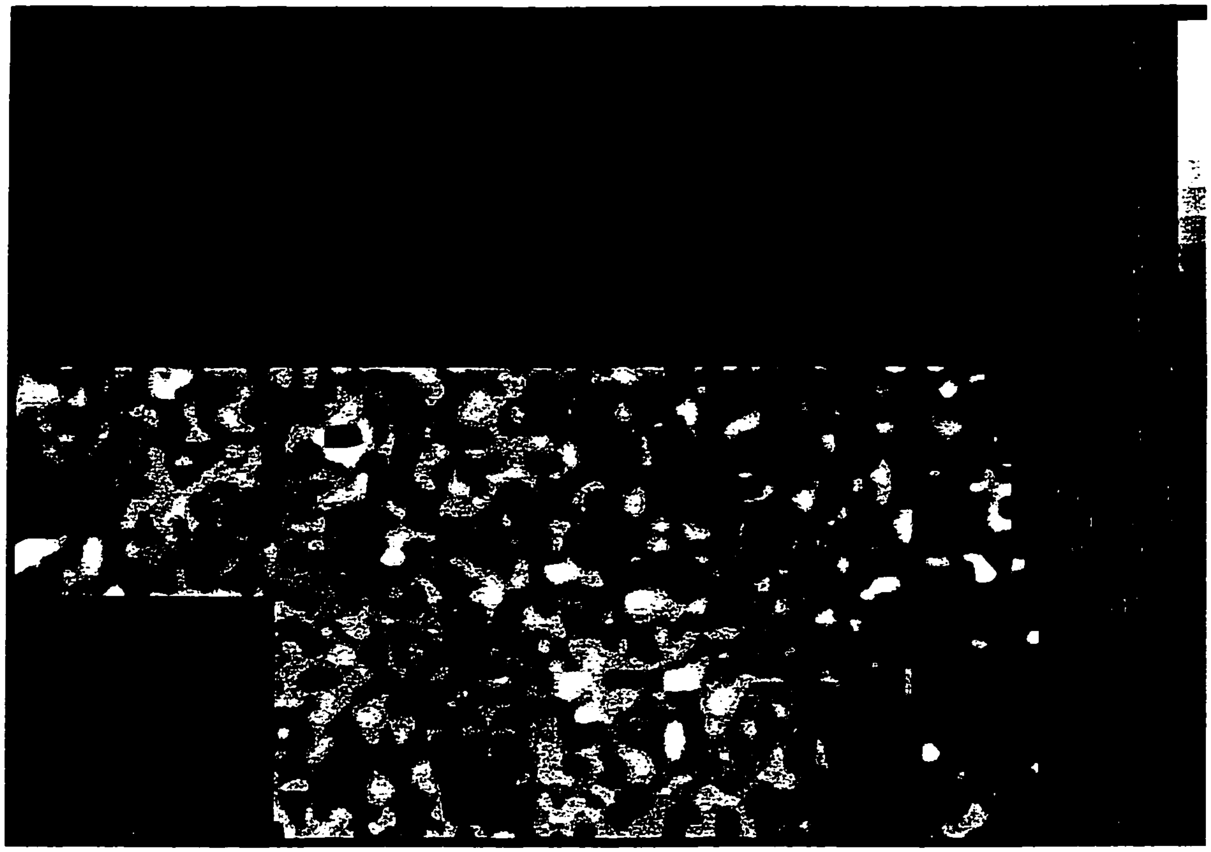

Figure A1.6 Magnetometry image of Bemersyde Hill Curvilinear Enclosure. This image (bscmag1.tif) produced through spike removal, bicubic interpolation, and printing all data points from -3.6 to 4.7 nT at a scale 1:428.

Conclusion

Through survey and subsequent excavation we know Bemersyde Hill Curvilinear Homestead to be a triple-ditched circular enclosure of roughly 80 m by 60 m internal size and with an external diameter of roughly 195 meters. The enclosure was surrounded by a hollow-way. The ditches appear to vary in size with the inner ditch being roughly 3 meters, the second ditch being roughly 8 meters, the third ditch being roughly 7 meters, and the outer ditch being roughly 10 meters wide. None of these ditches appears as a uniform anomaly on the geophysics images, however, and these sizes should be taken as only extremely rough estimates. The main site entrance was to the southeast with a small secondary entrance to the south. Numerous internal geophysics anomalies suggest the possible presence of at least 4 roundhouses plus a variety of other structures.

The survey results from the adjacent sub-rectangular enclosure (see Bemersyde Hill Rectilinear Homestead) indicate that its southwestern ditch was adjusted to respect the line of the outer ditch of the larger curvilinear enclosure. This suggests that they may have been in use at the same time, or that the sub-rectangular enclosure was a later addition. As no internal features were identified on the geophysical survey of the sub-rectangular enclosure, it is possible that it served a function different from that of the curvilinear enclosure.

To truly elucidate the relationship between the curvilinear and sub-rectangular enclosures, more survey work needs to be done to the south of the existing surveyed area. This would allow information about the lines of the outermost ditch and bank of the curvilinear enclosure to be gathered, and will hopefully illustrate the conjunction of these features with the sub-rectangular enclosure.

Bemersyde Hill Rectilinear Homestead

Description

RAF aerial photographs (CPE/SCOT/UK 257, 3227-8) show a clear sub-rectangular cropmark at 200 meters above sea level on the lower saddle slope on the east side of Bemersyde Hill. The cropmarks suggest a single-ditched enclosure with opposing breaks on the east and west sides. Subsequent rectification of the oblique photographs placed these breaks on the line of a hedge removed ten years before, but as it was not possible to use control points to the north of the site some distortion of the plot is likely.

In addition to the enclosure, the aerial photographs also show a substantial linear cropmark running northeast away from the site, but this feature was not geophysically surveyed. This is because cropmark rectification suggested that its course ran through a natural depression. Information supplied by the farmer to the field survey team indicated that this depression suffers from poor drainage, probably due to broken field drains, and is consistently wetter than the surrounding soil. It is therefore likely that the northeast trending cropmark is not of archaeological origin.

The purpose of the geophysical survey was to define the position and nature of the enclosure and to identify any internal structures. In addition the proximity of this site to the curvilinear cropmark in the higher field to the southwest required that any possible relationship between the two sites was investigated.

Interpretation

The 24 grids of resistivity survey were very successful, producing evidence for the entire enclosing ditch. The ditch is a high resistance feature and has breaks at its western and eastern ends. Its shape is rectilinear except in the southwest where it curves slightly to respect the line of Bemersyde Hill Curvilinear Homestead's outermost ditch. Total enclosure dimensions are 48.5 by 41.0 meters internally or 56.0 by 45.0 meters including the ditches. Entrances are each approximately 7.5 m wide.

The 20 grids of magnetometry results were not as useful for defining the enclosing ditches as those from the electrical resistance meter however the magnetometry survey clearly shows a 20 meter long arc of the southern enclosing ditch. Magnetic evidence also suggests the presence of a yard, or other activity area with magnetized debris, in the southern half of the enclosure.

There is no evidence for internal curvilinear structures at Bemersyde Hill Rectilinear Homestead, but the high resistance area in the northeast corner of the enclosure suggests a possible rectilinear structure. This suggests a possible Roman period date, but excavation would be required to confirm this hypothesis.

Perhaps most interesting of all is feature G, a wide arc of moderately high resistance to the south of the enclosure. This feature swings from the south of Bemersyde Hill Curvilinear Homestead and ends at the southern edge of Bemersyde Hill Rectilinear Homestead. Comparison of the geophysical evidence from the two sites suggests that this feature may be a continuation of the hollow-way identified on the western side of Bemersyde Hill Curvilinear Homestead.

Table A1.3 Archaeological features identified from geophysical survey of Bemersyde Hill Rectilinear Homestead.

Feature	Technique	Interpretation
A	Resistivity	Enclosing ditch.
B	Magnetometry and Resistivity	Enclosing ditch.
C	Resistivity	Possible rectilinear structure in northeast corner of enclosure.
D	Magnetometry	Area of high magnetic signals in southern portion of enclosure. These signals may be evidence for structures or a yard.
E	Resistivity	Outermost ditch of Bemersyde Hill Curvilinear Homestead.
F	Magnetometry and Resistivity	Second ditch of Bemersyde Hill Curvilinear Homestead.
G	Resistivity	Possible extension of hollow-way around Bemersyde Hill Curvilinear Homestead.

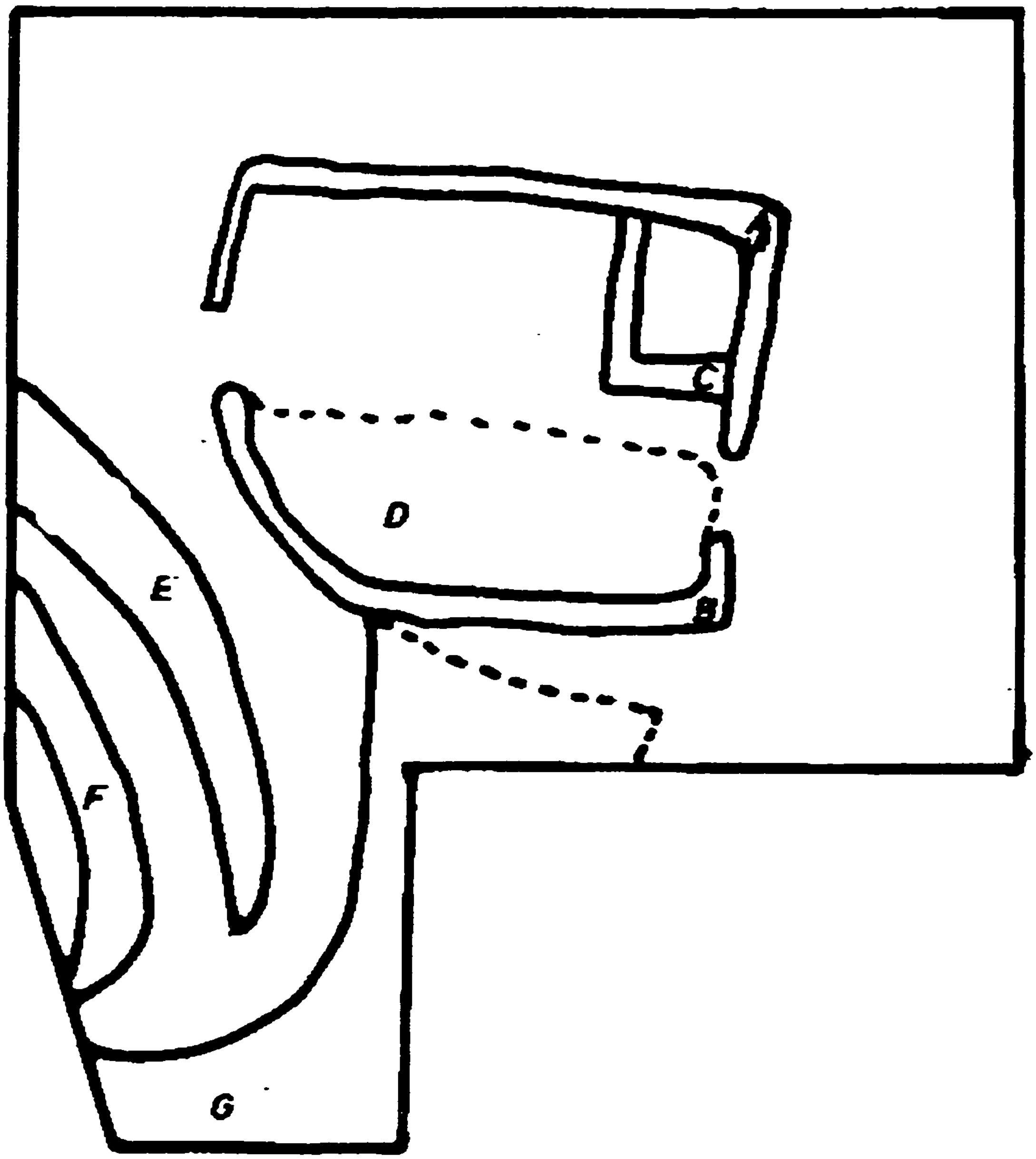

Figure A1.7 Interpretation of geophysics evidence from Bemersyde Hill Rectilinear Homestead at 1:1000

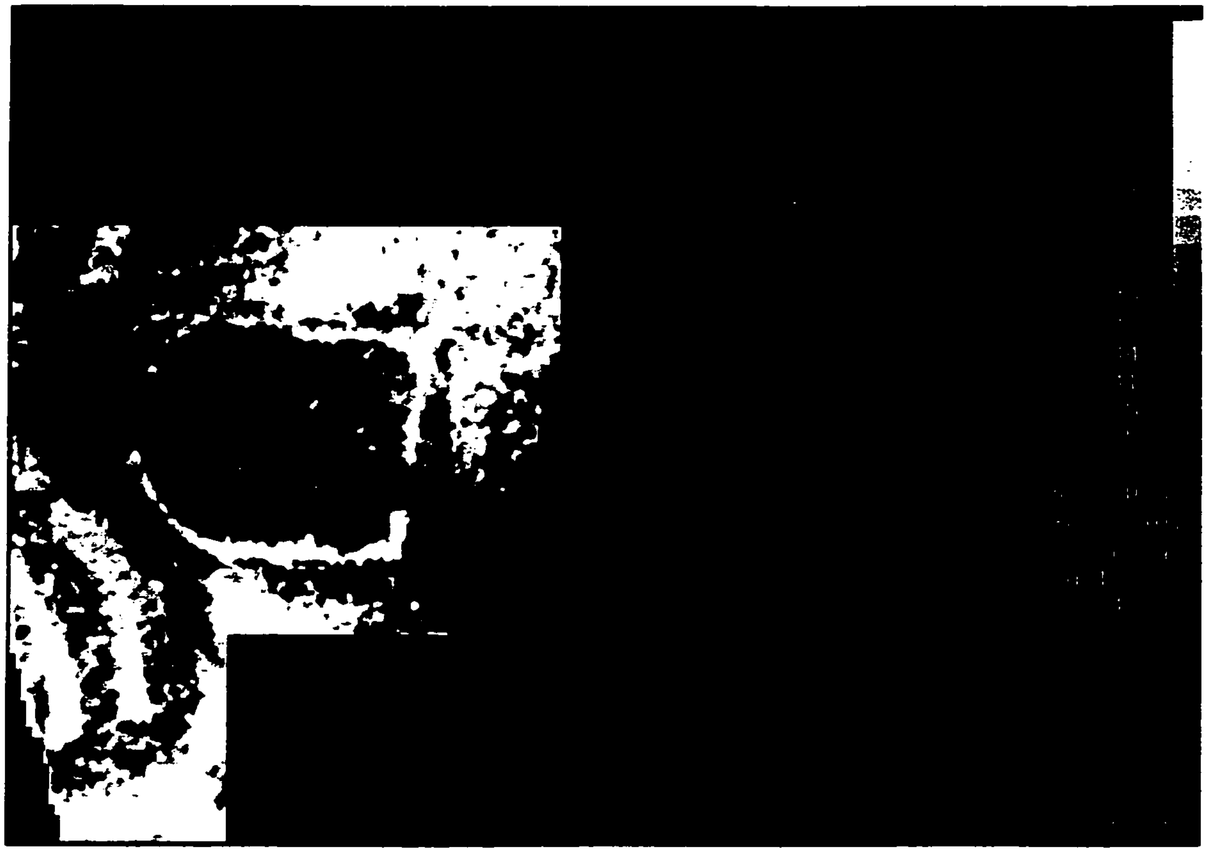

Figure A1.8 Resistivity image of Bemersyde Hill Rectilinear Homestead. This image (bsrres5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 35 to 75 ohms at a scale of 1:1000.

Figure A1.9 Magnetometry image of Bemersyde Hill Rectilinear Homestead. This image (bsrmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -1.3 to 2.4 nT at a scale of 1:1000.

Conclusion

The southwestern section of this enclosure's ditch curves to fit the line of the outermost eastern ditch of the Bemersyde Hill Circular Fort (NT53SW site 51). This suggests that they were either constructed about the same time or that the sub-rectangular enclosure came later.

Evidence from geophysical survey suggests that the hollow-way identified in the survey and excavation of Bemersyde Hill Curvilinear Homestead terminates at the southern boundary of Bemersyde Hill Rectilinear Homestead. If this is the case, and only additional survey south of the two sites or excavation would confirm it, then it suggests that the two homesteads are quite tightly integrated. One possibility is that the rectilinear enclosure is later than the curvilinear enclosure and cross-cuts the earlier hollow-way. Another possibility is that the two homesteads and the hollow-way were in use at the same time, and that access to the entrance of the curvilinear enclosure was obtained by traversing through the (possibly ceremonial) rectilinear enclosure. Of these two possible explanations, the evidence better supports the first as the evidence for an internal rectilinear structure in the rectilinear homestead suggests a relatively late Roman-period date.

Bemersyde Moss

Description

The double ditched enclosure at Bemersyde Moss (NT 6130 3442) sits on a gentle slope at 155 m over datum between a small burn and the moss itself. To the west lies Bemersyde Hill and to the east lies Whitrighill.

The aerial photograph cropmarks which provide evidence for the enclosure at Bemersyde Moss show both of its encircling ditches as broken cropmarks in each of four modern fields. The inner ditch is roughly circular while the outer ditch is somewhat more ovoid with its longest axis running northeast to southwest.

A geophysical survey was undertaken at Bemersyde Moss in September 1991. The field crew was directed by Dr. Kate Clark of the Newstead Research Project. All four modern fields that lie over the enclosure were surveyed with a total of 38 resistivity grids and 36 magnetometry grids. The northeastern and southwestern fields lay under permanent pasture while the southeast field was covered in clover, and the northwest field was covered with barley stubble and straw.

Interpretation

Homestead features that appear in magnetometer images include: everything but the northwest section of the inner ditch, an entranceway in the east, two terminals of the inner ditch around this entranceway, the southeastern portion of the outer ditch, and a variety of internal structural features. The high magnetic susceptibility of the sediments filling some portions of the inner ditch is intriguing, and suggests that the ditch as a whole was filled with different materials possibly at different times.

Measurement of electrical resistivity at the Bemersyde Moss homestead revealed evidence for both surrounding ditches, the eastern entranceway, and a variety of internal structural features. The checkerboard lines in the extreme upper left of the resistivity images should be ignored as they are the result of modern barley rows that disrupted survey of this field. Also apparent in the resistivity printout is a high-resistance area in the eastern portion of the site marking the entrance to the site and corresponding with the entrance area visible in the magnetometry data. Just within the inner ditch from this entrance there is evidence several structures.

Table A1.4 Archaeological features identified from geophysical survey of Bemersyde Moss.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Inner Ditch
B	Resistivity	Outer Ditch
C	Magnetometry and Resistivity	Entrance
D	Magnetometry and Resistivity	Structural features within enclosure.
E	Resistivity	Disturbance from modern barley rows.

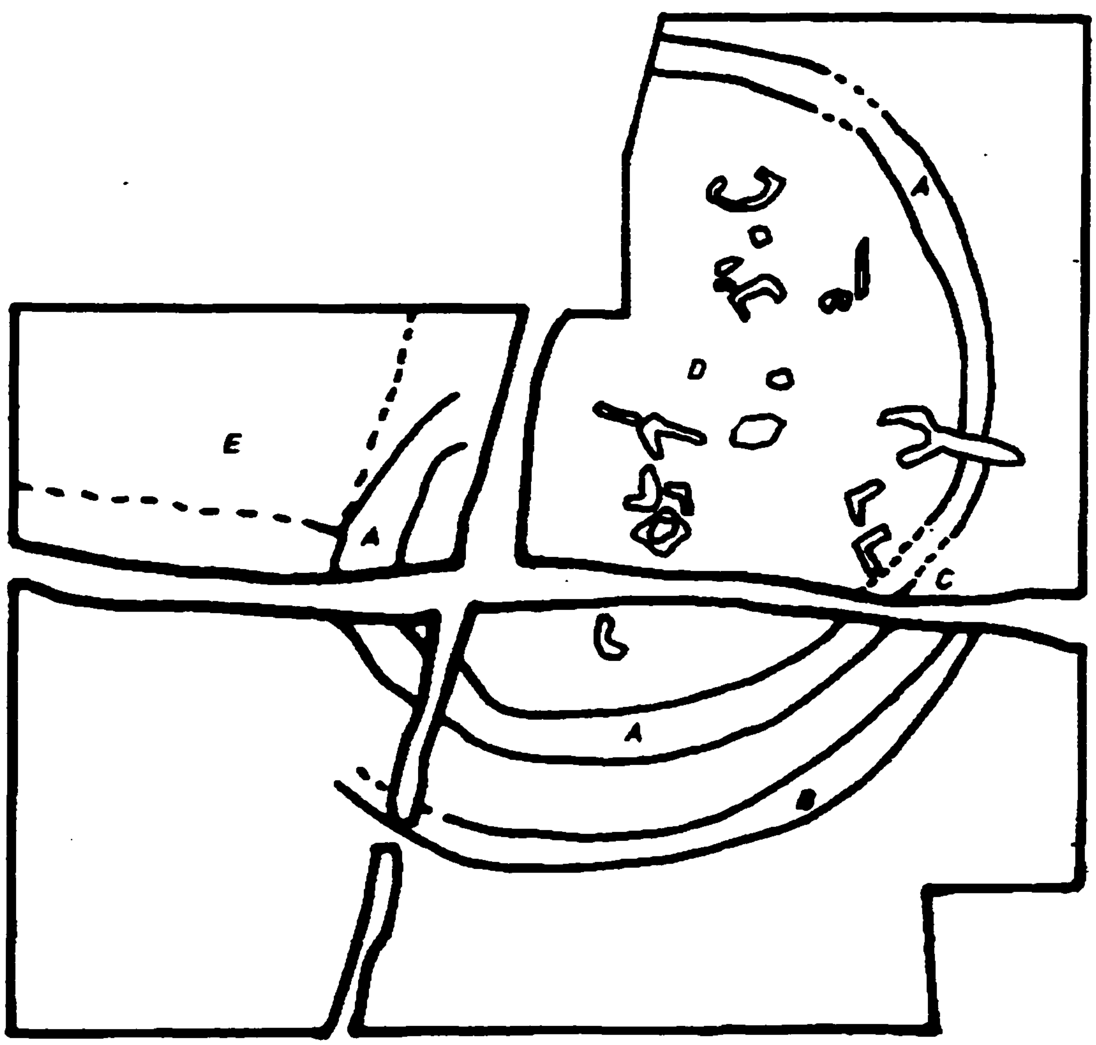

Figure A1.10 Interpretation of geophysics evidence from Bemersyde Moss at 1:1000

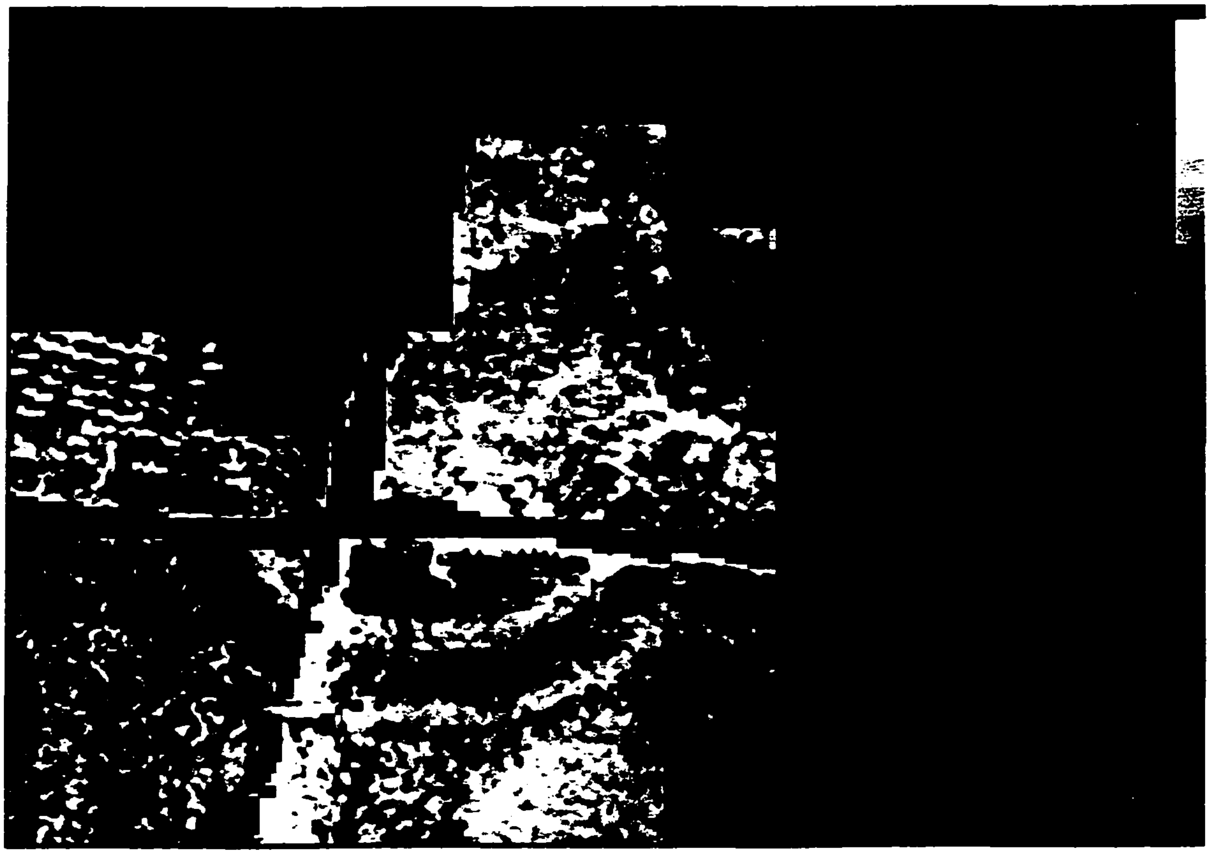

Figure A1.11 Resistivity image of Bemersyde Moss. This image (bsmres5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 30 to 60 ohms at a scale of 1:1000.

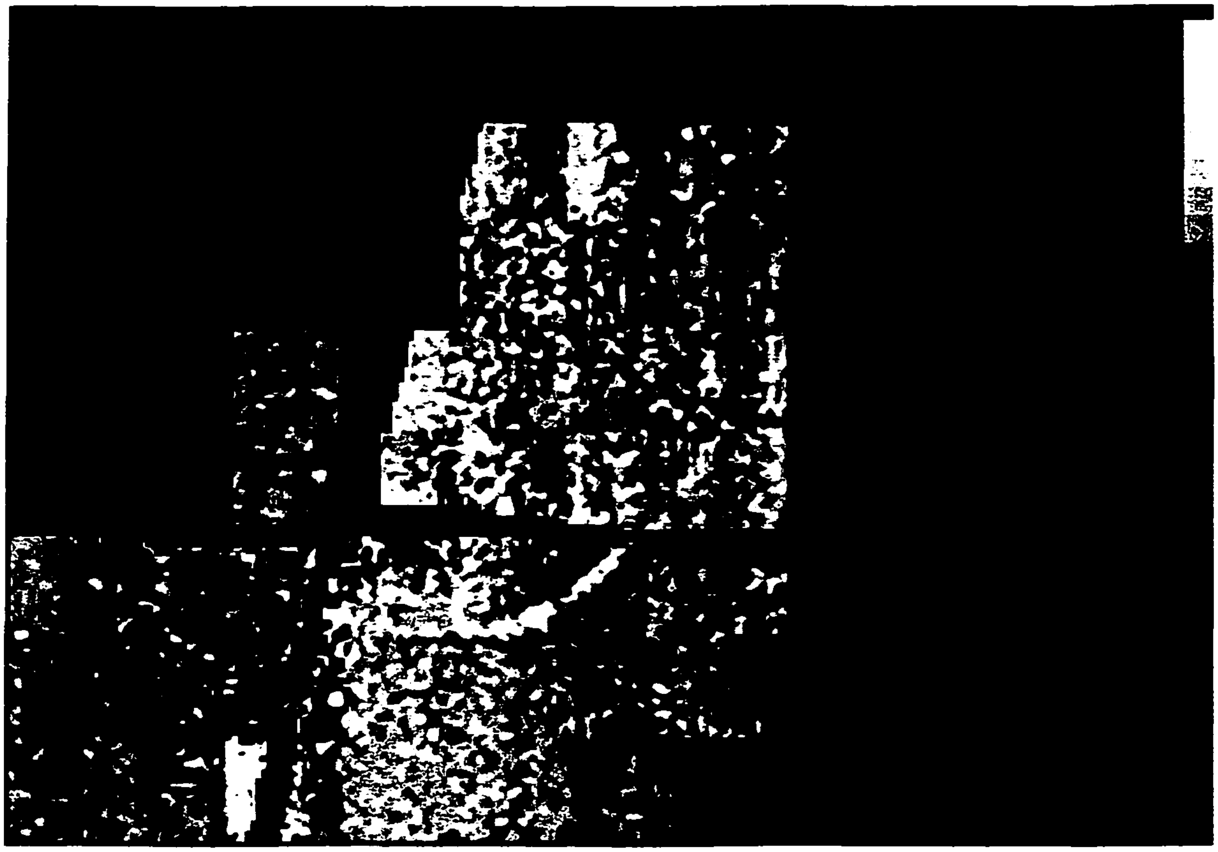

Figure A1.12 Magnetometry image of Bemersyde Moss. This image (bsmmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -3.5 to 8 nT at a scale of 1:1000.

Conclusion

The double-ditched enclosure at Bemersyde Moss has an internal diameter of approximately 87.5 m. An entranceway was constructed in the eastern portion of the site. Evidence for a variety of internal features was recovered, some distinctly curvilinear and a couple somewhat rectilinear, making this an interesting and relatively well-preserved site at which to carry out future excavation. It would be interesting to try and verify the presence of rectilinear structures via excavation and to collect, if possible, dating evidence to determine whether this curvilinear homestead was occupied during the Roman period.

The enclosure at Bemersyde Moss sits in a densely occupied portion of the landscape with many enclosures nearby. These include Bemersyde Hill, Whitrighill, Third, Brotherstone Hill, Brotherstone Hill South, Clintmains, Clinthill, and Heckside. Bemersyde Moss enclosure probably would have been visible from all of these sites except Clintmains, though this intervisibility would have been highly dependent on height of vegetation. In a forested landscape, smoke from hearths at other sites may have been visible while in an open landscape the earthworks themselves may have been visible.

The enclosure at Bemersyde Moss does not seem to be placed in an extremely defensible position. In fact, the only evidence for it having been constructed for a defensive purpose is the existence of enclosing earthworks themselves. It is, however, located near the standing water at Bemersyde Moss.

Birchgrove

Description

The enclosure at Birchgrove (NT 5761 3242) sits at 130 m above sea level on a southeast facing slope. The Eildon Hills lie to its west, the River Tweed lies to its east, and Newton St. Boswell's lies to its south. Also 500 meters to the south is Sprousten Burn.

The NMRS report for Birchgrove enclosure states:

> An air photograph reveals the NW side and parts of the adjacent sides of a rectilinear ditched enclosure as crop markings in a cultivated field on the W side of the main road, 280 yds ENE of Birchgrove. The rest of the enclosure is not visible on the photograph, since it lies in an adjacent field to the S which was under grass when the photograph was taken. The work measures 200 ft from NE to SW by at least 210 ft transversely, and has an entrance roughly in the centre of the NW side. Its date is unknown, but in view of the fact that the N and W corners are angular, it is not likely to be of Roman construction.

Rectification of the site's aerial photograph cropmarks show the entire northwest side of the enclosure and parts of the northeast and southwest sides. Also shown is an entrance in the center of the northwestern side. Only one enclosing ditch is visible. Two linear cropmarks extend off from the enclosure: one to the northwest and one jogging to the east and turning toward the north.

Interpretation

Geophysical survey was undertaken at this site by members of the Newstead Research Project. The field crew was directed by Dr. Kate Clark. In total 12 grids of magnetometry and 24 grids of resistivity were completed, but unfortunately no results were obtained with either technique. This suggests that the enclosure may have been ploughed away or that the archaeological features were filled with sediments not significantly different from the surrounding matrix in terms of magnetic susceptibility or electrical resistance. It is possible that geophysical survey at a more moist time of year or on the southern portion of the enclosure might prove more profitable.

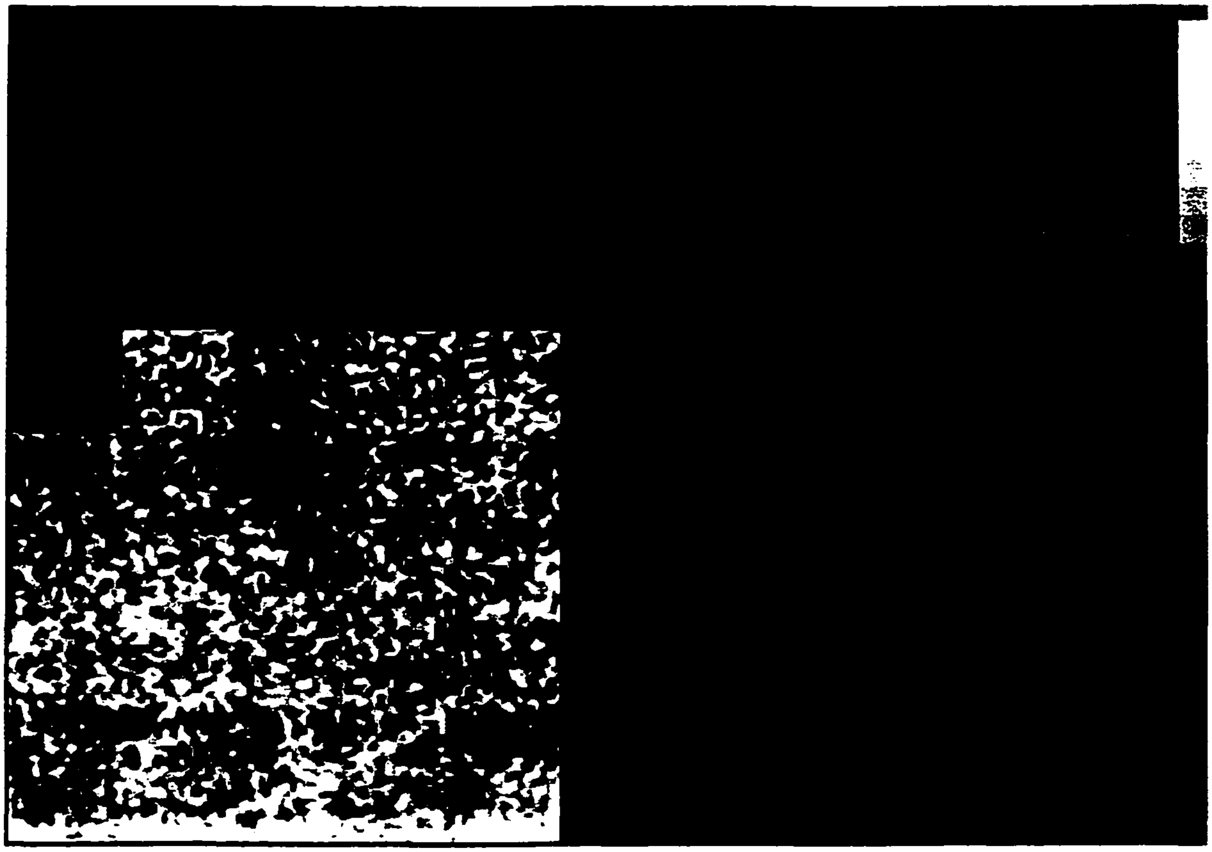

Figure A1.13 Resistivity image of Birchgrove. This image (birres1.tif) produced through spike removal, bicubic interpolation, and printing of data points from 36.4 to 61.9 at a scale of 1:1000.

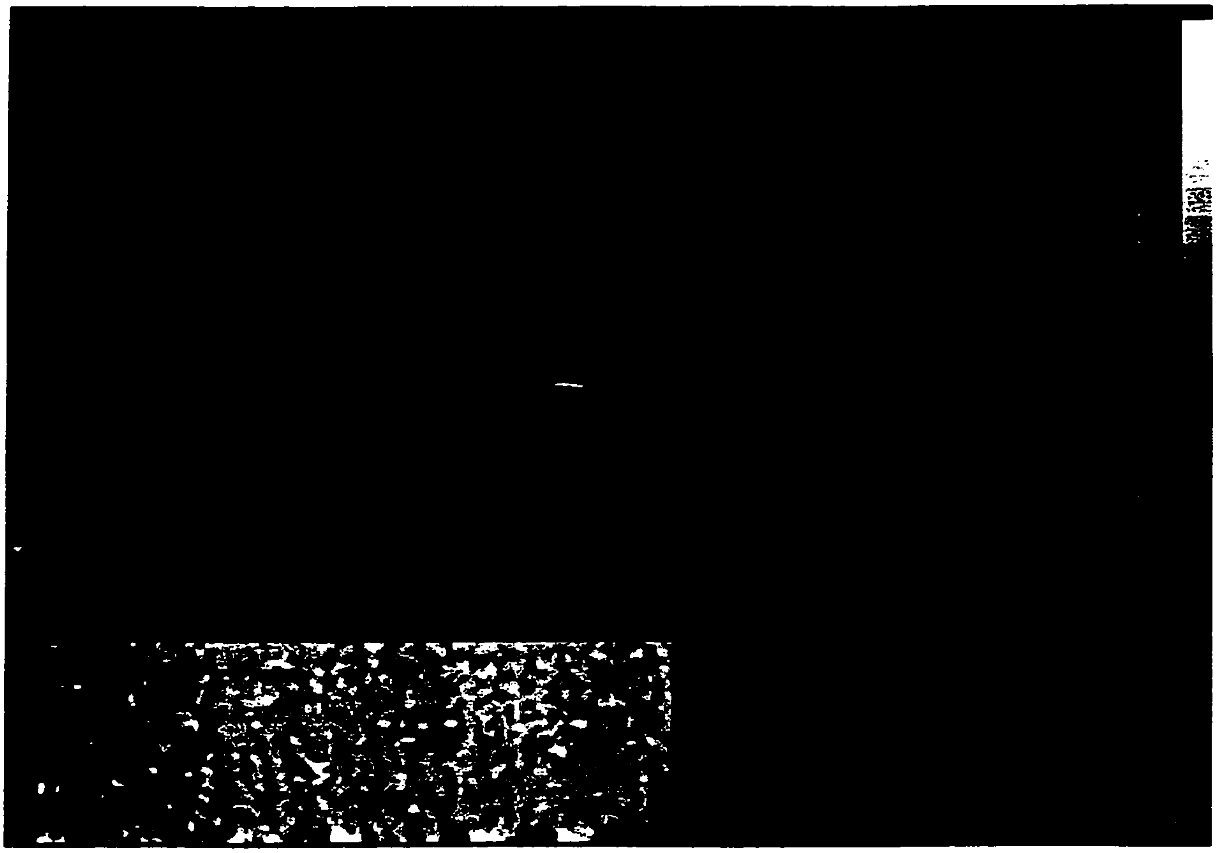

Figure A1.14 Magnetometry image of Birchgrove. This image (birmag1.tif) produced through spike removal, bicubic interpolation, and printing of data points from -5.2 to 4.3 at a scale of 1:1000.

Conclusion

No evidence for the homestead at Birchgrove was recovered via geophysical survey.

Bogle Field

Description

The single ditched rectilinear enclosure at Bogle Field (NT 567 335) sits at 155 m over sea level on the lower northeastern slope of Eildon Hill North. Just north and slightly west of the enclosure sits the Roman fort of Trimontium, and just east of the enclosure sits the circular enclosure at Red Rig. Bogle Field enclosure is 350 meters northwest of Bogle Burn.

Twelve grids were surveyed by a field crew directed by Dr. Kate Clark. From this evidence the Bogle Field enclosure appears to be roughly 47 m wide, and at least that distance long.

Interpretation

Geophysics results show the western, southern, and eastern ditches of the enclosure with an entranceway in the middle of the southern ditch. The high magnetic band running across the very top of the image is probably due to local gravel quarrying, and is unlikely to mark the northern enclosure boundary.

The various geophysics anomalies in the interior of this enclosure can not definitively be associated with archaeological features, however these anomalies are likely to represent past activity areas and structures within the site. These anomalies are both curvilinear and rectilinear.

Table A1.5 Archaeological features identified from geophysical survey of Bogle Field.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Ditch.
B	Resistivity	Entrance.
C	Magnetometry and Resistivity	Curvilinear and rectilinear geophysical anomalies in the interior probably representing roundhouses and/or other structures.

Figure A1.15 Interpretation of geophysical evidence from Bogle Field

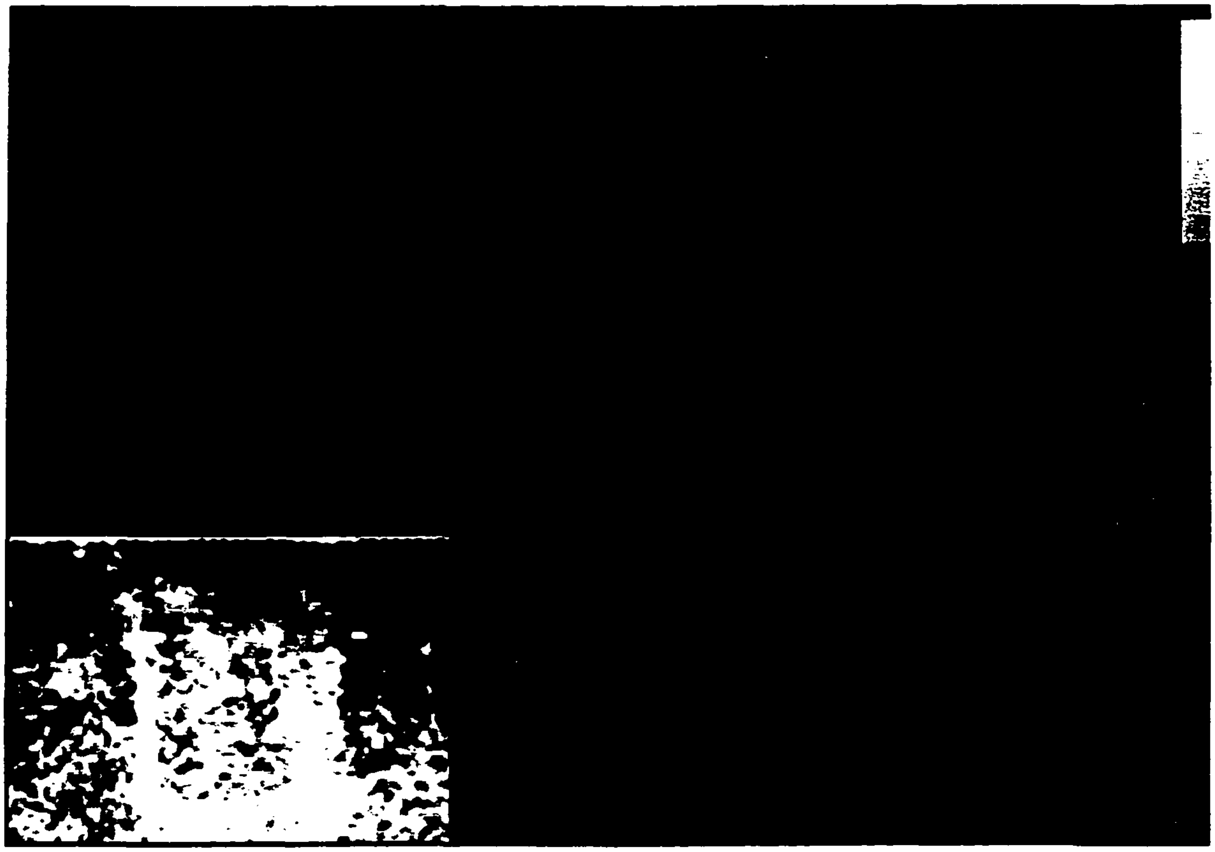

Figure A1.16 Resistivity image of Bogle Field. This image (bogres5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 33 to 41 ohms at a scale of 1:1000.

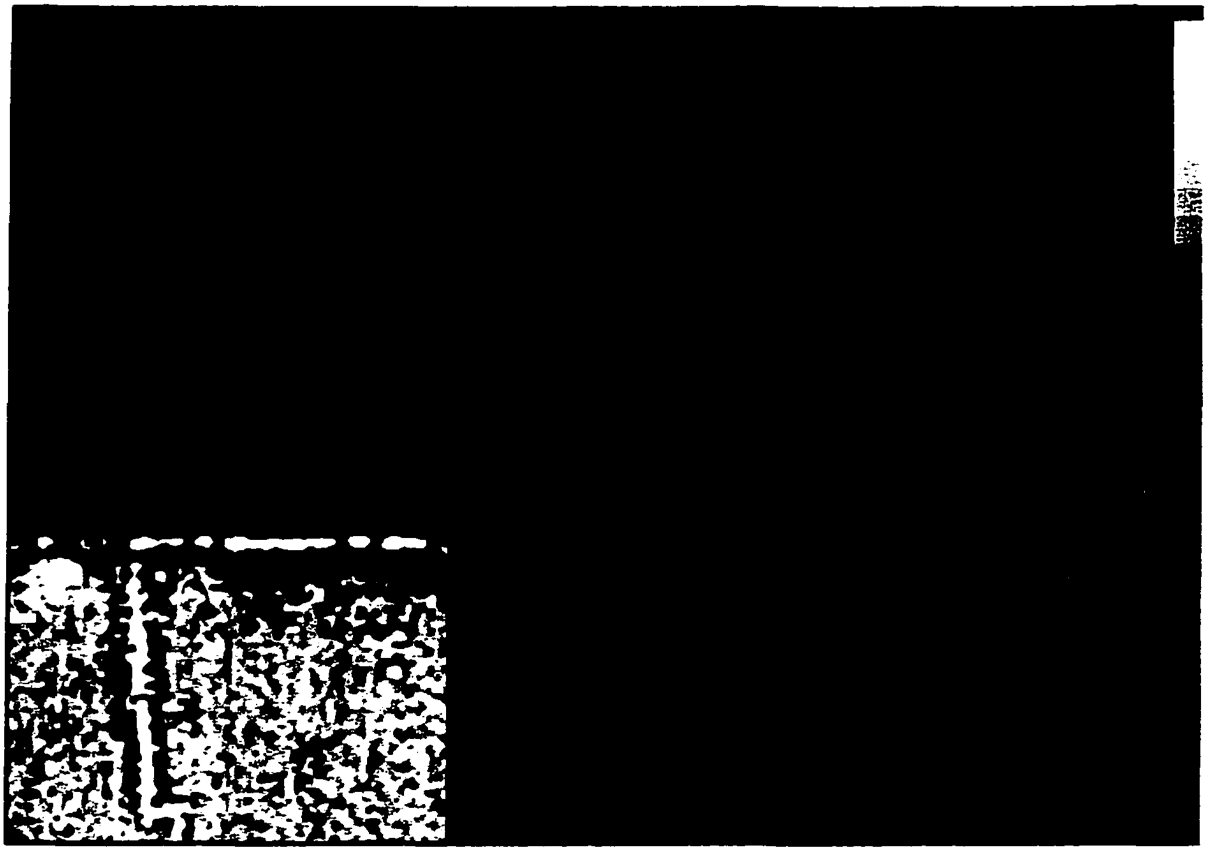

Figure A1.17 Magnetometry image of Bogle Field. This image (bogmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -2 to 2 nT at a scale of 1:1000.

Conclusion

The enclosure at Bogle Field is located near the Tweed River and in the vicinity of archaeological sites at Trimontium, Eildon Hill North, and Red Rig. It is therefore located in an intriguing portion of the landscape. As one of a cluster of enclosure sites nestled around the Roman fort at Trimontium, Bogle Field is a candidate for further exploration on the basis that it may contain information about Roman and Native contact. On the basis of this geophysical survey it seems possible that intact archaeological features and contexts would be uncovered through excavation and that both curvilinear and rectilinear internal features might be recovered.

Bogle Field is currently classed as a Roman site and in fact shares a NMRS site number with the Roman fort at Newstead. The only feature which marks the site as somewhat unusual from native rectilinear enclosures is the fact that the entrance is centered on the southern side of the site. It is quite possible that this is a native rectilinear enclosure, but to be certain excavation would be required. Unless excavation is undertaken to evaluate whether this site is Roman and occupied at the same time as the Roman fort, Bogle Field would benefit from being given a NMRS site number separate from that of Trimontium.

Bowden Moor

Description

A circular enclosure identified through an aerial photograph cropmark sits on the northern slope of Bowden moor (NT 5264 3216) at 270 m above sea level. This position is at the shoulder of the hill where the topography becomes more gentle after steep lower slopes. The enclosure is positioned between two small burns, and lies east of Cauldshiels Loch.

The NMRS report for this site states:

> Air photographs (106G.Scot.UK 142: 5060-1) reveal the crop mark of an enclosure in a cultivated field on Bowden Moor, 300 yds ESE of earthwork NT53SW6. The enclosure is approximately circular on plan and measures 100 ft in diameter within a single bank. A linear earthwork (NT53SW5) impinges on it on the SE.

The enclosure at Bowden Moor was first visited by members of the Newstead Research Project in 1992 who found the site lying in permanent pasture. A team, directed by Dr. Kate Clark, returned to carry out both resistivity and magnetometry surveys. Thirteen grids were completed with each technique.

Interpretation

The resistivity results show linear earthwork NT53SW6 and two additional earthworks. The four low resistance lines on the resistivity images curve away from the slope of the hill and are most likely the result of geology. The magnetometry results clearly show the line of earthwork NT53SW6 and the two additional earthworks. No sign of the curvilinear enclosure was found during geophysical survey.

Given that the aerial photograph was not originally available to the Newstead Research Project, and that no trace of linear earthwork NT53SW5 can be seen in the geophysical results, it is very likely that the circular enclosure at Bowden Moor was not surveyed.

Table A1.6 Archaeological features identified from geophysical survey of Bowden Moor.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Earthwork NT53SW5
B	Magnetometry and Resistivity	Earthwork
C	Magnetometry and Resistivity	Earthwork

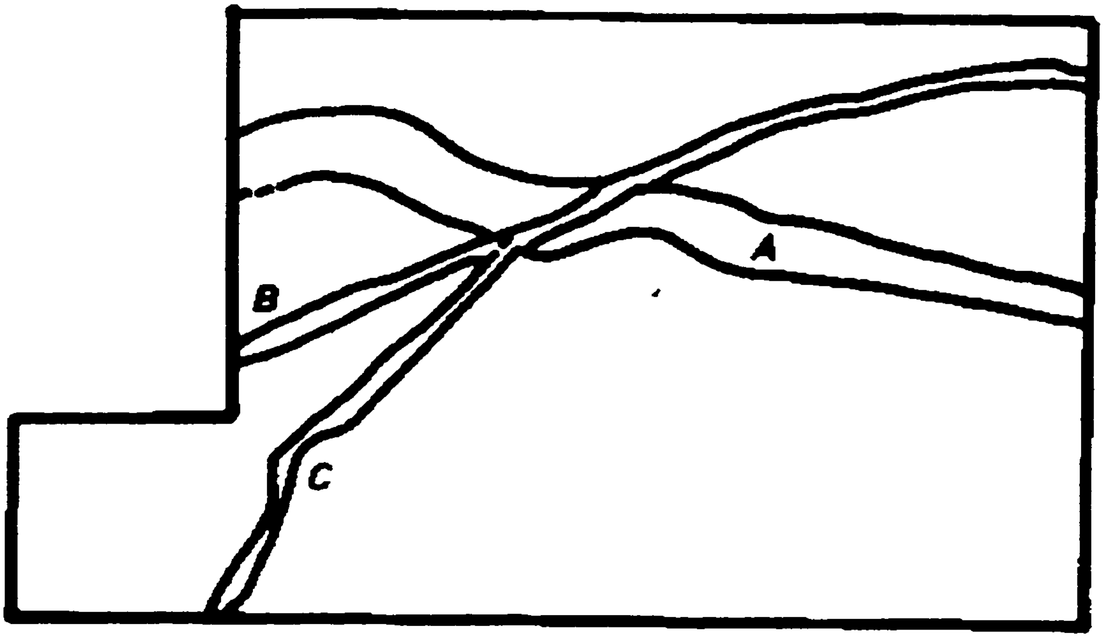

Figure A1.18 Interpretation of geophysical evidence from Bowden Moor at 1:1000.

Figure A1.19 Resistivity image of Bowden Moor. This image (bowres5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 100 through 200 ohms at a scale of 1:1000.

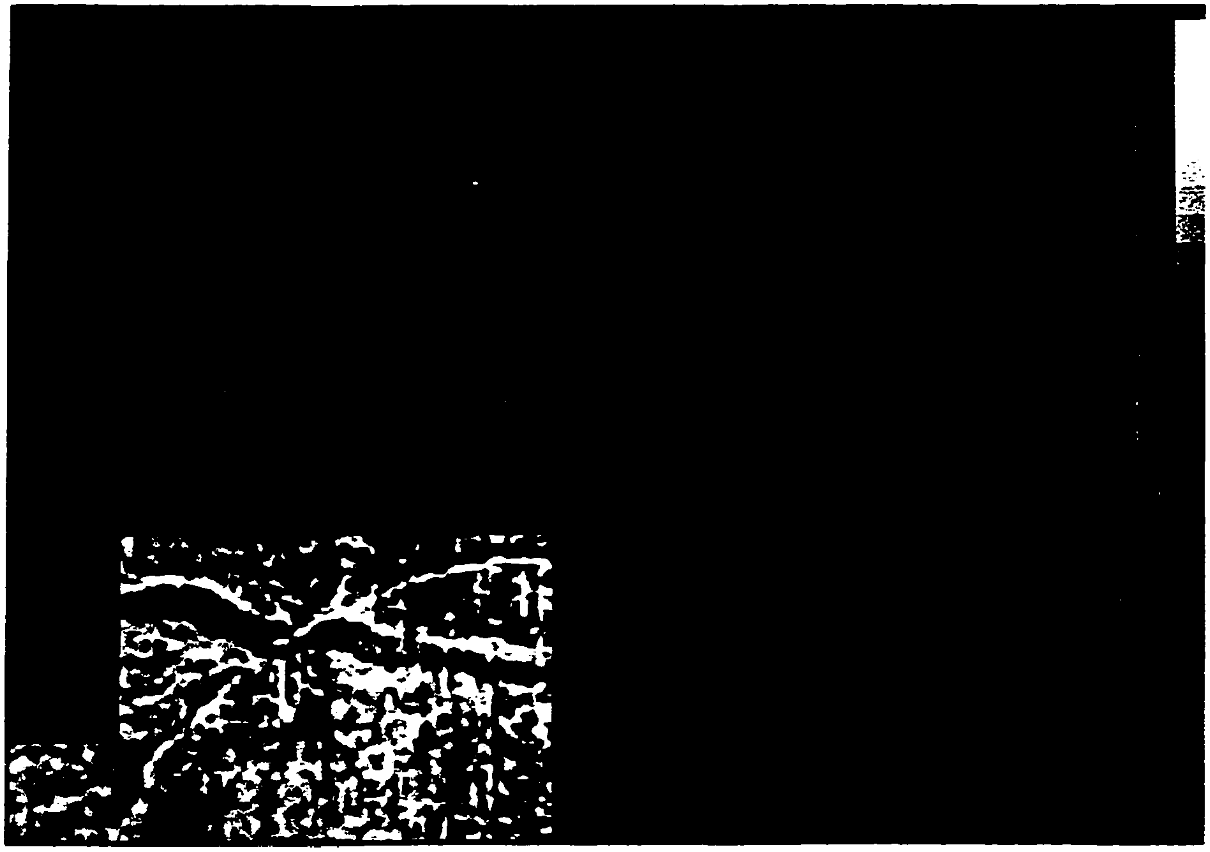

Figure A1.20 Magnetometry image of Bowden Moor. This image (bowmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -4 through 2.8 nT at a scale of 1:1000.

Conclusion

This site has probably not yet been geophysically surveyed, but as it sits amidst an extensive series of earthworks it is worthy of further study.

Butchercote Promontory Fort

Description

The oval promontory fort (NT 6275 3468) at Butchercote sits roughly 165 m above sea level and is bordered by a cliff on the west and a ravine on the south. Maidenhall Burn sits at the bottom of the western cliff and one of its feeder creeks runs down the southern ravine. This creek passes within 25 m of the fort. Butchercote rectangular enclosure is located 325 m to the northeast of the promontory fort.

The NMRS report for this site states:

> An oval fort, 258 ft x 174 ft occupies the SW end of a rocky promontory. At the SW end, on cultivated land, a rampart can be traced in the form of a terrace running round the point of the promontory. 40 ft beyond this are the remains of another terrace at a lower level. The NE end seems to have been almost obliterated by cultivation and here two slight hollows 45 ft apart seem to represent trenches. J. H. Craw 1921
>
> The terrace on the SW is 3.5 m broad. On the NE is a vague broad hollow approximately 23.0 m across, and 0.7 m maximum depth. (Visible on RAF air photographs: 106G/Scot.UK 18; 7241). Visited by OS 24 May 1955.
>
> The SW end of this earthwork is as described above. The NE section is at present under crop and no trace of the earthwork can be made out there. Surveyed at 1:2500. Visited by OS 24 September 1962.

Interpretation

A field crew directed by Paul Cheetham of the Newstead Research Project visited the site in 1990 to conduct a geophysical survey. A total of 28 grids of resistivity and 26 grids of magnetometry were completed.

Geophysical survey at Butchercote oval promontory fort was hampered by bedrock close to the surface. The bedrock appears as a scaly pattern of highs and lows on the magnetometer plot, and as a seemingly patternless series of highs and lows on the resistivity plot. None of the archaeological features is evident from the resistivity survey, but three ditches appear as medium magnetic anomalies on the magnetometry results. The high background resistance and near-surface magnetized bedrock are both more apparent at first glance than are the archaeological features themselves.

Table A1.7 Archaeological features identified from geophysical survey of Butchercote Promontory Fort.

Feature	Technique	Interpretation
A	Magnetometry	Inner ditch.
B	Magnetometry and Resistivity	Second ditch.
C	Magnetometry	Possible third ditch.

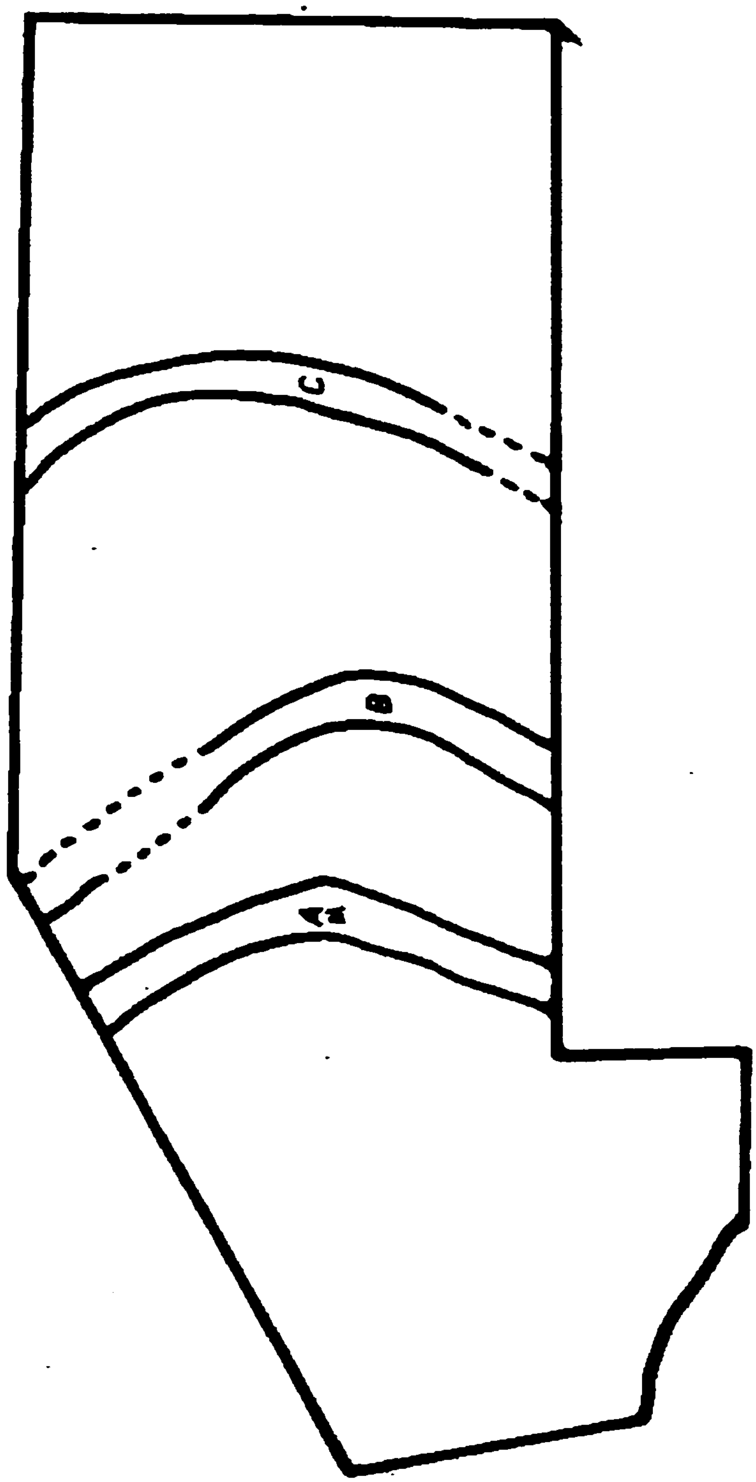

Figure A1.21 Interpretation of geophysical evidence from Butchercote Promontory Fort

Figure A1.22 Resistivity image of Butchercote Promontory Fort. This image (bcpres3.tif) produced through spike removal, bicubic interpolation, and printing of data points from 195 to 325 ohms at a scale of 1:1069.

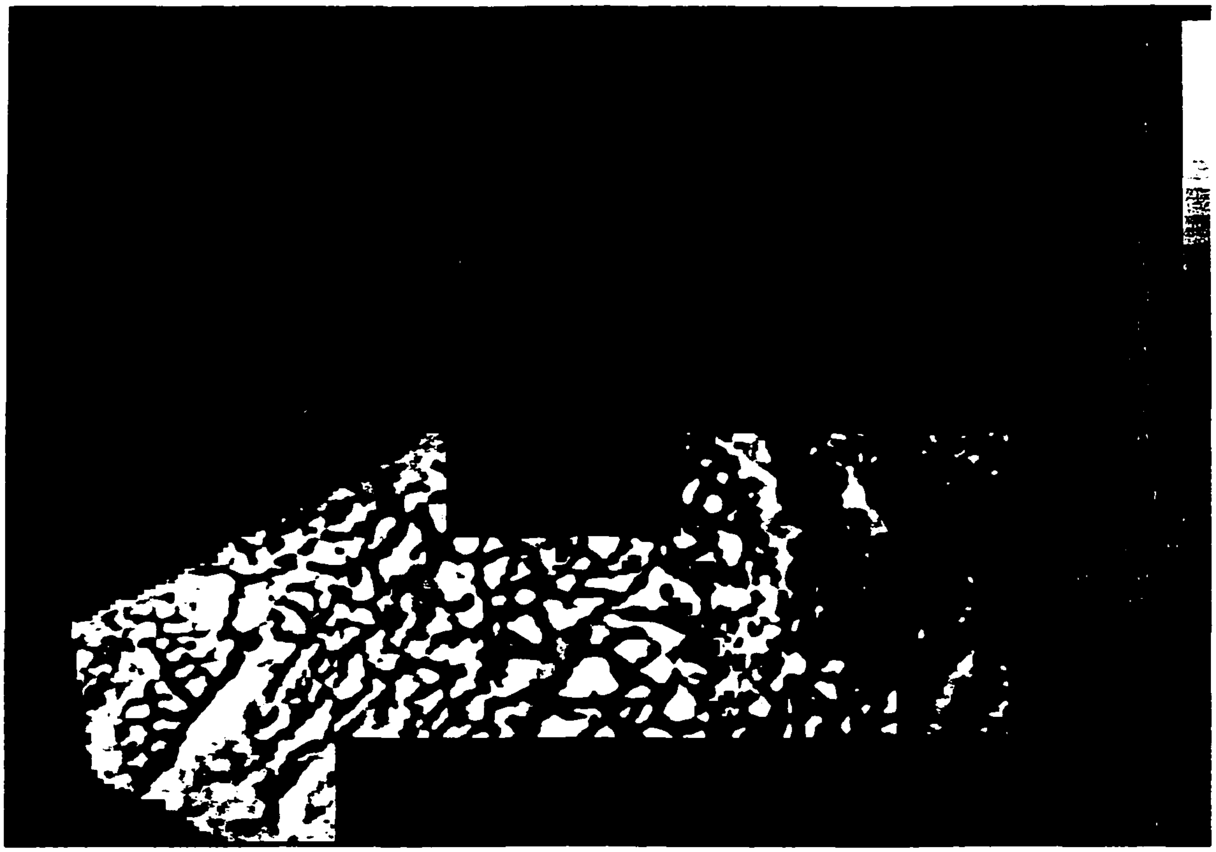

Figure A1.23 Magnetometry image of Butchercote Promontory Fort. This image (bcpmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -40 to 80 nT at a scale of 1:1000.

Conclusion

The continuing existence of the ditches of the Butchercote oval promontory fort, given extensive ploughing and near-surface bedrock, suggests strongly that the ditches may have been carved into the bedrock.

The oval promontory fort commands good views to the west. From it can be viewed the enclosures at Butchercote, Brotherstone Hill South, Third, Whitrighill, Bemersyde Curvilinear Homestead, and Spadislee. This site is defensively located, and has nearby fresh water sources.

Butchercote Rectilinear Homestead

Description

The sub-rectangular enclosure at Butchercote (NT 631 349) sits between the 165 and 170 m contour lines on a relatively flat area between Butchercote Craigs and Sandyknowe Craigs. It is located 50 m south of a feeder creek for Maidenhall Burn, and 325 m northeast of the neighboring Butchercote Promontory Fort.

Butchercote enclosure appears as a three-sided cropmark on aerial photographs. The northwestern and southwestern sides appear single-ditched while the northeastern side appears double-ditched.

Interpretation

A field crew of the Newstead Research Project visited the site in 1990 to conduct geophysical surveys. This crew was directed by Dr. Kate Clark, and a total of 43 resistivity grids and 40 magnetometry grids were completed.

Resistivity results suggest that the Butchercote sub-rectangular enclosure is triple ditched on the southern side, and at least double ditched elsewhere, with an entrance on the eastern side. A patchwork of high-resistance anomalies suggest a variety of curvilinear and rectilinear internal features. Structural features are also present between the first and second ditches on the eastern side of the enclosure. The ditches appear on the resistivity images as both high and low features, suggesting very heterogeneous fills.

Magnetometry at the Butchercote sub-rectangular enclosure clearly shows the innermost ditch of the enclosure with an entrance to the east. The ditch terminals on either side of this entrance have very different magnetic signatures than other sections of the ditch which suggests different fill in these areas. Less clear, but still present, is evidence for two additional ditches to the south. Internal high magnetic anomalies suggest the possible presence of archaeological features, and again these are both curvilinear and rectilinear. Structural features are also present between the first and second ditches on the eastern side of the enclosure.

Table A1.8 Archaeological features identified from geophysical survey of Butchercote Rectilinear Homestead.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Inner ditch. This clearly defined ditch has slightly irregular squared corners, and an entrance on the eastern side. There also appear to be gaps in the ditch at both southern corners.
B	Magnetometry and Resistivity	Entrance.
C	Magnetometry and Resistivity	Second ditch, south side of homestead. This second ditch appears as a low anomaly on both resistivity and magnetometry images.

D	Magnetometry and Resistivity	Possible third ditch on south side of enclosure.
E	Magnetometry and Resistivity	Second ditch, north side. On the east end this ditch curves southwards and abuts the intersection of features A and F.
F	Magnetometry and Resistivity	Second ditch, east side. This clear feature appears as a high resistance, low magnetic anomaly and abuts the northeastern corner of the inner ditch then turn southwards in a slightly rounded corner.
G	Magnetometry	Ditch section. This short high resistance anomaly lies between the termination of the east side second ditch and the entrance way.
H	Resistivity	Ditch section. Appears to align with feature G.
I	Magnetometry and Resistivity	L-shaped possible ditch to the southeast of the inner ditch.
J	Magnetometry	Ditch section southeast of enclosure.
K	Magnetometry	Ditch section southeast of enclosure.
L	Magnetometry and Resistivity	Internal structural features -- too many to detail, but these appear to be both curvilinear and rectilinear.
M	Magnetometry and Resistivity	Structural features between first and second ditches on east side of enclosure. These appear to fall within the line of the second ditch.

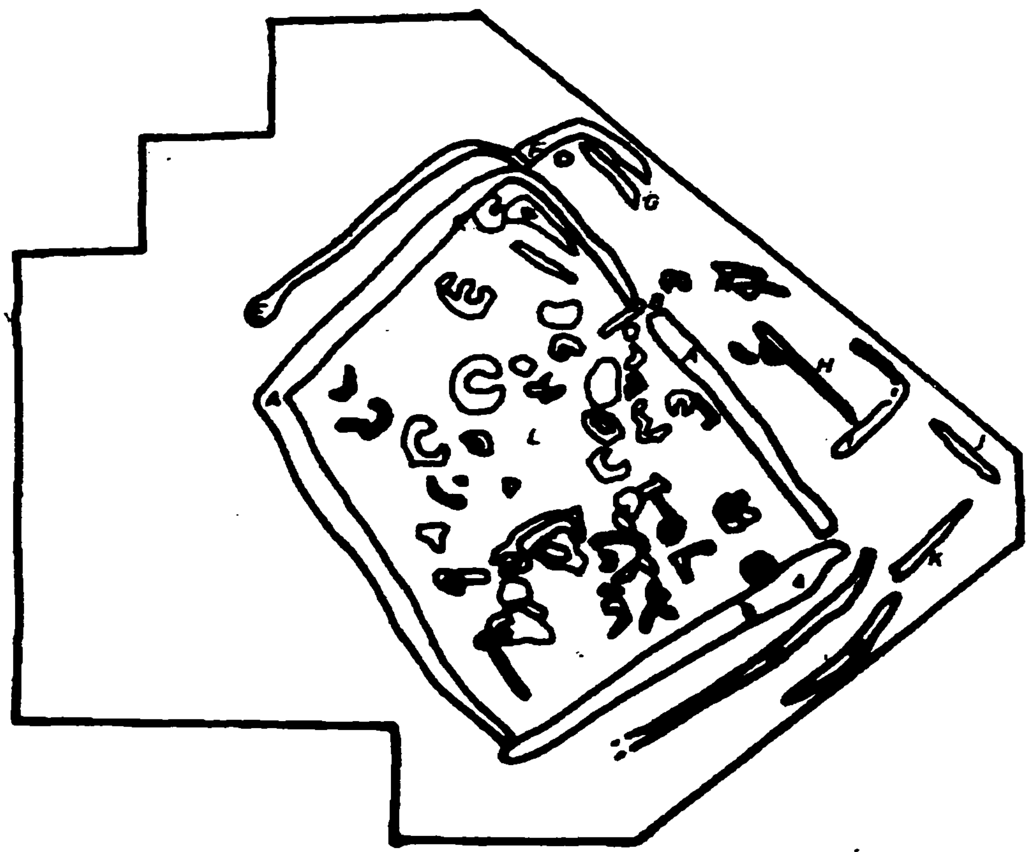

Figure A1.24 Interpretation of geophysical evidence from Butchercote Rectilinear Homestead

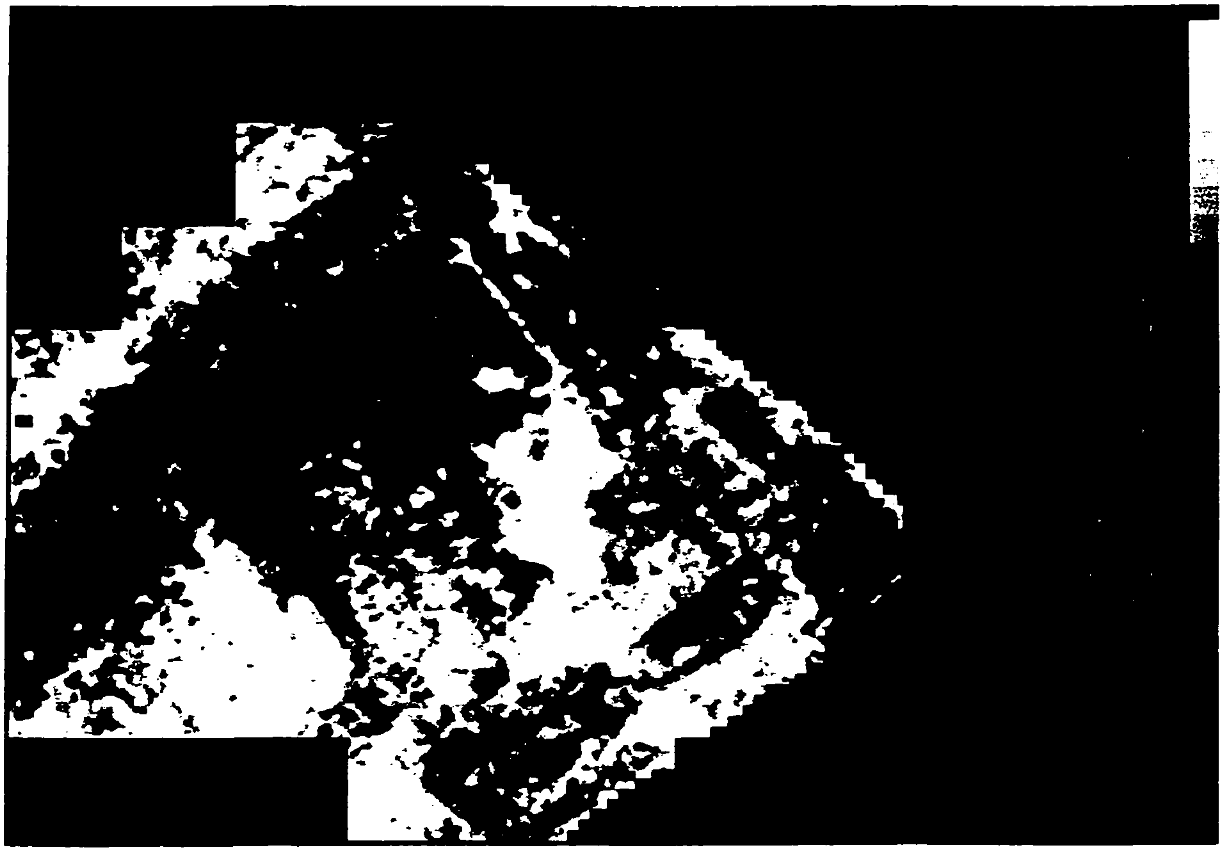

Figure A1.25 Resistivity image of Butchercote Rectilinear Homestead. This image (bcrres5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 55 to 120 ohms at a scale of 1:1000.

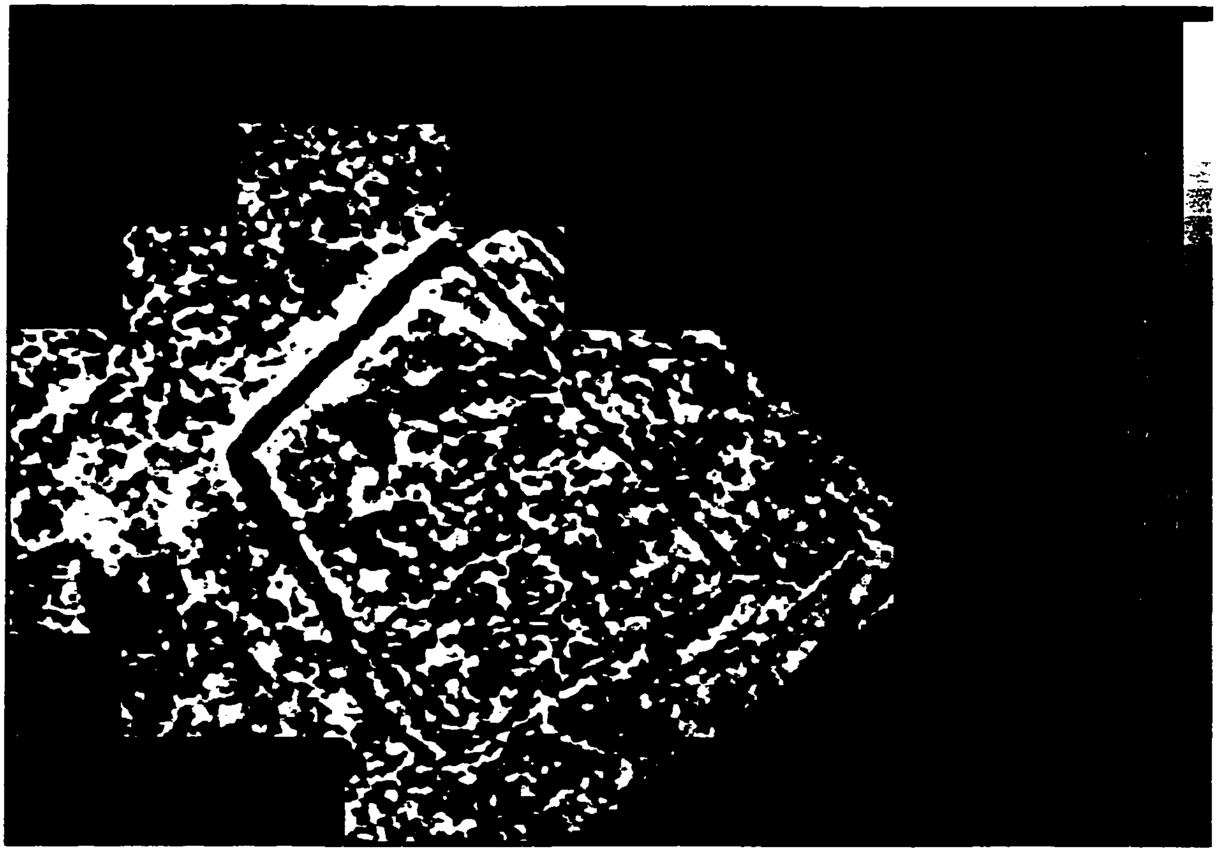

Figure A1.26 Magnetometry image of Butchercote Rectilienar Homestead. This image (bcrmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -10 to 10 nT at a scale of 1:1000.

Conclusion

This enclosure appears to have been reshaped at different periods, suggesting a multiphase occupation. Evidence for reshaping of the northeast corner is particularly clear from the geophysical evidence. Overall, the odd shape of Butchercote, and the multiple lines of ditch around the enclosure, lead one to wonder if originally this site may have been curvilinear.

The inner ditch corners on the south side of the enclosure appear to be interrupted. Excavation has shown that the ditch in the northeastern corner of Lilliesleaf Rectilinear Homestead had been interrupted by a small passageway over the ditch, and something similar may be present at Butchercote Rectilinear Homestead.

There is a great deal of evidence for structures within the enclosure, and the geophysics data suggests that these structures may be both curvilinear and rectilinear.

Internal rectilinear structures would suggest that one of the occupation phases at this homestead may have been during the Roman period.

The rough internal dimensions of the enclosure are 73 m by 45 m while the external dimensions are 110 m by 83 m. This suggests a high degree of investment in the enclosing banks and ditches, though Bemersyde Rectilinear Homestead is not as defensively located as Butchercote Promontory Fort.

The rectilinear enclosure commands good views to the west. From it can be seen Butchercote Promontory Fort and the enclosures at Brotherstone Hill South, Third, Whitrighill, Bemersyde Curvilinear Homestead, and Spadislee.

This site would be extremely interesting to excavate. Relatively good site preservation is suggested by the quantity of internal geophysics signals, and the possibility that this site began as a curvilinear homestead and was later restructured into a rectilinear enclosure is intriguing.

Ridgewalls Cairneymount

Description

The enclosure at Ridgewalls Cairneymount (NT 5500 3966) lies 230 m above sea level on the southern side of Cairneymount Hill in Lauderdale. An enclosure of similar size containing a small ruined farmhouse and outbuilding of late 18th or early 19th century date adjoins the site. A modern farmhouse, built just west of the site in the 19th century, continues in use today.

A modern spring lies just southwest of the archaeological enclosure. Clackmae Burn provides another nearby source of water, flowing 200 m to the south of the enclosure. This site lies on the same ridge as Chesterlee. Perhaps due to the intervening plantation the two sites are not currently intervisible.

This homestead has been known since at least the mid-18th century and remains of its earthworks are still visible in the plantation east of the main field. It is located on a gentle slope and is not in a very defensible location.

The NMRS report for Cairneymount states that

> The earthwork that was situated in the paddock adjoining the East side of the garden of Cairneymount has been almost entirely leveled by cultivation. All that remains is a shallow depression, marking the site of the inner enclosure, and a curved segment of ditch, roughly concentric with the rim of the depression, preserved in the plantation bordering the paddock on the East. The ditch is 110 ft long, 10 ft to 12 ft wide, and up to 2 ft deep.

The earthwork is briefly referred to by A Milne (1743) and G Chalmers (1887) and is described in more detail by D Christison (1895).

According to the latter the interior was oval, measuring 188ft by 138 ft, and was surrounded by triple ramparts and ditches. The inner rampart was not, however, concentric with the other two, being separated from them by a space 84ft wide on the Southeast but only 28 ft wide on the Northwest. The outer rampart measured about 300 yards in circumference.
RCAHMS 1956, visited 1947.

The shallow depression marking the site of the inner enclosure, as described above, is too poorly defined to survey. It would appear to be almost circular, being about 54.0 m by 50.0 m. The fragment of ditch in the adjoining plantation is poorly defined but a small stretch of bank can also be vaguely defined here. Surveyed at 1:2500.
Visited by OS 16 February 1961.

Cropmarks on aerial photographs show the enclosure to be double-ditched and curvilinear. A round dark cropmark suggests at least one internal structure, and a gap in the eastern portion of the surrounding ditches suggests an entranceway.

Interpretation

A field crew of the Newstead Research Project visited Cairneymount in 1992 to complete geophysical surveys. They found the field in permanent pasture and bounded by stone walls with sheep netting and electric fencing. In total, 24 grids of resistivity and 24 grids of magnetometry were done. Magnetic susceptibility samples were taken by David Redhouse from the second ditch of the Cairneymount enclosure.

Resistivity printouts suggest a double-ditched, triple-banked curvilinear enclosure. The banks appear as hazily defined high resistance anomalies separated from one another by more narrow, and slightly better defined, low resistance anomalies.

The two ditches visible on the resistivity printouts appear on the magnetometry results, however only the inner ditch appears clearly. A very strong stippled anomaly running northeast on the western side of the survey plot was caused by a water pipe and is not an archaeological feature.

Table A1.9 Archaeological features identified from geophysical survey of Ridgewalls Cairneymount.

Feature	Technique	Interpretation
A	Resistivity	Inner bank.

B	Magnetometry and Resistivity	Inner ditch.
C	Resistivity	Second bank.
D	Magnetometry and Resistivity	Second ditch.
E	Resistivity	Second ditch.
F	Resistivity	Possible third bank.
G	Resistivity	Third bank.
H	Magnetometry	Three small magnetic anomalies which may mark internal structural features.
I	Magnetometry	Modern water pipe.

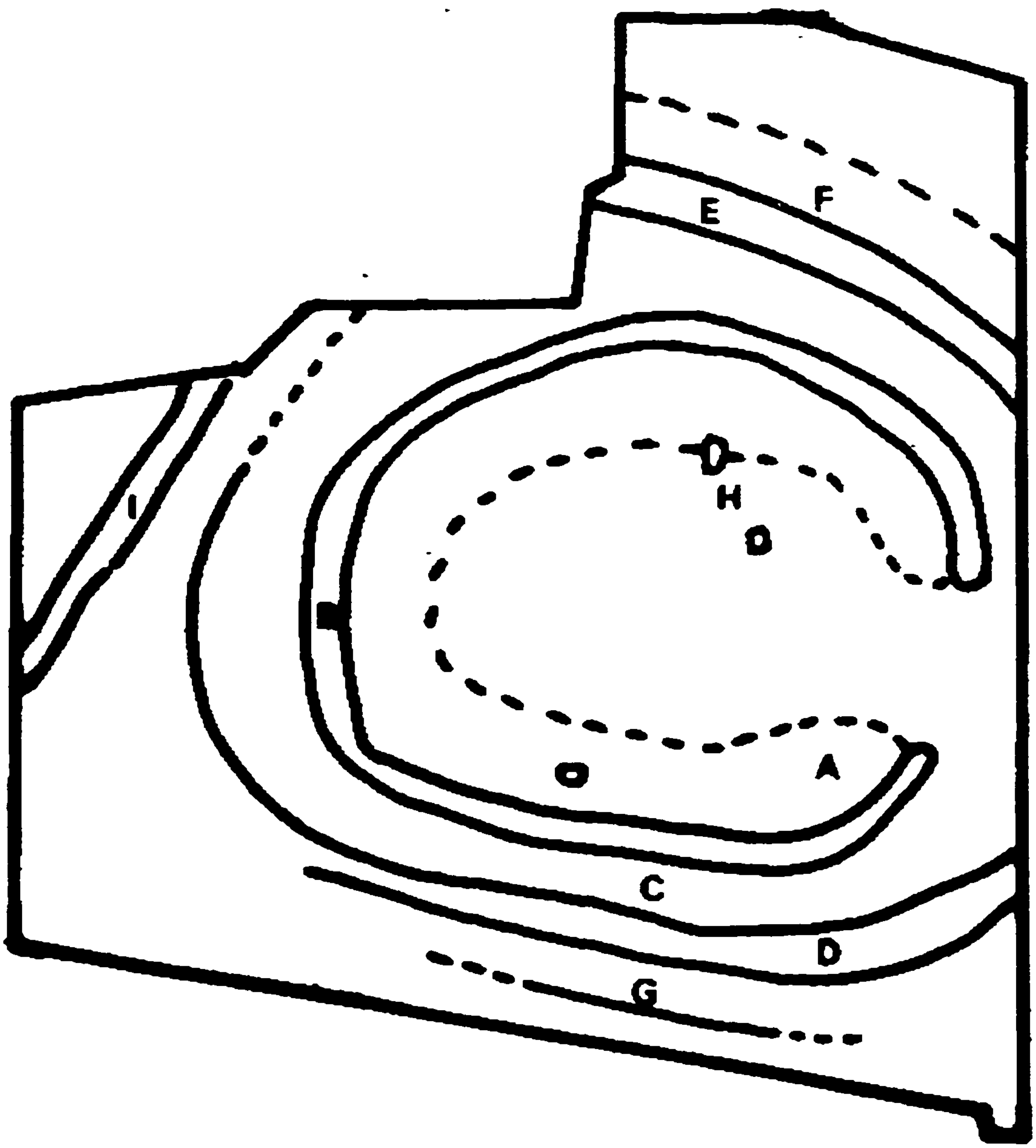

Figure A1.27 Interpretation of geophysical evidence from Ridgewalls Cairneymount

Figure A1.28 Resistivity image of Ridgewalls Cairneymount. This image (cmres5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 40 to 105 at a scale of 1:1000.

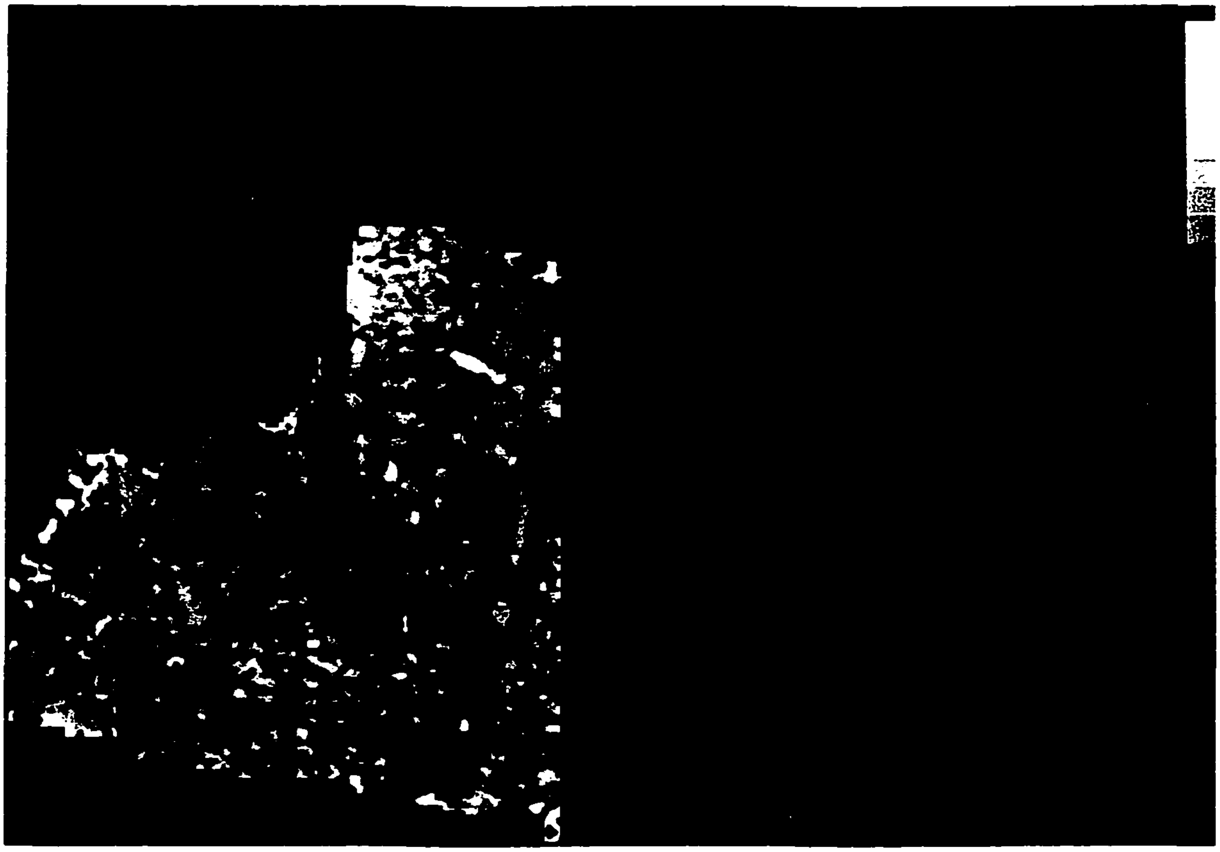

Figure A1.29 Magnetometry image of Ridgewalls Cairneymount. This image (cmmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -5 to 5 at a scale of 1:1000.

Conclusion

Geophysical survey at Cairneymount provided clear evidence for the continuing presence of the homestead ditches and spread from the banks in advance of excavation. No clear evidence for internal structures was detected via geophysics despite the clear cropmark on aerial photographs. Excavations carried out on this site as part of the Newstead Research Project (Dent 1993) after the geophysical survey confirmed the presence of the two inner ditches and the intervening bank, the entrance, and an area within the enclosure which produced evidence for at least three ring-groove roundhouses with medieval pottery and spindle whorls. The third bank was not sought during excavation as it was recognized in the geophysical evidence after the excavation was completed.

Cauldshiels Hill

Description

The fort at Cauldshiels Hill (NT 5155 3165) sits 350 m south-southeast of, and up a relatively steep slope from, Cauldshiels Loch. Other nearby water sources include a feeder creek for Linn Dean 550 m to the west, a feeder creek for Lady Moss and Holydean Burn 700 m to the south, and a spring source for a feeder creek of Huntly Burn 525 m to the east-southeast. As Cauldshiels Hill has steep northern, western, and southern sides and a gently sloping shoulder to the east, the last of the water sources is the most easily accessible from the fort.

The NMRS record for Cauldshiels Hill states:

> This fort is situated on the summit of Cauldshiels Hill, at a height of 1076 ft OD. It is roughly oval on plan, measuring internally 220 ft from E to W by 120 ft transversely. The defenses have comprised a continuous inner rampart (A on plan) drawn round the natural crest of the knoll that forms the actual summit of the hill, with the addition of a second and third rampart (B and C), each fronted by a ditch, on the S half of the perimeter. These outer works may also have been continuous, but there is now no trace of them along the steep N slope. Judging by the two short segments that survive, on the SE arc, the inner rampart was probably a drystone wall; the outer ramparts, each of which is about 25 ft thick at the base and some 5 ft high externally, appear to have been constructed of heaped upcast from their respective ditches. At the W end of the fort there are some slight indications that the defences were supplemented by the interpolation between ramparts B and C of two discontinuous segmental ramparts (D and E), but the remains are difficult to interpret at this point owing to their wasted condition and surface quarrying. It could be that the defences are not all of one period; thus stone rampart A, and perhaps the segmental ramparts D and E may represent the primary fort, while the earthen ramparts B and C could have been added at a later date. The entrance was evidently on the E since rampart B and its ditch both end about 12 ft from the lip of the steep N-facing slope, thought the gap in the inner rampart (A) has been largely destroyed by quarrying, and the corresponding gap in rampart C has been blocked by a later linear earthwork (NT53SW5).
>
> A length of flattened turf dyke which runs downhill from the W end of the fort to Lin 530 (RCAHMS 1957) appears to be a field boundary, probably of no great age. Apart from the foundations of a small modern structure situated between ramparts A and B, the interior of the fort is featureless. RCAHMS 1957, visited 1950.

This fort is generally as described by the RCAHM, except that the wasted remains of rampart 'A' can be seen as a low spread mound about 3.0 m broad on the W and S sides. At the E end of the fort, rampart 'C' and the counterscarp of the ditch in front of it do not turn sharply as shown on the plan, but curve smoothly to the SW. Surveyed at 1:2500. Visited by OS (WDJ) 9 February 1961.

Interpretation

Geophysical survey of the fort at Cauldshiels Hill was difficult due to extremely high resistance on site, shallow soil cover, and near-surface bedrock. In total only 5 grids of resistivity and 8 grids of magnetometry were completed by the Newstead Research Project field crew directed by Dr. Kate Clark. A portion of the enclosing ditch appears on the resistivity plot as a high resistance feature, but no other sign of archaeological features is apparent. The magnetometry results show an area of great magnetic disturbance in the northeastern portion of the survey area. This may be due to underlying bedrock, but could also be evidence for an archaeological feature.

Table A1.10 Archaeological features identified from geophysical survey of Cauldshiels Hill.

Feature	Technique	Interpretation
A	Resistivity	Ditch
B	Magnetometry	Area with much magnetic disturbance.

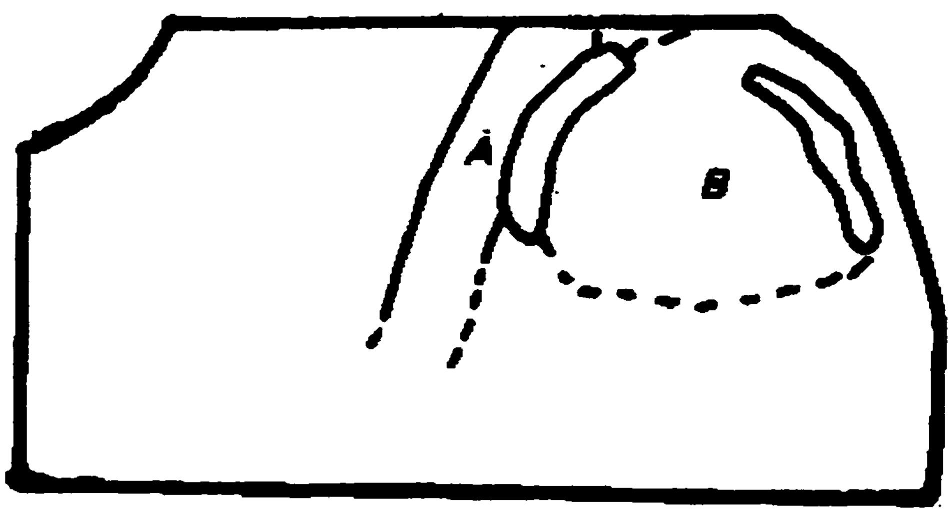

Figure A1.30 Interpretation of geophysical evidence of Cauldshiels Hill

Figure A1.31 Resistivity image of Cauldshiels Hill. This image (cshres5.tif) produced through spike removal, bicubic interpolation, and printing of data from 600 to 1200 ohms at a scale of 1:1000.

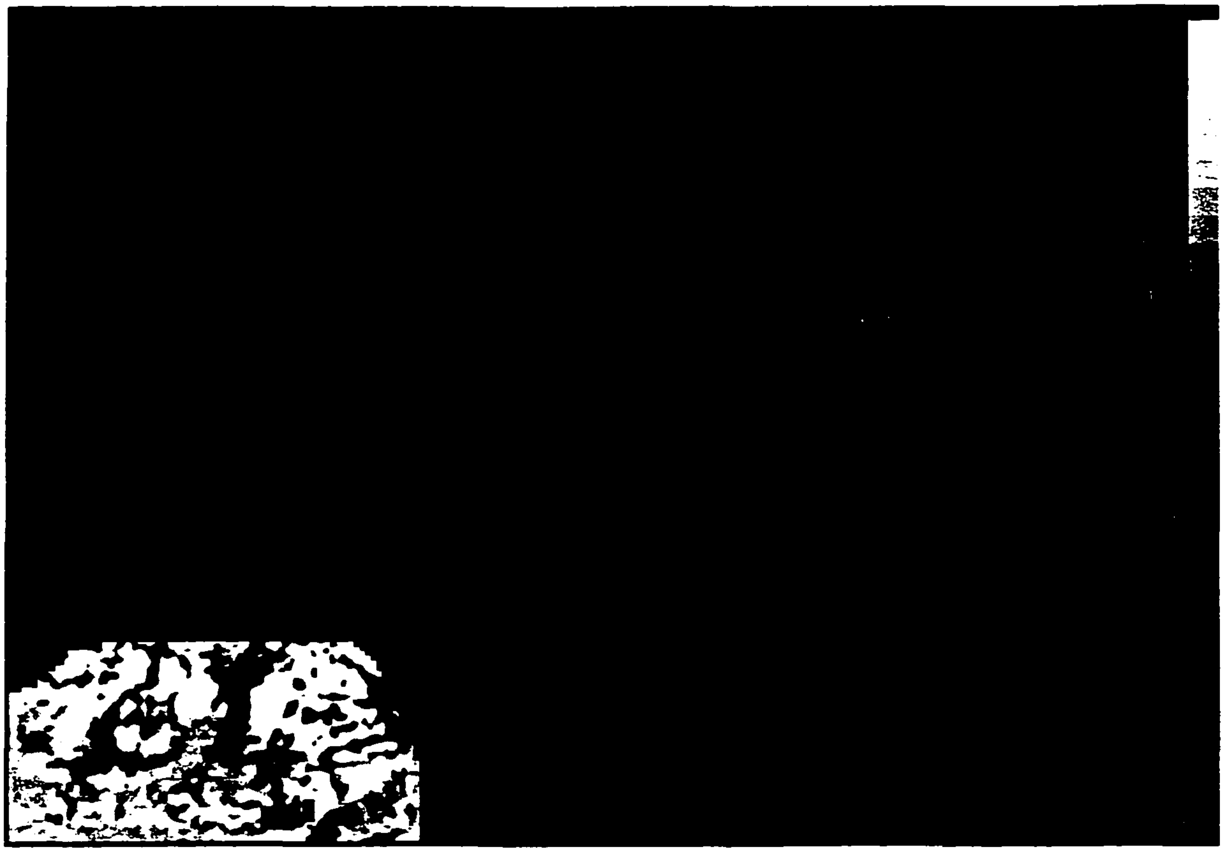

Figure A1.32 Magnetometry image of Cauldshiels Hill. This image (cshmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -15 to 15 nT at a scale of 1:1000.

Conclusion

Excavation undertaken by the Newstead Research Project after the geophysical survey of Cauldshiels Hill were directed by John Dent, Borders Regional Archaeologist (Jones *et al.* 1991). This excavation revealed evidence for a rock-cut enclosing ditch with an entrance to the east surrounded by a complex sequence of entrance structures. One circular house platform was discovered in the fort's interior, and this was also cut into the bedrock. Finds from the excavation included whetstones and fragments of a saddle quern, suggesting an Iron Age date for the fort. A burial with beaker was also discovered during the excavation of the Cauldshiels Hill fort, and suggests that the site was also used during the Bronze Age.

Chester Knowe

The geophysical data collected during the 1993 survey of Chester Knowe (NT 554 356) is now missing, and all that is left is a very poor printout of the magnetometry data. The enclosure is single-ditched and curvilinear, and parts still remain standing in the plantation adjacent to the surveyed field.

The NMRS record for this site states:

A "camp" occupies the summit of Chester Knowe. Though almost obliterated by cultivation and otherwise, it appears to have been oval, surrounded by a ditch and two ramparts. Name Book 1859

The OS map marks a small fort on Chester Knowe, at a height of nearly 800 ft OD; it is shown as rhomboidal on plan, measuring some 150ft E-W by 120ft transversely within a bank and external ditch. Very faint traces of the bank and ditch are still visible at the NE corner, but otherwise the work has been completely obliterated by ploughing and quarrying. RCAHMS 1956, visited 1947

The SW half of this earthwork has been obliterated by quarrying and recent tree-planting. On the NE half, only a faint trace of the bank is still visible for a distance of about 70.0m, and on the N side a short stretch of ditch can be traced. The bank (a low, spread mound) measures 7.0m - 8.0m broad and 0.2m high; the ditch is about 7.0m wide. Surveyed at 1:2500 scale. Visited by OS (WDJ) 17 February 1961

NT 554 356. In 1993 K Clark from the Newstead Research Project surveyed Chester Knowe. This earthwork is recorded in the NMRS as site NT53NE 31. Magnetometry results show a single ditched enclosure. Sponsors: National Museum of Scotland, University of Bradford, Borders Regional Council. A L Wise 1995

Chesterlee Cairneymount

Description

The oval enclosure at Chesterlee Cairneymount (NT 5550 3973) sits between 215 and 220 m above sea level on a northeastern slope. The site commands views primarily to the east and north. Water is located 400 m to the south in Clackmae Burn, and 600 m to the east in the Leader Water.

The NMRS report for Chesterlee Cairneymount earthwork states:

This earthwork is situated 600 yds E of Cairneymount, at 700 ft OD on the shoulder of a spur facing the Leader Water, and is crossed by the road from Clackmae to Langshaw. In shape a rectangle with rounded angles, it appears to have measured some 300 ft from E to W by 200 ft transversely within a single rampart and external ditch.

A stretch of the W rampart and ditch, 30 yds long, is still preserved in Cairneymount Covert 60 yds from its E end. The rampart, formed of heaped earth and stone, measures 25 ft to 30 ft in thickness at the base and up to 3 ft in height above the interior, while the ditch is 14 ft wide and 2 1/2 ft deept. Elsewhere the remains have been levelled by cultivation or road-widening, but Lynn's survey of the defences N of the road (D Christison 1895) is confirmed by soil-marks visible on National Survey air photographs taken in 1946. There are no traces of entrances or internal buildings.

Although it commands a wide view on three sides, the earthwork is not in a strong defensive position, as it is overlooked from the W and can be approached without difficulty from all quarters. It is most likely to be medieval in date. RCAHMS 1956, visited 1947.

The remains of this earthwork are as described above. Slight traces of banks (0.2 m high) can be seen in the cultivated grass field to the E of the covert, and would appear to be parts of the E and N sides of the earthwork. No traces of the work were found in ploughed fields on the N and S sides of Cairneymount Covert. Surveyed at 1:2500. Visited by OS (WDJ) 16 February 1961.

Interpretation

A field crew directed by Dr. Kate Clark of the Newstead Research Project visited the site in 1993 to conduct magnetometry and resistivity surveys. The enclosure lies in four parts: under two modern fields that were surveyed, in a modern plantation that was not surveyed, and in a field south of the modern road which was not surveyed. A total of 31 grids of resistivity and 23 grids of magnetometry were completed. Although the magnetometry survey produced no results, the resistivity plots show roughly the northern half of a single ditched ovoid enclosure with a variety of internal structural features. Though the ovoid ditch does not appear on the magnetometry plot, three low magnetic anomalies align with the location of the ditch as shown on the resistivity plot.

Table A1.11 Archaeological features identified from geophysical survey of Chesterlee Cairneymount.

Feature	Technique	Interpretation
A	Resistivity	Ditch.
B	Resistivity	Internal structural features.
C	Resistivity	Modern agricultural feature, possibly a field drain.

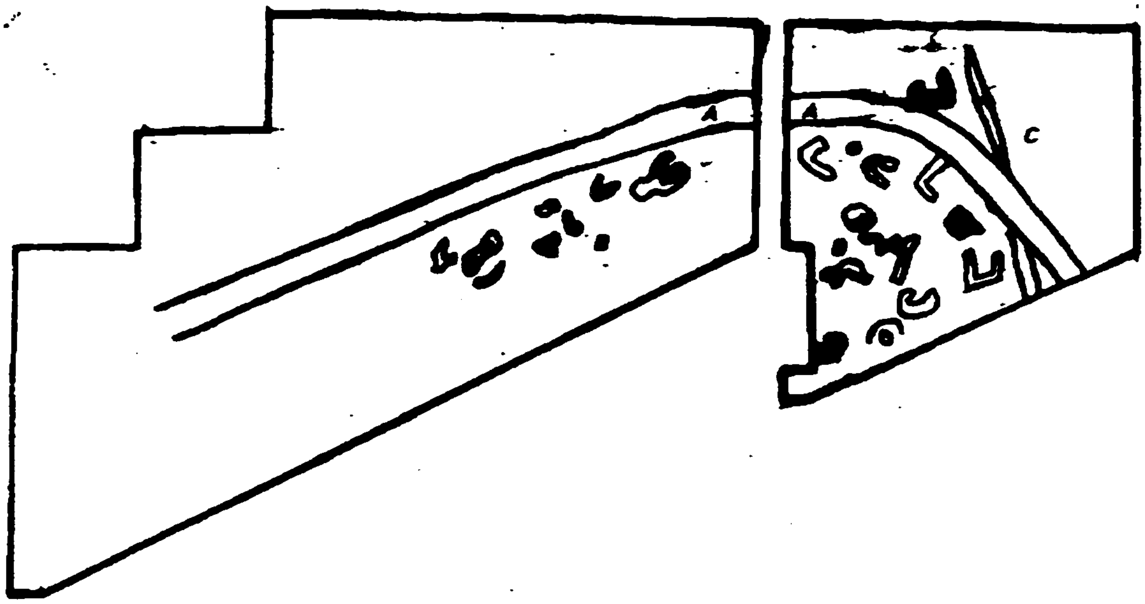

Figure A1.33 Interpretation of geophysical evidence from Chesterlee Cairneymount

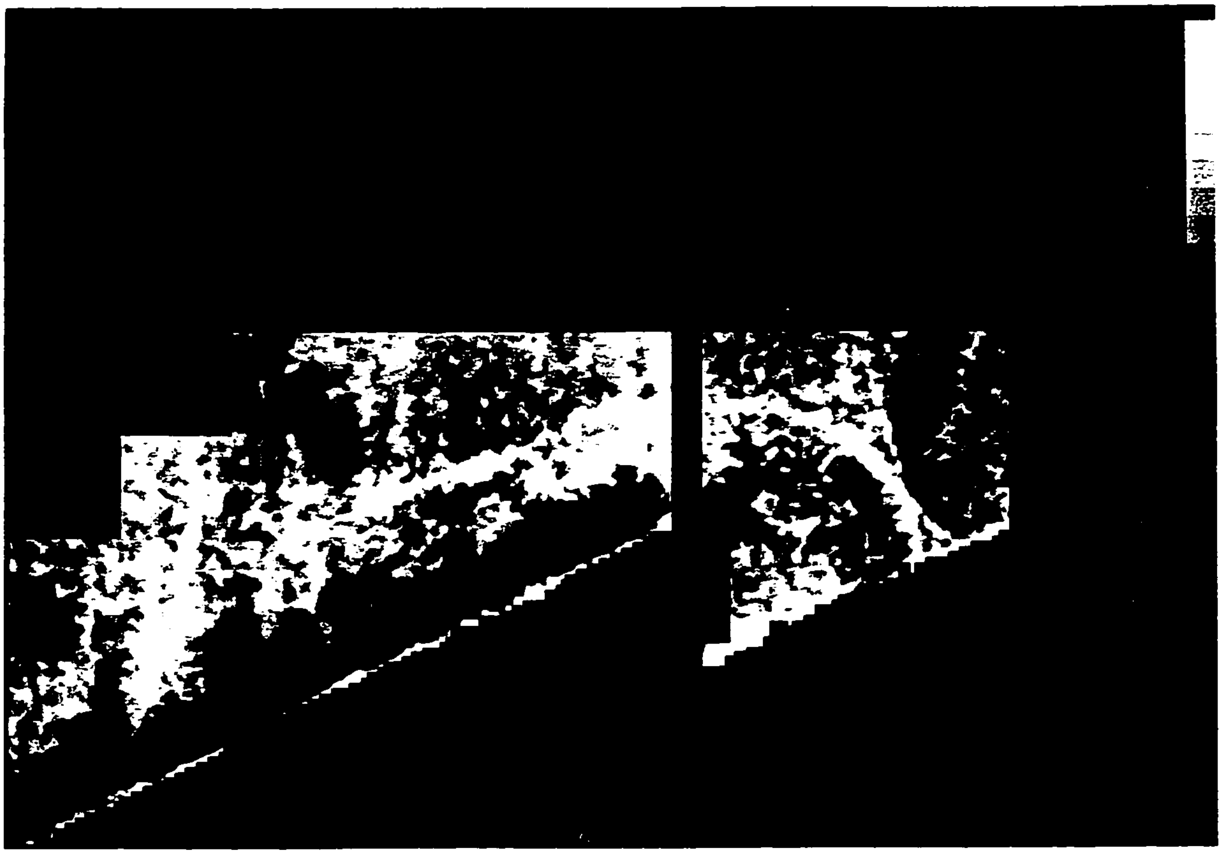

Figure A1.34 Resistivity image of Chesterlee Cairneymount. This image (clcres5.tif) produced through spike removal, bicubic interpolation, and printing data from 27 to 53 ohms at a scale of 1:1000.

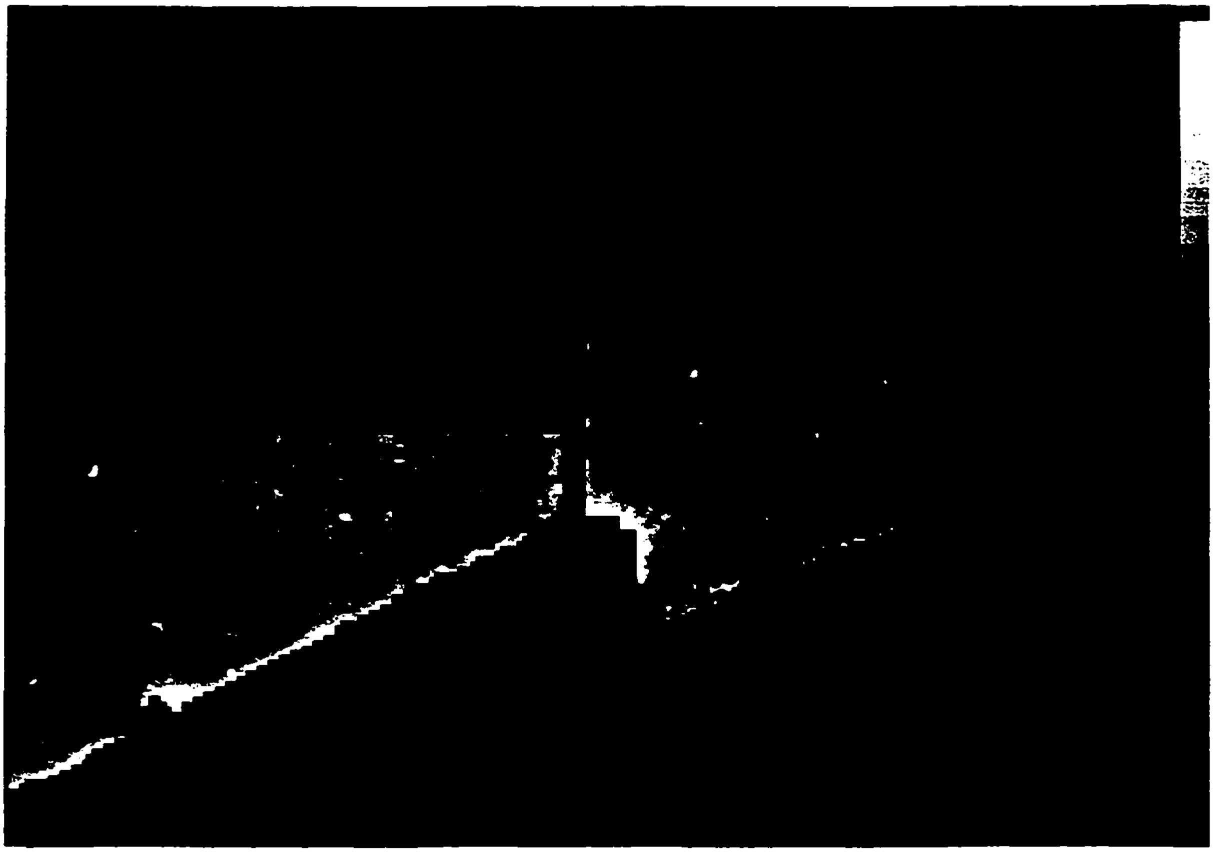

Figure A1.35 Magnetometry image of Chesterlee Cairneymount. This image (clcmag3.tif) produced through spike removal, bicubic interpolation, and printing of all data from -7.9 to 8.8 nT at a scale of 1:1000.

Conclusion

The proposed date for this enclosure is Medieval as its morphology would be unusual in prehistory.

Clint Hill

Description

The enclosure at Clint Hill (NT 6033 3288) sits 150 m above sea level on a south facing slope. Current water sources are a well near a modern settlement 100 m to the south and the River Tweed 425 m to the south. Clint Hill enclosure lies on the same ridge as the two enclosures at Heckside 1 and 2. Aerial photograph (BW/5180) cropmarks show the southern half of a single-ditched curvilinear enclosure with a possible entrance to the southeast.

Interpretation

The site was visited by a field crew directed by Dr. Kate Clark of the Newstead Research Project in 1993. An electrical resistance survey was carried out, but no magnetometry was possible because of equipment problems. Only the southern half of the enclosure could be surveyed as the northern portion currently is overlain by a plantation. The resistivity results complement the aerial photographic evidence, also showing the southern half of a curvilinear single ditched enclosure with a possible entrance to the southeast. Unexpectedly, the resistivity evidence also suggests that there may be an earthwork running north to south just west of the enclosure and curving to respect the line of the enclosure's ditch.

The entrance to the Clint Hill enclosure appears as a broad high resistance area roughly 20 m wide, which suggests the area may have been formed with hard-packed earth or even stones. The great width is possibly due to subsequent ploughing, and spreading of the underlying archaeological material. There are no clear internal features on the resistivity results, however the large high-resistance area associated with this entrance may block out underlying weaker signals.

Table A1.12 Archaeological features identified from geophysical survey of Clint Hill.

Feature	Technique	Interpretation
A	Resistivity	Ditch
B	Resistivity	Entrance
C	Resistivity	Entrance - high resistance feature
D	Resistivity	High resistance feature
E	Resistivity	Possible earthwork

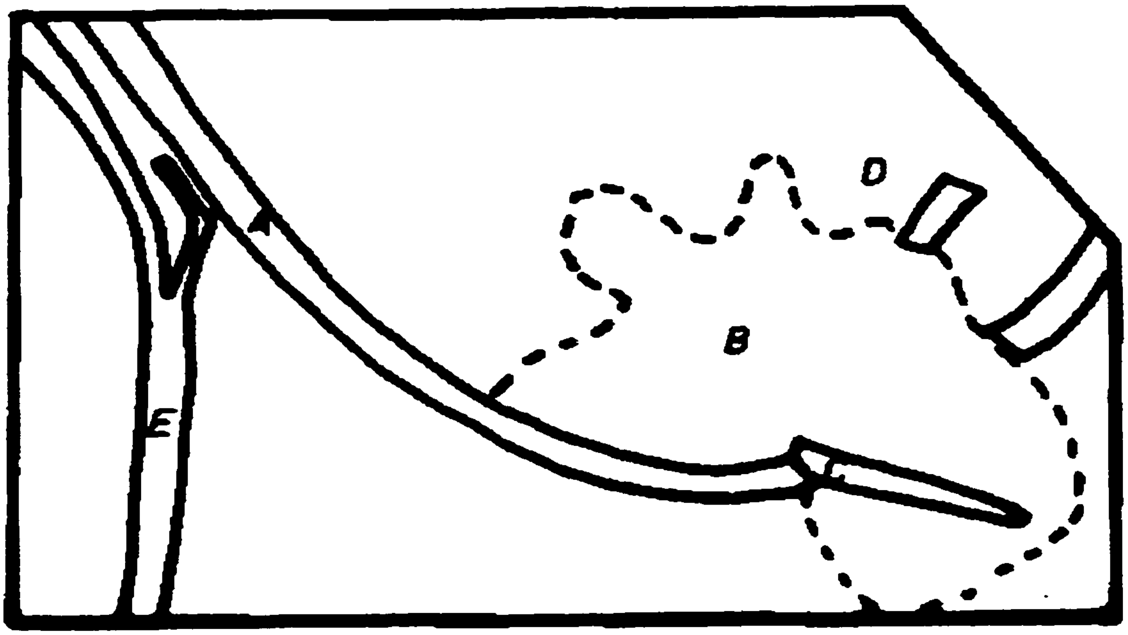

Figure A1.36 Interpretation of geophysical evidence from Clint Hill

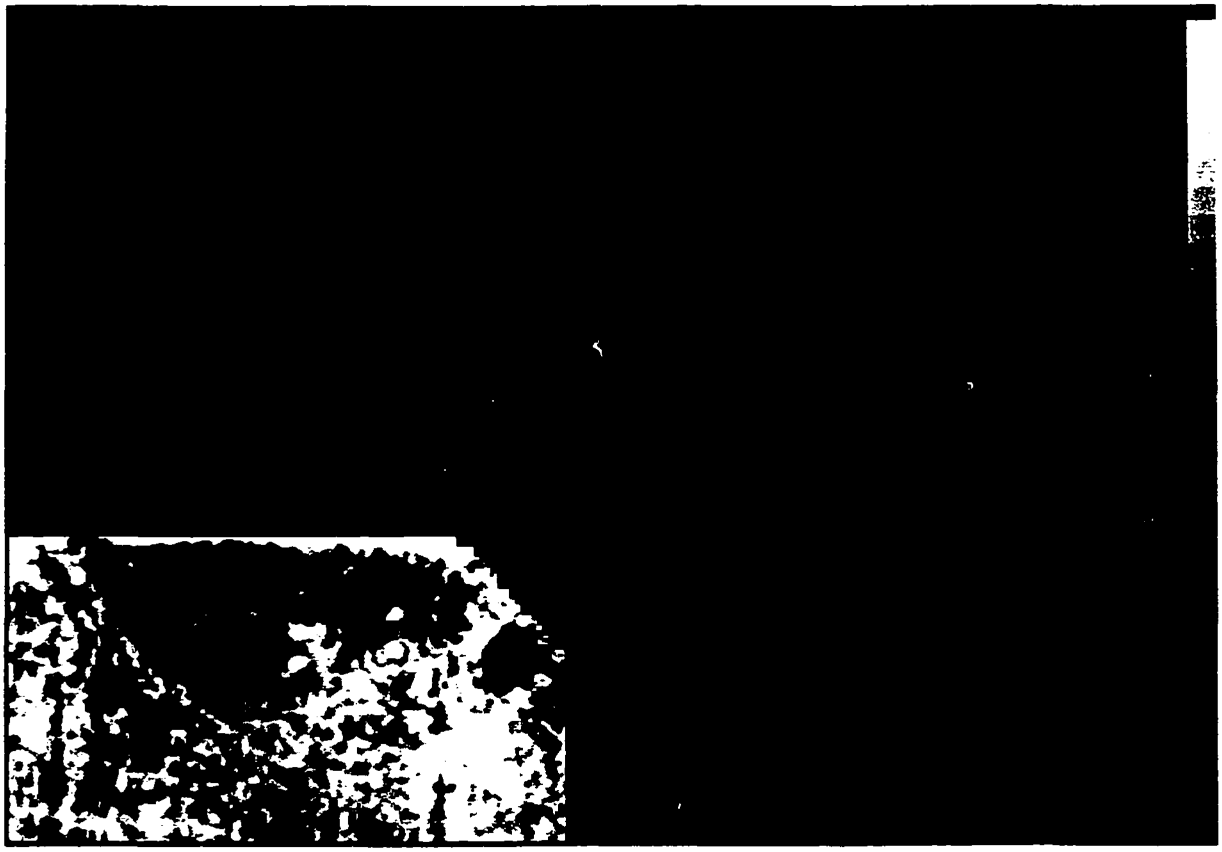

Figure A1.37 Resistivity image of Clint Hill. This image (chres5.tif) produced through spike removal, bicubic interpolation, and printing of data from 21 to 39 ohms at a scale of 1:1000.

Conclusion

The enclosure at Clint Hill and the two enclosures at Heckside may have been intervisible in the past if occupied at the same time, but the view is currently blocked by a modern plantation. Smoke from fires would still be visible among the sites. The enclosure at Clintmains is also visible from Clint Hill.

The evidence for a possible earthwork just west of the enclosure is interesting, and re-examination of the aerial photographs for substantiating evidence would be extremely useful.

Clint Mains

Description

The Clint Mains enclosure (NT 6153 3270) sits 90 m above sea level on a southeastern facing slope on the north side of Maidenhall Burn. Cropmarks on aerial photographs (BW/5181-83, BW/1564-65) show the Clint Mains enclosure as being double ditched, sub-rectangular, and lying beneath two modern fields.

Interpretation

In 1992 the eastern field was surveyed by a field crew directed by Dr. Kate Clark of the Newstead Research Project. In total 37 grids of resistivity and 39 grids of magnetometry were completed, and good responses were obtained from each technique.

Resistivity results show faint traces of modern cultivation scars as well as ditches and high resistance internal features. These probably represent round structures. The area of low resistance in the southern portion of the plot probably reflects the enclosure's positioning on a slope, and the presence of flowing water at the bottom. The enclosure appears to be roughly 105 m in length and 80 m in width, excluding that portion that lies in the western field. The ditches appear as high resistance features with a response width of 1 to 4 m. A possible high resistance entranceway appears in the east-northeast portion of the enclosure. There are indications of both a circular and squared-off finish in the enclosure's southeastern corner, suggesting possible multi-phased ditch construction.

Magnetometry plots show curvilinear ditch segments enclosing an area of strong magnetic anomalies. These anomalies correspond with the internal features appearing on the resistivity results. Modern field drains appear on the plot as regularly spaced north to south running lines, and a modern water pipe runs across the most northern survey grid. Results show a single ditch, roughly sub-rectangular in outline but made up of curvilinear segments. This ditch appears as a high magnetic anomaly of 1 to 2 m response width, though there are some faint portions. An interesting semicircular high-magnetic line appears just off the southeastern corner of the enclosure, and suggests multiple ditch construction phases or a possible abutting enclosure. Magnetometry results do not indicate any entrance in the east-northeastern portion of the ditch. Instead the ditch appears as a smooth unbroken line.

The enclosure's internal features are less clear on the magnetometry results than on the resistivity results. However at least five partial rings are visible on the plot, each appearing as a high magnetic anomaly.

Table A1.13 Archaeological features identified from geophysical survey of Clint Mains.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Ditch phase. The southeastern portion of the enclosing ditch appears to have been extensively re-shaped in at least two building episodes. A small and curvilinear ditch appears to have been re-structured to produce a larger, rectilinear ditch with a corner in the southeast.
B	Magnetometry and Resistivity	Another ditch phase. The southeastern portion of the enclosing ditch appears to have been extensively re-shaped in at least two building episodes. A small and curvilinear ditch appears to have been re-structured to produce a larger, rectilinear ditch with a corner in the southeast.
C	Magnetometry and Resistivity	Possible entrance.
D	Magnetometry and Resistivity	Possible entrance.
E	Magnetometry and Resistivity	Rectilinear structural feature.
F	Magnetometry and Resistivity	Curvilinear structural feature
G	Magnetometry and Resistivity	Curvilinear structural feature
H	Magnetometry and Resistivity	Curvilinear structural feature
I	Magnetometry and Resistivity	Curvilinear structural feature
J	Magnetometry and Resistivity	Cluster of rectilinear features in southern part of enclosure
K	Magnetometry and Resistivity	Miscellaneous internal structural features
L	Magnetometry	Modern water pipe

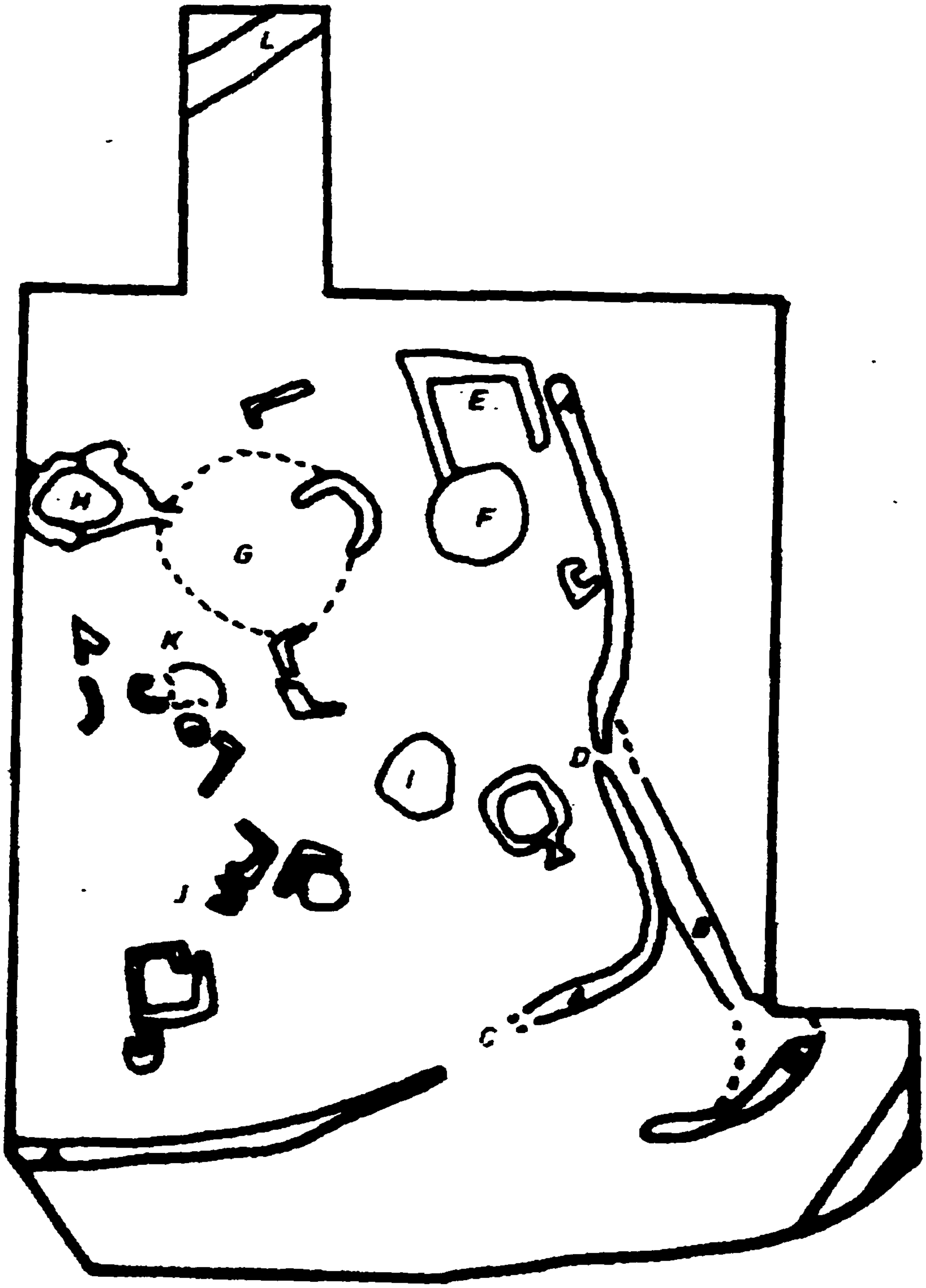

Figure A1.38 Interpretation of geophysical evidence from Clint Mains

Figure A1.39 Resistivity image of Clint Mains. This image (clmres5.tif) produced through spike removal, bicubic interpolation, and printing of data from 24 to 45 ohms at a scale of 1:1000.

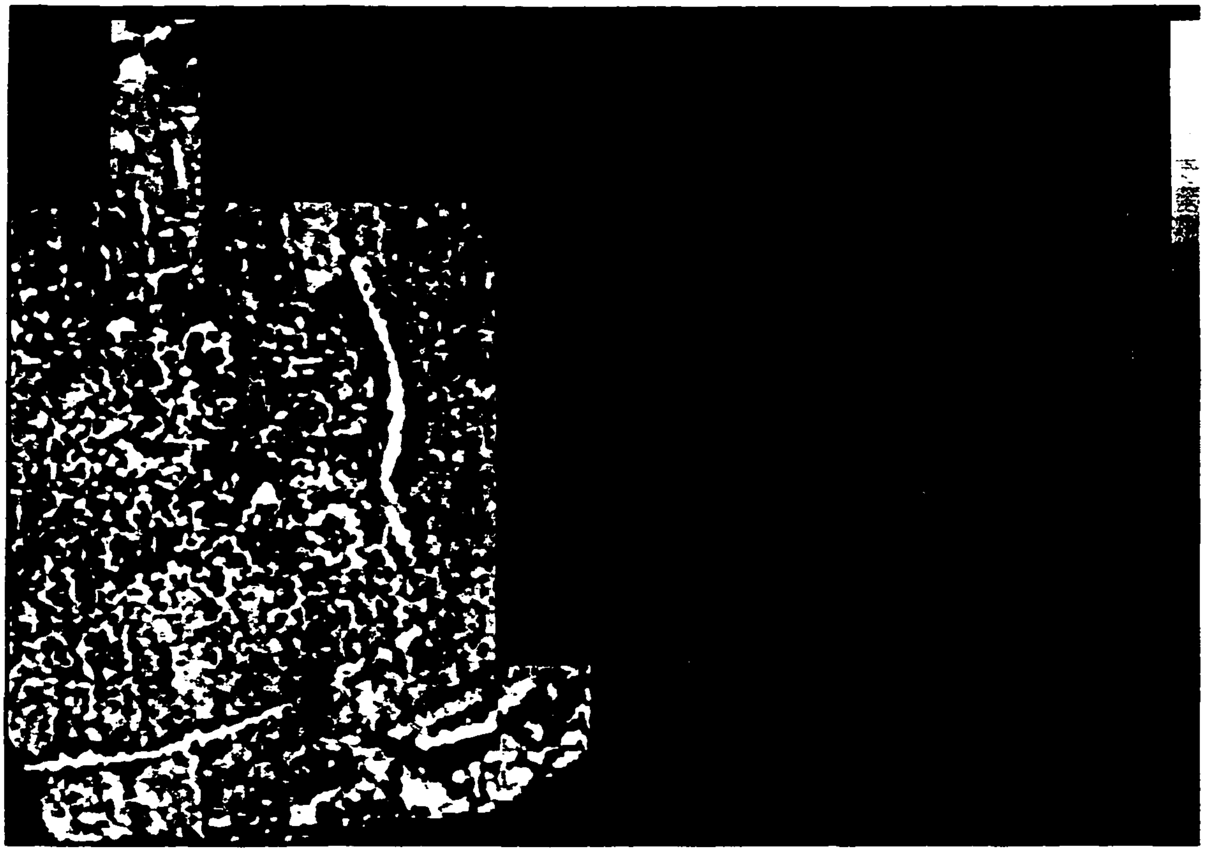

Figure A1.40 Magnetometry image of Clint Mains. This image (clmmag3.tif) produced through spike removal, bicubic interpolation, and printing of data from -2 to 2 nT at a scale of 1:1125.

Conclusion

The enclosure at Clint Mains is perhaps visible from Heckside 1 and 2 and the enclosure at Clint Hill.

The unique thing about the geophysics results for Clint Mains is the clear evidence for internal features. Nine high resistance anomalies appear on the resistivity plot. All are roughly circular, and vary in diameter from 7 to 20 m. Some appear as relatively uniform high resistance circular features, suggesting a hard-packed dirt floor or cobbling, while others appear as high resistance rings, suggesting filled-in ring ditches. The largest internal feature is positioned in the north of the enclosure, and appears to have linear extensions running north and south from it.

The clarity of Clint Mains numerous internal features, as well as the hint of multi-phased ditch construction makes this an important site for further archaeological investigation. Further archaeological investigation on this site could help to clarify the applicability of chronological sequences of structures derived from sites in East Lothian. For example, there is a suggestion that ring grooved houses may slightly predate ring ditch houses in southeastern Scotland (Mercer and Tipping 1994).

Craigsford Camp Plantation

Description

The circular enclosure at Craigsford Camp (NT 5634 3781) sits 187 m above sea level on the eastern shoulder of a ridge lying between the conjunction of the Leader Water and the River Tweed. The site is currently surrounded on the north, west, and south sides by Camp Plantation.

The NMRS record for Craigsford Camp Plantation earthwork states:

> This earthwork, formerly known as Brownhill (D. Christison 1895) is situated 700 yds SSW of Craigsford Mains between the converging arms of Clatteringford Dean and Craigsford Burn. It occupies a slight knoll (600 ft OD), bounded by ravines on the N and S sides and partly on the W, but is open to the E.
>
> The work has long since been levelled by cultivation, but crop marks, first observed on the ground and the end of the 19th century, by Christison, and visible on an air photograph reveal that it was circular and measures some 200 ft in diameter within double concentric ditches. One entrance is clearly visible in the E side, and there may be another entrance in the W side. RCAHMS 1956, visited 1947.
>
> No surface traces of this earthwork were found. Visited by OS (WDJ) 16 February 1961.
>
> Additional air photographs have been taken by the RCAHMS in 1976, 1978 and 1980.

Dr. Kate Clark of the Newstead Research Project first visited the site in September 1990. At that time the ground was finely cultivated, and appeared to have been sown after harvest of the 1990 barley crop. She noted that the hill below the knoll falls quite steeply to the road, and that a level plateau exists immediately below the site itself. Also the field boundary to the east, indicated on early maps, no longer exists.

Interpretation

A field crew of the Newstead Research Project, under Dr. Clark's direction, returned in 1992 to conduct resistivity and magnetometry surveys. In total, 35 resistivity grids and 26 magnetometry grids were completed. The enclosure at Craigsford Camp was located in one modern field which allowed complete survey of the site.

The resistivity plot from Craigsford Camp shows at least a double-ditched circular enclosure with an entrance in the southeast and a possible entrance in the west. The interior of the enclosure shows no clear evidence for structures, but interestingly the northwest quadrant is the only without extremely low electrical resistance. This suggests a possible differentiation of the enclosure's internal space, perhaps a low-lying moist area and a better-drained elevated area. Also visible on the resistivity plot is a backwards-L shaped high resistance area in the upper right.

The magnetometry results from Craigsford Camp Plantation do not clearly show any of the enclosing ditches, the entrances, or any internal area differentiation with the exception of a short section of the second ditch in the northeast part of the site. Many isolated magnetic anomalies are visible on the plot, however, and these correlate with the locations of the banks and ditches. The only magnetic signal that may relate to an internal feature is the circular feature between the entrances.

Table A1.14 Archaeological features identified from geophysical survey of Craigsford Camp Plantation.

Feature	Technique	Interpretation
A	Resistivity	Inner bank
B	Magnetometry and Resistivity	Inner ditch
C	Magnetometry and Resistivity	Second bank
D	Magnetometry and Resistivity	Second ditch
E	Resistivity	Main entrance
F	Magnetometry and Resistivity	Secondary entrance
G	Magnetometry and Resistivity	Inner bank between the entrances, with some evidence for possible associated structural features
H	Resistivity	Inner ditch between the entrances
I	Resistivity	Second bank between the entrances
J	Resistivity	Second ditch between the entrances
K	Resistivity	Possible third bank between the entrances
L	Magnetometry	Circular feature, possible structural
M	Resistivity	Area of low resistivity within the enclosure, possibly a poorly-drained yard
N	Resistivity	Evidence for internal curvilinear features
O	Resistivity	Possible rectilinear ditch

P	Resistivity	Possible bank associated with rectilinear ditch and overlying the second bank and ditch of the curvilinear enclosure.
Q	Resistivity	Modern feature, possibly an animal track

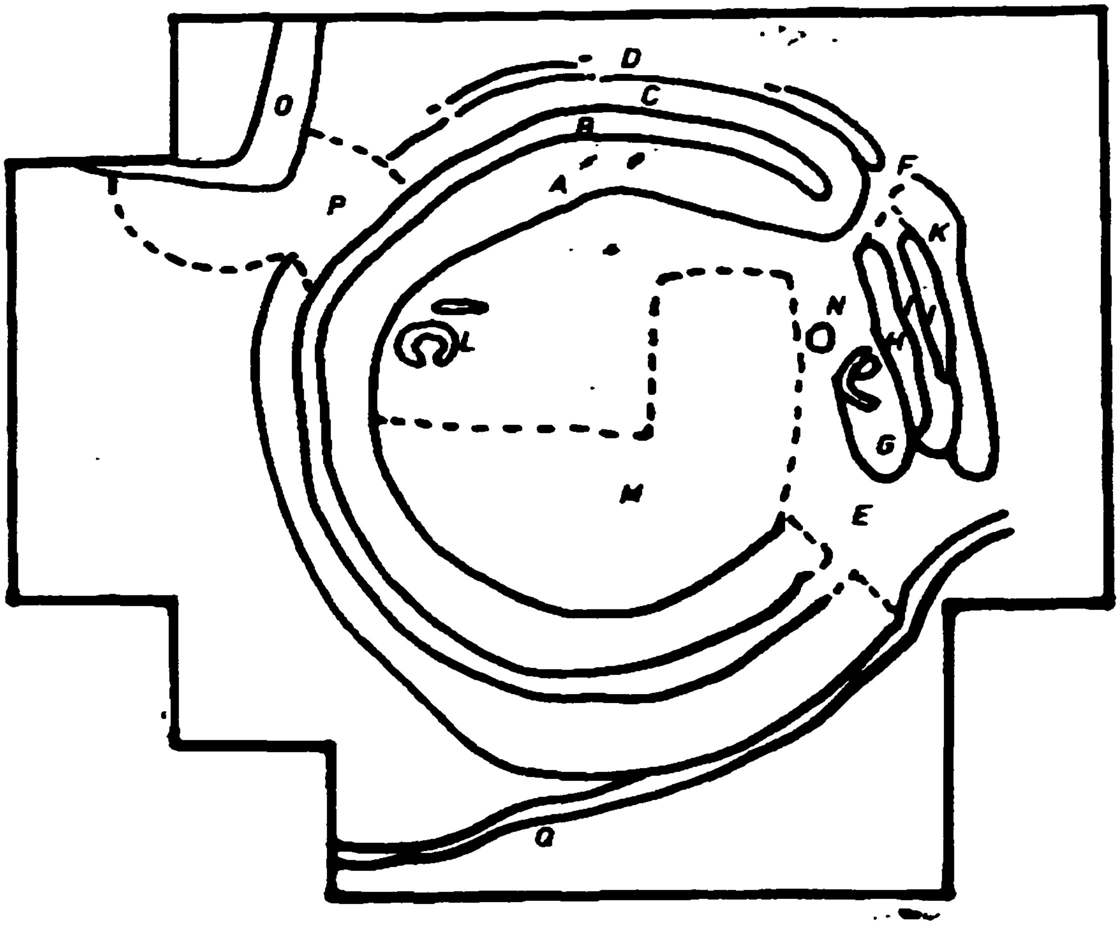

Figure A1.41 Interpretation of geophysical evidence from Craigsford Camp Plantation

Figure A1.42 Resistivity image of Craigsford Camp Plantation. This image (cfcres5.tif) produced through spike removal, bicubic interpolation, and printing of data from 45 to 85 ohms at a scale of 1:1000.

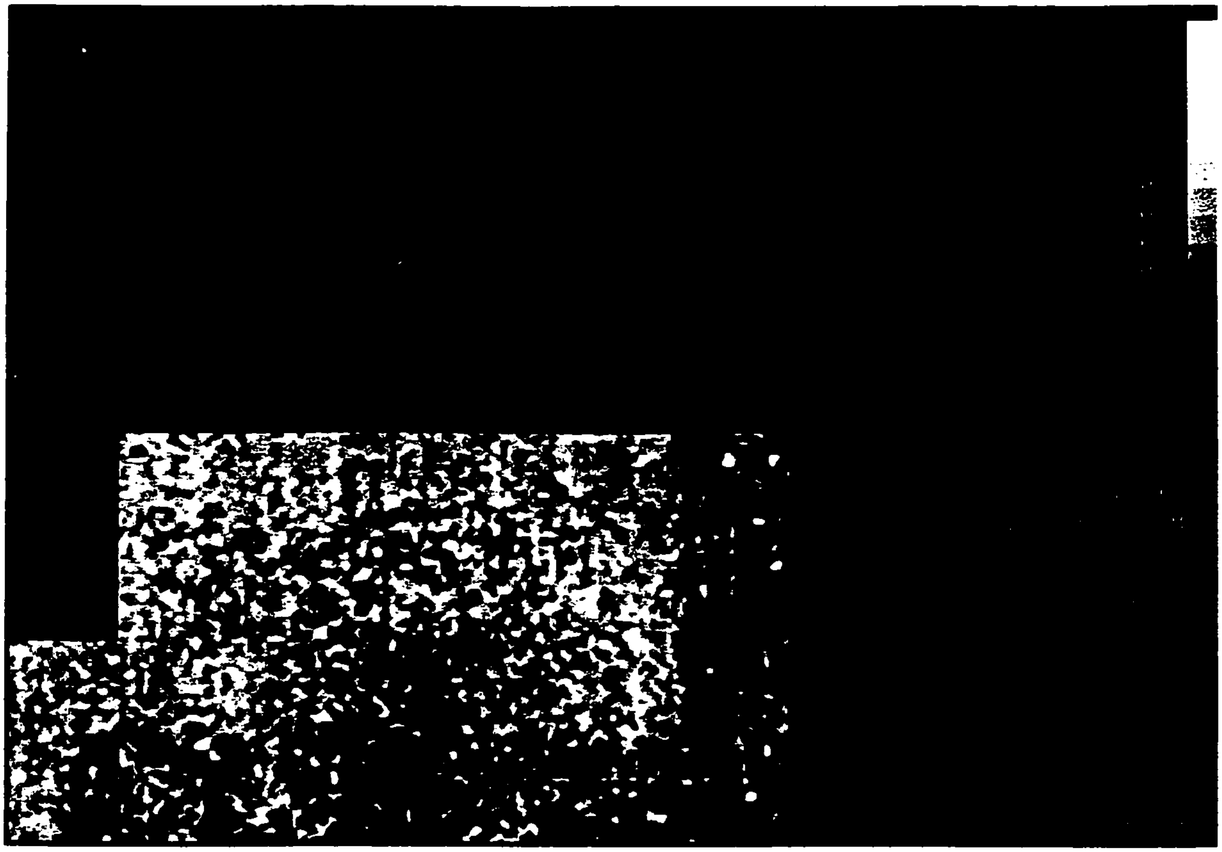

Figure A1.43 Magnetometry image of Craigsford Camp Plantation. This image (cfcmag3.tif) produced through spike removal, bicubic interpolation, and printing of all data from -1.9 to 1.8 nT at a scale of 1:1000.

Conclusion

Geophysical survey at Craigsford Camp Plantation has produced intriguing evidence suggesting that a second rectilinear enclosure overlies the northwest portion of the well-preserved curvilinear enclosure. The complex array of banks and ditches between the primary and secondary entrances to the curvilinear enclosure also suggest some diachronic re-structuring.

The sites that are possibly visible from Camp Plantation are limited to White Hill and Huntshaw.

Craigsford Camp Plantation enclosure is located in a defensible position on the landscape: at the top of a hill and surrounded on three sides by steep slopes and water. It has a view to the east down to, and across, the Leader Water.

Drygrange Mains

Description

The enclosure at Drygrange Mains (NT 572 361) sits 145 m above sea level on the ridge just west of the Leader Water. A small creek that feeds the Leader lies 350 m to the south, and Packman's Burn lies 200 m to the north. The field in which the enclosure lies has been ploughed extensively in the past, and soil cover is extremely shallow. Currently the land is being used for permanent pasture.

Aerial photograph (A72092) cropmarks show three sides of a small rectilinear enclosure adjacent to an L-shaped crop mark. The three corners of the enclosure are all slightly rounded.

Interpretation

A field crew directed by Dr. Kate Clark of the Newstead Research Project visited Drygrange Mains in 1993 to conduct resistivity and magnetometry surveys. In total, 20 grids of resistivity and 19 grids of magnetometry were completed. Both techniques produced interesting plots of the site, but each picked up a different set of archaeological features.

The geophysics plots show the north, west, and east sides of a single-ditched curvilinear enclosure. The ditch segments appear as low-resistance features except for a short segment on the eastern side. Also visible is a small rectilinear enclosure that is fairly square with uneven rounded corners which overlays the eastern half of the curvilinear enclosure.

Table A1.15 Archaeological features identified from geophysical survey of Drygrange Mains.

Feature	Technique	Interpretation
A	Resistivity	Ditch of large enclosure
B	Resistivity	Ditch of large enclosure
C	Resistivity	Ditch of large enclosure
D	Magnetometry and Resistivity	Ditch of small enclosure
E	Magnetometry	Curvilinear and rectilinear features in large enclosure
F	Resistivity	Curvilinear feature in small enclosure parallel to ditch
G	Magnetometry	Curvilinear feature either in small enclosure or eastern portion of large enclosure
H	Resistivity	Western entrance in large enclosure, directly opposite eastern entrance.

I	Magnetometry and Resistivity	Eastern entrance in large and small enclosure.
J	Resistivity	Modern drain
K	Magnetometry	Modern water pipe

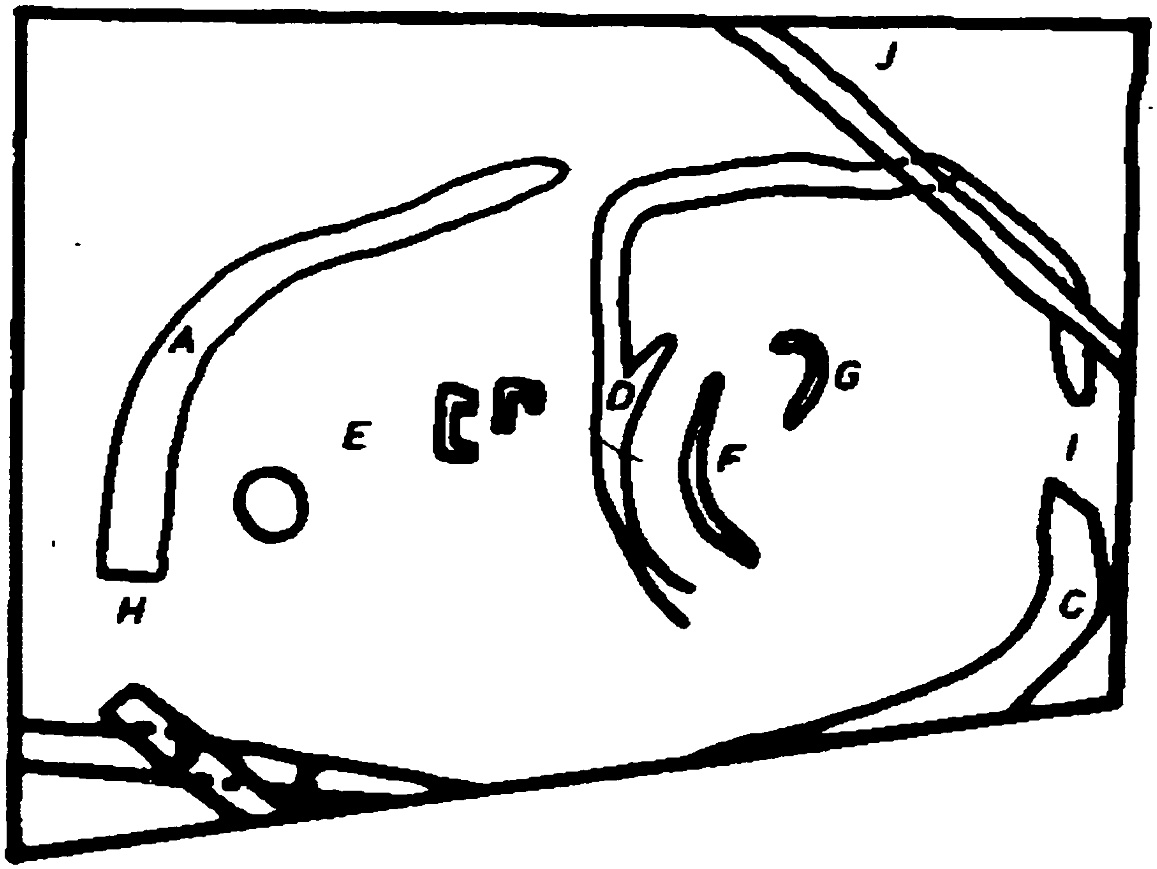

Figure A1.44 Interpretation of geophysical evidence from Drygrange Mains

Figure A1.45 Resistivity image of Drygrange Mains. This image (dgmres5.tif) produced through spike removal, bicubic interpolation, and printing of data from 135 to 295 ohms at a scale of 1:1000.

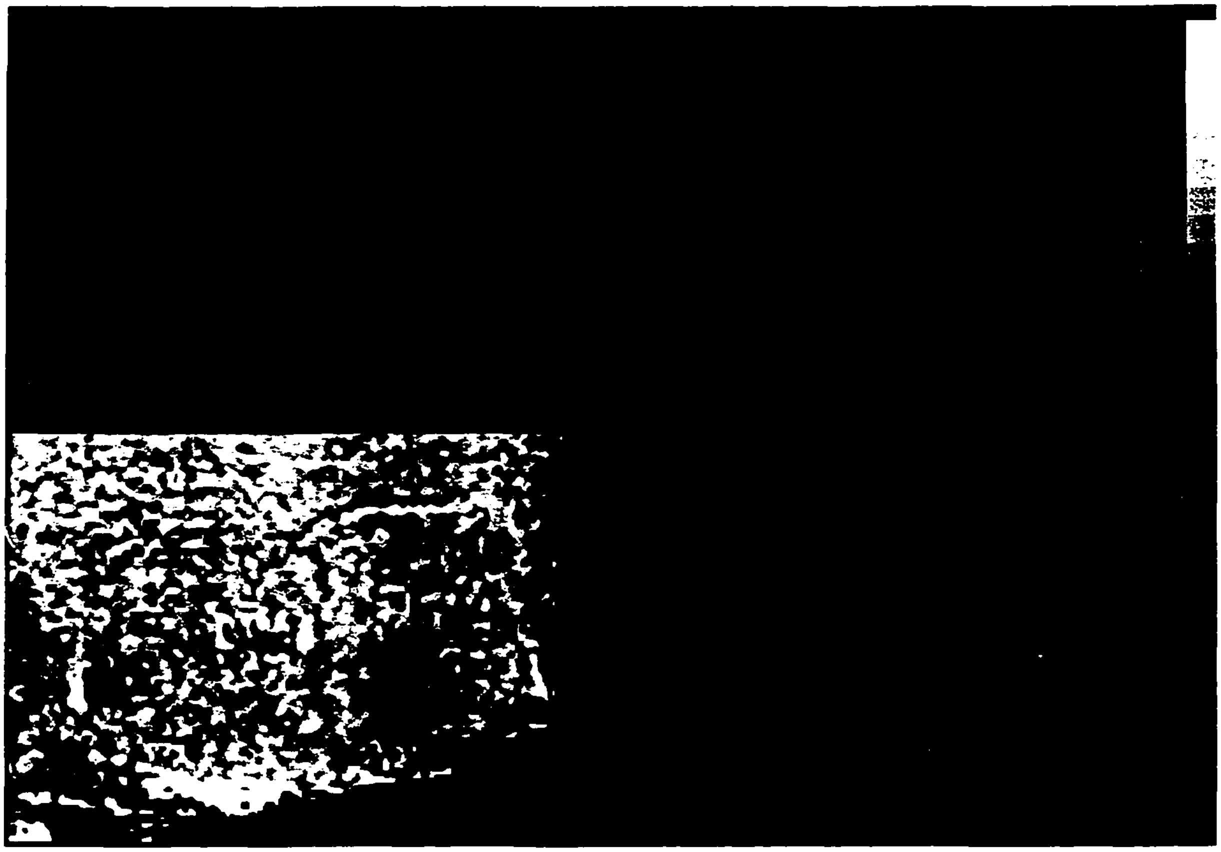

Figure A1.46 Magnetometry image of Drygrange Mains. This image (dgmmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -2.5 to 2.5 nT at a scale of 1:1000.

Conclusion

The geophysical survey of Drygrange Mains produced evidence for two overlapping enclosures. A larger enclosure, presumably earlier in date, is single ditched and curvilinear with an entrance in the west and another possible entrance in the east. The smaller enclosure, presumably more recent in date, is also single ditched but is rectilinear being square-shaped with uneven rounded corners. There is an internal curvilinear feature on the resistivity survey which is clearly parallel to the western ditch of the small enclosure. A curvilinear feature in the magnetometry data could in fact be evidence for a feature in either of the enclosures.

Due to its location, the enclosure at Drygrange Mains has a good view of Black Hill, which lies directly across the Leader Water, and of the enclosure at Redpath Dean. No other sites are readily visible. It is not a very defensible location. Although there is some geophysical evidence for internal curvilinear and rectilinear structures which suggests that the enclosure may have acted as a homestead, the presence of opposing entrances suggests that the enclosure may also have been a henge monument at some point in its history.

East Lodge

Description

The site at East Lodge (NT 594 354) sits 175 m above sea level on a ridge southwest of Redpath Hill. Originally identified in an aerial photograph taken by Colin Martin in 1984, the site appears primarily as an L-shaped cropmark. This L-shaped section forms the southeastern corner of an enclosure. Also visible as cropmarks are the northern half of the eastern side of the enclosure (separated from the L-shaped segment by a gap), and a more curvilinear cropmark lying to the northwest and running roughly southwest to northeast. Inside the main structure is a cluster of cropmarks that are not clearly defined.

The Newstead Research Project field crew that visited the site in 1992 reported that the site lay under barley stubble, and that the surveyed field slopes southward to the floor of the valley through which runs the Halidean Burn. This burn, and an adjacent boggy area, lie approximately 450 m southeast of the site. The well and spring feeding the burn running through Redpath lie roughly this distance to the northwest of the site. A brick well-house was noted by the field crew in the field lying directly to the south of the survey area.

Interpretation

A total of 41 resistivity grids and 32 magnetometry grids were completed. The resistivity printout shows numerous plough scars running roughly northwest to southeast across the entire image. Most importantly, the resistivity survey suggests the site at East Lodge is a sub-rectangular enclosure with evidence for the eastern side, a possible entrance on the eastern side, the southeastern corner, part of the southern side, part of the western side, and the northwestern corner. All segments of this enclosure appear as high resistance features.

The southeastern corner of the site also appears as a high magnetic anomaly. No other portion of the enclosure is evident from the magnetometry survey but the interior contains a cluster of magnetic anomalies. The most intriguing feature that appears on the magnetometry printout is a low magnetic linear feature running roughly north to south. This linear feature lies 17 m east of the enclosure itself, and represents a possible earthwork. There is a gap in this possible earthwork just southeast of the rectilinear enclosure.

Table A1.16 Archaeological features identified from geophysical survey of East Lodge.

Feature	Technique	Interpretation
A	Resistivity	Ditch defining northwest corner of rectilinear enclosure
B	Magnetometry and Resistivity	Ditch defining southeast corner of rectilinear enclosure
C	Resistivity	Ditch segment west of rectilinear enclosure
D	Resistivity	Curvilinear anomaly overlying ditch on west side of rectilinear enclosure
E	Magnetometry	Several curvilinear structural features inside rectilinear enclosure
F	Magnetometry	Curvilinear feature to east of rectilinear enclosure and west of possible earthwork
G	Magnetometry	Possible earthwork
H	Magnetometry	Curvilinear feature east of earthwork
I	Resistivity	Possible entrance

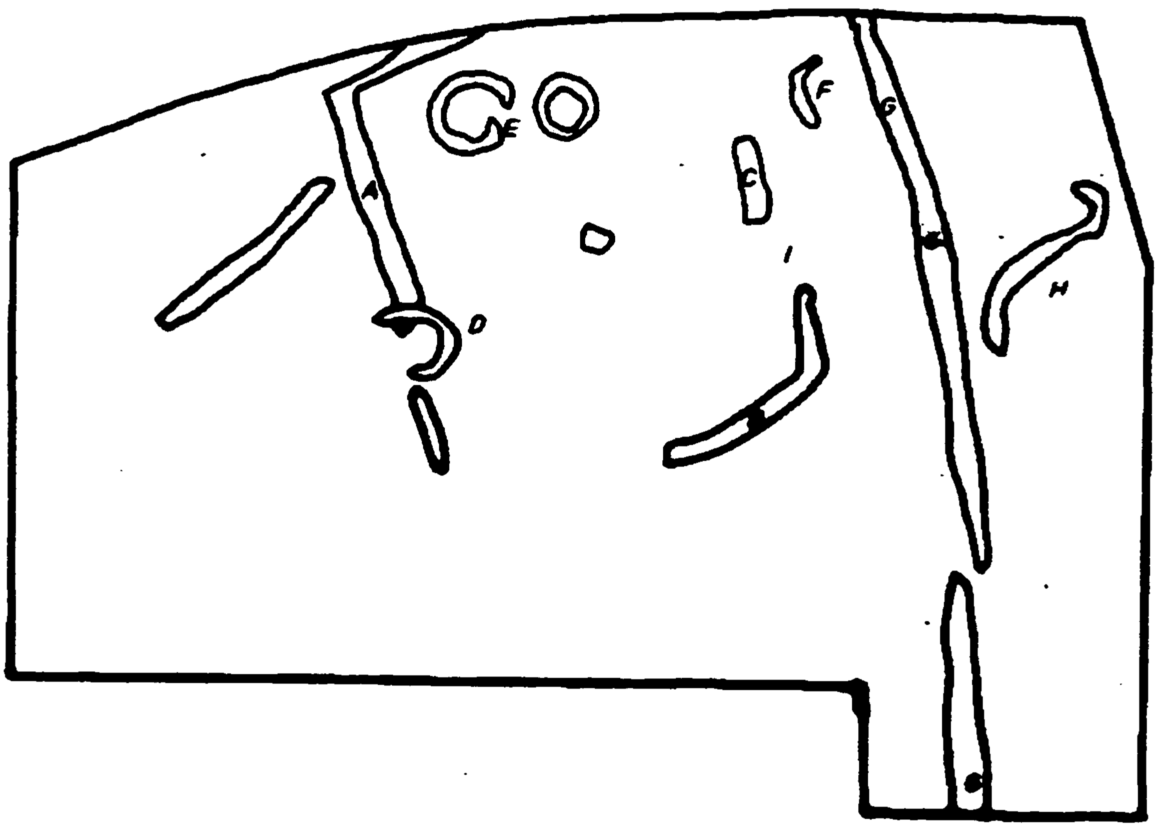

Figure A1.47 Interpretation of geophysical evidence from East Lodge

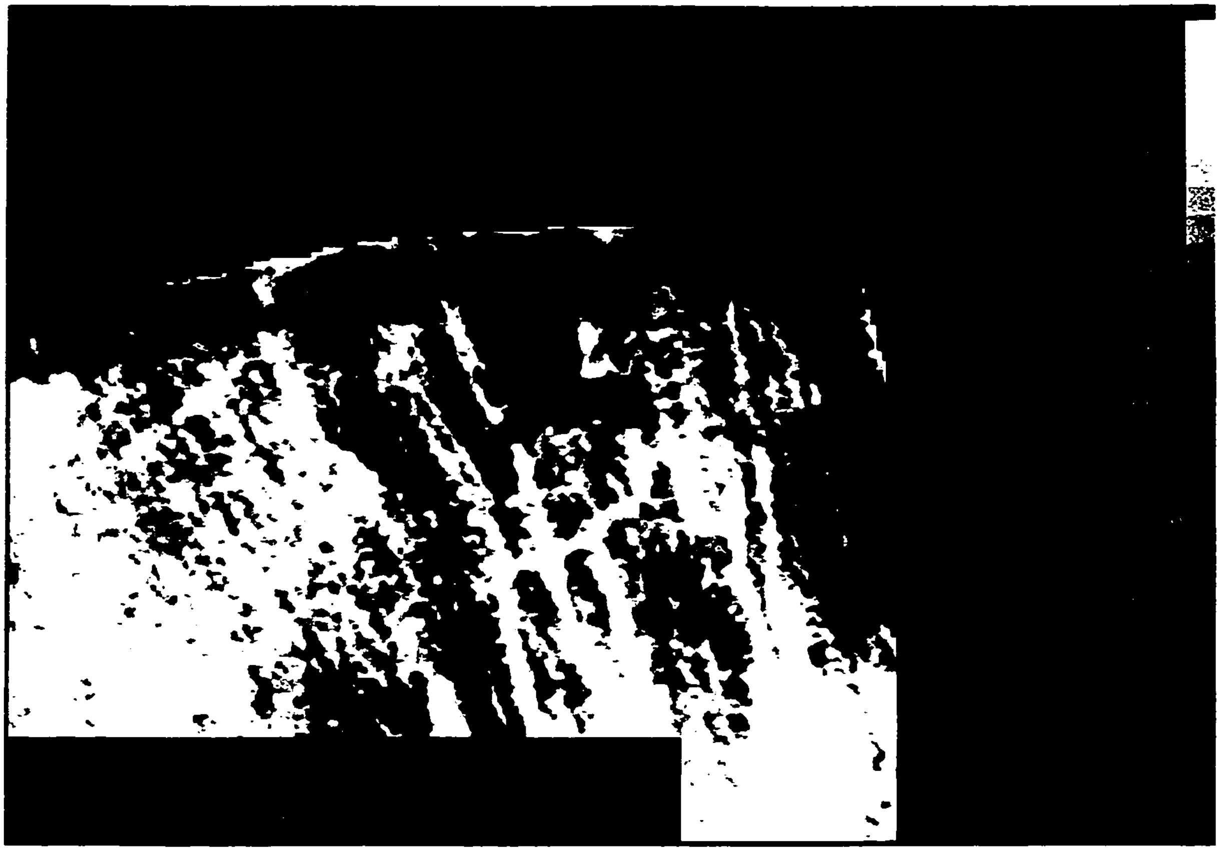

Figure A1.48 Resistivity image of East Lodge. This image (elres5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 40 to 60 at a scale of 1:1000.

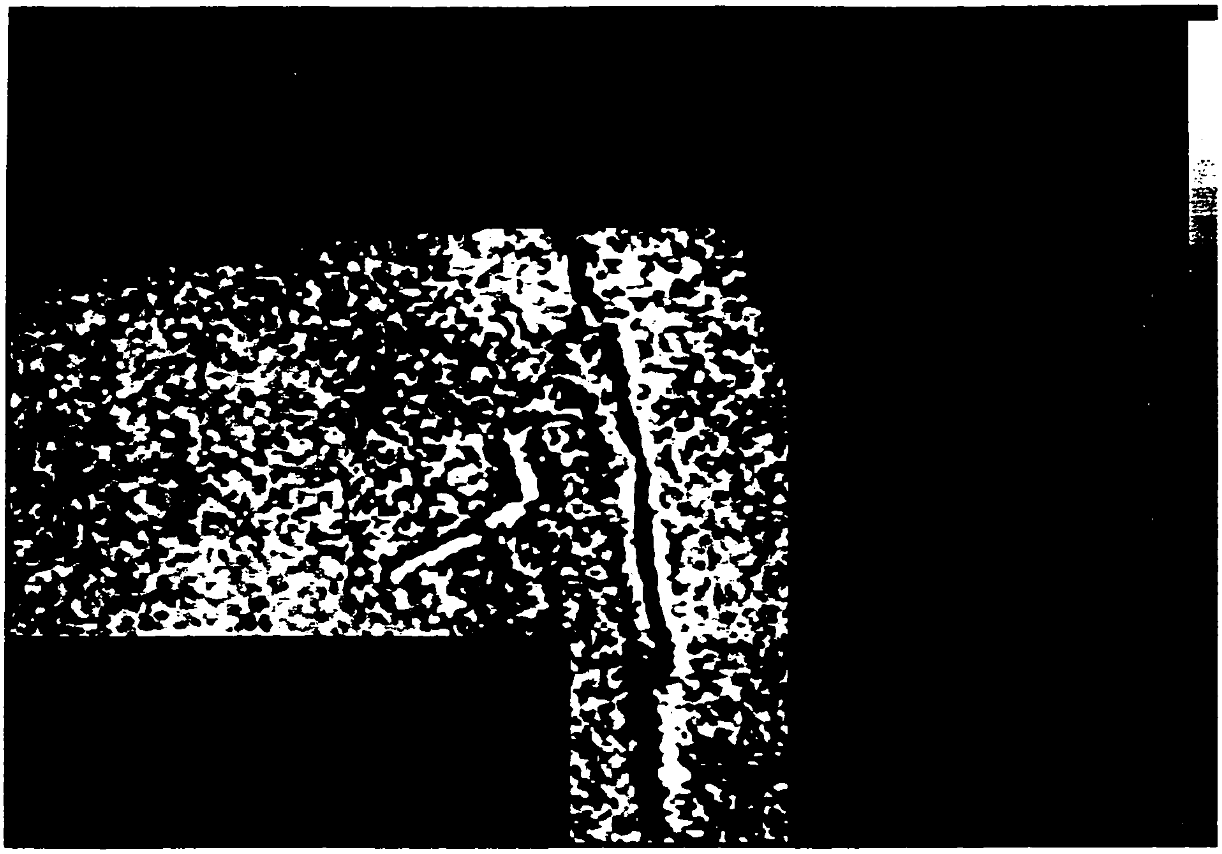

Figure A1.49 Magnetometry image of East Lodge. This image (elmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -1.2 to 2.5 at a scale of 1:1000.

Conclusion

The geophysics evidence from East Lodge suggests that there is a rectilinear enclosure with internal curvilinear features adjacent to an earthwork running from north to south. There also appears to be a short gap in the earthwork just southeast of the enclosure. Furthermore there is a curvilinear feature overlying the ditch on the western side of the rectilinear enclosure, and a short ditch segment just slightly west and completely outside the rectilinear enclosure. These features may perhaps represent unenclosed settlement, or indicate multiple construction phases.

Easter Housebyres

Description

The NMRS report for Easter Housebyres (NT 539 372) states:

There is an earthwork, probably a homestead, on the farm of Easter Housebyres (5398 3727). It is an enclosure of fully half an acre.

The farmer at Easter Housebyres could not give any information about this earthwork. No traces of it were found during field investigation.

On a preliminary visit in 1993 Kate Clarke found the grid reference placed the site in a pasture opposite the steading buildings of Old Easter Housebyres. Given the topography of the ground she believed that the site may have extended out of the pasture field and into an area covered by tree saplings with a small area of cut grass. Permission was obtained from Professor Fowler of the University of Edinburgh, owner of the grassy area, to conduct a geophysical survey.

The resident at Old Easter Housebyres also noted that Professor Dennis Harding had taken aerial photographs of this area. At the time of writing these photographs had not been deposited in the NMRS, and were therefore unavailable for analysis.

Interpretation

A field crew of the Newstead Research Project returned later in 1993 to conduct both electrical resistance and magnetometry surveys. A total of 10 grids were surveyed with each technique, however no results were obtained from either survey. The magnetic anomalies which appear on the printout of the magnetometry survey were caused by a metal fence between the pasture and grassy patch surveyed, a metal spike in the ground of the pasture, and numerous pieces of scrap metal scattered about the surface of the pasture.

From the results of these geophysical surveys it is impossible to tell whether no trace of the enclosure remain to be detected or, rather more likely, if the grid reference provided for the enclosure is incorrect. Professor Harding's aerial photographs will hopefully shed some light on the precise position of the enclosure.

Figure A1.50 Resistivity image of Easter Housebyres (ehres1.tif) produced through spike removal, bicubic interpolation, and printing of all data points from 48.6 to 166.3 at a scale of 1:500.

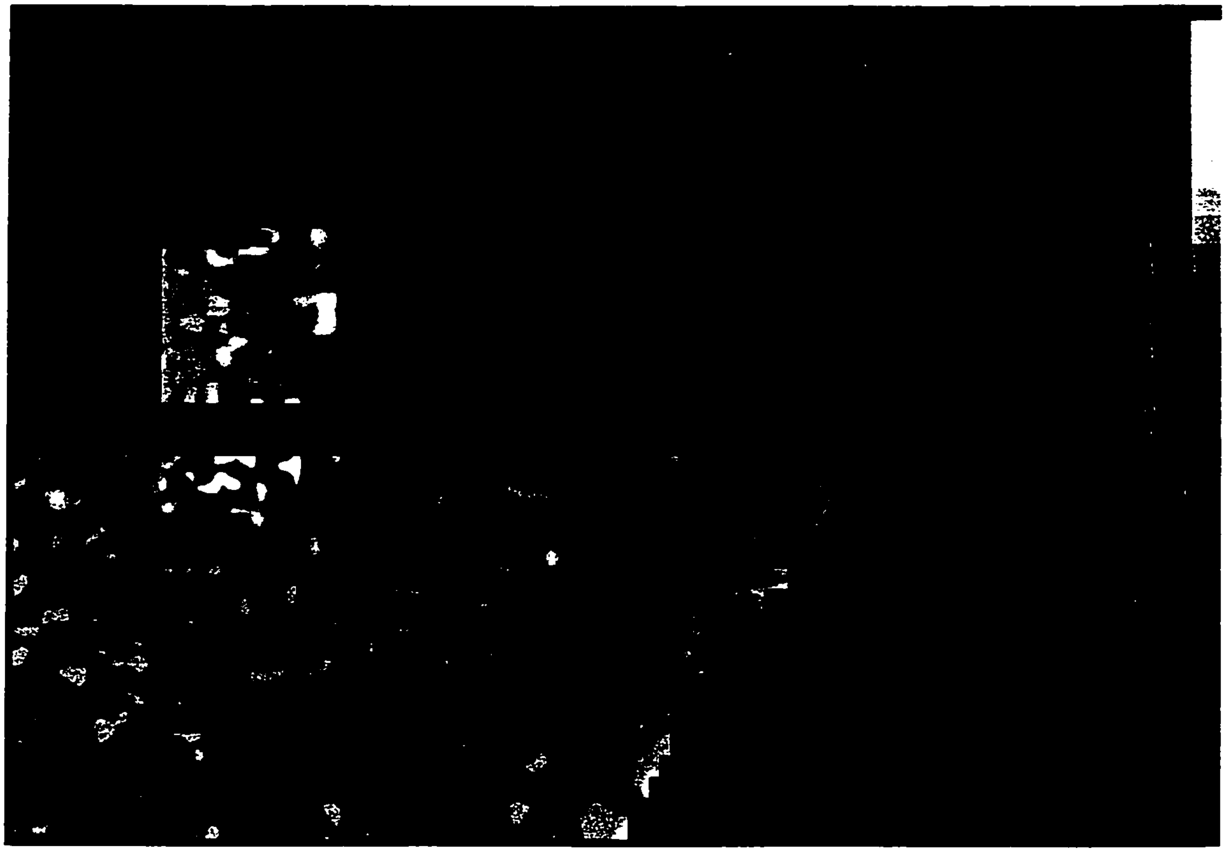

Figure A1.51 Magnetometry image of Easter Housebyres (ehmag1.tif) produced through spike removal, bicubic interpolation, and printing of all data points from -23.6 to 22 at a scale of 1:500.

Conclusion

The area surveyed at Easter Housebyres sits 240 m above sea level on the shoulder of the extremely steep western slope of Housebyres Hill. Water is plentiful nearby, consisting primarily of two small creeks. The first lies 75 m northwest of the surveyed area, and flows into Housebyres Moss to the northeast. The second lies 100 m west of the surveyed area, and flows into Blake Burn at the bottom of the western slope. This location makes the site defensible from the west, however it is overlooked from the east by the summit of Housebyres Hill. Approaches from the northeast and southeast are "protected" by Housebyres Moss and Gattonside Moss, respectively. This location commands an excellent view south down the Blake Burn valley and west along the Tweed River valley.

Eildontree Plantation

Description

The site at Eildontree Plantation (NT 5641 3358), described in the NMRS as a possible timber building, sits 150 m above sea level on the lower northeast slope of Eildon Hill North. The site is located in a landscape of relatively dense archaeological sites with the fortlet at Red Rig 375 m to the east, the enclosure at Red Rig 550 m to the northeast, the enclosure at Oakendean House 325 m to the northwest, and the center of the Roman fort at Newstead roughly 875 m to the northeast. Water is plentiful in the area with Bogle Burn 450 m to the southeast and a creek running beside Oakendean House roughly 475 m to the northwest.

The site at Eildontree Plantation was originally identified as a cropmark in aerial photograph CUCAP RX/2992. It was more extensively examined in 1992 when a field crew from the Newstead Research Project visited the site and completed 20 grids of resistivity and 6 grids of magnetometry.

Interpretation

The resistivity survey shows evidence for more than eight modern field drains. It also shows the vague outline of a possible enclosure that appears to be circular and is defined by a hazy area of low resistance. Fewer magnetometry grids were completed, and all of the magnetic anomalies identified in the grids correspond with modern field drains.

Table A1.17 Archaeological features identified from geophysical survey of Eildontree Plantation.

Feature	Technique	Interpretation
A	Resistivity	Possible enclosure ditch
B	Resistivity	Modern field drains
C	Magnetometry and Resistivity	Internal features marking the position of field drains

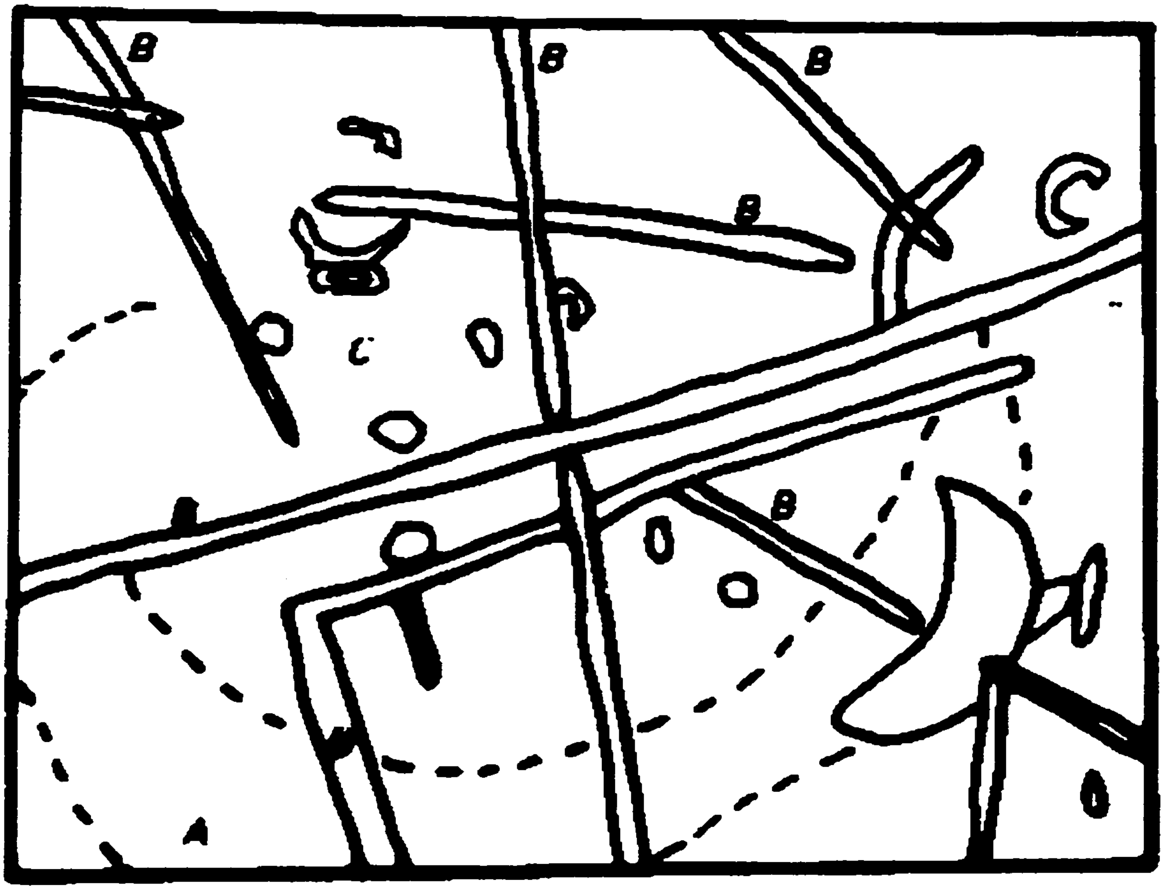

Figure A1.52 Eildontree Plantation geophysics interpretation

Figure A1.53 Resistivity image of Eildontree Plantation (etpres5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 30 to 41 at a scale of 1:1000.

Figure A1.54 Magnetometry image of Eildontree Plantation (etpmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -1.5 to 1.3 at a scale of 1:1000.

Conclusion

A smaller sampling interval with both geophysical techniques may have been more successful in identifying remains of any timber hall that existed at Eildontree Plantation. The evidence for a possible enclosure is interesting, though not completely convincing, as a possible archaeological feature. The extensive modern field drains appear, however, to have disrupted a large area of the field and therefore relatively poor preservation of any archaeological remains can be expected.

Fens

Description

A field crew of the Newstead Research Project visited Fens (NT 6048 3116) in 1991 to conduct resistivity and magnetometry surveys. The found the field in permanent pasture, with an old field boundary running east-northeast to west-southwest in the northern portion of the survey area and a second field boundary running north from the first.

Interpretation

After extensive processing (to counteract the fact that the data were collected at a range of 2000 ohms, but downloaded with a setting of 20 ohms) the geophysical data provide evidence for a rectilinear enclosure with offset entrances on both the eastern and western sides. The resistivity data do not show these entrances clearly, but do clearly show the single enclosing ditch on the eastern, western, and southern sides of the site. Several internal circular features are also apparent, including a low-resistance circular feature in the southeastern corner of the enclosure and a low resistance circular feature in the northwestern portion of the site.

Equipment problems during the magnetometry survey of Fens mean that the geophysical images are not as clear as they might be. The northern and southern halves of the survey were done on different days, and on both the gradiometer was extremely difficult to balance and showed highly variable readings. It appears from the field report that the gradiometer could not be zeroed at all during survey of the northern half of the site.

Despite the problems with the magnetometer survey, all four sides of the single ditched rectilinear enclosure appear as high-magnetic anomalies. There is a clear entrance in the ditch on the eastern side of the enclosure, and there also appears to be a second entrance directly opposite on the western side. The internal circular feature in the southeastern corner appears as a poorly delineated cluster of both high and low magnetic anomalies. Also apparent are the relatively quiet areas in the northern half of the enclosure that correspond with the two internal features identified on the resistivity printouts.

Table A1.18 Archaeological features identified from geophysical survey of Fens.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Ditch
B	Magnetometry and Resistivity	Possible roundhouse
C	Resistivity	Possible roundhouse
D	Magnetometry	Miscellaneous internal features
E	Magnetometry	Possible field drain
F	Magnetometry and Resistivity	Entrance
G	Magnetometry	Entrance
H	Resistivity	Disused field boundary

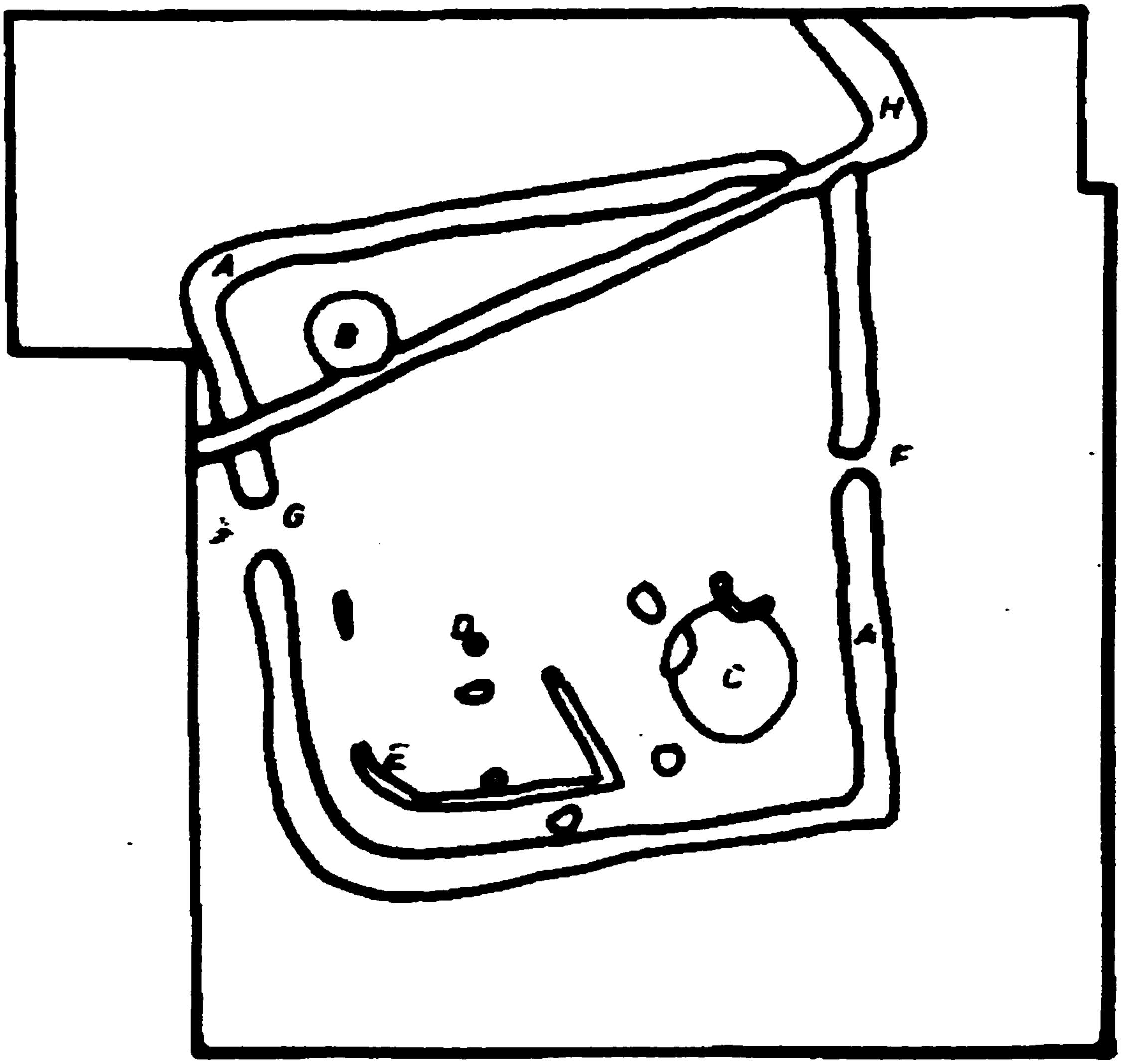

Figure A1.55 Fens geophysics interpretation

Figure A1.56 Resistivity image of Fens (fensres5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 1.2 to 2.3 at a scale of 1:1000.

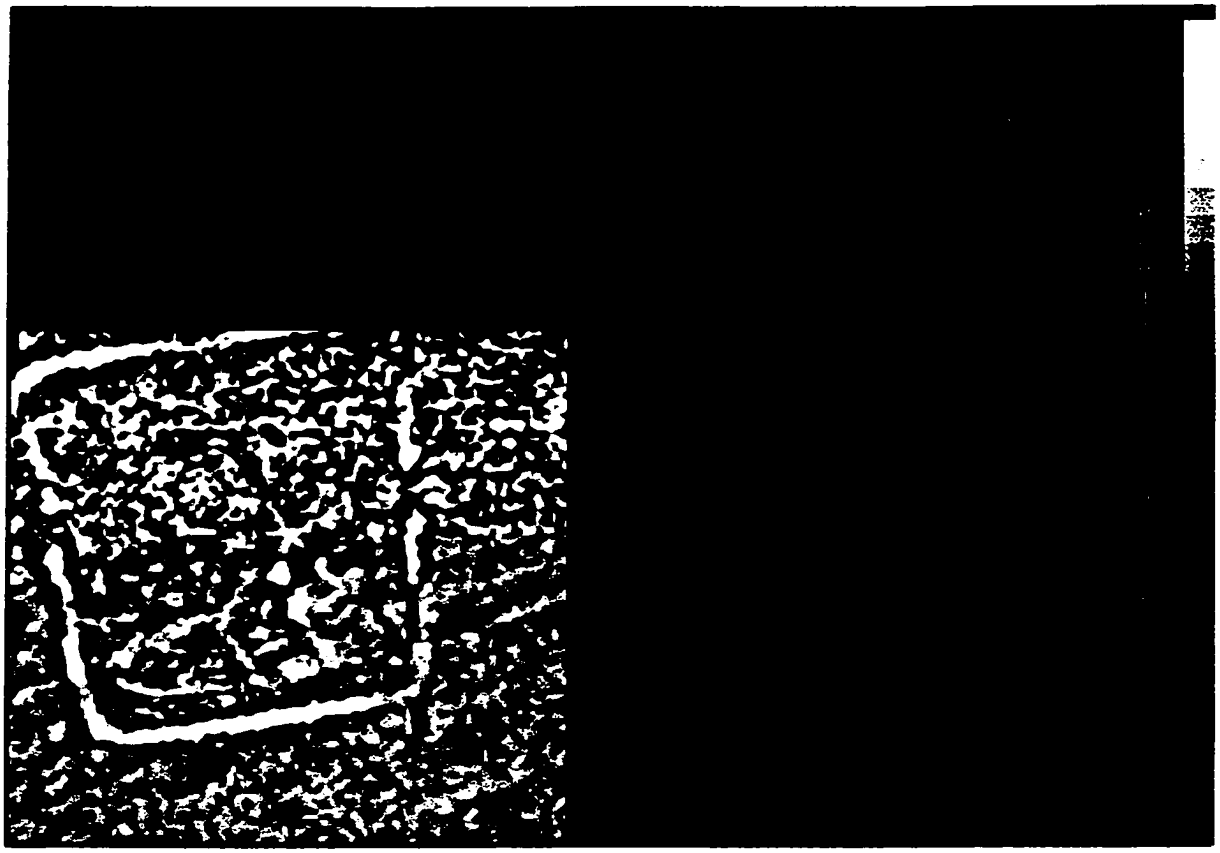

Figure A1.57 Magnetometry image of Fens (fensmag5.tif) produced through spike removal, bicubic interpolation, destriping and printing of data points from -3 to 3 at a scale of 1:1000.

Conclusion

The geophysical survey at Fens defined a sub-rectangular enclosure measuring 65 by 85 m. Two entrances are present, one on the east side of the enclosure and the other on the west side, and two circular features roughly 10 and 15 m in diameter respectively are visible within the enclosure and probably represent structures.

An old field boundary cuts across the northeastern corner of the site, so the geophysical evidence is somewhat unclear, but it appears that there is a gap in the ditch in this portion of the site just as there was at Lilliesleaf.

Further investigation of Fens is warranted as there appears to be good preservation, and because there is only evidence for curvilinear internal features within this rectilinear enclosure.

Heckside 1

Description

The first of two enclosures at Heckside (NT 6037 3303) sits 165 m above sea level on the northeast facing slope of Clint Hill. It is the center-most site on the ridge containing the enclosures of Heckside 2 and Clinthill. This ridge lies between Bemersyde Moss and the River Tweed. This location commands good views to the north and east.

Cropmarks on aerial photographs shows the enclosure at Heckside 1 lying beneath two modern fields. It appears as an ovoid double-ditched enclosure with a possible entrance in the southeast and two internal circular features.

Interpretation

A field crew of the Newstead Research Project visited Heckside 1 in 1993 to conduct geophysical surveys. Access was only available for the southern field under which the enclosure lies. This field was planted with tall rye grass. Both resistivity and magnetometry techniques were employed, and a total of 28 and 14 grids were surveyed respectively.

The resistivity plots clearly show the southeastern quadrant of the enclosure. Two ditches are visible in the resistivity data. The outermost ditch has a gap in the southeastern section while the innermost ditch shows an entranceway, possibly paved, in the same area. Both ditches appear as high resistance features, and both fade out in the western portion of the surveyed area. Three relatively large internal features can be seen on the plot, most appearing as high-resistance ringed features. These are likely to represent structures. Also visible on the bottom of the resistivity printouts are several parallel and perpendicular high resistance features. These appear to be field drains, and are probably relatively recent.

Magnetometry results are less clear for Heckside 1, but can be interpreted with reference to the resistivity data. The plot shows two parallel lines at the bottom that correspond to the field drains identified in the resistivity plots. Two tight clusters of magnetic anomalies lie roughly at the center and top right of the plot. These appear to be external to the enclosing ditches, and may either be archaeological features or localized outcrops of underlying geology. Both ditches are faintly visible as thin curving slivers of low magnetism. A circular area of high magnetism within the enclosure may represent a fourth structure.

Table A1.19 Archaeological features identified from geophysical survey of Heckside 1.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Inner ditch.
B	Magnetometry and Resistivity	Outer ditch
C	Magnetometry and Resistivity	Entrance
D	Magnetometry and Resistivity	Internal features, probably structures
E	Resistivity	Possible external feature
F	Magnetometry	External area of high magnetism
G	Magnetometry	External area of high magnetism
H	Resistivity	Modern field drains

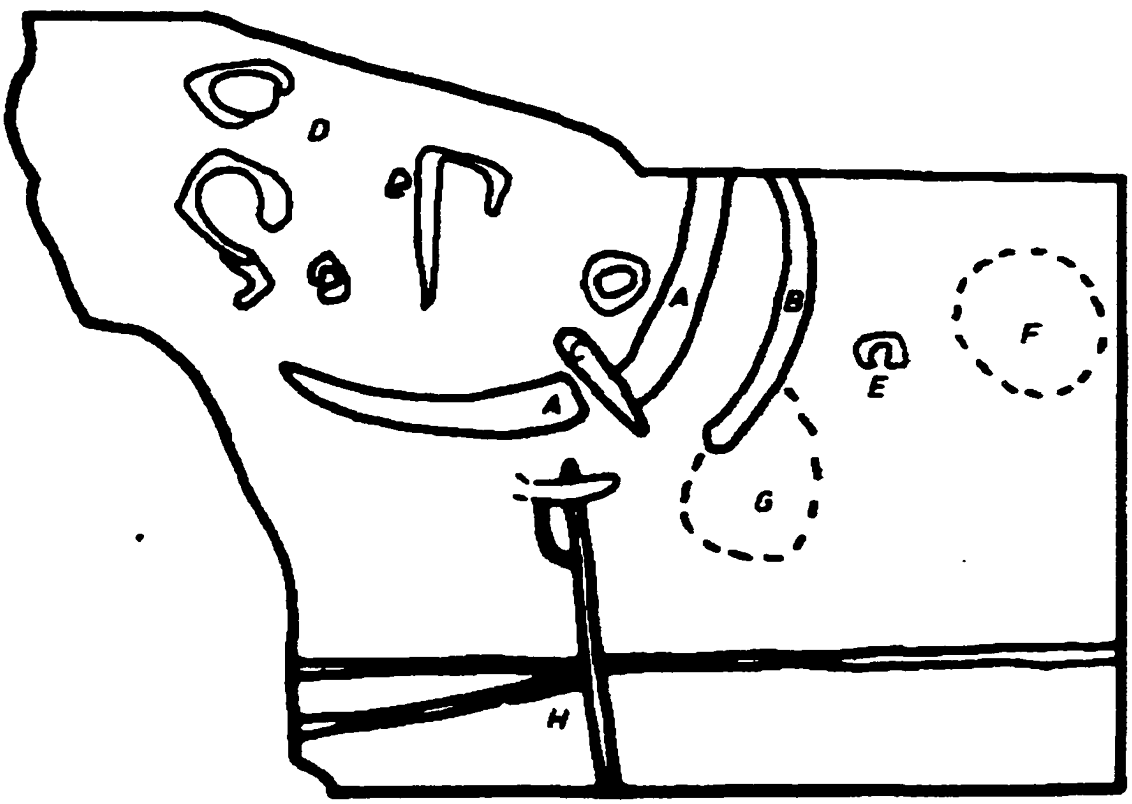

Figure A1.58 Heckside 1 geophysics interpretation

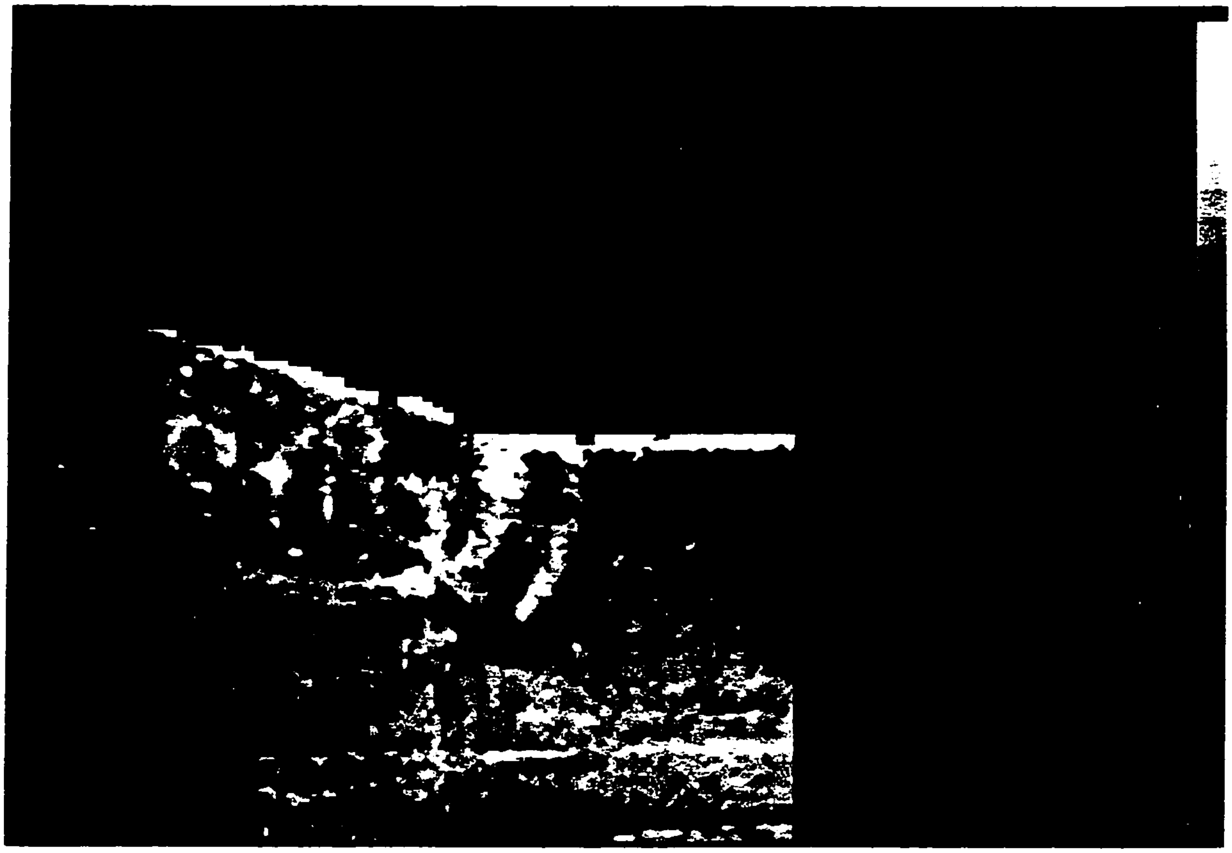

Figure A1.59 Resistivity image of Heckside 1 (hs1res5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 12 to 38 at a scale of 1:1000.

Figure A1.60 Magnetometry image of Heckside 1 (hs1mag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -9.5 to 12 at a scale of 1:1000.

Conclusion

A variety of archaeological sites would have been visible from Heckside 1 if the surrounding plantations were not present. These include Heckside 2, Bemersyde Moss, Spadislee, Third, Whitrighill, Butchercote promontory fort, Brotherstone Hill West, Brotherstone Hill South, and Bemersyde Hill, and perhaps Clinthill. The two Heckside enclosures lie in especially intimate proximity, being only 325 m apart.

Heckside 2

Description

The enclosure at Heckside 2 (NT 6082 3315) sits 148 m above sea level on the northeast facing slope of Clint Hill. It is the easternmost site on the ridge containing the enclosures of Heckside 1 and Clinthill. This ridge lies between Bemersyde Moss and the River Tweed, and the position of Heckside 2 commands good views to the north and east.

Cropmarks on aerial photographs show the northern half of the enclosure at Heckside 2. It appears as an ovoid double-ditched enclosure. Though the outermost ditch is regular and unbroken, the innermost ditch appears to have a gap in its northeast section, and may have been re-shaped in at least two construction phases at its eastern end. Two ringed features are visible inside the enclosing ditches. The southern half of the enclosure at Heckside 2 currently lies beneath a plantation. Inside this plantation part of the western side of the innermost ditch is still visible.

Interpretation

A field crew of the Newstead Research Project visited Heckside 2 in 1993. In total, 18 grids of resistivity and 4 grids of magnetometry were completed. The resistivity plot shows three concentric curvilinear enclosing ditches.

All three ditches show evidence for multi-phase construction. The eastern end of the innermost ditch is abrupt, and appears to be overlain by a curvilinear structure. The line of the innermost ditch at this point is on a line that would have intersected the second ditch, suggesting that the inner and second ditches were not in use at the same time. Further support for this hypothesis comes from an orphaned extent of ditch, presumably part of an earlier line for either ditch two or three that lies midway between the two on the resistivity printouts. The final piece of evidence suggesting multi-phase construction at this site is the peculiar shape of the outermost ditch, and the fact that it appears to have a gap in the north. The west end of the outermost ditch is also more squared than is normal with these curvilinear enclosures.

The magnetometer plot is much less informative than the resistivity, largely because so few grids were completed. The inner ditch appears as a thin speckled arch in the lower right corner of the plot, and a small magnetic anomaly visible in the upper left corner either represents an external feature or perhaps a geological outcrop.

Table A1.20 Archaeological features identified from geophysical survey of Heckside 2.

Feature	**Technique**	**Interpretation**
A	Magnetometry and Resistivity	Inner ditch
B	Resistivity	Second ditch
C	Resistivity	Third ditch
D	Resistivity	Possible internal structure
E	Resistivity	Possible external feature
F	Resistivity	Possible external feature
G	Magnetometry	External area of high magnetism

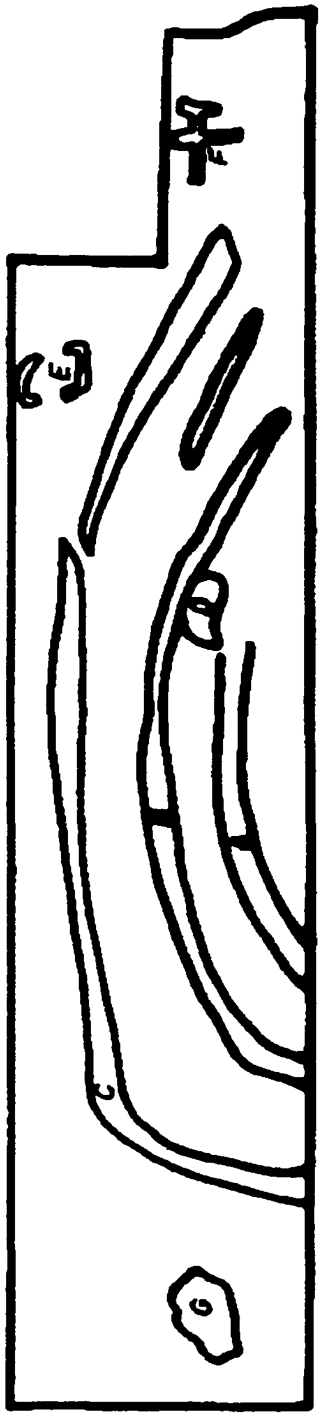

Figure A1.61 Heckside 2 geophysics interpretation

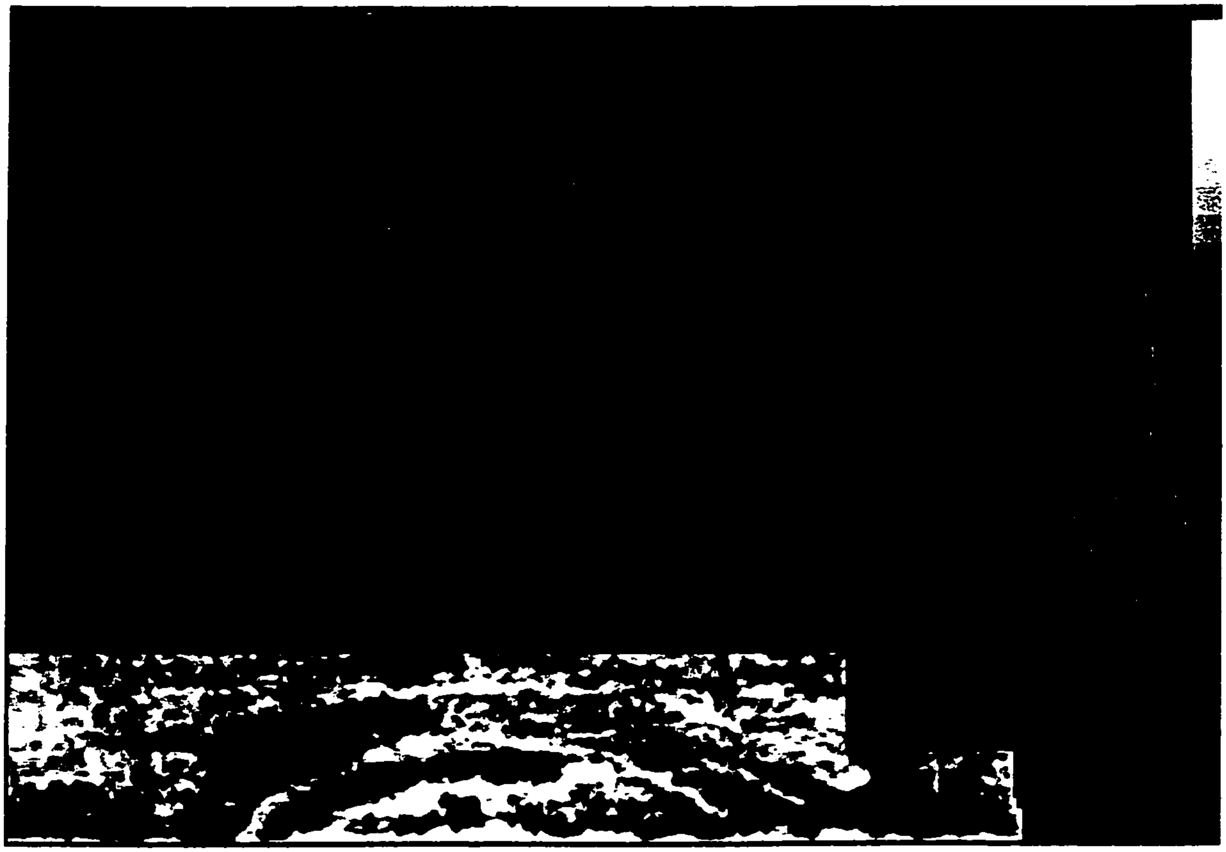

Figure A1.62 Resistivity image of Heckside 2 (hs2res3.tif) produced through spike removal, bicubic interpolation, and printing of data points from 21 to 34 at a scale of 1:1069.

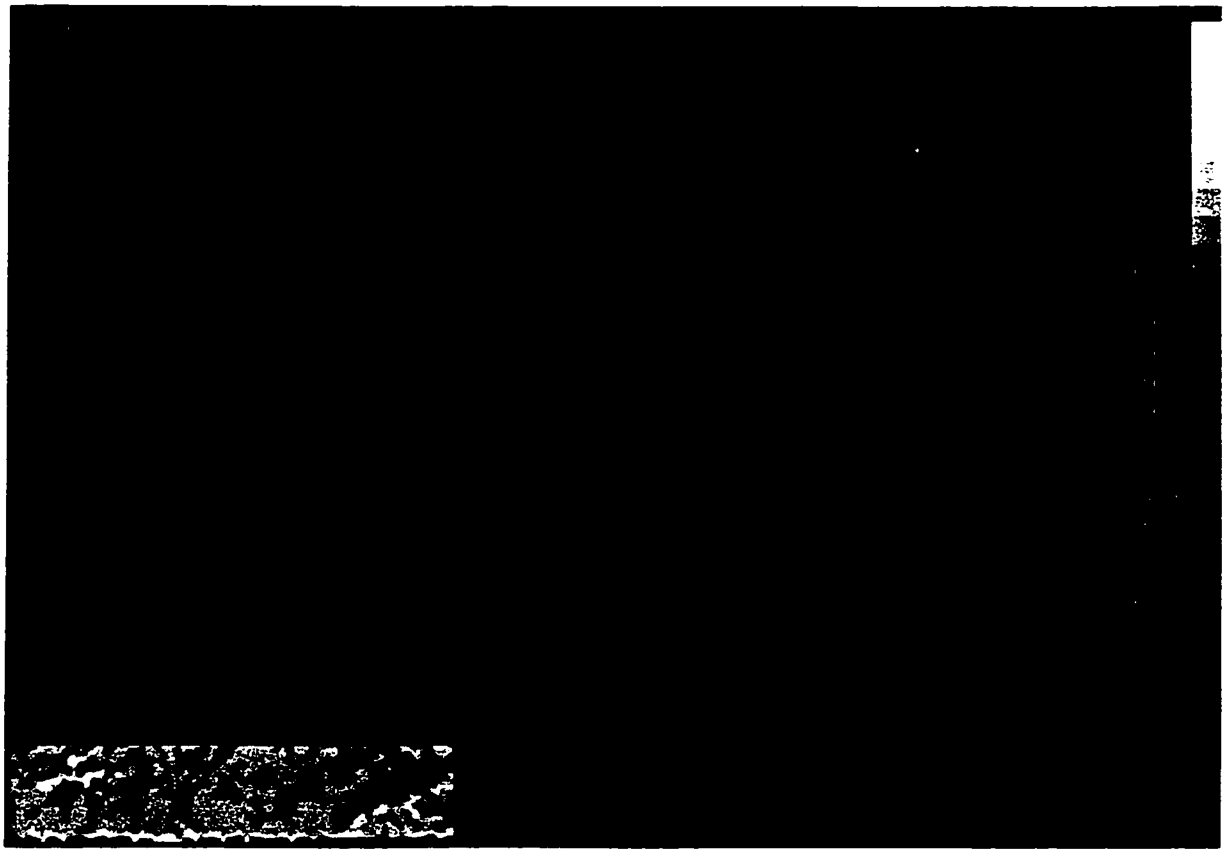

Figure A1.63 Magnetometry image of Heckside 2 (hs2mag3.tif) produced through spike removal, bicubic interpolation, and printing of all data points from -79.3 to 62.7 at a scale of 1:1000.

Conclusion

The inter-visibility of archaeological sites is notable in this area. From Heckside 2 a variety of sites can be seen including Heckside 1, Bemersyde Moss, Spadislee, Third, Whitrighill, Butchercote promontory fort, Brotherstone Hill West, Brotherstone Hill South, Bemersyde Hill., and perhaps Clinthill. The two Heckside enclosures lie in intimate proximity in this archaeological landscape, being only 325 m apart.

Heckside 2 is very interesting as one of very few triple ditched curvilinear enclosures surveyed in the region. The evidence from this site suggests that it was constructed over multiple phases, and potentially re-shaped and re-sized quite significantly.

Huntlyburn House

Description

The site of Huntlyburn House (NT 5241 3355) was first recorded in the NMRS as a cropmark of the northern segment of a curvilinear double-ditched earthwork. After ground visits, it was suggested that the earthwork was "oval on plan with maximum internal measurements of approximately 300 ft from ENE to WSW by 260 ft transversely." No ground traces of this earthwork remained during a repeat visit in 1961.

The site rests 157 m above sea level on the summit of Sheepfold Hill. This location is on the first high ridge overlooking the Tweed River valley, and is just west-northwest of Eildon Hill North. The earthwork is located 175 m north of Toft Burn.

The aerial photograph for this site is clear and has good control points. It shows the site as extending over the nearby road with the major part of the interior to the north of the road, and indicates a double-ditched curvilinear enclosure with a possible entrance visible on the west side of the inner ditch. Linear cropmarks in proximity to the enclosure suggest the possibility of a field system.

Interpretation

The portion of the site north of the road was subjected to geophysical survey, as that part lying south of the road was being used to grow crops. The survey was designed to define the full extent of the enclosure ditches, to investigate the internal area, and to interpret the linear cropmarks to the east of the enclosure that might indicate part of a field system.

Resistivity results show the northern portion of a double-ditched curvilinear enclosure. The resistance readings were hazy in the northwest section of the enclosure due to a strong signal from the underlying bedrock. Both ditches appear clearly on the resistivity printouts. The innermost ditch has an entrance in the northwest and this is slightly offset from a break in the outer ditch in the northwest. There is also evidence for a curvilinear structure inside the enclosure. The resistivity meter also detected two field drains, but these appear to be relatively modern. No evidence for a field system to the east of the enclosure was recovered.

Few grids were done with the gradiometer, but a short section of the inner ditch was recovered in the northeastern portion of the site.

Table A1.21 Archaeological features identified from geophysical survey of Huntlyburn House.

Feature	Technique	Interpretation
A	Resistivity	Inner ditch
B	Magnetometry and Resistivity	Outer ditch
C	Resistivity	Possible internal structure
D	Resistivity	Modern field drain
E	Resistivity	Modern field drain
F	Resistivity	Area of high background resistance, probably due to geology

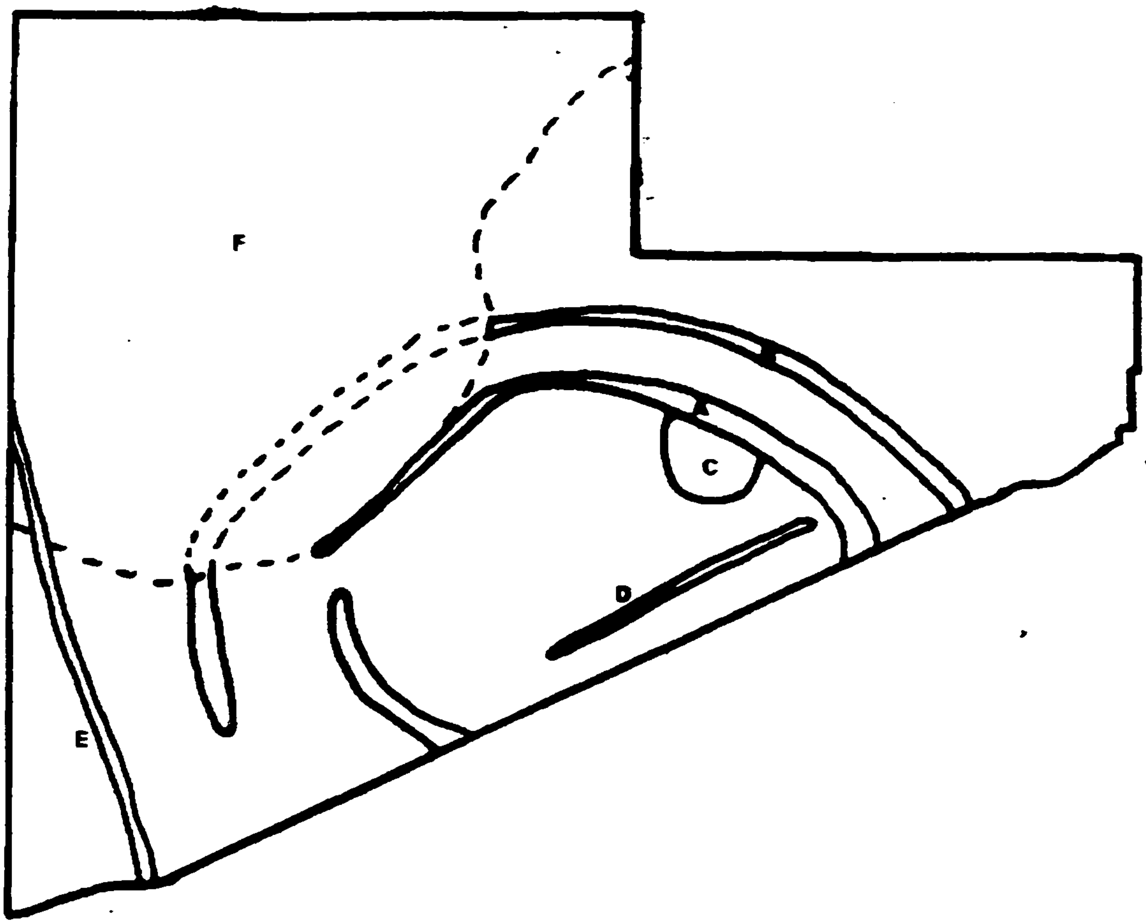

Figure A1.64 Huntlyburn House geophysics interpretation

Figure A1.65 Resistivity image of Huntlyburn House (hbhres3.tif) produced through spike removal, bicubic interpolation, and printing of data points from 53 to 85 at a scale of 1:1000.

Figure A1.66 Magnetometry image of Huntlyburn House (hbhmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -3 to 5 at a scale of 1:1000.

Conclusion

Huntlyburn House occupies the top of a pronounced knoll with a steep scarp slope to the north. The field in which it is now contained is a permanent pasture of irregular shape and runs northward into the valley of a dried-up stream. The vegetation suggests that this lower northern area is still subject to marshy conditions during the wetter months. The slope extends into a dry valley whose southern side rises to the ridge defining the northern edge of Bowden Moor.

The enclosure commands an extensive view along the valley of Ettrick Water to the southwest and towards the River Tweed to the northeast, in addition to direct line of sight to the ridges to the northwest and northeast. Visible archaeological sites include Brae, Blackcock Cleuch, Quarry Hill, and Eildon Hill North.

The double-ditched curvilinear enclosure at Huntlyburn House is unusual in having an entrance in the northwest.

Kaeside

Description

The NMRS report for Kaeside (NT 5173 3414) reports that:

> A fort known as "Castlestead" which was "surrounded with a deep ditch, in some places with two fosses, more than a mile and a half in compass, called the Kaeside, or rather the Kidside. Some part of the ditch is about 10 ft high. The place where the camp has been, there are two very deep fosses to the N, but to the S the rampiers are broken down by cultivation." Chalmers states that it consisted of a double fosse and rampart but ONB notes two embankments on the slope of the hill. Nothing can now be identified on the ground but Aps show a rampart enclosing an area roughly 100 m by 50 m. A road is said to have led westwards from the site.
>
> The OS siting lies on the top of a slight poorly defined N facing spur which is now regularly cultivated. There are no surface indications or ramparts or ditches but below the crest of the spur on a steep slope are two curvilinear terraces, one above the other, both approx 60.0 m long. The upper one is 4.0 m wide with a 0.8 m outer scarp and the lower is up to 8.0 m wide and 1.2 m high, both terminate in steep slopes and they almost certainly did not continue beyond their present length. The scarps were formerly wooded which may indicate their origin.
>
> The marks shown on the OS Aps are probably fortuitous.

Interpretation

A field crew of the Newstead Research Project visited Kaeside in 1993 to conduct a geophysical survey. They found the field used for permanent cattle pasture, and inhabited by an aggressive herd. In total, 22 grids of resistivity and 31 grids of magnetometry were completed with some risk of life and limb by the crew.

Resistivity results clearly show sections of both the inner and outer ditch of a double-ditched curvilinear enclosure. Magnetometry results provided a much clearer image of the enclosure itself, including evidence for two curvilinear enclosing ditches and some possible internal structural features. The enclosure appears as a relatively high magnetic feature, with an inner diameter of roughly 50 m.

Table A1.22 Archaeological features identified from geophysical survey of Kaeside.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Inner ditch
B	Magnetometry and Resistivity	Outer ditch
C	Magnetometry	Possible internal structural features

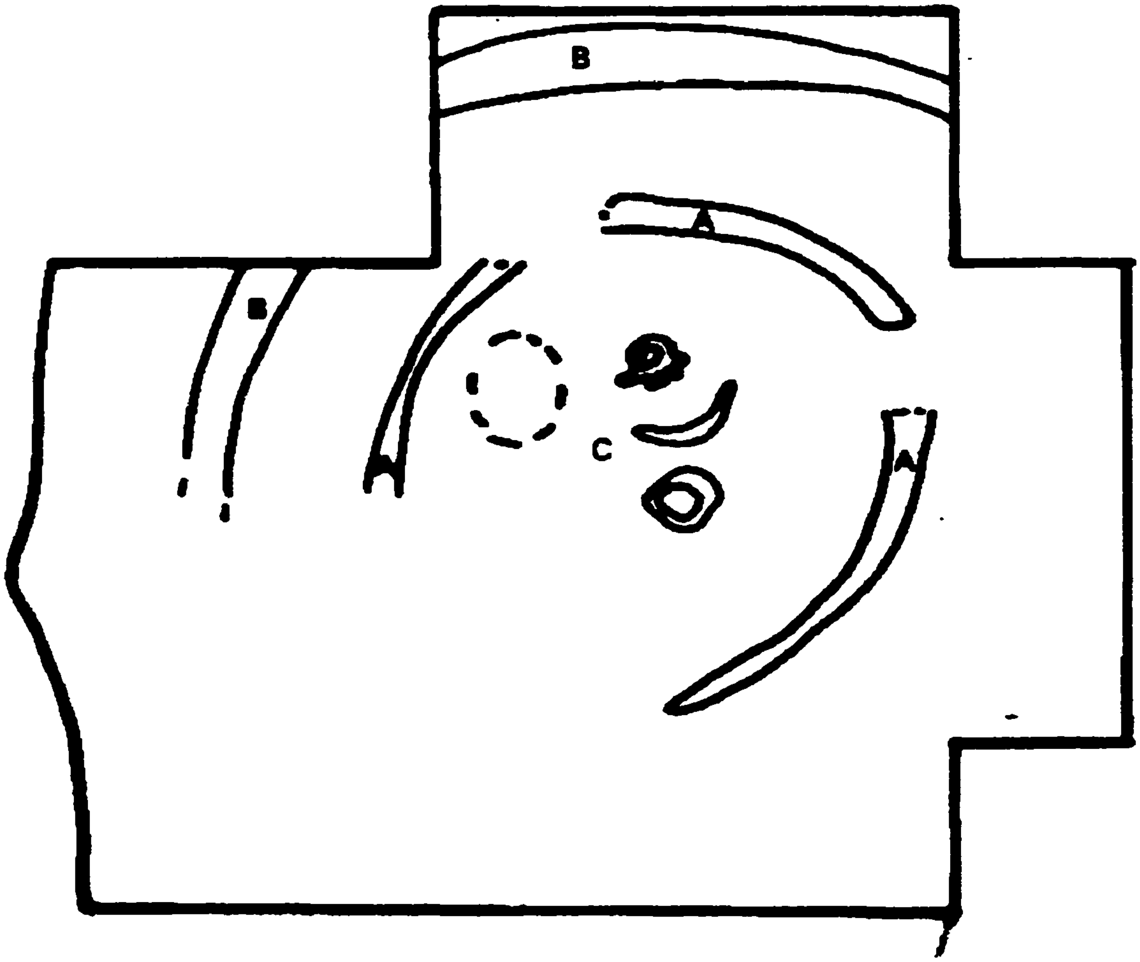

Figure A1.67 Kaeside geophysics interpretation

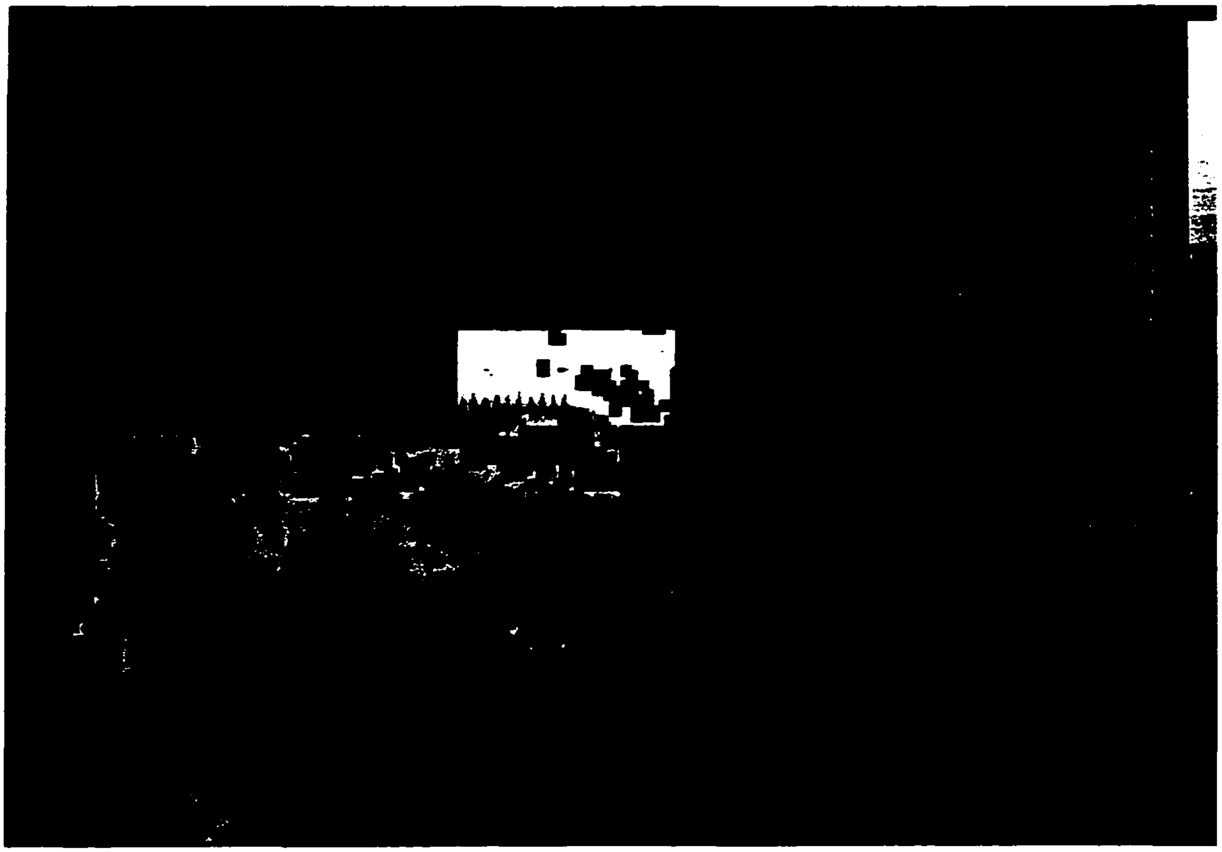

Figure A1.68 Resistivity image of Kaeside (ksres3.tif) produced through spike removal, bicubic interpolation, and printing of all data points from -185.2 to 513.2 at a scale of 1:1000.

Figure A1.69 Magnetometry image of Kaeside (ksmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -3 to 3 at a scale of 1:1000.

Conclusion

Geophysical survey at Kaeside confirms the presence of a double-ditched curvilinear enclosure.

The enclosure at Kaeside lies between the 125 and 150 m contour lines on a steep north-facing slope overlooking an alluvial plain that gently slopes to the River Tweed. A small creek flows west to east in a small valley 200 m south of Kaeside. Gun Knowe Loch lies 300 m north of Kaeside on the alluvial plain. Archaeological sites visible from Kaeside include Sheepfold, Gattonside, Quarry Hill, and Eildon Hill North.

This landscape position is relatively defensible, but is more noteworthy for its extensive views east down the Tweed river valley and to the northwest up the valley of the Gala Water.

Lilliesleaf, Hillhead

Description

The northernmost enclosure near Hillhead farm in Lilliesleaf (NT 5436 2555) sits 155 to 160 m above sea level on a gentle south facing slope just to the south of the Ale Water. Lilliesleaf Moss lies 400 m southwest of the enclosure, and the southern enclosure near Hillhead farm in Lilliesleaf (called Lilliesleaf, Hillhead South) lies 125 m to the south. A small creek lies approximately 375 m to the north. The landscape in which the Lilliesleaf enclosures lie is a natural basin created by Netherraw Hill, Bewliehill, Hilltop, and Hillhead.

Though this enclosure lies in the outer zone of the Newstead Research Project, a field crew visited to geophysically survey in 1993. A total of 15 grids of resistivity and 31 grids of magnetometry were completed.

Interpretation

Resistivity printouts do not provide much information about the site's enclosing features, but do show two circular areas of extremely low resistance, and a high resistance noisy area in the northeast corner of the site.

Magnetometry printouts clearly show three sides of a single ditched rectilinear enclosure. Entrances to this enclosure are visible on the east and west sides. A linear high magnetic anomaly crosses the survey area just south of the line of the southern side of the enclosure and blocks the ditch signal. It is unclear what causes this magnetic signal, but it may be related to geology as it aligns with the slope break in the field.

During subsequent excavation at Lilliesleaf we discovered that there is a gap in the ditch in the northeast corner of the site. In retrospect this gap appears in the geophysical survey, but had been originally overlooked. The survey interpretation presented here includes the gap.

Table A1.23 Archaeological features identified from geophysical survey of Lilliesleaf.

Feature	Technique	Interpretation
A	Magnetometry	Ditch
B	Magnetometry	East entrance
C	Magnetometry	West entrance
D	Magnetometry	Unidentified feature - possibly a ditch or field drain
E	Magnetometry and Resistivity	Internal structural features
F	Magnetometry	Water pipe

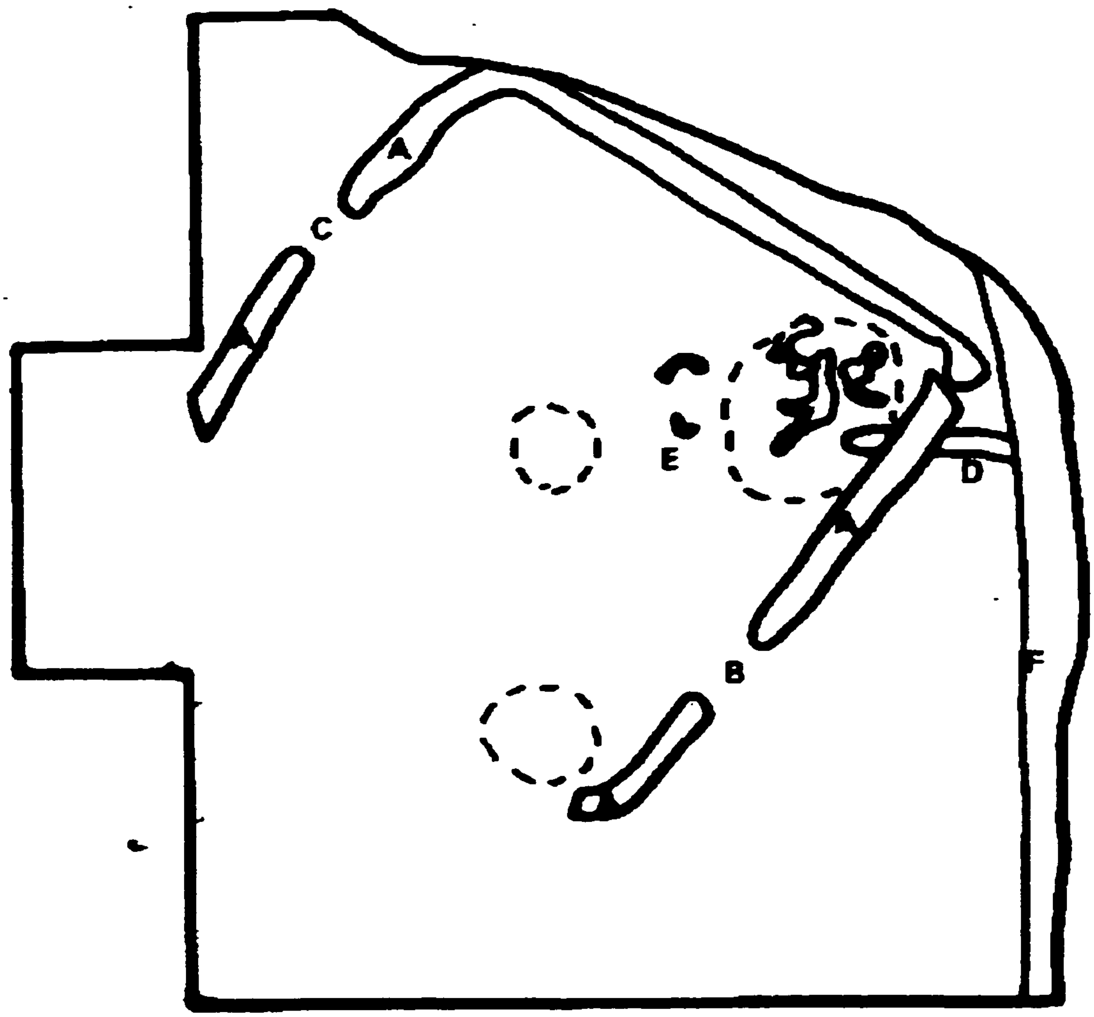

Figure A1.70 Lilliesleaf geophysics interpretation

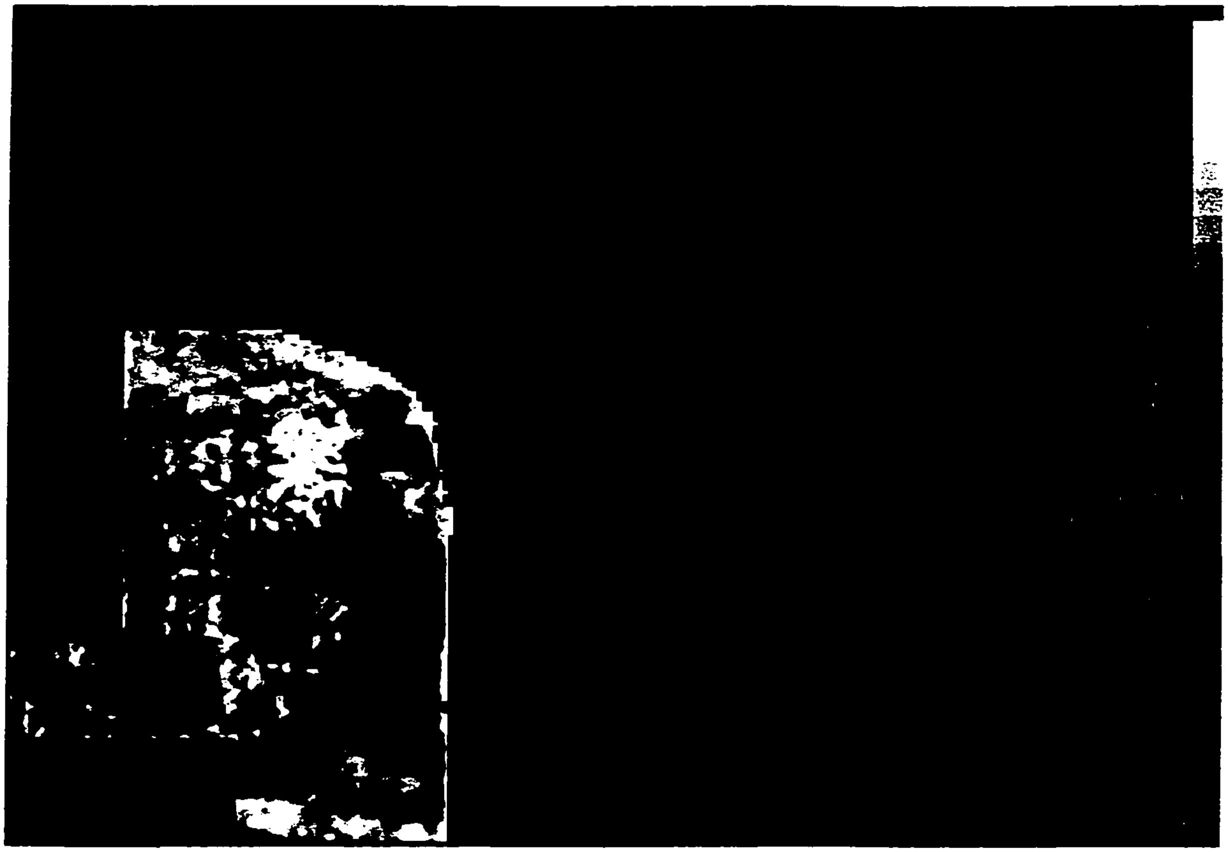

Figure A1.71 Resistivity image of Lilliesleaf (llres3.tif) produced through spike removal, bicubic interpolation, and printing of all data points from 58 to 139.2 at a scale of 1:1000.

Figure A1.72 Magnetometry image of Lilliesleaf (llmag5.tif) produced through spike removal, bicubic interpolation, destriping and printing of data points from -10 to 10 at a scale of 1:1000.

Conclusion

Two sherds of Roman samian ware were recovered during geophysical survey at Lilliesleaf. As a result, this single-ditched rectilinear enclosure was identified as a promising native site for further investigation by the Newstead Research Project. In 1996 a crew directed by Simon Clarke and the author returned to excavate in the northeast corner of the site. Please see Chapter 3 for preliminary results from this excavation.

Lilliesleaf, Hillhead South

Description

This site (NT 5438 2535) lies in the same field, and slightly south, of the rectilinear enclosure at Lilliesleaf, Hillhead. It appears as a curvilinear cropmark on aerial photographs taken by John Dent, Borders Regional Archaeologist.

The field crew from the Newstead Research Project which surveyed this site did not have access to any of the aerial photographs, and positioned the geophysical survey grids somewhere in the south-central portion of the field near Lilliesleaf Moss. Unfortunately, the survey was done hurriedly in heavy rain on the last day of the 1993 field season and no record of the precise location of the grids was made. It is therefore extremely difficult to interpret the few anomalies that were recorded with the fluxgate gradiometer. The geophysics images are presented here in order to complete the archival record, but without any interpretation.

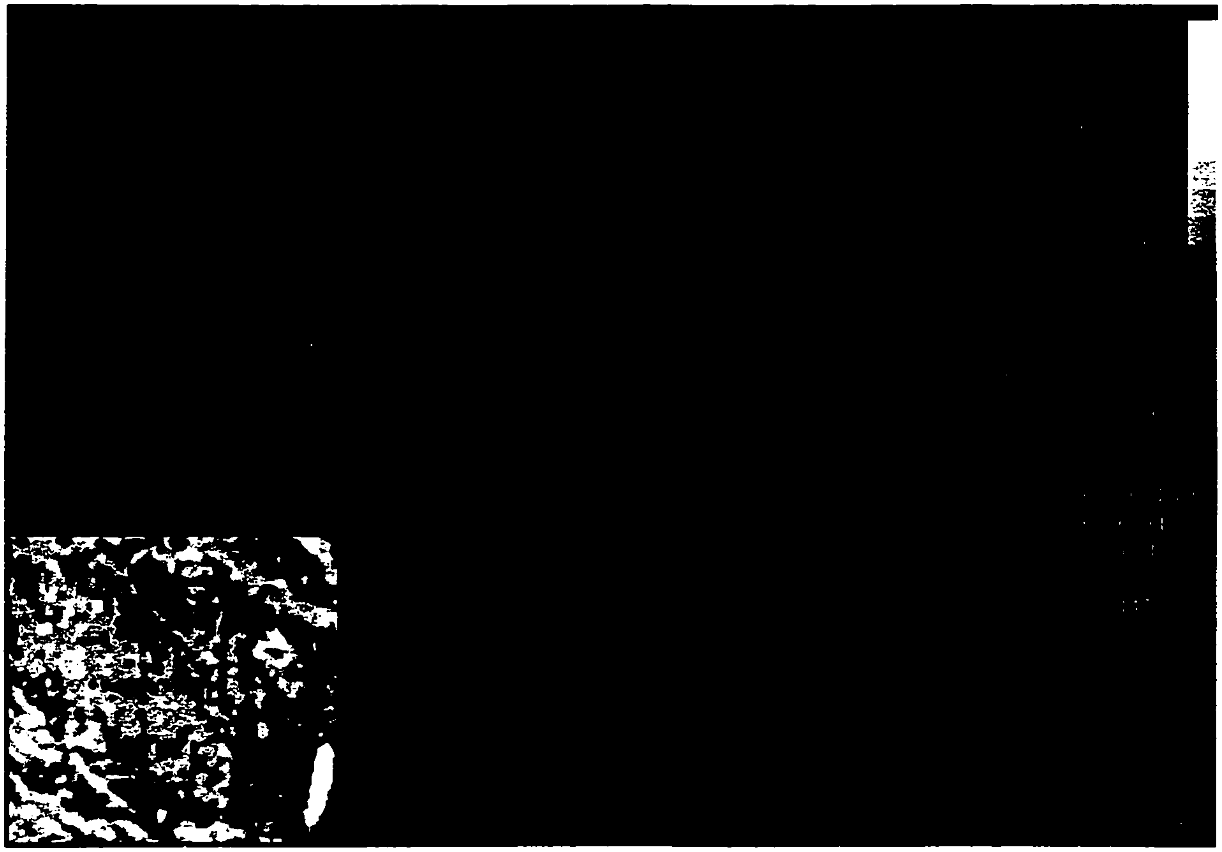

Figure A1.73 Magnetometry image of Lilliesleaf, Hillhead South (sllmag3.tif) produced through spike removal, bicubic interpolation, and printing of all data points from -3.4 to 3.6 at a scale of 1:1000.

Conclusion

This curvilinear enclosure is interesting given its proximity to the excavated rectilinear enclosure at Hillhead, Lilliesleaf and to Lilliesleaf Moss.

Littledean

Description

The enclosure at Littledean (NT 632 313) is located on the same promontory as the remains of Littledean Tower and a modern farmhouse. The edge of the bluff around the promontory is roughly 70 m above sea level, and the top edge of the bluff slopes up to a maximum elevation of 88 m above sea level.

Interpretation

Geophysics results show that the promontory is enclosed by a complicated series of seven ditches and at least 5 banks. The innermost ditch is sharply defined with no hint of multi-phase construction. The second, third, fourth, fifth, and sixth ditches all appear as fragments in the survey results, suggesting that there may have been multiple phases of construction with some ditches being added relatively late in the sequence.

The entrances to all seven ditches are roughly aligned toward the west, the only direction from which the promontory is accessible, but each entrance is staggered from those before and after. There are only hints of possible internal features in the form of curvilinear anomalies in both the resistivity and the magnetometry data.

Table A1.24Archaeological features identified from geophysical survey of Littledean.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Inner ditch
B	Magnetometry	Second ditch
C	Magnetometry	Third ditch
D	Magnetometry and Resistivity	Fourth ditch
E	Magnetometry	Fifth ditch
F	Magnetometry and Resistivity	Sixth ditch
G	Magnetometry	Seventh ditch
H	Magnetometry and Resistivity	Entrance in inner ditch
I	Magnetometry and Resistivity	Entrance in second, third, and fourth ditches
J	Magnetometry	Entrance in fifth ditch
K	Magnetometry and Resistivity	Entrance in sixth ditch
L	Magnetometry	Entrance in seventh ditch
M	Magnetometry and Resistivity	Curvilinear anomalies, possibly structural features, within promontory fort.

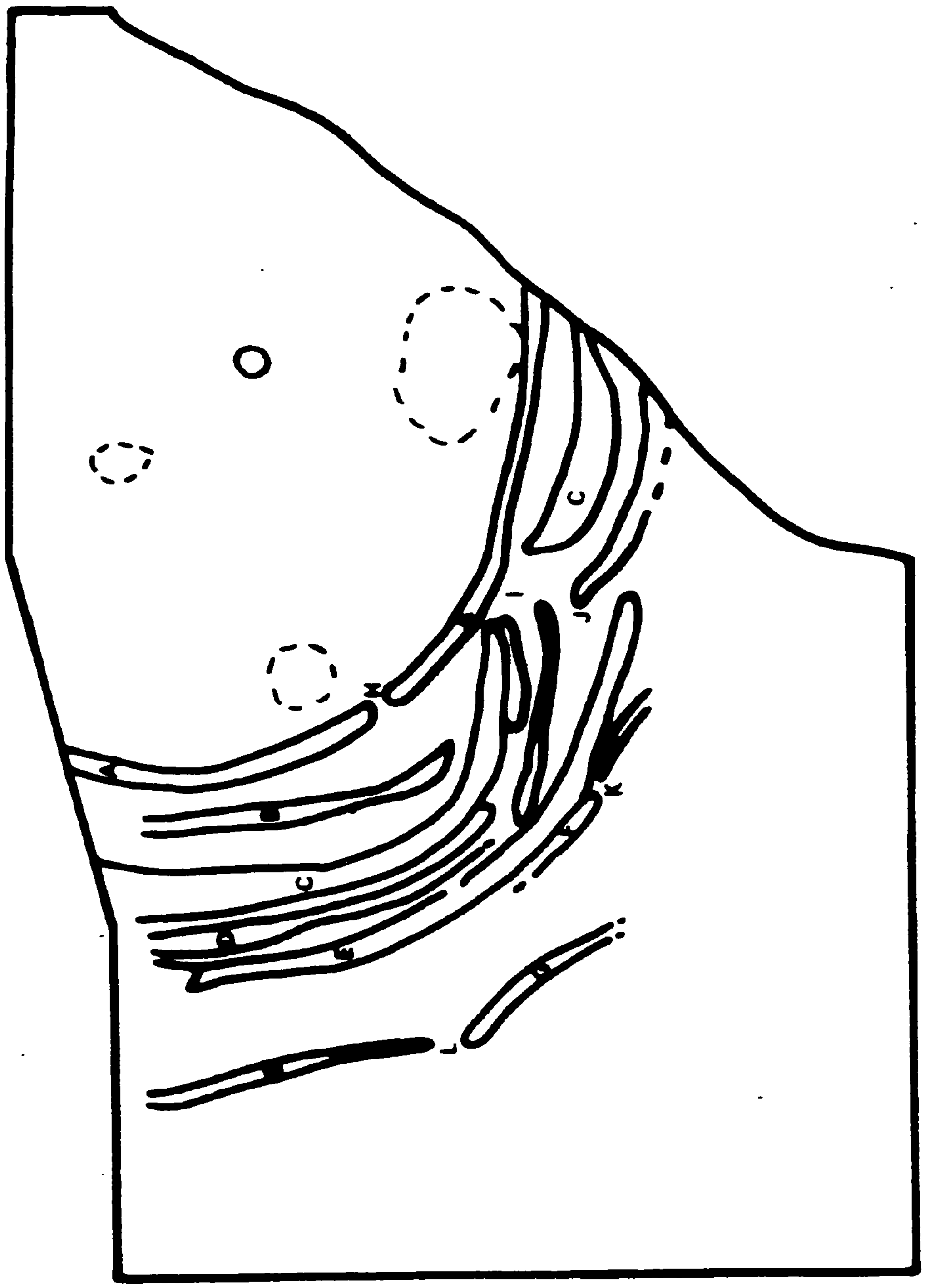

Figure A1.74 Littledean geophysics interpretation

Figure A1.75 Resistivity image of Littledean (ldres3.tif) produced through spike removal, bicubic interpolation, and printing of data points from 32 to 59 at a scale of 1:1176.

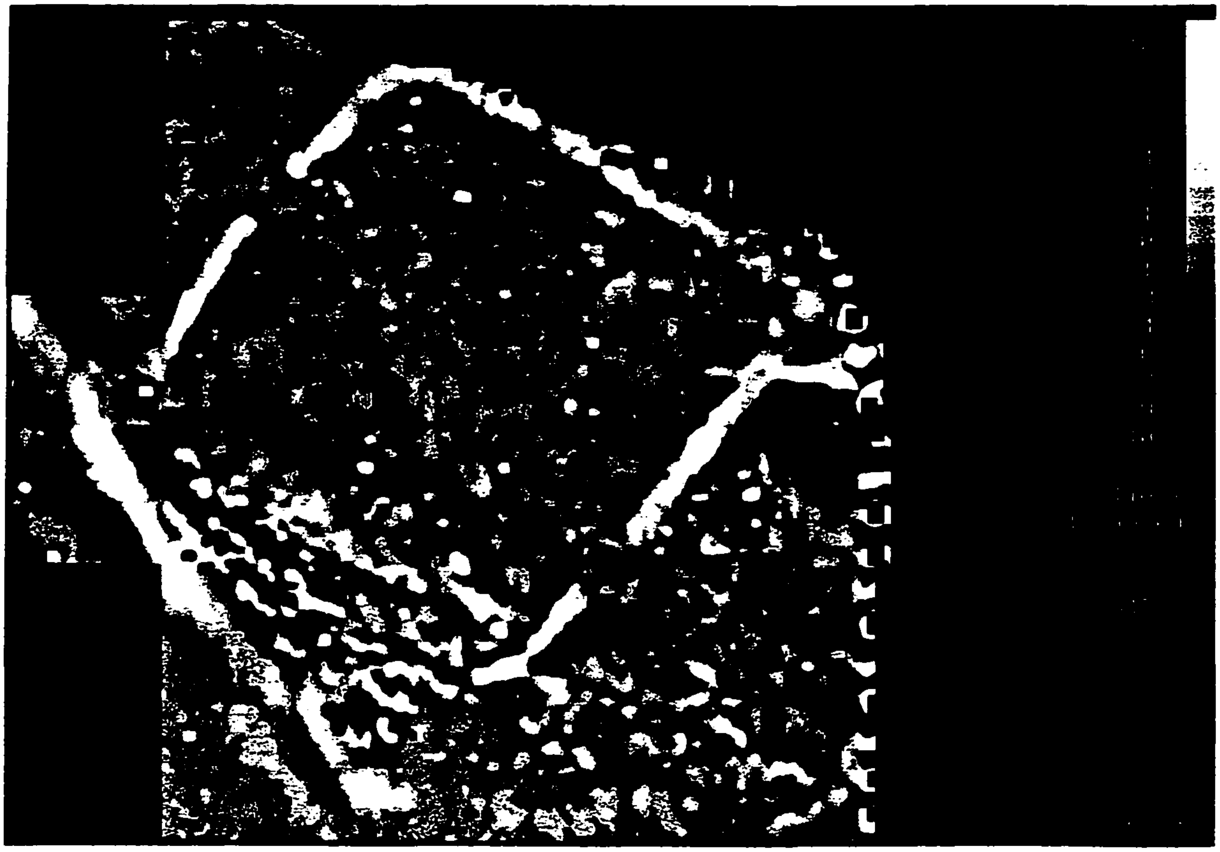

Figure A1.76 Magnetometry image of Littledean (ldmag3.tif) produced through spike removal, bicubic interpolation, and printing of data points from -1.8 to 1.8 at a scale of 1:1069.

Conclusion

The site at Littledean overlooks the River Tweed to the north and Littledean Burn/Ploughlands Burn to the east and south. Such a promontory location offers an extremely defensible location, and commanding views. In this case, views are especially good east and west along the Tweed River Valley as well as north to the ridges of Clinthill, Butchercote Craigs, and Sandyknowe Craigs.

It is unsurprising that in such a defensible position, strategically placed on the River Tweed, there should be a heavily entrenched promontory as well as the standing remains of a medieval tower. Internal measurements of the enclosure are not easy to estimate as forested areas on the north, east, and south sides prevented complete survey coverage. At its widest point, however, the seventh ditch encloses a space at least 235 m long.

With such a complicated series of defenses neatly enclosing Littledean Tower it is quite likely that all the ditches are contemporaneous with the Tower. However, the evidence, for curvilinear anomalies within the inner ditch suggests an earlier promontory fort. It is therefore likely that at least the inner ditch was used to enclose a prehistoric promontory fort, and that this ditch and the favorable location were re-used in later times.

Archaeological sites visible from Littledean include Smailholm Tower, Clintmains, Clinthill, Heckside 2, and Benrig Dean.

Mellerstain Mill

The survey data for Mellerstain Mill remain with Paul Cheetham who directed the fieldwork.

Oakendean House

Description

Aerial photograph cropmarks (A72143-6, B44433-34, C86974/po/CN taken by John Dent, and C86936/po/CN taken by John Dent) for Oakendean House (NT 563 338) show a number of enclosures and linear earthworks. The two features of central interest at Oakendean House are two abutting double-ditched enclosures. The eastern enclosure is circular and the western enclosure is rectilinear, thus offering an opportunity for archaeologists to better understand the temporal relationship of these settlement morphology types in the Borders region of Scotland. Two linear earthworks run north to south across these enclosures: the easternmost earthwork bisects the curvilinear enclosure and the westernmost earthwork passes just west of the rectilinear enclosure. The earthworks have been tentatively identified as earthworks associated with marching camps of the Roman fort at Trimontium (e.g. Maxwell 1989) but more recent work suggests that these ditches may be associated with field systems surrounding the fort itself (Clarke and Jones 1994).

The enclosures at Oakendean House lie between 125 and 140 m above sea level on a slight knoll. The nearest water sources are Oaken Dean, 150 m to the west, and the River Tweed, roughly 500 meters to the north. These enclosures are located northwest of Eildon Hill North, and lie in a fairly dense archaeological landscape. The Roman fort of Trimontium lies to the northeast of the Oakendean enclosures, and the westernmost part of the fort is visible from it. Other nearby sites include those at Eildon Hill North, Eildontree, Red Rig, and the Newstead souterrains. These last two sites are not located in places directly visible from the ground at Oakendean House, but if contemporaneous structures were located at these sites in the past, they are likely to have been intervisible. Visible across the River Tweed from Oakendean House are the enclosures at Gattonside and Easter Hill.

Interpretation

The archaeological features at Oakendean House lie under three modern fields. In December 1995 a field crew visited the site to do a geophysical survey. A total of 13 grids of resistivity and 17 grids of magnetometry were completed in the western field, then lying under barley stubble. Relatively recent ploughing produced mud too deep for accurate laying of gridlines and surveying in the southeastern field, and a young winter wheat crop prevented surveying in the northeastern field.

Table A1.25 Archaeological features identified from geophysical survey of Oakendean House.

Feature	Technique	Interpretation
A	Resistivity	Inner ditch of western enclosure
B	Resistivity	Outer ditch of western enclosure
C	Resistivity	Possible linear earthwork
D	Resistivity	Low resistance curvilinear feature, possibly archaeological
E	Magnetometry	High magnetic anomaly, possible archaeological

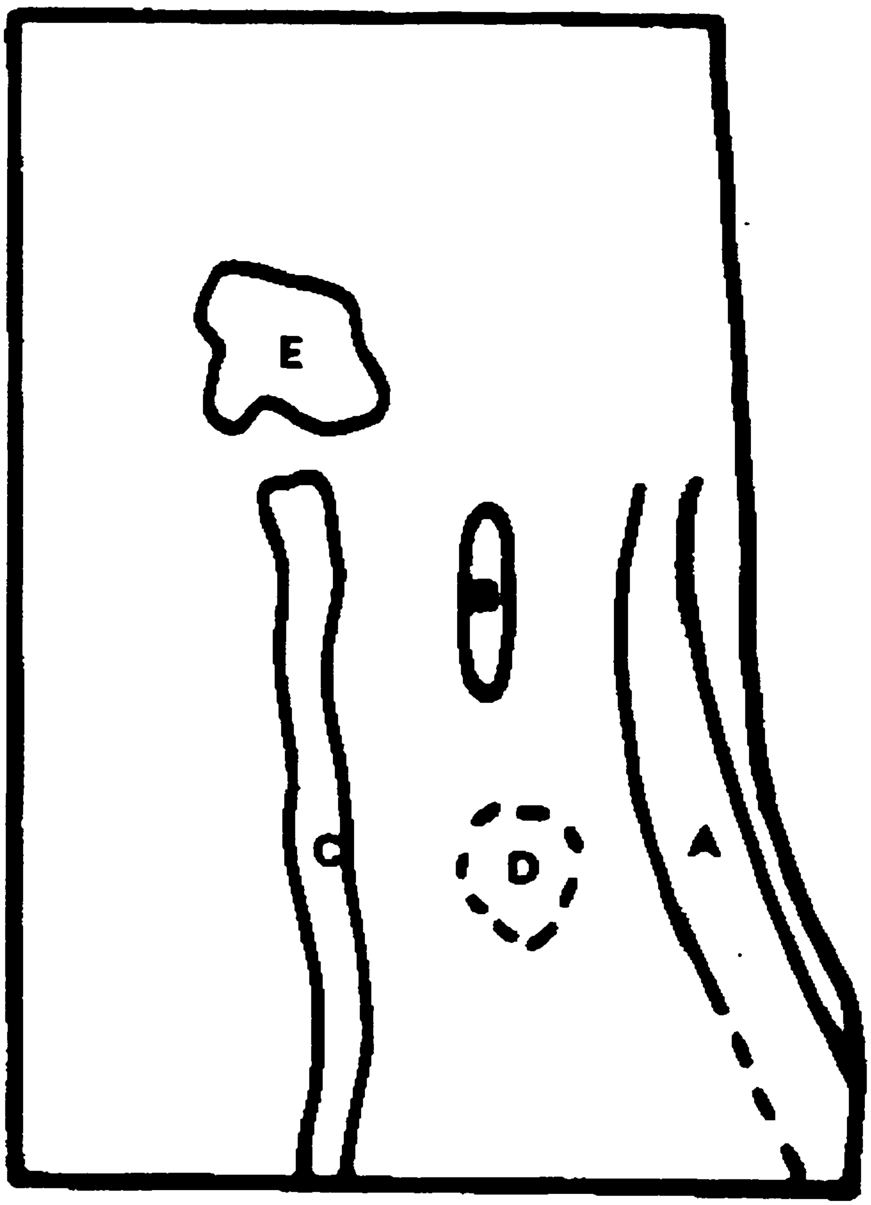

Figure A1.77 Oakendean House geophysics interpretation

Figure A1.78 Resistivity image of Oakendean House (odhres5.tif) produced through spike removal, bicubic interpolation, and printing of data from 36 to 49 ohms at a scale of 1:1000.

Figure A1.79 Magnetometry image of Oakendean House (odhmag3.tif) produced through spike removal, bicubic interpolation, and printing of all data from -23.7 to 22.6 nT at a scale of 1:1000.

Conclusion

Resistivity results provide evidence for the southwestern portion of the rectilinear enclosure identified at Oakendean through aerial photograph cropmarks. The innermost ditch appears to be curvilinear while the outer ditch appears to be more rectilinear. The corner area of the outermost ditch was, however, not surveyed. A low resistance feature running to the west of these ditches appears to represent the linear earthwork identified on aerial photographs. The resistivity survey also records numerous north to south running plough scars in the soil. These appear on the printouts as light colored parallel lines running from top to bottom.

This survey has resulted in improved knowledge of the precise location of the rectilinear enclosure and western linear earthwork at Oakendean House. The relationship between the enclosure and the earthwork, and these features with the curvilinear enclosure and eastern linear earthwork remain undefined. Further survey in all three fields seems appropriate given the complexity and archaeological importance of the site.

Quarry Hill

Description

This enclosure sits at the top of the northwest shoulder of Quarry hill (NT 5418 3370) at an elevation of 160 m above sea level. Though modern quarrying has made the northern edge of the hillslope into a cliff face, the steepness of the natural terrain would have rendered the north and west hillsides virtual cliffs in the past. Quarry Hill slopes more gently, but still very noticeably, up to Eildon Hill North in the southeast. The hill itself is bordered 175 m to the west by the eastern tributary of Harley Burn and 325 m to the east by Malthouse Burn. The summit is currently kept in permanent pasture.

Aerial photographs reveal the site at Quarry Hill as an L-shaped curvilinear cropmark. Geophysical surveys carried out in 1991 by a field crew of the Newstead Research Project significantly clarified knowledge of this site. In total 35 grids of resistivity and 40 grids of magnetometry were completed.

Interpretation

Geophysics results reveal most of the southern three-quarters of a double-ditched curvilinear enclosure with an entrance in the east. The northern and southwestern portions of the enclosure have been destroyed by modern quarrying. The center of the enclosure registers as a relatively low resistance area, possibly due to greater soil depth, and several anomalies probably representing internal structures are apparent.

Please note that geophysical results from grids 28, 29, 33, 34, 39, and 40 were affected by modern quarrying activity.

Table A1.26 Archaeological features identified from geophysical survey of Quarry Hill.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Inner ditch
B	Magnetometry and Resistivity	Outer ditch
C	Magnetometry	High magnetic line probably marking inner edge of bank
D	Magnetometry and Resistivity	Entrance
E	Magnetometry and Resistivity	Probable internal structural features

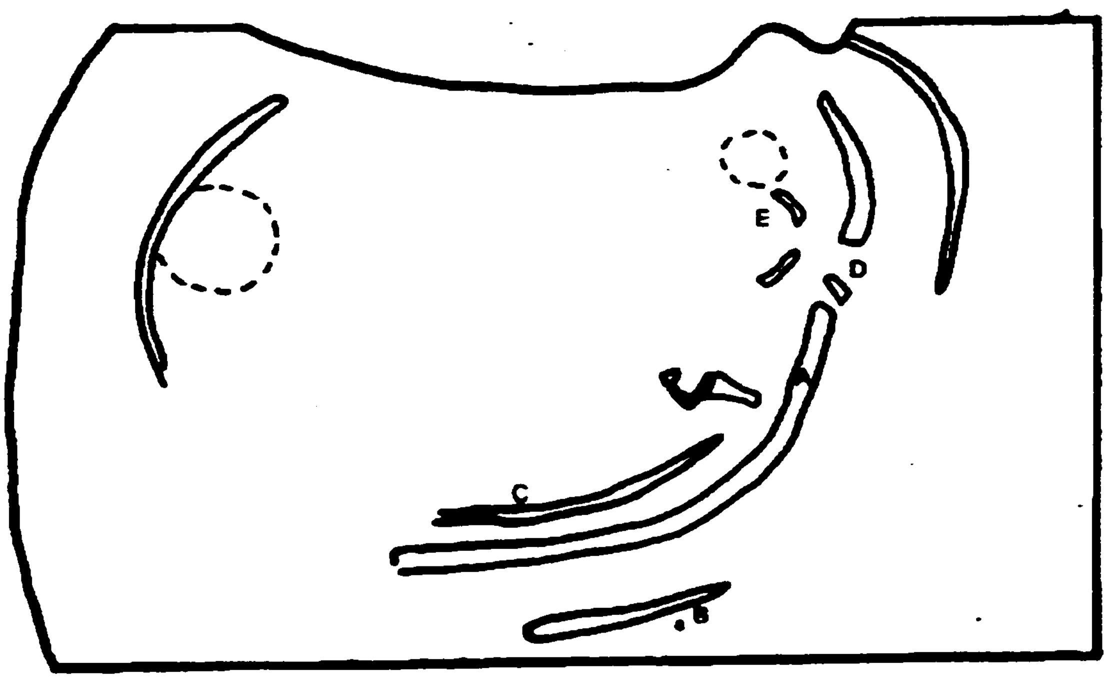

Figure A1.80 Quarry Hill geophysics interpretation

Figure A1.81 Resistivity image of Quarry Hill (qhres5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 65 to 125 at a scale of 1:1000.

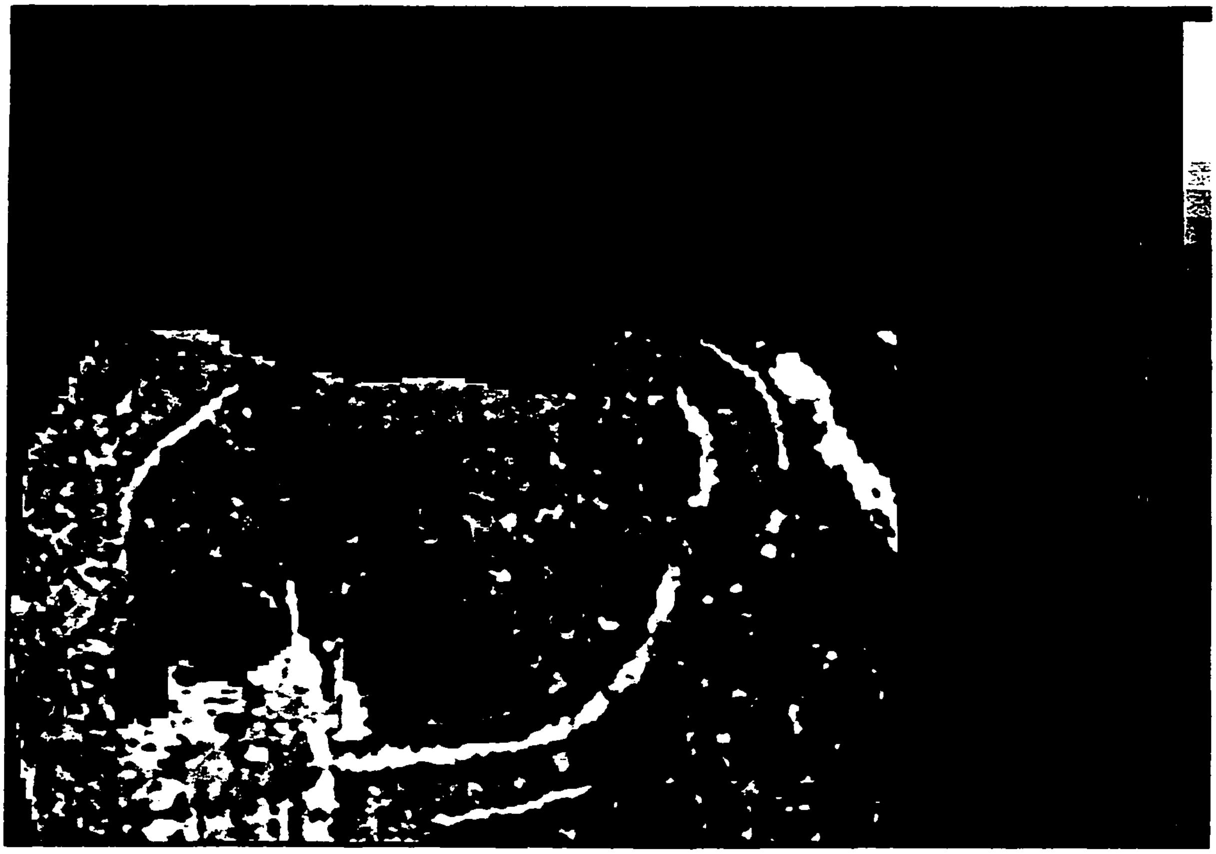

Figure A1.82 Magnetometry image of Quarry Hill (qhmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -5.5 to 5.5 at a scale of 1:1000.

Conclusion

Despite the ravages of modern quarrying, a good deal of the enclosure on Quarry Hill remains intact. Both the ditches and internal structural features appear very clearly in the geophysics data suggesting relatively good preservation.

Archaeological sites visible from Quarry Hill include Eildon Hill North, Trimontium, Blackoak Cleuch, Sheepfold, Gattonside, Pincushion Plantation, Back Brae, and Easter Hill. The location commands good views east and west up the Tweed River Valley, including the conjunction of the Tweed with the Gala Water. This position is very defensible from the river or from the alluvial plain, but it is not defensible from the south or from the direction of the Eildon Hills.

Red Rig

Description

The site of Red Rig (NT 5695 3368) is located on a ridge approximately 0.75 km southeast of Newstead village. It lies145 m above sea level on the lower northeastern slope of Eildon Hill North. Bogle Burn is located 200 m to the south and is the nearest water source at present.

The enclosure at Red Rig appears on aerial photographs as a double-ditched sub-circular site. The aerial photograph plots suggest differentiation of the site's enclosing ditch. One appears as a thinner ditched circular enclosure. The second appears to have an ovoid outline with a more substantial ditch.

Interpretation

Field crews of the Newstead Research Project visited Red Rig in 1989 and 1993 to complete geophysical surveys. Magnetometry was done on the two southern fields in 1989. These fields were re-surveyed in 1993, and the northwestern field was also done at this time. The 1989 survey was intended to accurately locate site features appearing on aerial photographs in order to assess the character and significance of the site and help plan an effective excavation strategy. The 1993 survey was intended to fill in missing information about the northwestern quadrant of the site.

Interpretation of the Red Rig geophysical evidence is quite difficult. This is partly because a modern trackway lined with metal fencing bisects the site north to south resulting in especially noisy magnetometer readings, partly because a disused stone field boundary bisects the site east to west, partly because excavation has disturbed the pattern of sediment on site, and partly because the site banks appear only on the resistivity printouts and the site ditches appear only on the magnetometer printouts.

Resistivity plots of Red Rig suggest a double ditched curvilinear enclosure with an entrance, possibly paved, in the east. The site's interior is not clearly defined by the resistivity survey, but some possible structural features are in evidence. There is some evidence for multi-phase construction of the enclosure system, because the resistivity signal representing the site's second bank appears to cross the magnetometry line representing the third ditch.

Magnetometry plots of Red Rig suggest that the site is triple-ditched rather than double. These data also suggest, however, that the site may have been enclosed during more than one construction phase. Particularly interesting are two short ditch segments, one on the east and one on the west, which suggest that the curvilinear ditches were straightened on these two sides at some point in time.

Table A1.27Archaeological features identified from geophysical survey of Red Rig.

Feature	Technique	Interpretation
A	Resistivity	Inner bank
B	Magnetometry	Inner ditch
C	Resistivity	Second bank
D	Magnetometry	Second ditch
E	Resistivity	Third bank
F	Magnetometry	Third ditch
G	Magnetometry and Resistivity	Entrance
H	Magnetometry and Resistivity	Possible internal structural features
I	Resistivity	Modern field drain

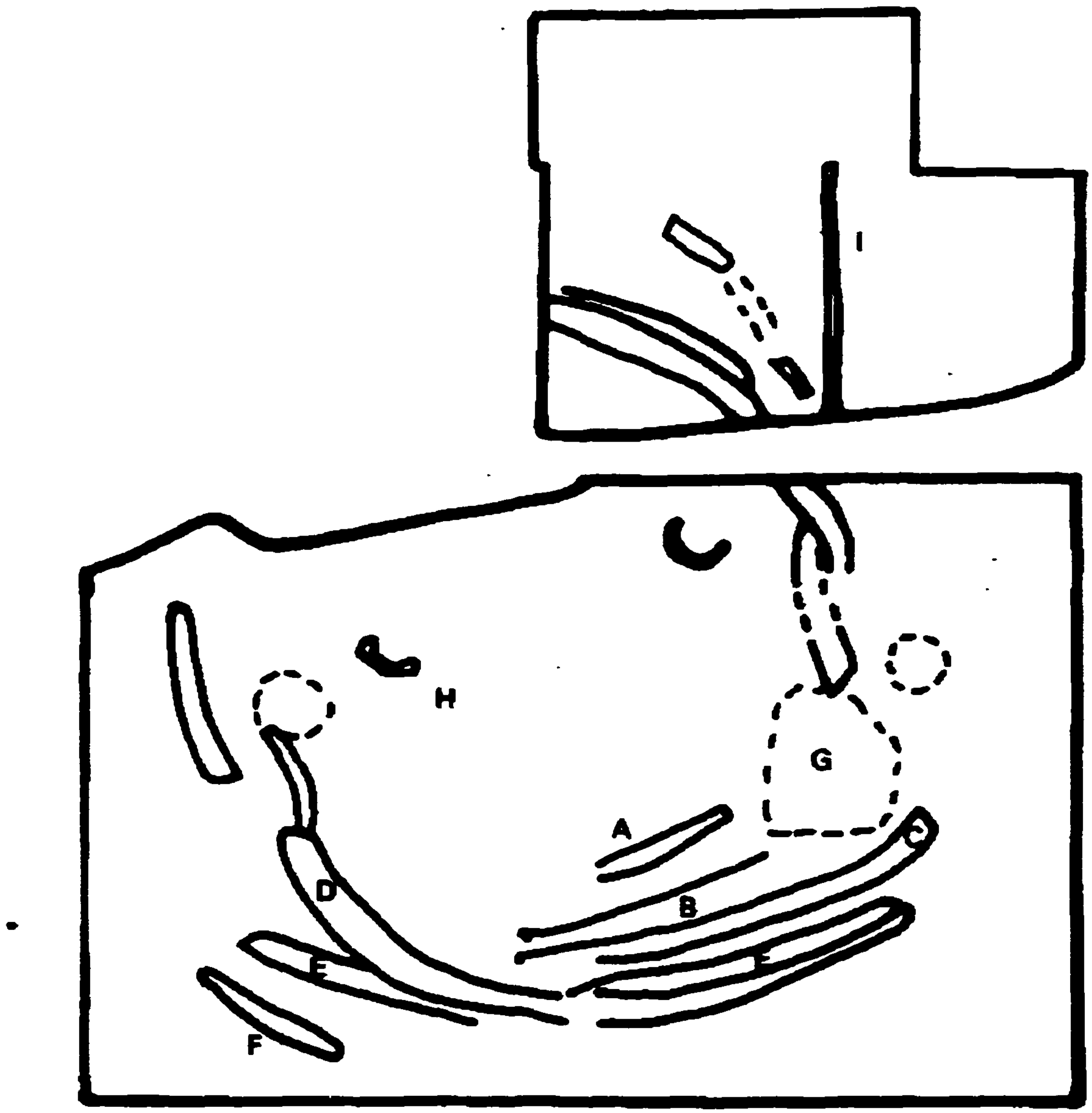

Figure A1.83 Red Rig geophysics interpretation

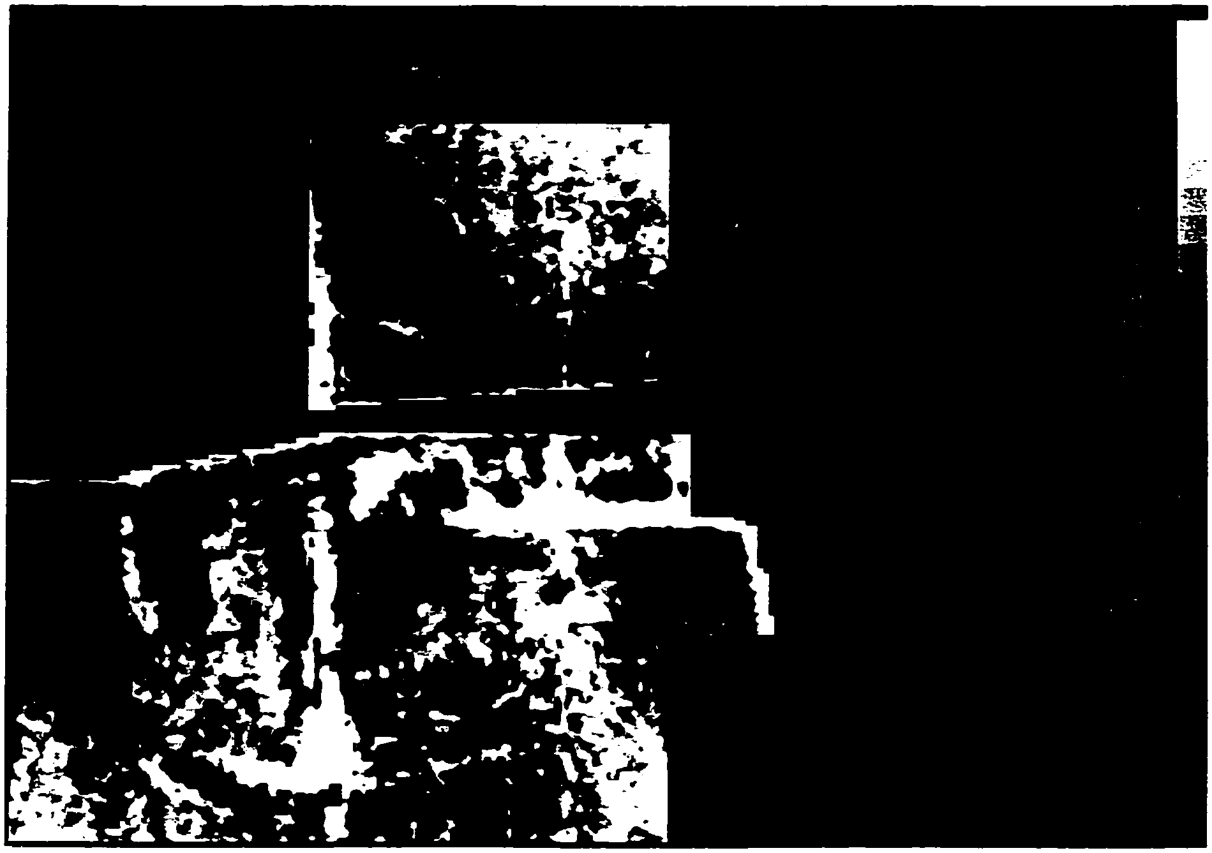

Figure A1.84 Resistivity image of Red Rig (rrres5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 45 to 60 at a scale of 1:1000.

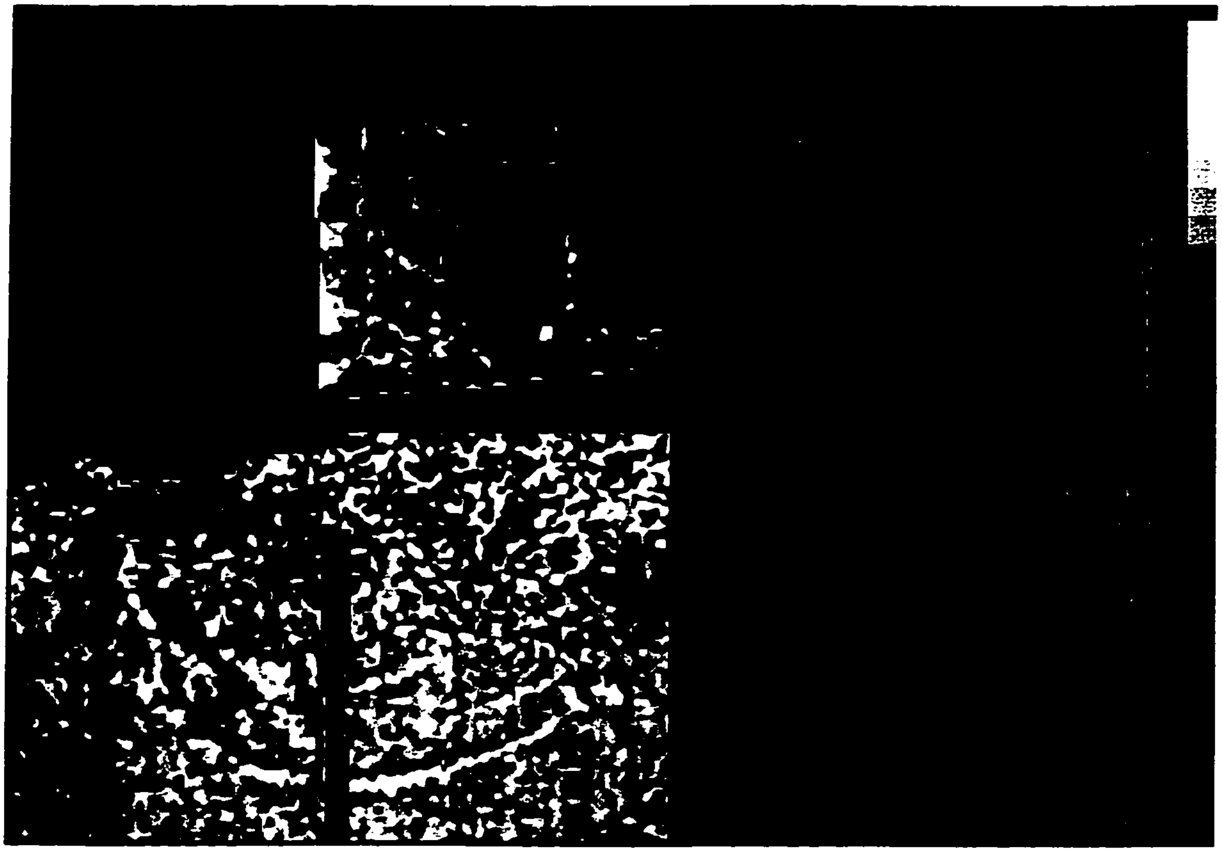

Figure A1.85 Magnetometry image of Red Rig (rrmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -2 to 2 at a scale of 1:1000.

Conclusion

The geophysical evidence from Red Rig suggests an all together disturbed site with intriguing suggestions of significant re-shaping through time. It is conceivable that this enclosure was transformed from a more curvilinear shape to a more rectilinear shape, but no evidence for clear corners was recovered and this hypothesis is speculative.

During excavation, the crew had great difficulty distinguishing archaeological deposits from the surrounding natural sediment as there was little differentiation in terms of color, sediment consistency, or artifact content. The excavation unfortunately produced no clarification about the number, shape, and construction of the ditches and banks. The excavation team was, however, lucky enough to hit on a narrow curvilinear trench packed with stones and interpreted as a possible palisade trench. They also discovered a small pit filled with loam, charcoal, cobbles, and a few animal bone fragments. It is extremely unlikely that either of these features appear in the geophysical data as the sampling strategy used does not generally recover archaeological remains of this size.

Red Rig forms part of a settlement cluster beside the Roman fort of Trimontium. This cluster includes the enclosure at Oakendean House, the enclosure and standing stone at Eildontree, a possible Roman fortlet, and Trimontium itself. Eildon Hill North dominates this portion of the landscape. Archaeological sites visible from Red Rig include Oakendean House, Eildontree, the Roman fortlet, Trimontium, Eildon Hill North, Gattonside, Easter Hill, Pincushion Plantation, Leaderfoot Lodge, Kirklands, and Bemersyde fort.

Redpath

Description

The enclosure at Redpath (NT 588 362) sits 150 m above sea level on the west-facing lower shoulder of Redpath Hill. Sitting on a gentle slope, the site is not in a very defensible position. The Leader Water lies 30 m to the west down a fairly steep slope, or 600 m following a relatively easier course. A small creek flows 300 m south of the enclosure, and Redpath Dean lies 250 m north.

Cropmarks on aerial photographs show the site at Redpath as the north, west, and east sides of a small square enclosure.

Interpretation

Resistivity printouts show faint hints of the west and north sides of the enclosure, and the magnetometer recorded faint traces of the north, west, and east sides. There is a possible entrance at the north end of the east side, and the suggestion of one directly opposite it on the west side but the second entrance is by no means certain. Clear evidence for curvilinear internal structures was also recovered with each technique.

Table A1.28Archaeological features identified from geophysical survey of Redpath.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Ditch
B	Magnetometry and Resistivity	Probable internal structural features
C	Magnetometry and Resistivity	Entrance
D	Magnetometry and Resistivity	Possible second entrance

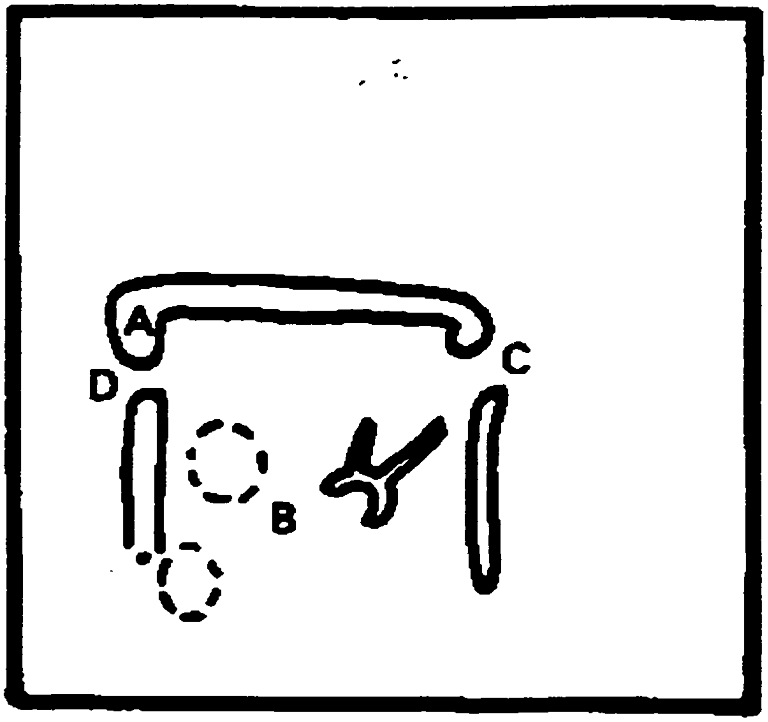

Figure A1.86 Redpath geophysics interpretation

Figure A1.87 Resistivity image of Redpath (r49res5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 70 to 140 at a scale of 1:1000.

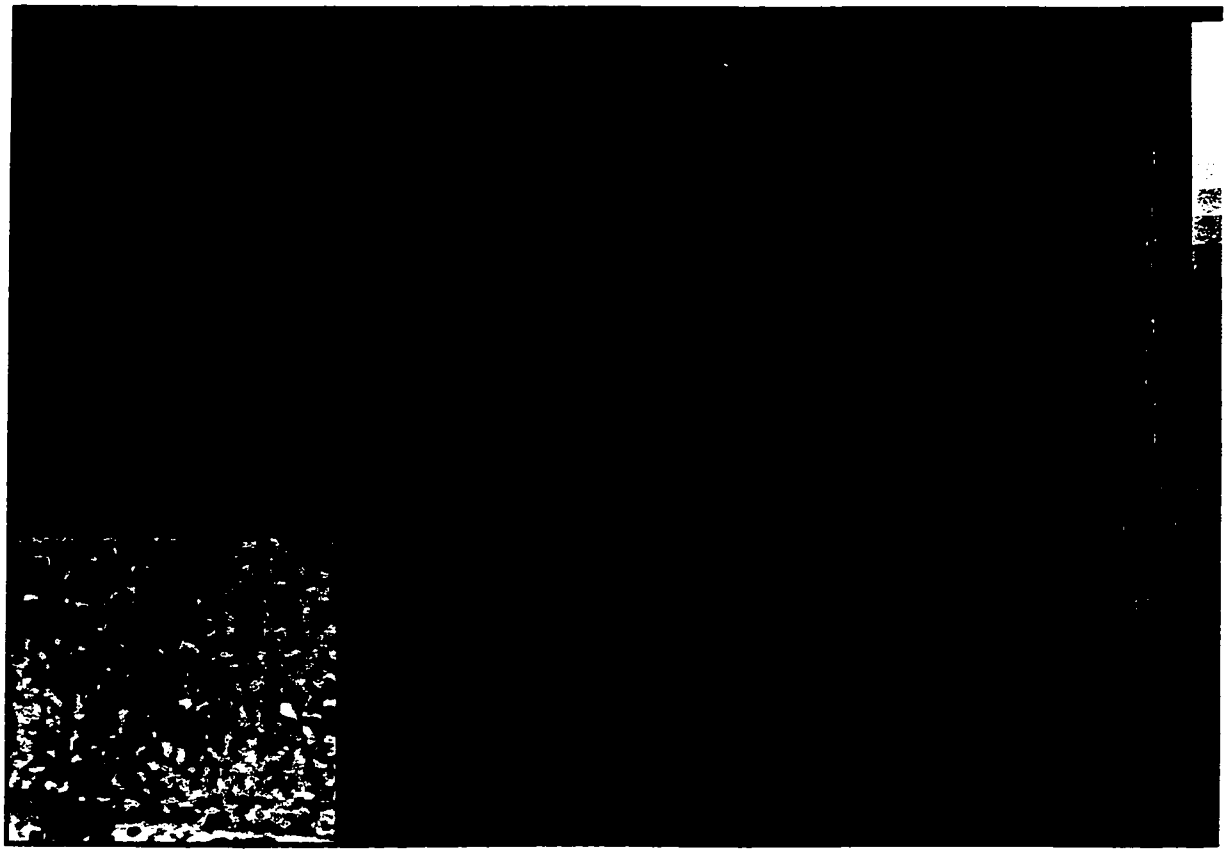

Figure A1.88 Magnetometry image of Redpath (r49mag3.tif) produced through spike removal, bicubic interpolation, and printing of all data points from -8.5 to 8.7 at a scale of 1:1000.

Conclusion

This tiny rectilinear site appears to be an enclosure with some evidence for curvilinear internal structures. Its size - just 25 m across - is, however, extremely unusual for a prehistoric enclosure and it likely post-dates the Roman period.

Visibility includes Trimontium on clear and sunny days, Redpath Dean, Red Rig, Black Hill, White Hill, and Kirklands. The site at Redpath commands a good view north and south along the valley of the Leader Water, probably including the conjunction between it and the Tweed.

Rink

Description

The scheduled enclosure on Rink Hill (NT 480 327) is located 200 m above sea level on the crest of the hill. The NMRS record for this site states:

> The striking remains of this fort lie for the most part in a walled plantation on the summit of Rink Hill at a height of 640ft OD.
>
> The earliest work on the site appears to have been an oval fort or settlement measuring some 500ft by 300ft within a single rampart, which is now represented only by a ploughed-out fragment lying W of the plantation wall.
>
> The next structural phase was an almost circular enclosure about 200 ft in diameter, formed by two heavy concentric ramparts, with a median ditch. The ruin of a massive stone wall lies on the inner rampart, but it is impossible to tell whether this is a contemporary feature or whether it represents a third structural phase.
>
> The recorded relics from the site comprise pieces of "coarse earthenware" (presumably native pottery), a whorl, a Roman bronze 'head-stud' brooch of Colchester type (1st to early 2nd century), picked up on the W side of the fort in 1929. The upper stones of two rotary querns were found amongst the debris of wall A by the RCAHMS. These, together with the brooch, are now in the NMAS.
>
> A portion of a saddle-quern was found among the debris in the SE sector of the ditch in 1952. A (?) Roman penannular brooch has also come from this site.
>
> The ruinous foundations of several rectangular buildings which lie immediately E of the fort are probably of comparatively recent date.
> RCAHMS 1957, visited 1950; R W Feachem 1963; A S Robertson 1970; Proc Soc Antiq Scot 1912, 1929
>
> This fort is as described above, but, of the outer rampart on the W, only a short length of ploughed down scarp remains N of a field dyke.
> Visited by OS (WDJ) 18 January 1961

Interpretation

The rink was visited in 1992 by a survey team from the Newstead Research Project. Both resistance and gradiometer surveys were undertaken on the western third of the enclosure, but unfortunately only the resistivity data remain accessible. These data clearly show both the bank and ditch of an oval enclosure. No evidence for entrances or internal features was recovered during the resistivity survey.

Table A1.29Archaeological features identified from geophysical survey of the Rink.

Feature	Technique	Interpretation
A	Resistivity	Ditch
B	Resistivity	Bank

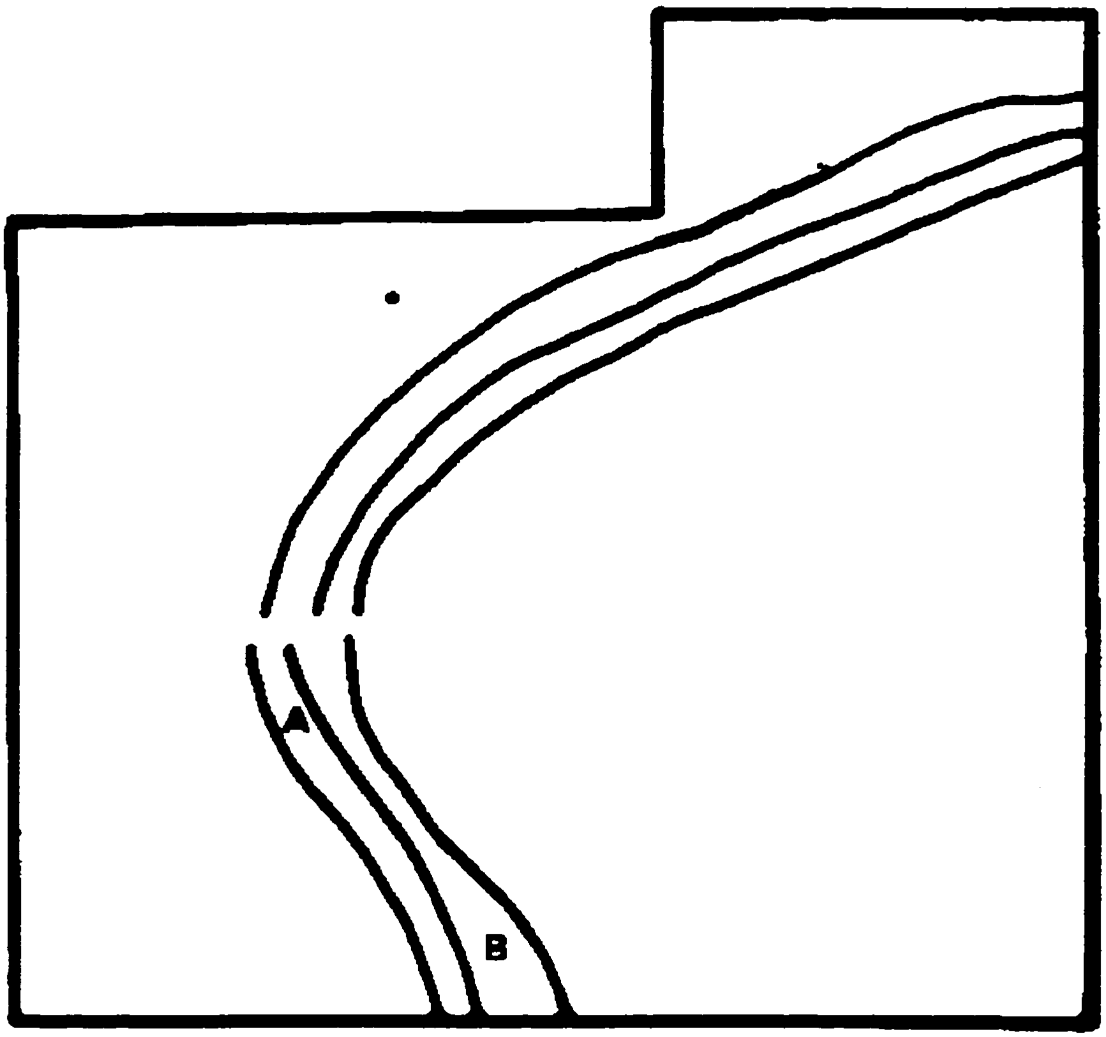

Figure A1.89 Rink geophysics interpretation

Figure A1.90 Resistivity image of the Rink (rinkres3.tif) produced through spike removal, bicubic interpolation, and printing of all data points from 228.2 to 531.2 at a scale of 1:1000.

Conclusion

The Rink oval enclosure is located in a fairly defensible location as Rink Hill has quite steep east and south slopes, a moderately steep north slope, and a more gentle west slope.

St. Boswell's Green

Description

Positioned at 95 m above sea level, the enclosure at St. Boswell's Green (NT 5947 3025) is almost on the summit of a small hill. The site lies 875 m south of the Tweed River, 150 m north of St. Boswell's Burn, and 650 m southeast of West Burn. This is a strikingly flat area of the landscape, more reminiscent of the Berwickshire plain than the Southern Uplands.

The cropmark for this enclosure represents the partial west and south sides of a single-ditched sub-rectangular enclosure with a break in the southern half of the west side. The field crew which first visited the site noted that the ditch appears as a slight depression in the gorse to the southeast of this cropmark. (Actually, the field crew recorded "a slight depression in the corpse to the southeast.")

Interpretation

Field crews from the Newstead Research Project visited St. Boswell's Green twice to complete this geophysical survey. In total, 8 grids of resistivity were done in 1991 and 6 grids of magnetometry were done in 1992. Only the northernmost portion of the enclosure was available for survey.

Resistivity results show a faint, indistinct low resistance line which corresponds with the northern portion of the enclosure. No sign of an entrance or any internal features is apparent.

Magnetometry results from the site are much more clear. The northern portion of the enclosing ditch appears as a relatively homogeneous high magnetic signal with a halo on either side of a low magnetic signal. Again, no sign of an entrance or internal features are apparent.

Table A1.30 Archaeological features identified from geophysical survey of St. Boswell's Green.

Feature	Technique	Interpretation
A	Magnetometry	Ditch

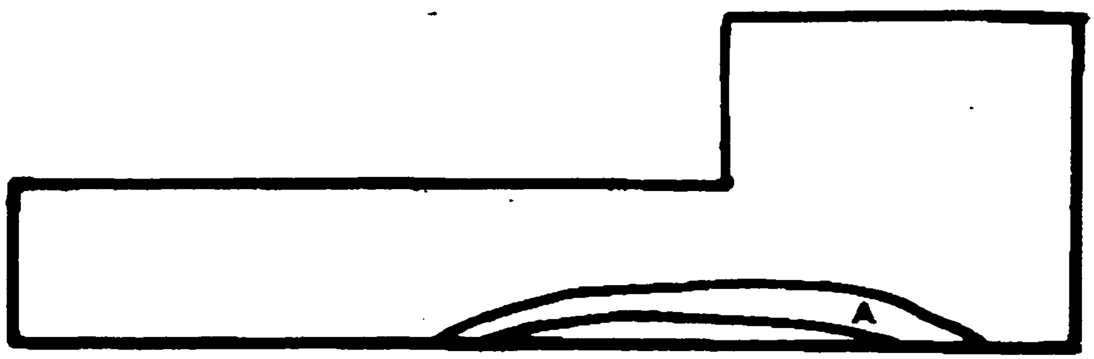

Figure A1.91 St. Boswell's Green geophysics interpretation

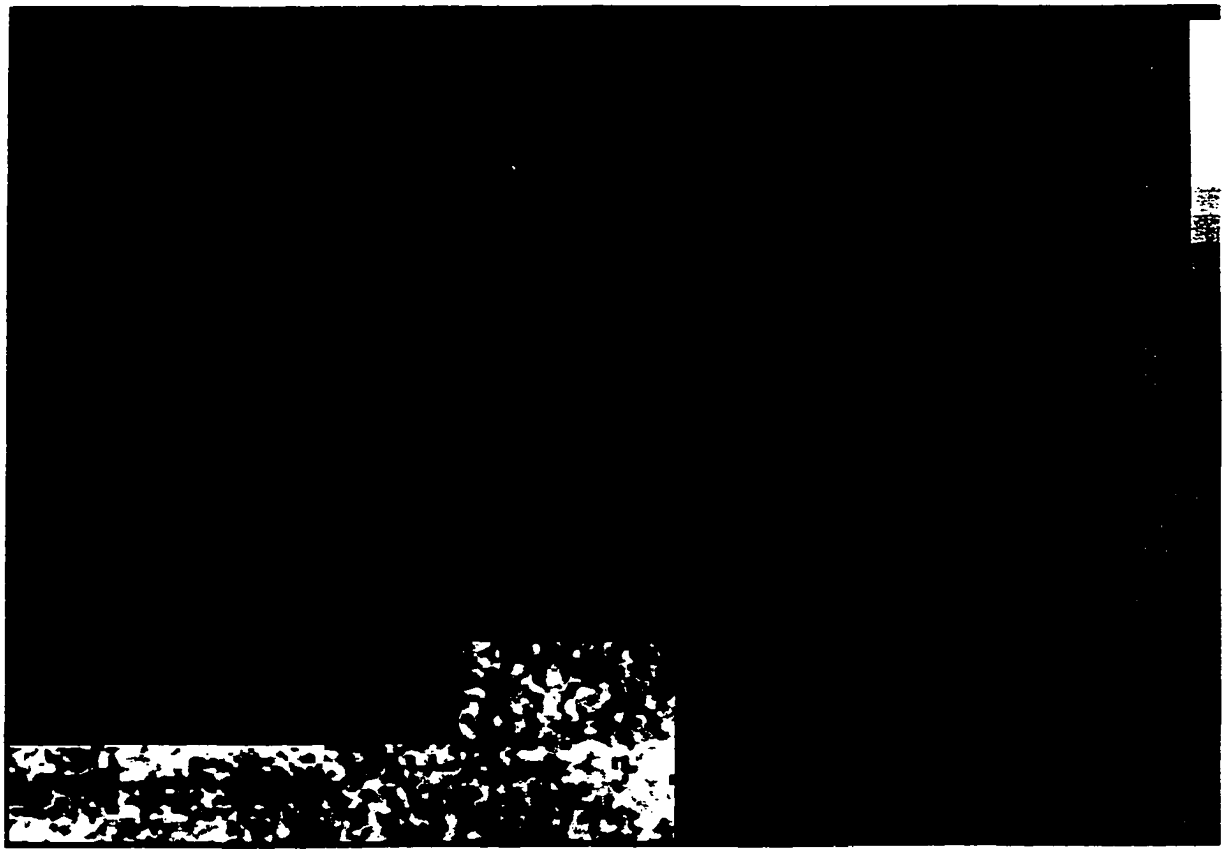

Figure A1.92 Resistivity image of St. Boswell's Green (stbres3.tif) produced through spike removal, bicubic interpolation, and printing of all data points from 47.6 to 97.3 at a scale of 1:1000.

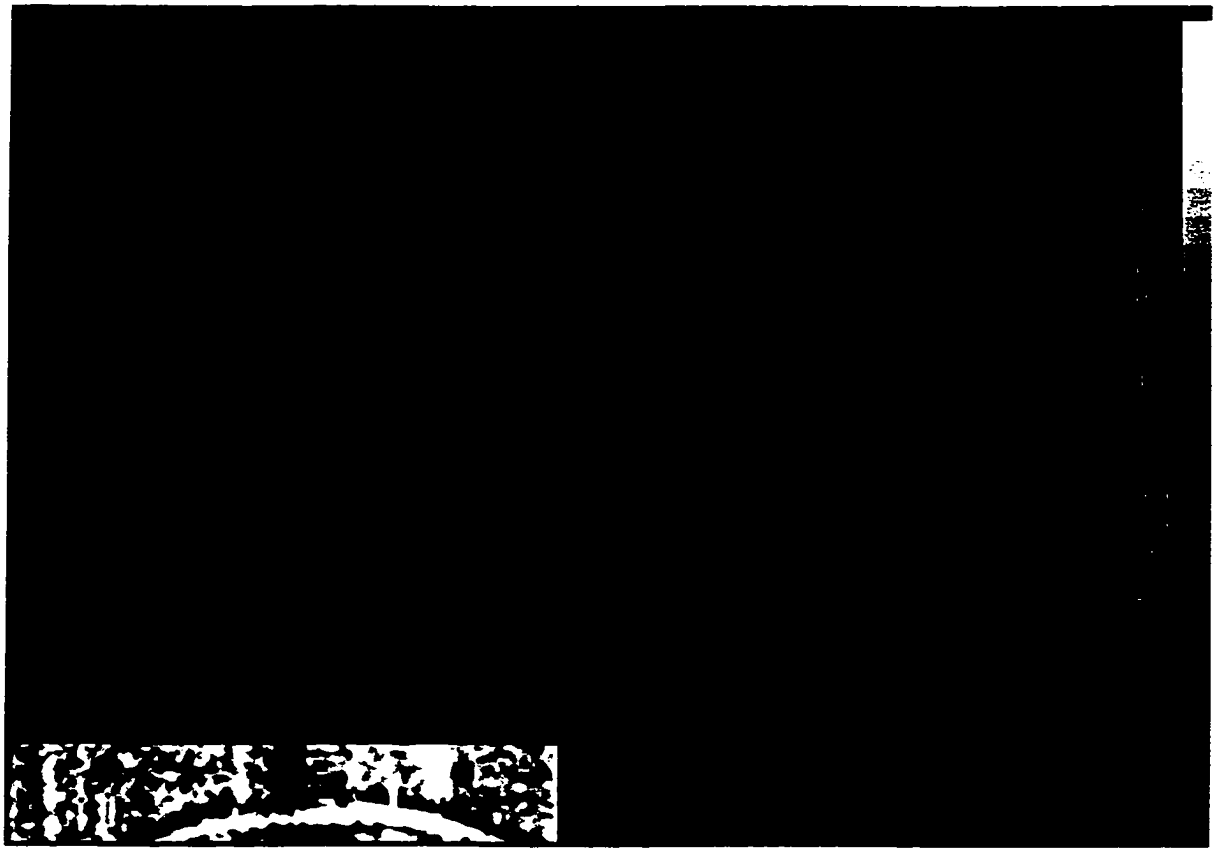

Figure A1.93 Magnetometry image of St. Boswell's Green (stbmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -2 to 2.5 at a scale of 1:1000.

Conclusion

Sites visible from the curvilinear enclosure at St. Boswell's Green include Benrig Dean, Clintmains, Clinthill, Heckside 2, Dryburgh Abbey, and perhaps also Littledean Tower. The site's location provides good views north to the Tweed, northwest, and east.

Souterrains, Newstead

Description

The Newstead souterrains (NT 5661 3390) were located between 135 and 140 m above sea level on the lower northeastern slope of Eildon Hill North. This is just 300 m east of the enclosure at Oakendean House, 425 m northeast of Eildontree, 250 m northwest of the enclosure at Red Rig, and roughly 500 m southwest of the center of Newstead itself.

The NMRS report for the Newstead souterrains states that:

> A Souterrain was discovered a quarter of a mile Southeast of Newstead in 1845. It consisted of a single narrow, curved, subterranean chamber, measuring 54 feet in length along the medial line and increasing in breadth from 4 feet 2 inches at the entrance to 7 feet at the back. The side-walls were dry-built of dressed sandstone and rose vertically to a height of 3 feet; above this height the span was reduced by oversailing corbels formed of Roman cornice-mouldings, two of them a cable, while numerous fat and chamfered stones lying on the floor of the chamber suggested that the roof had been lintelled.
>
> In 1849 a second souterrain was found about 100 yards East of the first. It is said to have been of the same general character, but was built of whinstone as well as sandstone and the stones were not so neatly dressed. There is no direct evidence that any of them were Roman. Both structures were destroyed on discovery.

When the site was visited by the Ordnance Survey in 1961, no trace of either souterrain remained.

Interpretation

A geophysical survey of the souterrains site was conducted by a field crew of the Newstead Research Project in 1990. The purpose of this survey was to determine if any sub-surface evidence for the souterrains remained, or if they had been directly associated with any settlement site. The survey grid was established in the northwestern corner of the field where the souterrains were reported, and should definitely have covered the location of the first souterrain if its location was accurately recorded.

In total 8 grids of magnetometry and 20 grids of resistivity were completed. Neither set of survey results shows any clear evidence for the former position of the souterrains, or of any surrounding enclosures. However, the resistivity results show a series of poorly defined curvilinear high resistance marks that may be associated with former human activity in the area.

Figure A1.94 Resistivity image of Newstead Souterrains (soures3.tif) produced through spike removal, bicubic interpolation, and printing of all data points from 42.5 to 140 at a scale of 1:1000.

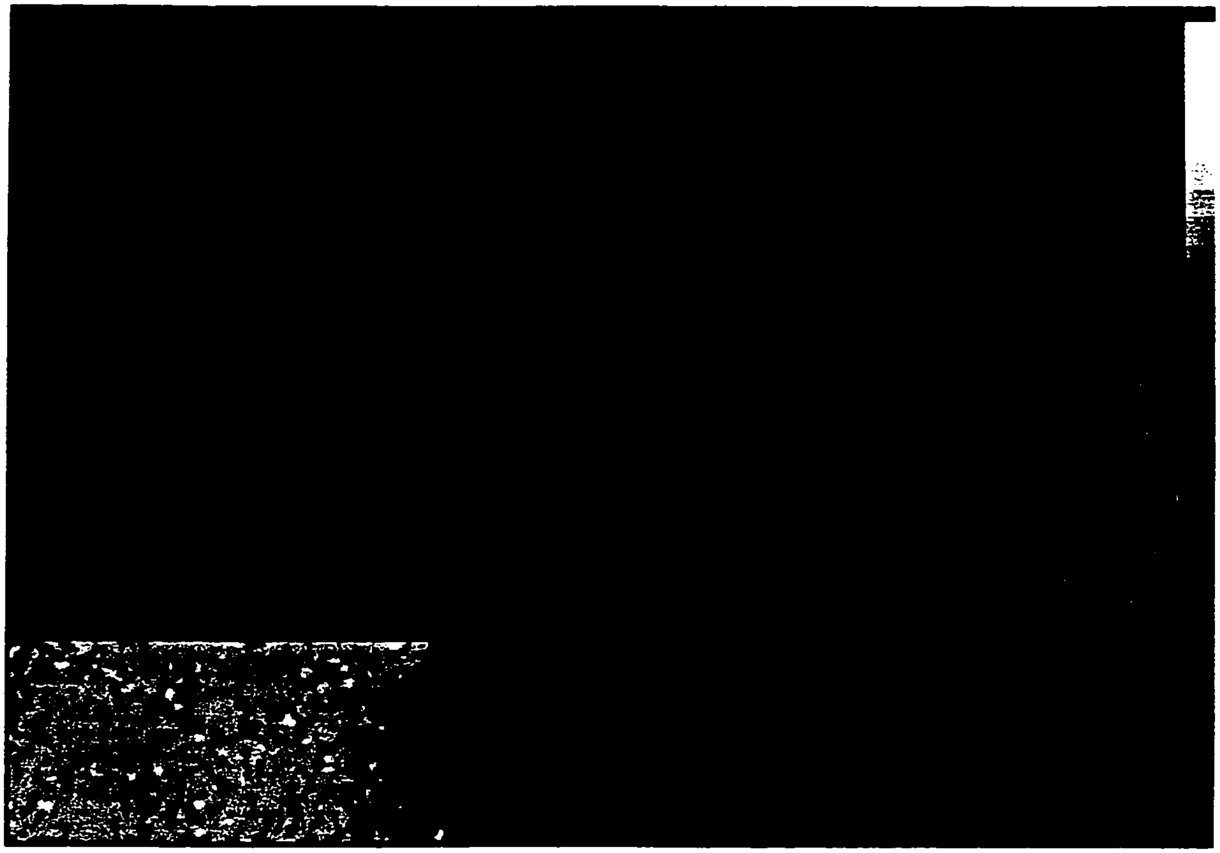

Figure A1.95 Magnetometry image of Newstead Souterrains (soumag3.tif) produced through spike removal, bicubic interpolation, and printing of all data points from -13.8 to 11.6 at a scale of 1:1000.

Conclusion

Geophysical survey around the area where the Newstead souterrains were reported in the last century suggests that these features were not associated with any enclosed settlement.

Archaeological sites visible from the site include Oakendean House, Eildontree, Red Rig, Newstead, Eildon Hill North, Gladswood, Easter Hill, Gattonside, Pincushion Plantation, Kirklands, and Bemersyde Hill.

South Whitrighill

Description

The enclosure at South Whitrighill (NT 621 344) was identified as a cropmark on aerial photographs, but these photographs were unavailable to members of the Newstead

Research Project. All that was known in advance of the geophysical survey is that cropmarks were located in the corner of this field.

Interpretation

A field crew of the Newstead Research Project visited South Whitrighill (NT 621 344) in 1993 to perform electrical resistance and magnetometry surveys. A total of 22 resistivity grids and magnetometry grids were completed.

Resistivity printouts suggest that the enclosure might be a single ditched D-shaped or rectilinear homestead site with a possible adjoining annex and a possible entrance in the east. The resistivity images are, however, so filled with geophysical features created by modern field uses (e.g. field drains and animal tracks) that it is extremely difficult to separate archaeological features from the modern features.

Magnetometry printouts suggest that the enclosure might be either curvilinear or rectilinear, and suggest a possible entrance in the southeast. The gradiometer picked up anomalies clearly representing modern features to the west and south of the enclosure. It also picked up a possible east annex, and a variety of potential internal structural features.

Table A1.31Archaeological features identified from geophysical survey of South Whitrighill.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Ditch
B	Magnetometry and Resistivity	Possible entrance
C	Magnetometry and Resistivity	Possible internal structural features
D	Magnetometry and Resistivity	Possible annex to enclosure
E	Magnetometry	Modern animal tracks west of enclosure
F	Magnetometry	Modern water pipe
G	Magnetometry	Modern field drains south of enclosure

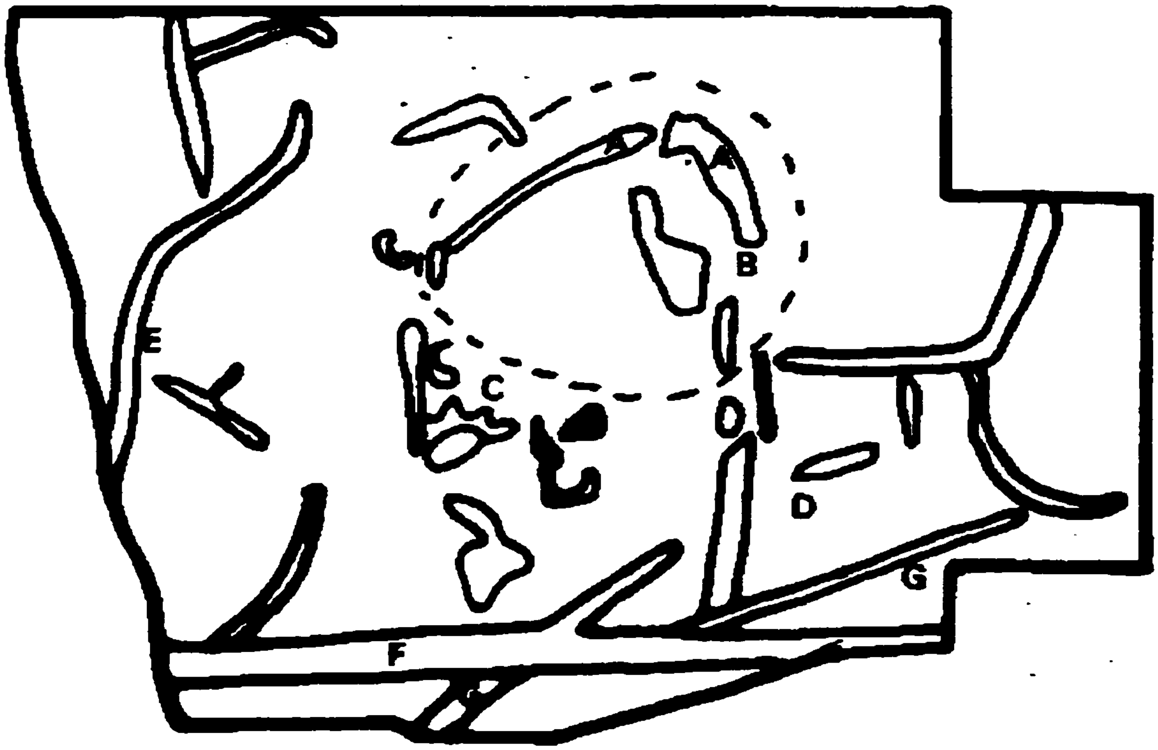

Figure A1.96 South Whitrighill geophysics interpretation. Note that the area encircled by a dotted line on the geophysics interpretation encloses the area least disturbed by modern activity.

Figure A1.97 Resistivity image of South Whitrighill (swhres5.tif) produced through spike removal, bicubic interpolation, and printing data points from 15 to 50 at a scale of 1:1000.

Figure A1.98 Magnetometry image of South Whitrighill (swhmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -6 to 6 at a scale of 1:1000.

Conclusion

Geophysical survey at South Whitrighill produced inconclusive results. Modern animal tracks, field drains, and water pipes are numerous around the enclosure, and their geophysical signals are extremely difficult to separate from archaeological signals.

Third

Description

The earthwork at Third (NT 614 3505) lies between 140 and 150 m above sea level beside a small burn. This creek drains the lower slopes of Redpath Hill and Bemersyde Hill. The site lies just northwest of Whitrig Bog and north of Bemersyde Moss.

The NMRS entry for Third describes it as an earthwork with a small ravine on its northwest and southeast sides. No ditches or ramparts have been noted on these sides. A singular semi-circular ditch encloses the site in the other directions. Slight indications of a rampart on the inner side of the ditch was noted, suggesting that the complete work was roughly circular with an internal diameter of approximately 150 feet. No surface traces of this earthwork were visible at the last site visit in 1962.

Interpretation

A field crew of the Newstead Research Project visited Third in 1993 while the field was being used as pasture for sheep. 47 grids of resistivity and 50 grids of magnetometry were surveyed.

Resistivity results from Third were extremely good. The northwest, west, and south portions of a double-ditched curvilinear enclosure clearly show in the results, along with a rectilinear western annex and a curvilinear northern annex. The innermost ditch of the enclosure has an entrance in the west, and the outer ditch has an entrance in the southwest. Several internal features are suggested by the resistivity data. Three possible internal round structures appear as high resistivity signals in the west and south portions of the innermost enclosure. Interestingly, all three of these round structures appear to overlie the innermost ditch suggesting that Third was constructed in multiple phases. High resistance structural anomalies also occur in the interior of each of the annexs. In the western annex there is evidence for both curvilinear and rectilinear structures, but in the northern annex there is only evidence for curvilinear features.

Magnetometry results provide an important complement to the resistivity printouts. The same range of archaeological features appear in the magnetometry data, but most of the archaeological features do not appear as clearly here as in the resistivity data. The entire archaeological site, however, has a much higher average magnetic signal than the surrounding land. Perhaps the most intriguing feature picked up by the gradiometer was evidence for two rectilinear structures in the western annex. The eastern of these two structures appears to either overlie or underlie a curvilinear structure detected during the resistance survey.

Table A1.32Archaeological features identified from geophysical survey of Third.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Inner Ditch
B	Magnetometry and Resistivity	Outer Ditch
C	Magnetometry and Resistivity	Possible roundhouse overlying inner ditch in south of enclosure.
D	Magnetometry and Resistivity	Possible roundhouse overlying inner ditch in southwest of enclosure.
E	Magnetometry and Resistivity	Possible roundhouse overlying inner ditch and blocking west passage from the innermost enclosure toward the west annex.
F	Magnetometry and Resistivity	Assorted curvilinear and rectilinear anomalies possibly representing internal structural features.
G	Magnetometry	Possible roundhouse between first and second ditches.
H	Magnetometry and Resistivity	Western annex.
I	Resistivity	Possible round structure in western annex.
J	Magnetometry	Possible square rectangular structure in western annex either underlying or overlying Feature I.
K	Magnetometry and Resistivity	Second possible rectilinear structure in western annex and lying west of Feature J.
L	Magnetometry and Resistivity	Northern annex.
M	Magnetometry	Possible round structure in northern annex.
N	Resistivity	Possible round structure in northern annex.
O	Magnetometry and Resistivity	Entrance

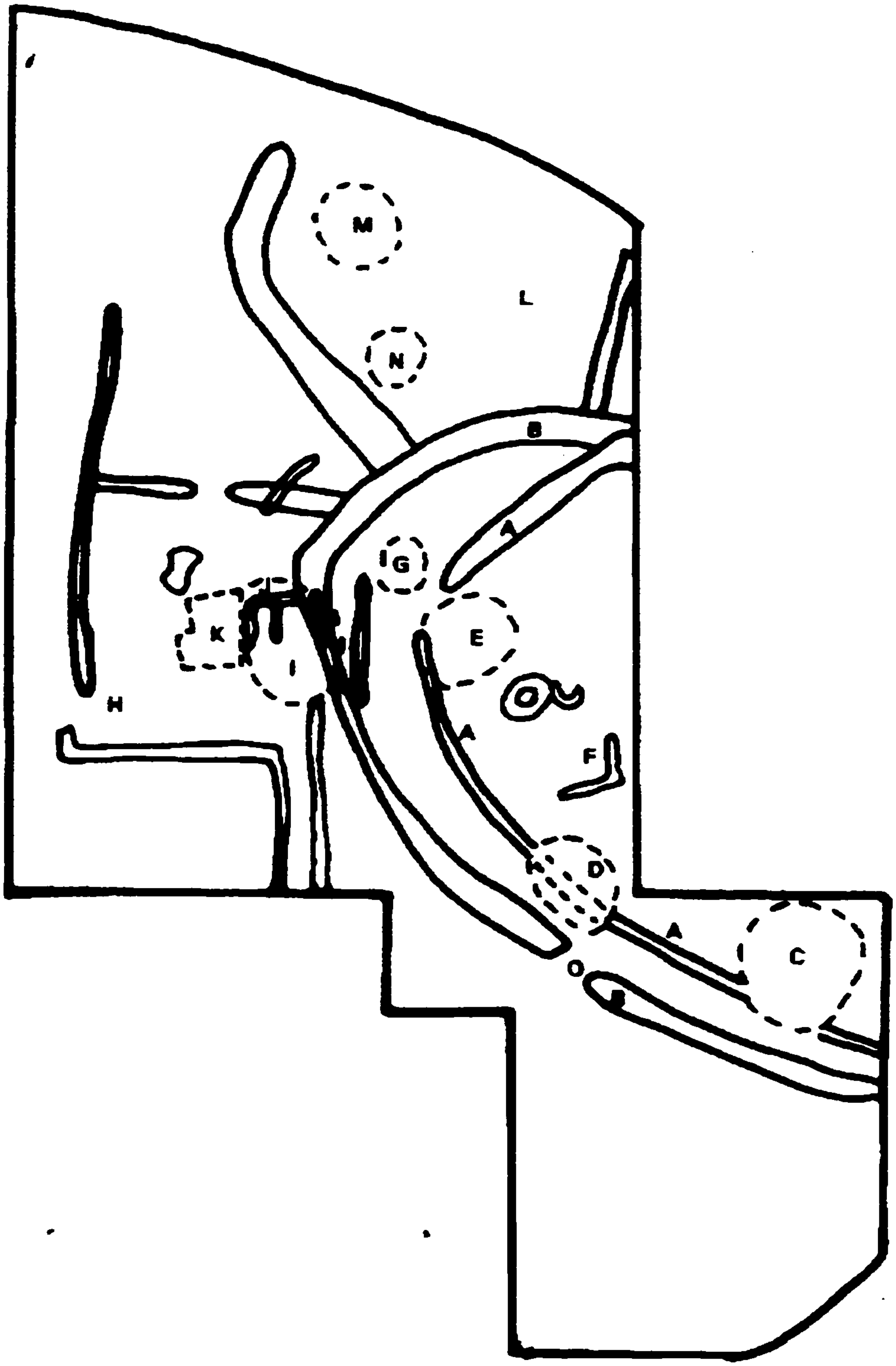

Figure A1.99 Third geophysics interpretation

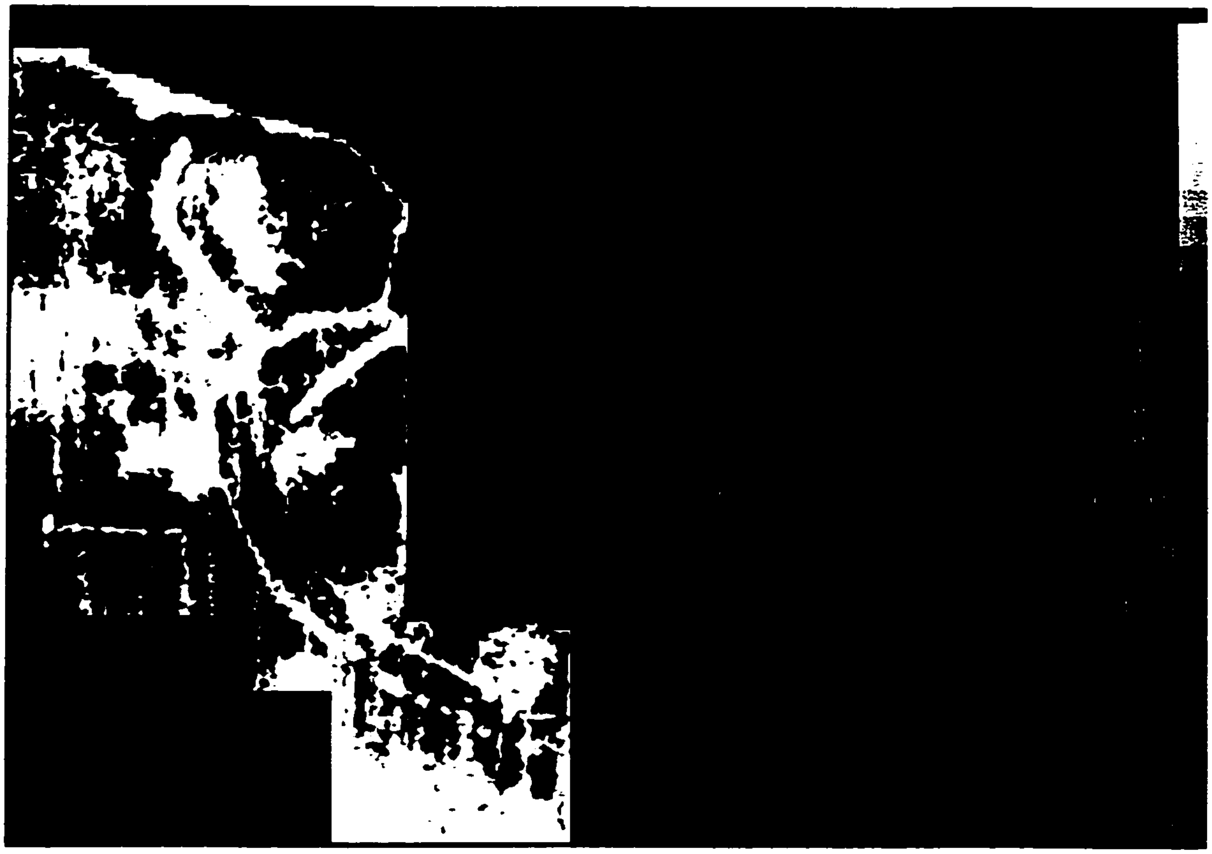

Figure A1.100 Resistivity image of Third (3rdres3.tif) produced through spike removal, bicubic interpolation, and printing of data points from 30 to 35 at a scale of 1:1375.

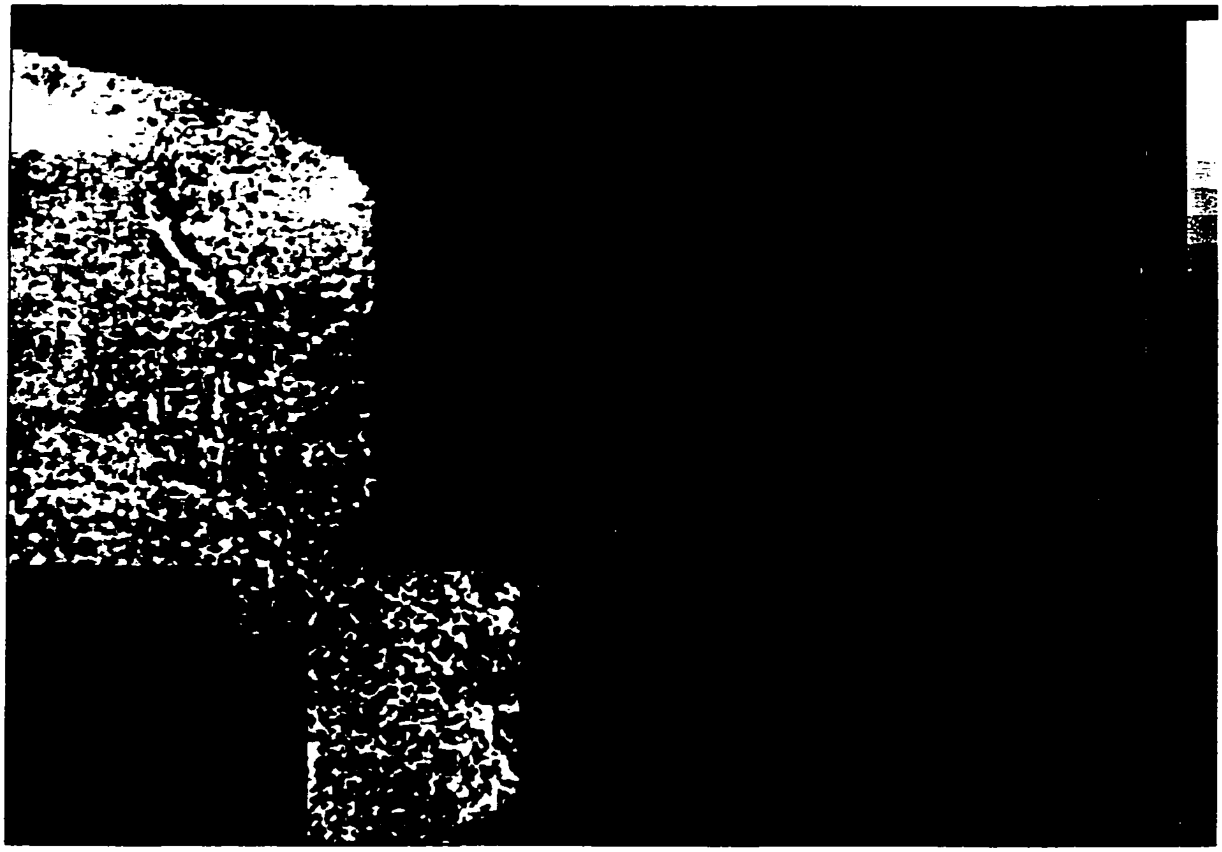

Figure A1.101 Magnetometry image of Third (3rdmag3.tif) produced through spike removal, bicubic interpolation, and printing of data points from -2.5 to 2.5 at a scale of 1:1500.

Conclusion

Geophysical survey of Third has produced convincing evidence of multiple building phases, suggesting that the site may have been used over a relatively long period of time. This impression is enhanced by the presence of a modern farmhouse over the center of this archaeological enclosure. As an example, the convergence of the inner and outer ditches to the north of the enclosure suggests that they were not constructed simultaneously, and that the enclosure may have been expanded. The three round houses that overlie the inner ditch furthermore suggest that the expansion may have been due to increased population size and the need for more living space.

Third is surrounded by other archaeological sites. Nearby enclosures include Brotherstone Hill West, Brotherstone Hill South, Spadislee, Bemersyde Moss, Bemersyde rectilinear, Bemersyde fort, Whitrighill, Whitrighill South, Butchercote promontory fort, Butchercote rectangular, and Heckside 1 and 2. These sites are inter-visible and appear to create an inwardly focused settlement pattern on the landscape.

Turfford Burn

Description

Cropmarks from aerial photographs suggest that there is an enclosure at Turfford Burn (NT 611 392) located 120 m above sea level on the north side of the Burn by the same name.

The NMRS record for Turfford Burn states:

> The broad ditch of an oval earthwork, measuring some 500ft by 350ft externally, appears as a soil mark on RAF air photographs (CPE/SCOT/315, A054-5) in the level triangular pasture field which is bounded on the S by the Turfford Burn, on the W by Fans Loanend Covert, and on the NE by the road from Cove House to Purvishaugh. (Information from RCAHMS Marginal Lands typescript 29 August 1950.)

Interpretation

A field crew of the Newstead Research Project visited the site in 1993 to conduct resistivity and magnetometry surveys. No trace of the cropmark enclosure was detected through geophysics, but the crew did discover a standing earthwork in the neighboring plantation. It is unclear whether this earthwork was once part of the cropmark enclosure, or whether it is an entirely separate site, but it most closely resembles a ring bank (Gates 1983).

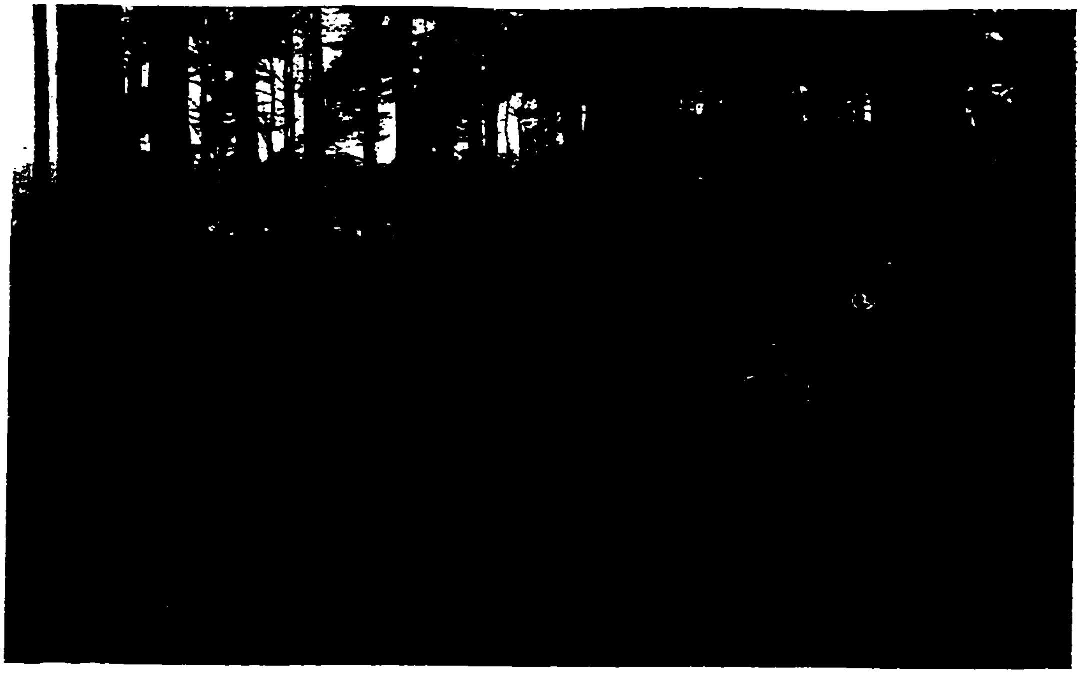

Figure A1.102 Earthwork in plantation adjacent to Turfford Burn

Figure A1.103 Resistivity image of Turfford Burn (turfres1.tif) produced through spike removal, bicubic interpolation, and printing of all data points from 8.8 to 126.9 at a scale of 1:625.

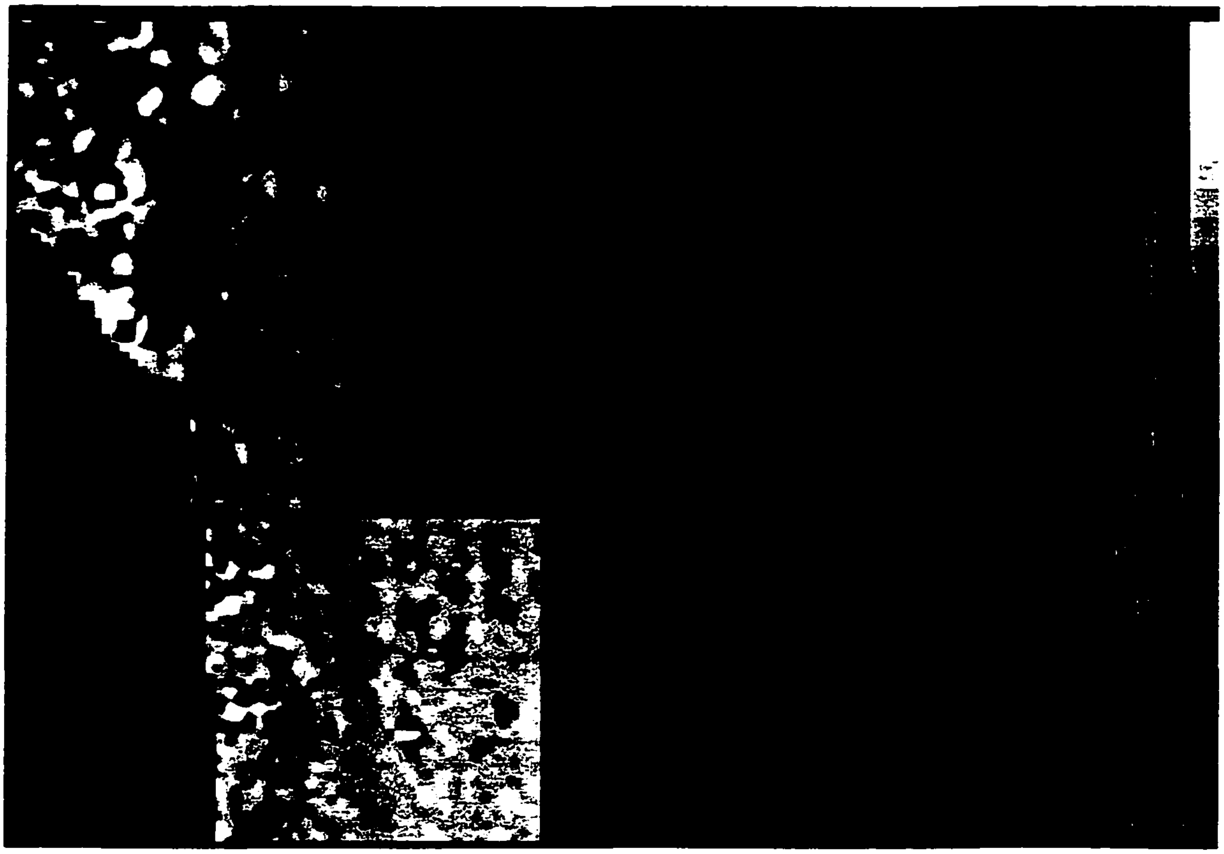

Figure A1.104 Magnetometry image of Turfford Burn (turfmag1.tif) produced through spike removal, bicubic interpolation, and printing of all data points from -3.5 to 3.3 at a scale of 1:625.

Conclusion

Re-surveying this field in a more moist year might yield evidence for the oval enclosure at Turfford Burn, and might make clear the relationship between this site and the earthwork in the modern plantation.

The position of this site, or sites, is noteworthy as it is one of the only archaeological sites in the study area that is not in a section of the landscape densely populated, and inter-visible, with other archaeological sites. For this reason the oval enclosure may warrant further archaeological attention.

Whitrighill

Description

The enclosure at Whitrighill (NT 6225 3455) lies 135 to 140 m above sea level beside the modern settlement of the same name. Just beside the site runs a feeder creek for Maidenhall Burn, serving to drain both Bemersyde Moss and Whitrig Bog. The moss lies west of the site and the bog is to the north. Whitrighill enclosure is overlooked by Butchercote Craigs to the southeast, and is part of a well-settled landscape. The enclosure is not in a very defensible location.

Whitrighill cropmarks on aerial photographs are very clear, showing a double ditched curvilinear enclosure with internal circular and rectilinear features. The NMRS record for Whitrighill (including a short statement by John Dent about the 1992 excavation) states:

> RAF air photographs CPE/SCOT/UK 257, 3224-5 reveal the cropmarks of the double ditches of an oval fort measuring 300ft by 240ft internally, in the field that adjoins Whitrighill farmhouse on the NE. RCAHMS Marginal Lands typescript, 9 June 1954. RCAHMS 1957.
>
> A magnetometer survey at this site revealed a clear circular feature, about 15m in diameter, in the SW part of this fort. It is unclear how this feature should be interpreted. R Jones {et al.} 1991.
>
> Part of the interior, and a section across the surrounding ditches of this oval enclosure were the subject of a six week excavation. The site, which is on a fertile ridge with stone, clay and open water nearby, was attractive to settlement in the Iron Age, and in the 16th century was part of a prestigious settlement which is shown on Timothy Pont's map.
>
> The enclosure was defined by a slight inner ditch less than 1m deep, and 4.5m from this a concentric outer ditch 6.5m wide and 3m deep. There were no traces of any accompanying bank, but the field had long been under cultivation. Organic preservation was good in this outer ditch and animal bone also survived.
>
> The interior contained traces of a roundhouse c8.5m in diameter represented by a slot with packing stones. Part of this had been removed when the ground was subsequently terraced to accommodate a much more substantial building. The later structure occupied a circular depression cut entirely into the slope. Although many stones had been removed, a circular wall foundation 2m wide enclosed a cobbled floor 12m across. The southern part of this floor had been modified, perhaps for problems of drainage, by the construction of a massive stone platform, which included blocks up to 1.2m in

length. On the S the internal cobbling had continued beyond the structure, and a depression in this surface contained a crouched human burial on the left side with head to N, a position typical of many British Iron Age graves.

Finds were few, but a yellow glass bead is unlikely to be earlier than the late Iron Age.

Over the site of these earlier remains were a metalled road, side ditch and the base of a retaining wall for a dyke. These led eastwards from the site of the historic Whitrigg and along the ridge towards neighbouring settlements.

Sponsors: National Museum of Scotland, University of Bradford, British Academy, Borders Regional Council, Society of Antiquaries of London. J S Dent 1992.

Interpretation

Today the fields overlying Whitrighill are used for agriculture, and geophysical survey was completed in barley stubble. In total, 50 grids of resistivity and 45 grids of magnetometry were done. An underground water pipe bisects the site from east to west. An overhead power line runs northwest to southeast across the site with a wooden pylon in the northwest quarter of grid 18. The power line enters the survey area at grid 27 and exits at grid 30.

Resistivity printouts show a complicated site, curvilinear in shape, with two surrounding ditches. The resistivity data show an entrance in the southeast of the site, but this entrance is just west of the entrance shown in the magnetometry data so this suggests that Whitrighill may have been constructed in multiple phases. There are many geophysical anomalies suggesting that internal structures may be preserved at Whitrighill. The most convincing of these anomalies are largely clustered in the southern half of the site. The most distinctive anomaly is a high resistance ring feature that is very clearly defined in the southwestern portion of the interior.

Magnetometry printouts for the enclosure at Whitrighill are also very interesting. Again, the major portion of the site appears to be double-ditched and curvilinear. The northern half of the interior is again relatively quiet, but the southern half is quite busy. There is one obvious internal curvilinear structural feature and this corresponds to that identified on the resistivity printout. As mentioned above, there is evidence for a southeastern entrance in the magnetometry data, but it is offset from the entrance shown in the resistivity images.

David Redhouse performed a magnetic susceptibility study on two samples collected during the 1992 excavations at Whitrighill. He reports that the first sample was from a piece of rock from a rubble spread representing part of a roundhouse cut into the hillside. The second sample was from soil that filled the voids in the scatter. His results indicate that the soil around the rubble scatter had a higher magnetic susceptibility than did the rubble itself and was therefore more likely to have generated the high positive signals seen on the magnetometer survey.

Table A1.33Archaeological features identified from geophysical survey of Whitrighill.

Feature	Technique	Interpretation
A	Magnetometry and Resistivity	Inner ditch
B	Magnetometry and Resistivity	Outer ditch
C	Resistivity	Inner bank
D	Resistivity	Possible entrance
E	Magnetometry	Possible entrance
F	Magnetometry and Resistivity	Probable curvilinear structure
G	Magnetometry and Resistivity	Numerous anomalies possibly representing internal structures.
H	Magnetometry and Resistivity	Modern water pipe

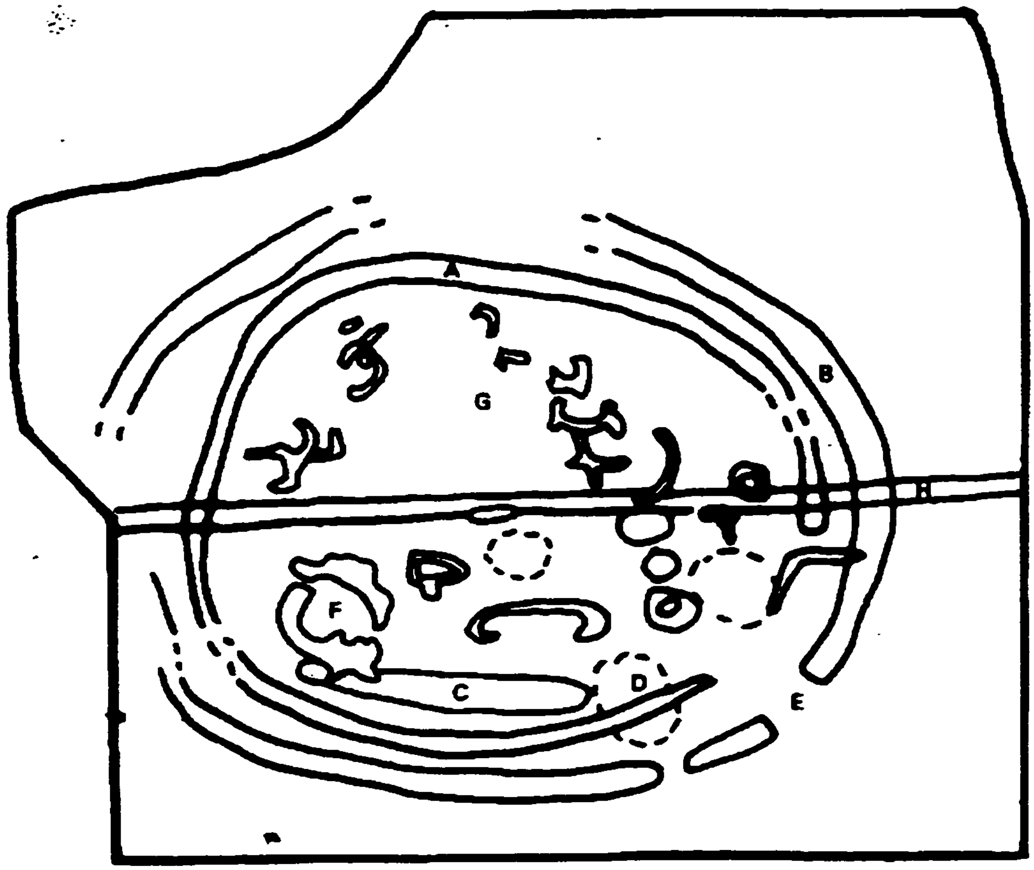

Figure A1.105 Whitrighill geophysics interpretation

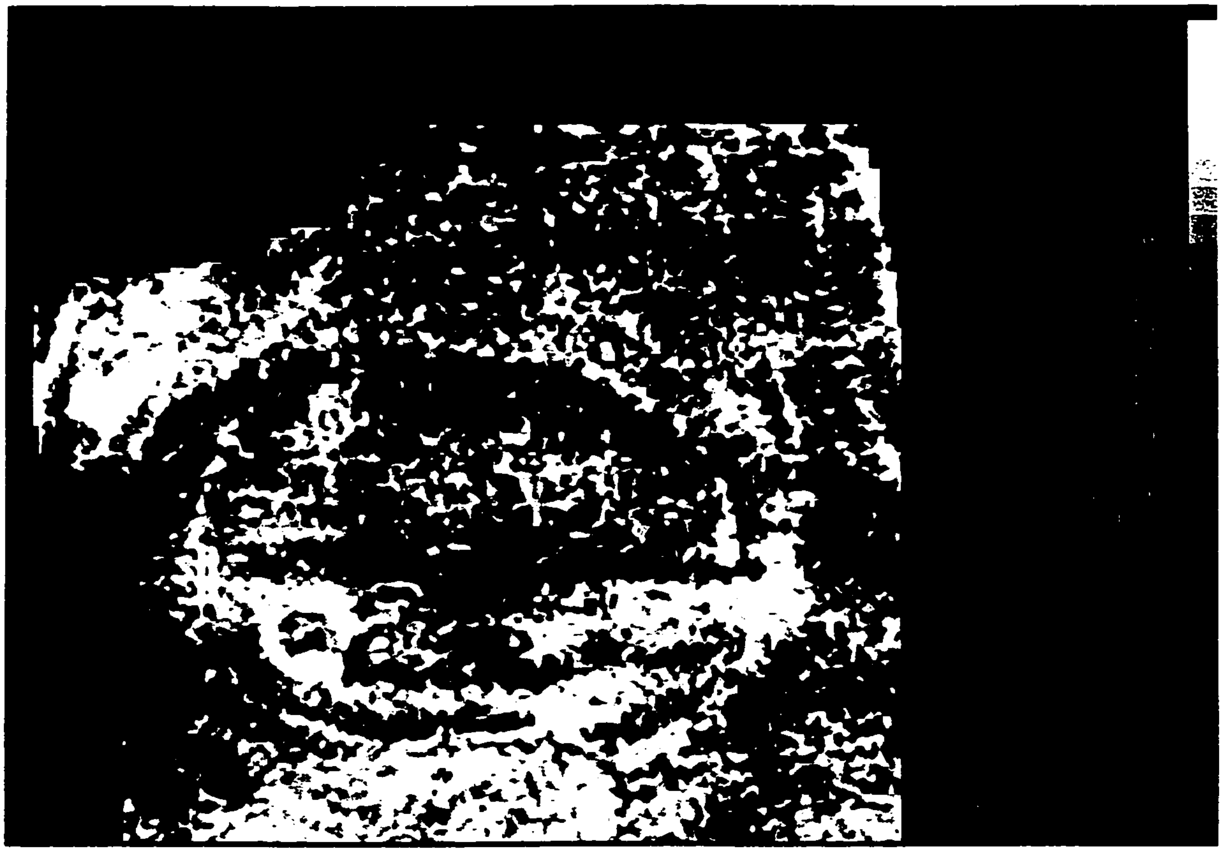

Figure A1.106 Resistivity image of Whitrighill (wrres5.tif) produced through spike removal, bicubic interpolation, and printing of data points from 39 to 60 at a scale of 1:1000.

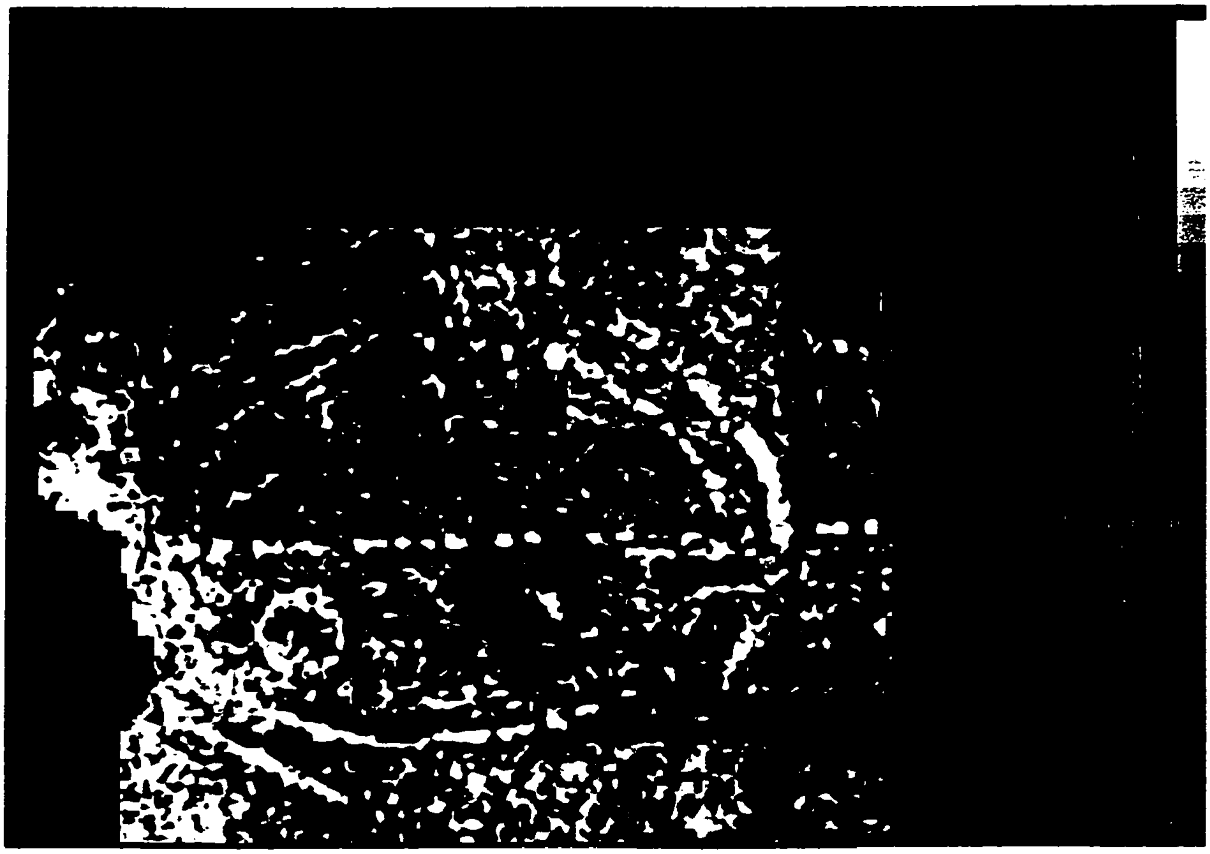

Figure A1.107 Magnetometry image of Whitrighill (wrmag5.tif) produced through spike removal, bicubic interpolation, and printing of data points from -5 to 2 at a scale of 1:1000.

Conclusion

The geophysical survey at Whitrighill provided useful detail, especially about the enclosure's interior, for planning subsequent excavation. Evidence suggests that the enclosure was built over multiple phases.

Sites visible from Whitrighill enclosure include Whitrighill South, Butchercote promontory fort, Third, Brotherstone Hill South, Brotherstone Hill West, Spadislee, Bemersyde Moss, Heckside 1 and 2, and the two Bemersyde homestead sites.

APPENDIX 2 – SETTLEMENT EVIDENCE

Table A2.1 Gazeteer of sites used for settlement analysis.

Site Name	No.	Number	Reclass	Morphology	Elev
ANCRUM	45	SETTLEMENT	Homestead	Curvilinear	125
ANCRUM	46	ENCLOSURES	Homestead	Curvilinear	95
ASHKIRKSHIEL	13	SETTLEMENT;	Promontory	Curvilinear	255
AULDWARK	39	ENCLOSURE	Homestead	Curvilinear	170
AVENEL	33	ENCLOSURE	Homestead	Curvilinear	170
AVENEL HILL	14	HOMESTEAD	Homestead	Curvilinear	170
BAILHILL	34	ENCLOSURE	Homestead	Curvilinear	150
BAITTENS	50	ENCLOSURE	Homestead	Curvilinear	125
BATTLEPARK	2	EARTHWORK	Homestead	Curvilinear	180
BELL HILL	10	FORT	Homestead	Rectilinear ?	300
BELSES MILL	11	ENCLOSURE	Homestead	Curvilinear	130
BEMERSYDE	36	ENCLOSURE	Homestead	Rectilinear	200
BEMERSYDE	51	FORT	Homestead	Curvilinear	200
BEMERSYDE	46	EARTHWORK	Homestead	Curvilinear	150
BEWLIE	2	EARTHWORK	Homestead	Rectilinear ?	160
BIRCHGROVE,	18	ENCLOSURE	Homestead	Rectilinear ?	125
BIRKENSIDE	21	ENCLOSURE	Homestead	Curvilinear	240
BIRKENSIDE	35	ENCLOSURE	Homestead	Curvilinear	240
BIRKENSIDE	4	FORT	Homestead	Curvilinear	240
BIRKENSIDE	31	ENCLOSURE	Homestead	Curvilinear	240
BIRKHILL	23	ENCLOSURE	Homestead	Curvilinear	135
BLACK	49	ENCLOSURE	Homestead	Curvilinear	180
BLACK HILL	5	FORT	Hillfort	Curvilinear	305
BLACKCASTLE	11	EARTHWORK	Homestead	Curvilinear	275
BLACKCASTLE	5	FORT,	Promontory	Curvilinear	205
BLACKCHESTE	1	FORT	Homestead	Rectilinear ?	150
BLACKCHESTE	28	ENCLOSURE	Homestead	Curvilinear	120
BLACKCHESTE	37	ENCLOSURE	Homestead	Curvilinear	195
BLACKCHESTE	38	ENCLOSURE	Homestead	Curvilinear	215
BLAEBERRY	79	CULTIVATION	Homestead	Curvilinear	250
BLOOMFIELD	5	EARTHWORK	Homestead	Rectilinear ?	185
BLOOMFIELD	26	ENCLOSURE	Homestead	Curvilinear	120
BLYTHE	1	FORT	Homestead	Curvilinear	280
BONNET	3	FORT	Homestead	Curvilinear	290
BOON	23	SETTLEMENT	Homestead	Curvilinear	205
BOON	47	ENCLOSURE	Homestead	Curvilinear	235
BOON	54	SETTLEMENT:	Homestead	Curvilinear	200
BOON BRIDGE	51	ENCLOSURE	Homestead	Curvilinear	160
BOON HILL	12	FORT	Homestead	Curvilinear	325
BOON MOOR	17	FORTS	Homestead	Curvilinear	270

BOOSMILL	1	FORT	Homestead	Curvilinear	215
BOOT	108	SETTLEMENT	Homestead	Curvilinear	145
BOW CASTLE	3	BROCH	Broch	Curvilinear	330
BOWDEN	16	ENCLOSURE	Homestead	Curvilinear	275
BOWHILL	27	ENCLOSURE	Homestead	Curvilinear	145
BRIDGEHAUGH	14	ENCLOSURE	Homestead	Curvilinear	155
BRIDGEND	52	SETTLEMENT	Homestead	Curvilinear	85
BROADLEE	4	FORT	Hillfort	Curvilinear	370
BRODEN	23	ENCLOSURE	Homestead	Curvilinear	260
BROOMHILL	8	ENCLOSURE	Homestead	Curvilinear	195
BROTHERSTON	31	FORT	Homestead	Curvilinear	245
BROTHERSTON	14	ENCLOSURE	Homestead	Curvilinear	240
BROTHERSTON	13	FORT	Hillfort	Curvilinear	265
BROWNMOOR	2	ENCLOSURE	Homestead	Curvilinear	200
BROX LAW	37	FORT	Homestead	Curvilinear	95
BULLION	84	ENCLOSURE	Homestead	Curvilinear	170
BUTCHERCOTE	3	FORT	Promontory	Curvilinear	165
BUTCHERCOTE	43	ENCLOSURE	Homestead	Rectilinear	170
CADDONLEE	7	FORT; GLASS	Hillfort	Curvilinear	190
CADDONLEE	14	ENCLOSURE	Homestead	Rectilinear ?	160
CADDONLEE	15	ENCLOSURE	Homestead	Rectilinear	165
CAMP KNOWE	15	FORT	Homestead	Curvilinear	235
CAMP KNOWE,	41	EARTHWORK;	Homestead	Curvilinear	135
CAMP	23	SETTLEMENT	Homestead	Curvilinear	185
CAMPKNOWE	9	FORT;	Homestead	Curvilinear	265
CARSINKER	21	ENCLOSURE	Homestead	Curvilinear	250
CASTLE HILL	1	FORT;	Homestead	Rectilinear,	115
CASTLE HILL	8	EARTHWORK	Homestead	Rectilinear ?	200
CASTLESIDE	3	SETTLEMENT;	Homestead	Rectilinear ?	285
CASTLESTEAD,	8	'FORT'	Homestead	Curvilinear	140
CAULDSHIELS	1	FORT	Hillfort	Curvilinear	330
CHAPEL MAINS	39	ENCLOSURE	Homestead	Curvilinear	145
CHAPEL ON	22	ENCLOSURE	Homestead	Curvilinear	130
CHAPEL ON	43	ENCLOSURE	Homestead	Curvilinear	175
CHATTO	12	ENCLOSURES	Homestead	Curvilinear	200
CHESTER HILL	11	FORT	Homestead	Curvilinear	235
CHESTER	31	EARTHWORK	Homestead	Curvilinear	240
CHESTERKNOW	8	EARTHWORK	Homestead	Curvilinear	210
CHESTERLEE	22	EARTHWORK	Homestead	Curvilinear	225
CHESTERSHAL	66	SETTLEMENT	Homestead	Curvilinear	125
CHILDKNOWE	9	ENCLOSURE	Homestead	Rectilinear ?	145
CLARILAWBUR	36	ENCLOSURES	Homestead	Curvilinear	160
CLERKLANDS	2	FORT	Homestead	Curvilinear	230
CLINT MAINS	35	ENCLOSURE	Homestead	Rectilinear	90
CLINTHILL	42	ENCLOSURE	Homestead	Curvilinear	160
CORBIE	4	EARTHWORK	Homestead	Curvilinear	70

CORBY LINN	4	EARTHWORK	Homestead	Rectilinear ?	200
CORTLEFERRY	15	ENCLOSURE:	Homestead	Curvilinear	250
COURTHILL	5	FORT	Homestead	Curvilinear	115
CRAG WOOD	3	FORT	Hillfort	Curvilinear	205
CRAIG HILL	5	SETTLEMENT	Homestead	Rectilinear	275
CRAIGEND	3	FORT	Homestead	Curvilinear	265
CRAIGIE WOOD	93	ENCLOSURE	Homestead	Curvilinear	215
CRAIGSFORD	37	HOMESTEAD;	Homestead	Curvilinear	160
DEANBRAE	42	ENCLOSURE	Homestead	Curvilinear	205
DOGDEN MOSS	3	MOUNDS,	Homestead	Curvilinear	215
DRYBURGH	81	ENCLOSURE	Homestead	Curvilinear	75
DRYGRANGE	70	ENCLOSURE	Homestead	Rectilinear	155
EARLSTON	57	ENCLOSURE	Homestead	Curvilinear	125
EAST	40	ENCLOSURE	Homestead	Curvilinear	165
EAST	41	ENCLOSURE	Homestead	Curvilinear	165
EASTER HILL	30	FORT	Homestead	Curvilinear	195
EASTER	18	ENCLOSURES	Homestead	Curvilinear	225
EDEN BURN 1	12	ENCLOSURE	Homestead	Rectilinear ?	200
EDEN BURN 2	13	ENCLOSURE	Homestead	Curvilinear	195
EDEN BURN 3	14	ENCLOSURE	Homestead	Rectilinear ?	195
EDEN BURN 4	31	ENCLOSURE	Homestead	Curvilinear	200
EILDON HILL	26	ENCLOSURE	Homestead	Curvilinear	300
EILDON HILL	57	FORT	Hillfort	Curvilinear	400
EILDONTREE	78	TIMBER	Homestead	Curvilinear	160
FAIRNLEE	21	ENCLOSURE	Homestead	Curvilinear	200
FALDONSIDE	20	ENCLOSURE	Homestead	Curvilinear	200
FALDONSIDE	63	ENCLOSURE	Homestead	Curvilinear	200
FANS	3	FORT	Homestead	Curvilinear	140
FAUGHHILL	36	ENCLOSURE	Homestead	Curvilinear	250
FENS	53	ENCLOSURE	Homestead	Rectilinear ?	75
FREER'S	48	ENCLOSURE	Homestead	Curvilinear	195
GALA DEAN	34	ENCLOSURE	Homestead	Curvilinear	190
GALASHIELS,	14	EARTHWORK	Homestead	Curvilinear	160
GATTONSIDE	52	RING-DITCH;	Homestead	Curvilinear	90
GILLKEEKET	36	ENCLOSURE	Homestead	Curvilinear	50
GLADSWOOD	7	ENCLOSURE	Homestead	Curvilinear	160
GLEDSWOOD	79	ENCLOSURE	Homestead	Curvilinear	125
GREATRIDGEH	25	ENCLOSURE	Homestead	Curvilinear	120
GRIZZLEFIELD	6	FORT	Homestead	Curvilinear	170
GRIZZLEFIELD	7	FORT	Homestead	Curvilinear	165
HARE LAW,	9	HOMESTEAD:	Homestead	Curvilinear	230
HAREHEAD	37	HUT-CIRCLES	Homestead	Curvilinear	295
HAREHEUGH	5	FORT	Hillfort	Curvilinear	215
HARELAW	2	EARTHWORK	Homestead	Curvilinear	200
HARESEAT	9	EARTHWORK	Homestead	Curvilinear	200
HARESTANES	49	FORT	Homestead	Curvilinear	60

HAYMOUNT	34	ENCLOSURE	Homestead	Curvilinear	135
HECKSIDE	7	FORT	Homestead	Curvilinear	150
HECKSIDE	40	FORT	Homestead	Curvilinear	145
HEUGH	5	ENCLOSURE	Homestead	Curvilinear	205
HILLHEAD,	28	ENCLOSURE;	Homestead	Rectilinear	160
HILLHEAD,	29	SETTLEMENT	Homestead	Curvilinear	150
HOLLYBUSH	6	EARTHWORK	Homestead	Curvilinear	245
HOLYDEAN	37	EARTHWORK	Homestead	Curvilinear	225
HOLYDEAN	38	ENCLOSURE	Homestead	Curvilinear	175
HOPTON	55	ENCLOSURE	Homestead	Curvilinear	175
HOUNDSLOW	5	ENCLOSURE	Homestead	Curvilinear	215
HOWDEN	19	EARTHWORK	Homestead	Curvilinear	95
HOWDEN	77	ENCLOSURE	Homestead	Curvilinear	145
HUNTINGTON	50	SETTLEMENT	Homestead	Curvilinear	195
HUNTINGTON 2	50	ENCLOSURE	Homestead	Curvilinear	200
HUNTLY BURN	2	SETTLEMENT;	Homestead	Curvilinear	205
HUNTLY BURN	3	ENCLOSURE	Homestead	Rectilinear	220
HUNTLY BURN	6	EARTHWORK	Homestead	Curvilinear	235
HUNTLYBURN	10	EARTHWORK	Homestead	Curvilinear	155
HUNTSHAW	1	SETTLEMENT;	Homestead	Curvilinear	195
HUNTSHAW	47	ENCLOSURE	Homestead	Curvilinear	215
HUTLERBURN	17	SETTLEMENT	Homestead	Curvilinear	325
HUTLERBURN	19	ENCLOSURE	Homestead	Curvilinear	330
JORDONLAW	3	CRANNOG	Crannog	Curvilinear	215
KNOCK HILL	8	FORT	Hillfort	Curvilinear	270
KNOWESOUTH	70	ENCLOSURE	Homestead	Curvilinear	125
KNOWESOUTH	71	ENCLOSURES	Homestead	Curvilinear	80
LAIRD'S HILL	3	FORT;	Homestead	Curvilinear	180
LANGHOPE	18	ENCLOSURE	Homestead	Curvilinear	340
LANGSHAW	50	ENCLOSURE	Homestead	Curvilinear	190
LANTON	69	ENCLOSURE	Homestead	Curvilinear	120
LANTON MOOR	23	EARTHWORK	Homestead	Curvilinear	165
LANTONCRAIG	31	FORT	Homestead	Curvilinear	260
LANTONHALL	40	ENCLOSURE	Homestead	Curvilinear	150
LANTONHILL	28	FORT	Homestead	Curvilinear	260
LAUDERHILL	52	ENCLOSURE	Homestead	Curvilinear	270
LEGERWOOD	46	ENCLOSURE	Homestead	Curvilinear	200
LEGERWOOD	3	ENCLOSURE	Homestead	Curvilinear	260
LEGERWOOD	8	ENCLOSURE;	Homestead	Curvilinear	235
LILLIESLEAF	34	ENCLOSURE	Homestead	Curvilinear	140
LINDEAN	10	EARTHWORK	Homestead	Curvilinear	150
LINGLIE	11	EARTHWORK	Homestead	Curvilinear	210
LITTLE	9	FORT	Hillfort	Curvilinear	145
LITTLEDEAN	51	FORT	Promontory	Curvilinear	75
LONG PHILIP	3	EARTHWORK	Homestead	Curvilinear	250
LONGNEWTON	19	ENCLOSURE	Homestead	Curvilinear	115

MAGDALENEH	60	ENCLOSURES	Homestead	Curvilinear	75
MAUSOLEUM	42	ENCLOSURE	Homestead	Curvilinear	140
MELLERSTAIN	19	ENCLOSURE	Homestead	Curvilinear	125
MELLOWLEES	9	ENCLOSURE	Homestead	Curvilinear	120
MIDDLESTEAD	29	ENCLOSURE	Homestead	Curvilinear	175
MINTO CRAIGS	30	FORT	Homestead	Curvilinear	215
MINTO HILLS	27	ENCLOSURE;	Homestead	Curvilinear	200
MINTO KAMES	13	ENCLOSURE	Homestead	Rectilinear	170
MIRE HILL	2	EARTHWORK	Homestead	Curvilinear	160
MOTE LINN	47	ENCLOSURE	Homestead	Curvilinear	175
MOUNT	61	FORT	Homestead	Curvilinear	155
MOUNTHOOLY	59	ENCLOSURE	Homestead	Curvilinear	80
MUIRHOUSE	4	EARTHWORK	Homestead	Curvilinear	260
NETHER	6	ENCLOSURE	Homestead	Curvilinear	335
NETHERN	42	CROPMARKS;	Homestead	Curvilinear	55
NEW	26	FORT	Homestead	Rectilinear ?	230
NEWHOUSE	8	ENCLOSURE	Homestead	Curvilinear	150
NEWHOUSE	18	ENCLOSURE	Homestead	Curvilinear	155
NEWSTEAD	95	ENCLOSURE	Homestead	Curvilinear	145
NEWSTEAD	96	ENCLOSURE:	Homestead	Rectilinear	155
NORTH	10	FORT	Homestead	Curvilinear	225
NORTH	30	ENCLOSURE;	Homestead	Curvilinear	250
NORTON	73	ENCLOSURE	Homestead	Curvilinear	185
NORTON	78	ENCLOSURE	Homestead	Curvilinear	190
OAKENDEAN	83	ENCLOSURES;	Homestead	Curvilinear	125
OAKWOOD	11	EARTHWORK	Homestead	Curvilinear	210
OAKWOOD	21	EARTHWORK	Homestead	Curvilinear	135
OVERWELLS	49	ENCLOSURE	Homestead	Curvilinear	180
OVERWELLS	57	ENCLOSURE	Homestead	Curvilinear	175
OVERWELLS	58	ENCLOSURE	Homestead	Curvilinear	180
PARK,	35	ENCLOSURE;LI	Homestead	Rectilinear ?	155
PENIEL HEUGH	2	FORT	Hillfort	Curvilinear	250
PENIEL HEUGH	2	FORT	Hillfort	Curvilinear	230
PHILIP HAUGH	71	SETTLEMENT	Homestead	Curvilinear	120
PILMUIR	1	HOMESTEAD,	Homestead	Rectilinear	250
PINNACLE	17	SETTLEMENT	Homestead	Curvilinear	125
PIRN KNOWE	3	ENCLOSURE	Homestead	Rectilinear	240
PIRNTATON	10	SETTLEMENT	Homestead	Curvilinear	315
PURVISHAUGH	30	ENCLOSURE	Homestead	Curvilinear	150
QUARRY HILL	7	EARTHWORK	Homestead	Curvilinear	165
RAVENSWOOD,	110	ENCLOSURE	Homestead	Curvilinear	125
REDPATH	49	ENCLOSURE	Homestead	Rectilinear ?	135
REDPATH	76	DITCH;	Homestead	Curvilinear	175
REDPATH	46	ENCLOSURE	Homestead	Rectilinear ?	165
RIDDELL	7	FORT	Homestead	Curvilinear	155
RIDGEWALLS,	21	SETTLEMENT	Homestead	Curvilinear	220

RINGLEYHALL	6	FORT	Homestead	Curvilinear	65
RINGLEYHALL	13	FORT	Homestead	Curvilinear	85
RINK HILL	7	FORT;	Homestead	Curvilinear	200
RINK HILL	9	FORT	Homestead	Curvilinear	165
ROWCHESTER,	5	FORT	Homestead	Curvilinear	195
RUECASTLE	52	ENCLOSURE	Homestead	Curvilinear	155
RUMBLETON	22	FORT	Homestead	Curvilinear	210
SANDYKNOWE	1	EARTHWORK	Homestead	Curvilinear	165
SCARCE LAW	83	ENCLOSURES	Homestead	Curvilinear	225
SHAWMOUNT	70	ENCLOSURE	Homestead	Curvilinear	215
SOUTH MINTO	6	FORT; ROUND	Homestead	Curvilinear	275
SPROTHOLM	25	ENCLOSURE	Homestead	Curvilinear	140
ST BOSWELLS	39	ENCLOSURE	Homestead	Rectilinear ?	90
ST LEONARD'S	53	ENCLOSURE;	Homestead	Curvilinear	140
ST LEONARDS	34	ENCLOSURE	Homestead	Curvilinear	180
ST LEONARDS	29	ENCLOSURE	Homestead	Curvilinear	180
STANDHILL	1	ENCLOSURE	Homestead	Curvilinear	155
SUCKLAWRIDG	21	ENCLOSURE;	Homestead	Curvilinear	70
SUCKLAWRIDG	32	ENCLOSURE	Homestead	Curvilinear	55
SUCKLAWRIDG	33	ENCLOSURE	Homestead	Curvilinear	55
SUNDERLAND	11	EARTHWORK	Homestead	Curvilinear	180
SWEETHOPE	2	FORT,	Homestead	Curvilinear	225
SYMINGTON	2	FORT	Homestead	Curvilinear	220
THE LAW	31	FORT	Homestead	Curvilinear	75
THIRD	3	EARTHWORK	Homestead	Curvilinear	145
THIRLADEAN	25	ENCLOSURE	Homestead	Curvilinear	155
THIRLESTANE	15	FORT	Promontory	Curvilinear	195
THIRLESTANE 2	24	ENCLOSURE	Homestead	Curvilinear	240
THIRLESTANE	4	FORT	Hillfort	Curvilinear	250
THIRLESTANE	49	ENCLOSURE	Homestead	Curvilinear	230
THIRLSTANE	25	ENCLOSURE	Homestead	Curvilinear	210
THREEPWOOD	15	ENCLOSURE	Homestead	Curvilinear	245
TORQUHAN	2	FORT	Hillfort	Curvilinear	360
TORQUHAN	13	ENCLOSURE	Homestead	Curvilinear	350
TORWOODLEE	7	FORT	Homestead	Curvilinear	150
TORWOODLEE	2	FORT, BROCH	Broch	Curvilinear	250
TOWER WOOD	33	ENCLOSURE	Homestead	Curvilinear	200
TRABROWN	3	SETTLEMENT	Homestead	Curvilinear	290
TROWS	27	ENCLOSURE	Homestead	Curvilinear	65
TURFFORD	11	EARTHWORK	Homestead	Curvilinear	135
TURFFORD	36	RING-DITCH	Homestead	Curvilinear	120
UPPER	9	ENCLOSURE	Homestead	Curvilinear	225
WANTON	35	HOMESTEAD	Homestead	Curvilinear	190
WANTON	40	ENCLOSURE	Homestead	Curvilinear	215
WANTON	46	SETTLEMENT	Homestead	Curvilinear	245
WANTON	64	ENCLOSURE	Homestead	Curvilinear	225

WATHERSTON	8 SETTLEMENT	Homestead	Curvilinear	330
WATHERSTON	9 FORT	Homestead	Curvilinear	345
WATHERSTON	19 ENCLOSURE	Homestead	Curvilinear	350
WEST MAINS	28 ENCLOSURE	Homestead	Curvilinear	195
WEST	5 FORT	Homestead	Curvilinear	170
WEST	37 ENCLOSURE	Homestead	Curvilinear	155
WEST	38 ENCLOSURE	Homestead	Curvilinear	150
WEST	39 ENCLOSURE	Homestead	Rectilinear ?	145
WEST	53 ENCLOSURE	Homestead	Curvilinear	155
WESTER	5 FORT;	Homestead	Curvilinear	335
WESTER	26 RING DITCH	Homestead	Curvilinear	85
WESTMAINS	26 ENCLOSURE	Homestead	Curvilinear	210
WESTMAINS	27 ENCLOSURE	Homestead	Curvilinear	190
WHITE HILL,	34 FORT	Homestead	Curvilinear	190
WHITEBURN	9 CRANNOGS	Crannog	Curvilinear	205
WHITELEE	24 ENCLOSURE	Homestead	Curvilinear	215
WHITRIGHILL	44 FORT; BURIAL	Homestead	Curvilinear	135
WHITRIGHILL	45 ENCLOSURE	Homestead	Curvilinear	135
WHITSLAID	32 ENCLOSURE	Homestead	Curvilinear	205
WILLIAMRIG	18 ENCLOSURE	Homestead	Curvilinear	110
WINDYDOORS	7 ENCLOSURE	Homestead	Curvilinear	345
YAIR	3 SETTLEMENT	Homestead	Curvilinear	200

Table A2.2 SPSS output for a crosstabulation of class and morphology for settlements in Table A2.1.

Valid Cases	Percent	Missing Cases	Percent	Total Cases	Percent
294	100.0%	0	.0%	294	100.0%

CLASS * MORPHOLOGY Crosstabulation Count

	Curvilinear	Rectilinear	Total
	1	2	
1 - Brochs	2		2
2 - Crannogs	2		2
3 - Hillforts	14		14
4 - Homestead	237	33	270
5 - Promontory Fort	5		5
6 - Roman		1	1
Total	260	34	294

Directional Measures

	Value	Asymp. Std. Error	Approx. T	Approx. Sig.
Kendall's tau-b	.090	.035	2.261	.024
N of Valid Cases				294

Table A2.3 Cluster membership for sites more than one kilometre from a main river. Columns headed 30, 25, 20, 15, and 10 indicate the number of possible clusters and entries for each site indicate cluster membership.

SITE NAME	NO	EAST	NORTH	30	25	20	15	10
Auldwark Cottages	39	342600	628500	1	1	1	1	1
Avenel Haugh	33	351670	636970	2	2	2	2	2
Avenel Hill	14	352260	636660	2	2	2	2	2
Baittens	50	367640	623250	3	3	3	3	3
Bemersyde	51	359900	634400	4	4	4	4	4
Bemersyde Moss	46	361200	634300	4	4	4	4	4
Blackcastle Hill	11	348110	621610	5	5	5	5	1
Blackchester	37	351300	649800	6	6	6	6	5
Blackchester 2	38	351100	649900	6	6	6	6	5
Blaeberry Plant.	79	345550	622550	5	5	5	5	1
Bloomfield	26	359440	624090	7	7	7	7	3
Blythe	1	358240	649410	8	8	8	6	5
Bonnet Plantation	3	355740	648420	8	8	8	6	5
Boon	47	357100	645100	8	8	8	6	5
Boon Hill	12	357490	646540	8	8	8	6	5
Boon Moor	17	358000	646000	8	8	8	6	5
Bowden Moor	16	352640	632160	9	9	9	8	2
Bowhill	27	343200	627700	1	1	1	1	1
Broden Strips	23	349700	630610	10	10	9	8	2
Broomhill	8	369220	647280	11	11	10	9	6
Brotherstone	31	360200	636900	4	4	4	4	4
Brotherstone Hill S	14	361940	635820	4	4	4	4	4
Brownmoor Glen	2	346060	626140	12	1	1	1	1
Camp Knowe, Bowden	41	355140	630330	9	9	9	8	2
Chatto Craigs	12	352100	638800	2	2	2	2	2
Chester Hill	11	352610	646820	6	6	6	6	5
Chesterknowes	8	352500	626300	13	12	11	10	7
Clerklands	2	349830	624560	13	12	11	10	7
Courthill	5	368800	636000	14	13	12	11	8
Craigie Wood	93	350310	631700	10	10	9	8	2
Deanbrae Burn	42	362000	645500	15	14	13	9	6
Dogden Moss	3	367500	649900	16	11	10	9	6
Earlston Mains	57	357970	638880	17	15	14	12	4
East Morriston	40	360490	641510	17	15	14	12	4
East Morriston	41	360530	641560	17	15	14	12	4
Easter Housebyres	18	353900	637200	2	2	2	2	2
Eden Burn 2	13	361800	645200	15	14	13	9	6
Eden Burn 4	31	362010	645250	15	14	13	9	6
Eildon Hill North	26	355000	632000	9	9	9	8	2

Eildontree Plant.	78	356410	633580	9	9	9	8	2
Faldonside	63	350040	631720	10	10	9	8	2
Fans	3	362270	641780	17	15	14	12	4
Faughhill Moor	36	352000	630720	9	9	9	8	2
Greatridgehall	25	365890	633700	14	13	12	11	8
Grizzlefield E. Rings	6	359210	640150	17	15	14	12	4
Grizzlefield W Rings	7	358800	640100	17	15	14	12	4
Hare Law, W. Mains	9	364500	648500	15	14	13	9	6
Harehead Hill	37	343600	628500	1	1	1	1	1
Harelaw	2	366440	648340	16	11	10	9	6
Hareseat Wood	9	353180	632780	9	9	9	8	2
Haymount	34	366900	633800	14	13	12	11	8
Heugh	5	358060	648490	8	8	8	6	5
Hollybush	6	347810	634480	18	16	9	8	2
Holydean	37	354070	630750	9	9	9	8	2
Holydean	38	354100	629900	9	9	9	8	2
Hopton	55	360200	624030	7	7	7	7	3
Houndslow	5	362550	647780	15	14	13	9	6
Howden	19	364200	625000	19	17	7	7	3
Huntly Burn	6	352370	632300	9	9	9	8	2
Huntlyburn House	10	352410	633550	9	9	9	8	2
Hutlerburn Hill	17	341000	623100	20	18	15	5	1
Hutlerburn Hill	19	341800	623000	20	18	15	5	1
Lairds Hill	3	369820	638790	21	19	16	11	8
Langhope	18	341900	620800	20	18	15	5	1
Langshaw	50	351500	639900	2	2	2	2	2
Lantoncraigs	31	362900	620820	22	20	7	7	3
Lantonhall	40	363070	622030	22	20	7	7	3
Lantonhill Craigs	28	362690	620760	22	20	7	7	3
Lauderhill	52	351300	647200	6	6	6	6	5
Legerwood	46	357900	643200	17	15	14	12	4
Legerwood Hill	3	358460	642170	17	15	14	12	4
Legerwood Hill	8	358000	641000	17	15	14	12	4
Long Philip Burn	3	344520	629760	1	1	1	1	1
Mausoleum Strip	42	360500	627360	23	7	7	7	3
Mellerstain Mill	19	364900	637800	24	21	12	11	8
Mellowlees Bridge	9	365330	637930	24	21	12	11	8
Minto Hills	27	355960	620410	25	22	17	13	7
Mire Hill	2	356250	624820	26	22	17	13	7
Nether Shiels	6	341150	646850	27	23	18	14	9
Norton	78	354100	649300	8	8	8	6	5
Overwells	49	368430	620720	3	3	3	3	3
Overwells	57	368340	620700	3	3	3	3	3
Overwells	58	368260	620630	3	3	3	3	3

Purvishaugh	30	360100	639900	17	15	14	12	4
Redpath	76	359400	635400	4	4	4	4	4
Ridgewalls, C.Mount	21	355000	639660	28	2	2	2	2
Rowchester, K. Main	5	354700	629000	9	9	9	8	2
Ruecastle	52	361460	620750	22	20	7	7	3
Rumbleton Law	22	367300	645400	11	11	10	9	6
Sandyknowe	1	363980	634610	4	4	4	4	4
Scarce Law	83	351000	647700	6	6	6	6	5
Shawmount	70	348830	629570	10	10	9	8	2
South Minto Hill	6	355920	620640	25	22	17	13	7
Standhill	1	356350	623100	26	22	17	13	7
Sweethope Hill	2	369640	639640	21	19	16	11	8
Symington Hill	2	342860	648200	27	23	18	14	9
Third	3	361500	635000	4	4	4	4	4
Thirlestane 2	24	356120	648170	8	8	8	6	5
Thirlestane Hill	49	357500	648500	8	8	8	6	5
Thirlstane	25	356140	647790	8	8	8	6	5
Threepwood Moss	15	352500	642400	29	24	19	6	5
Trabrown	3	350390	648710	6	6	6	6	5
Turfford Burn	11	361100	639200	17	15	14	12	4
Turfford Burn	36	359200	639200	17	15	14	12	4
Upper Blainslie	9	353600	644600	29	24	19	6	5
Wanton Walls	40	354720	648900	8	8	8	6	5
Wanton Walls	46	355070	648270	8	8	8	6	5
West Morrison	5	359900	640800	17	15	14	12	4
West Morriston	37	360170	640590	17	15	14	12	4
West Morriston	38	360250	640510	17	15	14	12	4
West Morriston	53	360200	640100	17	15	14	12	4
Wester Essenside	5	343040	620860	20	18	15	5	1
Wester Muirdean	26	369060	634850	14	13	12	11	8
Whitrighill	44	362200	634500	4	4	4	4	4
Whitrighill	45	362100	634400	4	4	4	4	4
Windydoors Hawse	7	343300	640400	30	25	20	15	10

Table A2.4 Cluster membership for sites less than 500 metres from a main river. Columns headed 30, 25, 20, 15, and 10 indicate the number of possible clusters and entries for each site indicate cluster membership.

SITE	NO	EAST	NORTH	30	25	20	15	10
Ancrum	45	361730	624150	1	1	1	1	1
Auldwark Cottages	39	342600	628500	2	2	2	2	2
Avenel Haugh	33	351670	636970	3	3	3	3	3
Avenel Hill	14	352260	636660	3	3	3	3	3
Baittens	50	367640	623250	4	4	4	4	1

Battlepark Plantation	2	344500	628200	2	2	2	2	2
Bemersyde	51	359900	634400	5	5	5	5	4
Bemersyde Moss	46	361200	634300	5	5	5	5	4
Birkenside	21	357200	641400	6	6	6	6	4
Birkenside	35	357000	641300	6	6	6	6	4
Birkenside Hill	4	356920	640970	6	6	6	6	4
Birkenside Hill	31	357000	641000	6	6	6	6	4
Black Andrew Plantation	49	351200	636200	3	3	3	3	3
Blackcastle Hill	11	348110	621610	7	7	7	7	2
Blackchester	28	356240	627600	8	8	8	8	5
Blackchester	37	351300	649800	9	9	9	9	6
Blackchester 2	38	351100	649900	9	9	9	9	6
Blaeberry Plantation	79	345550	622550	7	7	7	7	2
Bloomfield	26	359440	624090	1	1	1	1	1
Blythe	1	358240	649410	10	10	9	9	6
Bonnet Plantation	3	355740	648420	10	10	9	9	6
Boon	23	356700	646000	11	10	9	9	6
Boon	47	357100	645100	11	10	9	9	6
Boon	54	356400	645700	11	10	9	9	6
Boon Hill	12	357490	646540	11	10	9	9	6
Boon Moor	17	358000	646000	11	10	9	9	6
Bowden Moor	16	352640	632160	12	11	10	10	3
Bowhill	27	343200	627700	2	2	2	2	2
Broden Strips	23	349700	630610	13	12	11	10	3
Broomhill	8	369220	647280	14	13	12	11	7
Brotherstone	31	360200	636900	5	5	5	5	4
Brotherstone Hill South	14	361940	635820	5	5	5	5	4
Brownmoor Glen	2	346060	626140	2	2	2	2	2
Camp Knowe	15	354000	635740	3	3	3	3	3
Camp Knowe, Bowden	41	355140	630330	12	11	10	10	3
Camp Plantations, Craigsford	23	356340	637810	6	6	6	6	4
Campknowe Plantation	9	348200	621940	7	7	7	7	2
Chapel On Leader	22	355400	641300	6	6	6	6	4
Chatto Craigs	12	352100	638800	3	3	3	3	3
Chester Hill	11	352610	646820	9	9	9	9	6
Chester Knowe	31	355400	635600	3	3	3	3	3
Chesterknowes	8	352500	626300	8	8	8	8	5
Chesterlee, Cairneymount	22	355500	639730	6	6	6	6	4
Chestershall	66	361870	624440	1	1	1	1	1
Clarilawburn	36	354400	627200	8	8	8	8	5
Clerklands	2	349830	624560	7	7	7	7	2
Clinthill	42	360330	632880	5	5	5	5	4
Courthill	5	368800	636000	15	14	13	12	8
Craigie Wood	93	350310	631700	13	12	11	10	3

Deanbrae Burn	42	362000	645500	16	15	14	11	7
Dogden Moss	3	367500	649900	17	13	12	11	7
Earlston Mains	57	357970	638880	6	6	6	6	4
East Morriston	40	360490	641510	18	6	6	6	4
East Morriston	41	360530	641560	18	6	6	6	4
Easter Housebyres	18	353900	637200	3	3	3	3	3
Eden Burn 2	13	361800	645200	16	15	14	11	7
Eden Burn 4	31	362010	645250	16	15	14	11	7
Eildon Hill North	26	355000	632000	12	11	10	10	3
Eildontree Plantation	78	356410	633580	19	16	10	10	3
Faldonside	20	349700	632400	13	12	11	10	3
Faldonside	63	350040	631720	13	12	11	10	3
Fans	3	362270	641780	18	6	6	6	4
Faughhill Moor	36	352000	630720	12	11	10	10	3
Gillkeeket	36	344000	626900	2	2	2	2	2
Gladswood	7	358550	635120	5	5	5	5	4
Greatridgehall	25	365890	633700	20	17	13	12	8
Grizzlefield E. Rings	6	359210	640150	18	6	6	6	4
Grizzlefield W Rings	7	358800	640100	18	6	6	6	4
Hare Law, Westruther Mains	9	364500	648500	16	15	14	11	7
Harehead Hill	37	343600	628500	2	2	2	2	2
Harelaw	2	366440	648340	17	13	12	11	7
Hareseat Wood	9	353180	632780	12	11	10	10	3
Haymount	34	366900	633800	20	17	13	12	8
Heckside Plantation 1	7	360370	633030	5	5	5	5	4
Heckside Plantation 2	40	360800	633100	5	5	5	5	4
Heugh	5	358060	648490	10	10	9	9	6
Hillhead, Lilliesleaf	29	354380	625350	8	8	8	8	5
Hollybush	6	347810	634480	13	12	11	10	3
Holydean	37	354070	630750	12	11	10	10	3
Holydean	38	354100	629900	12	11	10	10	3
Hopton	55	360200	624030	1	1	1	1	1
Houndslow	5	362550	647780	16	15	14	11	7
Howden	19	364200	625000	21	18	1	1	1
Huntington	50	353280	649630	10	10	9	9	6
Huntington 2	50	353440	649660	10	10	9	9	6
Huntly Burn	2	340770	624190	22	19	15	13	2
Huntly Burn	6	352370	632300	12	11	10	10	3
Huntlyburn House	10	352410	633550	12	11	10	10	3
Huntshaw	1	357450	639950	6	6	6	6	4
Huntshaw	47	357000	641800	6	6	6	6	4
Hutlerburn Hill	17	341000	623100	22	19	15	13	2
Hutlerburn Hill	19	341800	623000	22	19	15	13	2
Knowesouth	70	361300	621100	23	18	1	1	1

Knowesouth	71	361030	621640	23	18	1	1	1
Lairds Hill	3	369820	638790	24	20	16	12	8
Langhope	18	341900	620800	22	19	15	13	2
Langshaw	50	351500	639900	3	3	3	3	3
Lanton	69	362390	621930	23	18	1	1	1
Lanton Moor	23	364150	622640	21	18	1	1	1
Lantoncraigs	31	362900	620820	23	18	1	1	1
Lantonhall	40	363070	622030	23	18	1	1	1
Lantonhill Craigs	28	362690	620760	23	18	1	1	1
Lauderhill	52	351300	647200	9	9	9	9	6
Legerwood	46	357900	643200	6	6	6	6	4
Legerwood Hill	3	358460	642170	6	6	6	6	4
Legerwood Hill	8	358000	641000	6	6	6	6	4
Lilliesleaf Moss	34	353900	625020	8	8	8	8	5
Linglie	11	346410	629990	2	2	2	2	2
Long Philip Burn	3	344520	629760	2	2	2	2	2
Mausoleum Strip	42	360500	627360	1	1	1	1	1
Mellerstain Mill	19	364900	637800	25	21	13	12	8
Mellowlees Bridge	9	365330	637930	25	21	13	12	8
Middlestead	29	344900	626700	2	2	2	2	2
Minto Craigs	30	358160	620930	26	22	17	8	5
Minto Hills	27	355960	620410	26	22	17	8	5
Mire Hill	2	356250	624820	27	8	8	8	5
Mote Linn	47	345200	626600	2	2	2	2	2
Mount Ulston	61	366500	622400	4	4	4	4	1
Mounthooly	59	366900	624180	4	4	4	4	1
Nether Shiels	6	341150	646850	28	23	18	14	9
Newstead	95	356910	633690	19	16	10	10	3
North Synton	30	348470	624280	7	7	7	7	2
Norton	73	354030	648730	10	10	9	9	6
Norton	78	354100	649300	10	10	9	9	6
Oakendean House	83	354100	649300	10	10	9	9	6
Overwells	49	368430	620720	4	4	4	4	1
Overwells	57	368340	620700	4	4	4	4	1
Overwells	58	368260	620630	4	4	4	4	1
Pirntaton	10	341900	649700	28	23	18	14	9
Purvishaugh	30	360100	639900	18	6	6	6	4
Quarry Hill	7	354100	633700	12	11	10	10	3
Redpath	76	359400	635400	5	5	5	5	4
Ridgewalls, Cairneymount	21	355000	639660	6	6	6	6	4
Rink Hill	7	348020	632700	13	12	11	10	3
Rink Hill	9	348360	633080	13	12	11	10	3
Rowchester, Kippilaw Main	5	354700	629000	12	11	10	10	3
Ruecastle	52	361460	620750	23	18	1	1	1

Rumbleton Law	22	367300	645400	14	13	12	11	7
Sandyknowe	1	363980	634610	20	17	13	12	8
Scarce Law	83	351000	647700	9	9	9	9	6
Shawmount	70	348830	629570	13	12	11	10	3
South Minto Hill	6	355920	620640	26	22	17	8	5
St Leonards Hill 2	29	355100	645700	11	10	9	9	6
Standhill	1	356350	623100	27	8	8	8	5
Sweethope Hill	2	369640	639640	24	20	16	12	8
Symington Hill	2	342860	648200	28	23	18	14	9
Third	3	361500	635000	5	5	5	5	4
Thirladean	25	344600	628000	2	2	2	2	2
Thirlestane 2	24	356120	648170	10	10	9	9	6
Thirlestane Hill	49	357500	648500	10	10	9	9	6
Thirlstane	25	356140	647790	10	10	9	9	6
Threepwood Moss	15	352500	642400	29	24	19	9	6
Trabrown	3	350390	648710	9	9	9	9	6
Turfford Burn	11	361100	639200	18	6	6	6	4
Turfford Burn	36	359200	639200	18	6	6	6	4
Upper Blainslie	9	353600	644600	29	24	19	9	6
Wanton Walls	40	354720	648900	10	10	9	9	6
Wanton Walls	46	355070	648270	10	10	9	9	6
Wanton Walls	64	354990	648010	10	10	9	9	6
Watherston	8	343300	646020	28	23	18	14	9
Watherston Hill	9	343570	646910	28	23	18	14	9
Watherston Hill	19	343200	646400	28	23	18	14	9
West Mains	28	355500	646700	11	10	9	9	6
West Morrison	5	359900	640800	18	6	6	6	4
West Morriston	37	360170	640590	18	6	6	6	4
West Morriston	38	360250	640510	18	6	6	6	4
West Morriston	53	360200	640100	18	6	6	6	4
Wester Essenside	5	343040	620860	22	19	15	13	2
Wester Muirdean	26	369060	634850	15	14	13	12	8
Whitrighill	44	362200	634500	5	5	5	5	4
Whitrighill	45	362100	634400	5	5	5	5	4
Whitslaid	32	356380	644550	11	10	9	9	6
Windydoors Hawse	7	343300	640400	30	25	20	15	10

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